Complete 1969 Color Set Directory

60c ■ JAN. 1969

Radio-Electronics

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SPECIAL ISSUE
COLOR TV 1969

How Color TV Works

Spot Color Faults Fast

Build: Beginners Dot-Bar Generator

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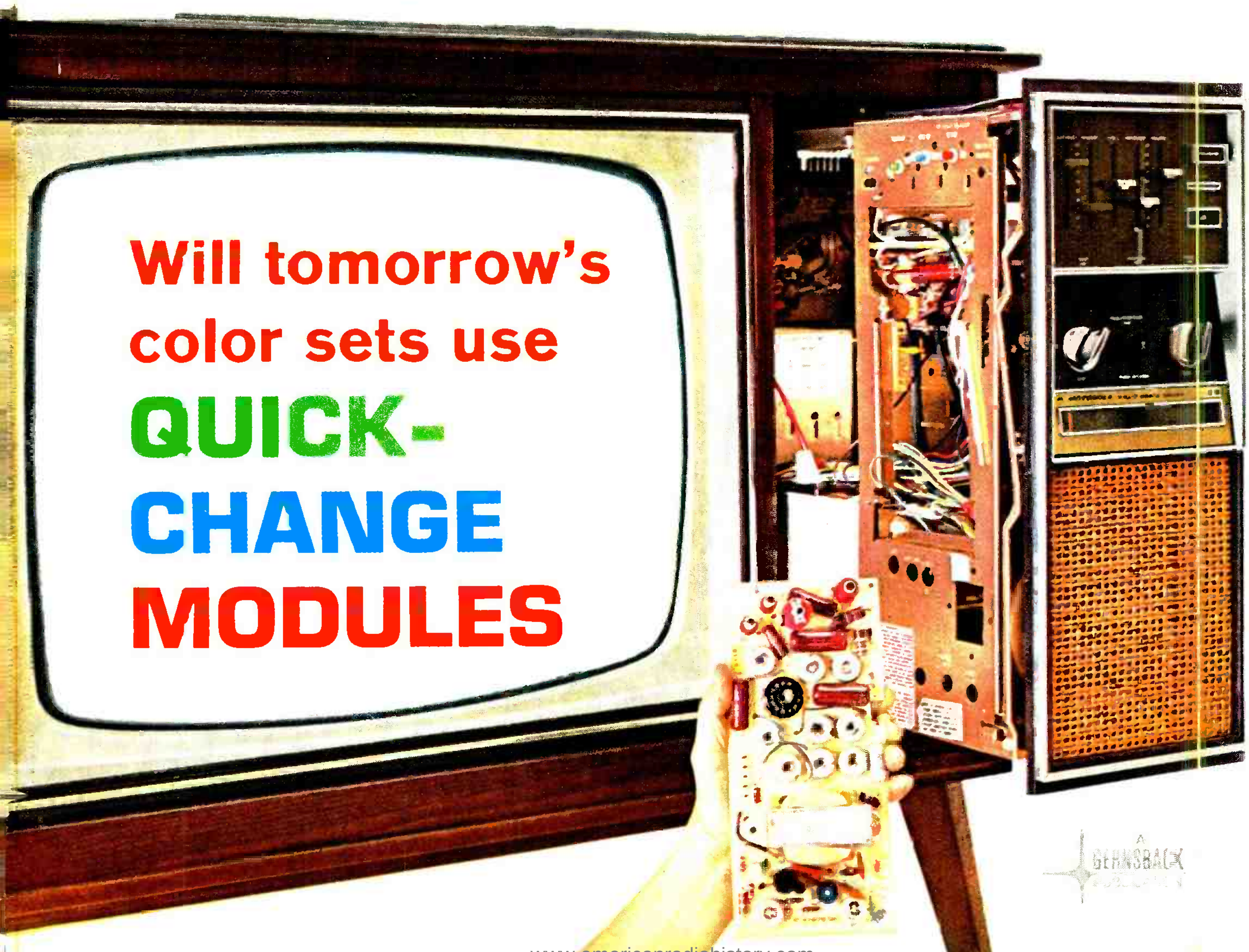

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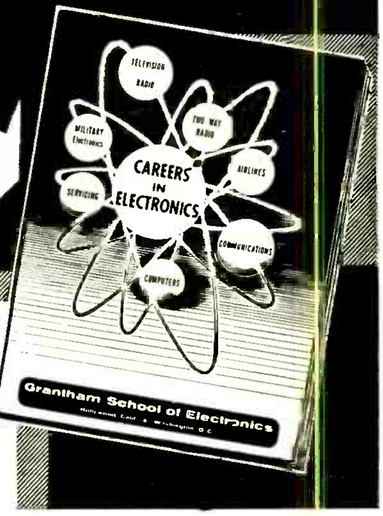

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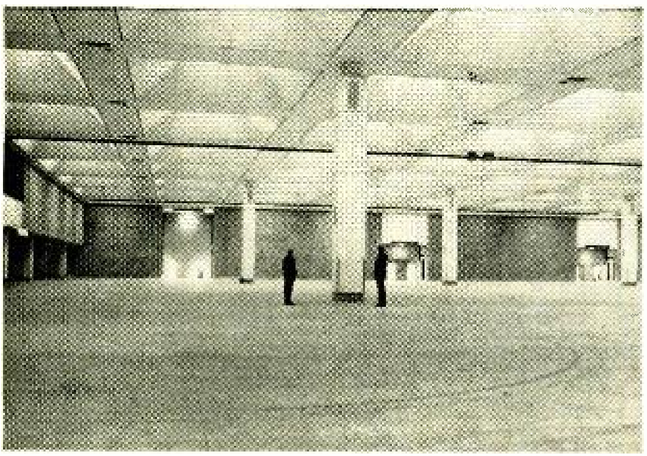
NEW & TIMELY

Volume 40 Number 1 RADIO-ELECTRONICS January 1969

CENTER WIRED FOR SOUND



Philadelphia's new Civic Center has been wired for sound on a grand scale with 103 speakers distributed throughout the center's arena, ballrooms, cafeterias, underground garages, 57 meeting rooms and convention show area. Most of the speakers are concealed in columns, and all can be controlled from a 4-rack control center.

But that's not all. For greater flexibility, the sound system includes 7 remote-location equipment racks and 17 remote-control panels. A maze of microphone jacks is spaced throughout the center within 30′ of each other. The Bogen Communications Division of Lear Siegler, Inc. designed and built the system to blanket the center's 321,000 square feet with sound.

LASER INTRUSION DETECTOR

Interrupted photocell beams have opened supermarket doors for years. Now the Army is using this principle to maintain security with an RCA-built alarm system that uses *pure* light beams. The transmitter and receiver units, including batteries, are cigarette-pack size to simplify concealment. A gallium arsenide injection laser in the transmitter is aligned with the receiver unit when the detector is set up. Any interruption of the light pulses between the units triggers a signal from the receiver, which can be monitored by a remote alarm unit.

COLOR TV PATENTS

A federal court has finally granted a patent to RCA for its photographic method of depositing phosphor dots on CRT faces—17 years after filing application. Philco lost a long legal dual. The patent, one of more than 1000 in the color TV field, is considered fundamental for competitive production of color CRT's. RCA may now seek royalties from tube manufacturers using the process.

Under a 1958 agreement, RCA made 100 of its early color patents available to the color TV industry, but claims royalty on post 1958 patents.

Rare-earth red phosphors used in combination with sulphide blue and green phosphors is another color patent in the courts. GT&E's Sylvania lays claim to the rare-earth discovery, now used in most color tubes.

LOOKING AHEAD

By DAVID LACHENBRUCH
CONTRIBUTING EDITOR

Looking into 1969

In technology, each year brings some completely undreamed-of developments, as well as some already on the timetable. We can't attempt to forecast the surprise ones but, from our vantage point, concentrating principally on the areas of direct interest to the consumer, we think Electronics 1969 will see these developments:

Color television

Although the new year probably won't see widespread acceptance of any unconventional color picture tubes (of the nonshadow-mask variety), it could well see a new, far more compact, shadow-mask type. This new tube will have a wider deflection angle (perhaps 110° or 120°, as compared to the standard 90° angle of today's tubes). Combined with solid-state or hybrid circuits, it can make possible extremely portable color sets. The new compact tube probably will appear by late 1969 in the "portable" sizes—18″ diagonal and smaller—where it is badly needed.

(continued on page 4)

IMPROVED PHOTO-MULTIPLIER

This extremely sensitive photomultiplier tube could play an importent role in unlocking the mysteries of DNA molecules or distant "pulsar" radio sources in the galaxy. The improved photomultiplier is 10 times as efficient as those currently in use. Photomultipliers use a series of "dynodes" to amplify primary electrons generated when weak incoming light strikes the material in the first dynode stage. RCA scientists

have discovered that gallium phosphide used in the important first stage now enables a photomultiplier to discriminate between light sources that may generate one, two, three or more primary electrons. This should make it possible to "see" details of nuclear, astronomical and biological events never observed before.

ELECTRONIC BARTENDER

Here's a computerized bartender that serves any one of 23 drinks in 4 seconds flat—provided you're lucky or smart. The electronic bartender is coupled with a one-arm bandit that registers the number of drinks won or dispenses tokens that can be

Radio-Electronics

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SPECIAL FEATURES

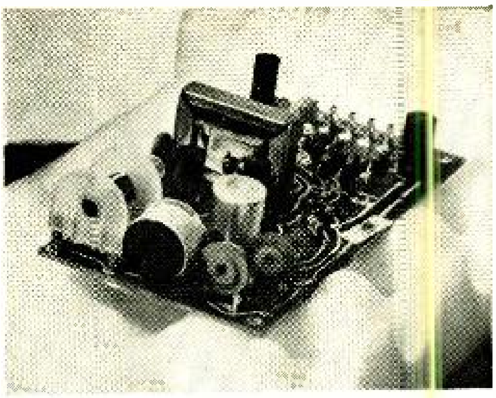
COLOR TELEVISION

BUILD THIS ONE

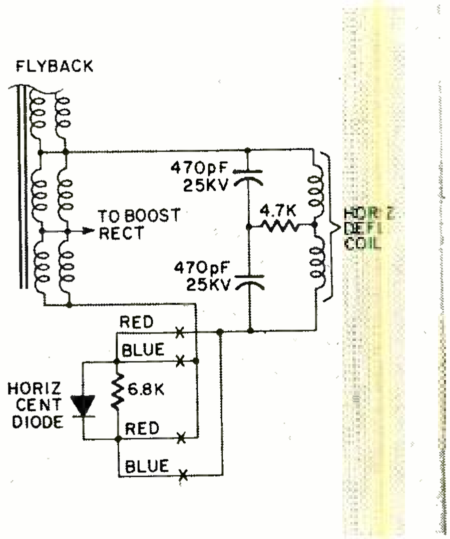
AUDIO

GENERAL ELECTRONICS

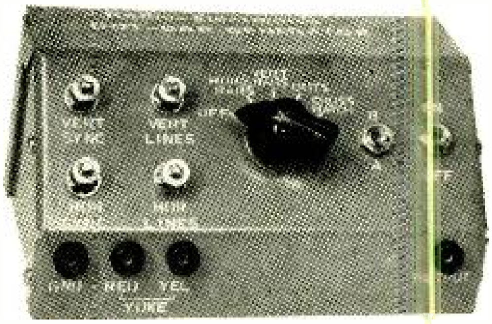
DEPARTMENTS



Plug-in modules like this one keep the Quasar color set at home even during "shop" repairs.
see page 32



The '69 color sets use a heap of new circuits. This is one of them. You'll find 11 more new ones inside.
see page 61



Portable dot-bar generator makes it a cinch to set up a color TV. Use it to get better color pictures.
see page 50

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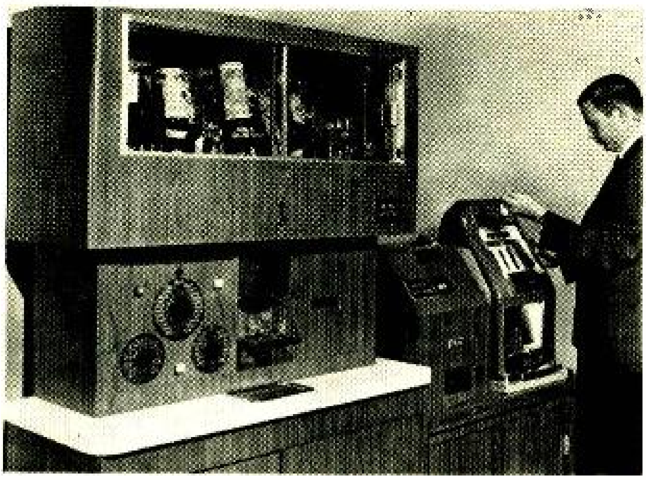


used later. In the 48 states where such games of chance are illegal, the slot machine can be equipped with a unit containing up to 1000 random questions and six pushbuttons to answer multiple-choice questions. The "Slot-Troic-803" is made by K & M Electronics Co., a Baltimore firm.

LOOKING AHEAD

Other color TV advances are likely to be evolutionary—afc being included in all but the lowest-priced sets, more convenient uhf tuning and possibly a varactor–diode tuner which virtually eliminates mechanical contacts.

Warranties and service

With "consumer protection" an increasing concern of the government, there will be much pressure to make warranties more understandable and meaningful. There will be an increasing trend to include labor in warranties—particularly on TV sets—and, quite possibly, toward longer in-warranty periods.

In an attempt to ease servicing headaches in the future, several manufacturers may adopt the modular-construction approach, permitting entire circuits to be replaced in the customer's home and repaired later in the shop or factory.

Television by cable

"CATV," which used to stand for "Community Antenna Television," will complete its metamorphosis in 1969 into "CAble TV," meaning complete acceptance of the inevitability of television as a closed-circuit as well as broadcast medium. The FCC, which currently seems to lean away from the idea of program originations or commercials via cable to the home (although it has no rules against these practices), will take a comprehensive new look at the future of the concept of TV-by-wire. Technology will now permit at least 20 or 25 simultaneous channels on a single CATV cable, and before the year is over some local systems could be offering that many programs.

Tape gear—audio and video

The various cartridge concepts will continue to grow in popularity—the 8-track continuous loop still primarily as an automotive music-maker and the cassette as a portable and home device. Major steps will be made to improve the frequency response and reliability of the cassette recorder. Although the cassette will make some inroads in the audiophile market, most true high-fidelity enthusiasts will continue to prefer the reel-to-reel approach. By year's end, reel-to-reel recorders in the under-$100 price range will have virtually disappeared, yielding to the cassette.

One longitudinal-scan home color recorder will probably reach the market, at $1000 to $1500 for a complete console, including 23" color set. However, its principal use will be as an off-the-air recorder, since no home-priced color camera or library of prerecorded material will be available during the year.

The Columbia Broadcasting System's EVR (Electronic Video Recorder), an electronic film attachment to play (but not record) material through color sets, should be available in prototype models.

Phonographs and records

The trend to compact phonograph systems and air-suspension speakers even in relatively low-priced models will intensify. Audio components will move from the "class" to the "mass" market, but with some deterioration of sound quality as new low-end "price leaders" are introduced.

The 3⅞" mini-disc, aimed at the youth market, will go nationwide. Play-as-you-walk phonographs for these thin, flexible records will be available under several brand names.

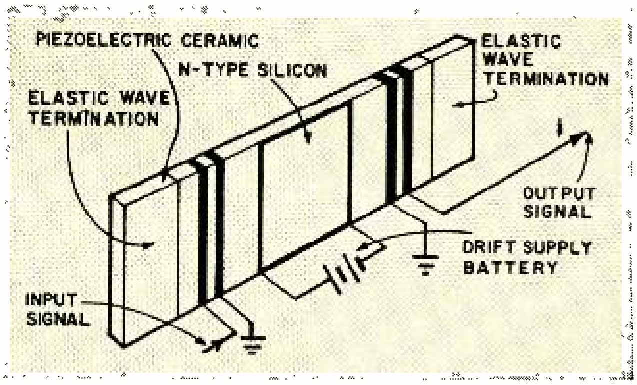
Radio

In the table radio, there will be new emphasis on sound quality, with a profusion of sets with air-suspension speakers. A large number of relatively high-priced sets will feature diode tuning in place of the more common mechanical type. Automobile radios will appear in entirely new configurations to satisfy government safety regulations. In some cases, they'll be moved completely from the dashboard and may feature diode controlling pushbuttons on armrests or in central consoles, with the chassis readily accessible in the trunk. **R-E**

Phonon Amps & IC MOSFETs

Two new devices developed at General Telephone & Electronics Labs may eventually find use in improved TV, FM and computer circuitry. One of the developments is called a phonon amplifier because it employs acoustic waves to amplify rf signals. The phonon is the basic unit of acoustic energy. GT&E scientists discovered they could greatly cut noise in phonon-amplified rf signals by capacitively coupling the piezoelectric ceramic and n-type silicon elements of the amplifier together with a thin layer of glycerol. The "static" problem was a major disadvantage in earlier phonon amplifiers.

An input rf signal to the ceramic plate is converted to an acoustic wave, part of which moves through the adjacent silicon. This wave is given a "kick" by electronic carriers in the silicon that are



Here's a new, complete ICS course in TV Servicing that costs less than $100.

With the first two texts, you can repair 70 percent of all TV troubles.

You need no previous experience to take this complete, practical course in TV Repairing.

You don't even have to know a vacuum tube from a resistor. Yet in a matter of months, you can be doing troubleshooting on color sets!

Course consists of 6 texts to bring you along quickly and easily. 936 pages of concise, easy-to-follow instruction, plus 329 detailed illustrations. You also receive a dictionary of TV terms geared directly to course material so you'll understand even the most technical terms. The dictionary will come in handy even after you've finished your course.

Instruction is simple, very easy to grasp. Photos show you what a TV screen looks like when everything is normal, and what it looks like when trouble fouls it up. The texts tell you how to remedy the problem, and why that remedy is best.

Quizzes are spotted throughout the texts so you can check your progress. At the end of the course, you take a final examination. Then you get the coveted ICS® diploma, plus membership in the ICS TV Repairman Association.

By the time you've finished the course, you should be able to handle tough, multiple TV problems, on color sets as well as black and white.

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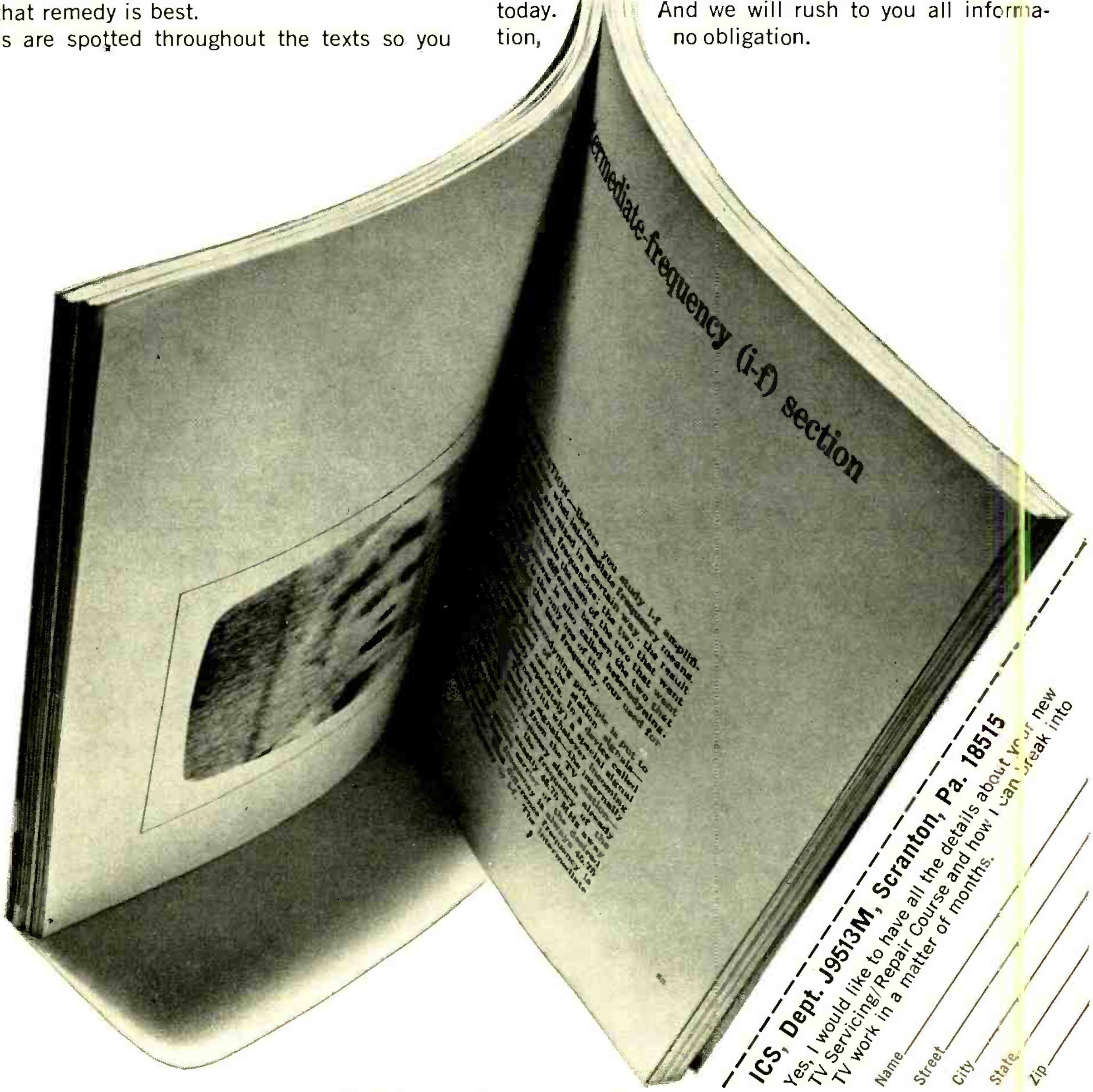

ICS, Dept. J9513M, Scranton, Pa. 18515

Yes, I would like to have all the details about your new TV Servicing/Repair Course and how I can break into TV work in a matter of months.

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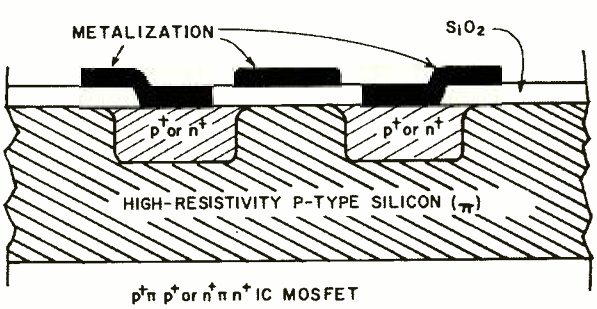

$p^+\pi\ p^+$or $n^+\pi\ n^+$ IC MOSFET

made to travel faster than the acoustic wave by a dc potential. Clear, stronger rf signals are then obtained when the amplified wave induces a voltage in the output electrodes. The device, which can be used to generate intermediate frequencies when a second frequency is introduced during oscillation, has been operated in the 1–4-MHz range.

GT&E's second recent development is a technique for fabricating metal oxide field effect transistors (MOSFET's) in integrated circuits. When both p- and n-type channels are included in IC circuits, the complementary arrangement offers faster operating speeds and lower power demands. But until now these circuits have been difficult to fabricate because both p- and n- channels must be put into separate opposite conductivity regions.

The new GT&E device, called a "$p+\pi p+$MOSFET," has both p and n channels fabricated on a high-resistivity, p-type silicon substrate. This single substrate technique greatly simplifies production of complementary MOSFET IC's for computer memories and digital switching circuits.

3D STRAIN TEST

Holography — lensless, three-dimensional photography that illuminates the subject with laser light—is now being used to test the toughness of metals. The dark, pointed area at the top of the photo is a notch 50/1000 inch wide made as a metal sample is pulled apart. Strain contours are made visible as interference fringe patterns (light and dark areas) by viewing the metal through its own superimposed holographic image. Dark areas seen in the photograph represent permanent strain contours at successive elevation differences of half a wavelength (12 millionths of an inch) of the illuminating laser light.

Glass Semiconductors Developed

A solid-state physics development involving the switching characteristics of glassy amphorous semiconductors may eventually bring about a size and price cut in some semiconductors.

Compounds such as oxide- and boron-based glasses and materials that contain tellurium and chemically similar elements can be made to act electrically like diodes and magnetic memory cores. Unlike the orderly crystalline structure of semiconductors that require complex and expensive doping, the glassy materials have a disordered (amphorous) atomic structure.

Two new switching devices using the materials have been developed and are being manufactured by Energy Conversion Devices, a Michigan firm. Called the Ovonic Threshold Switch (OTS) and Ovonic Memory Switch (OMS) by the developer and company president, Stanford R. Ovshinsky, the devices can switch both alternating current and direct current equally well. Ordinary semiconductor pn-type junctions have a preferred

Developer of the new devices, Stanford R. Ovshinsky, demonstrates the conducting state (right) and non-conducting (disordered) state of polymer structures.

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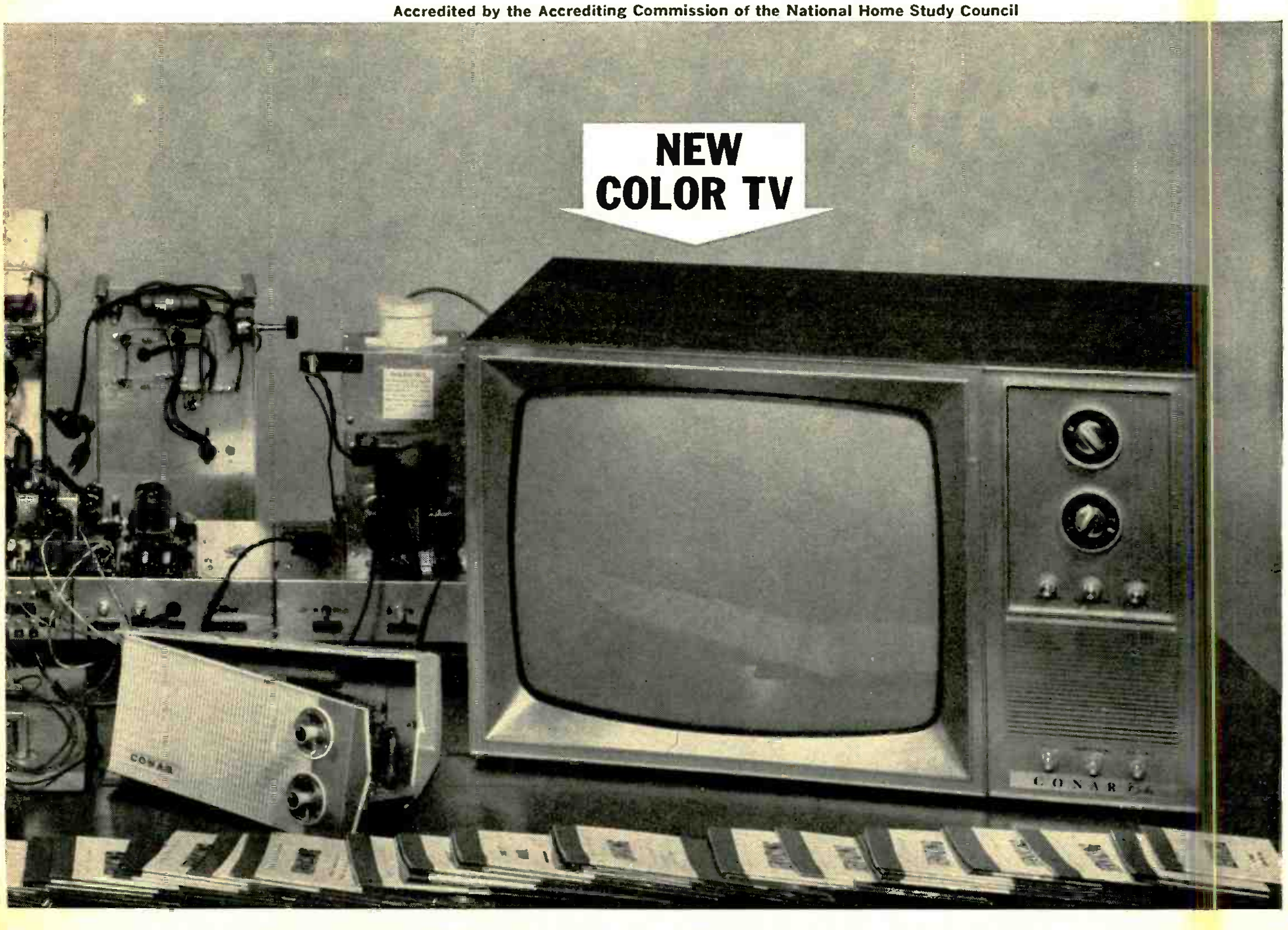


current direction.

When voltage is applied to an CTS, it remains an insulator until a threshold voltage is reached. It then switches rapidly (150 trillionths of a second) into conduction and conducts as long as current exceeds a critical value. Depending on its thickness and composition, threshold voltage may range from about two to several hundred volts. The OMS is similar, except it remains in its conducting state when current is removed, and blocks current when a pulse is again applied.

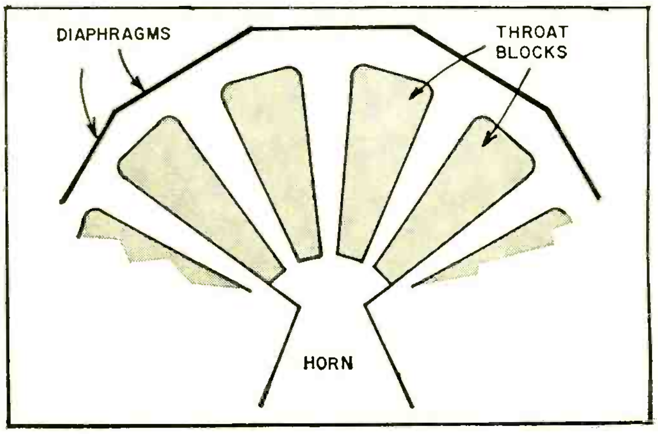
The firm forsees a number of "spectaculars" for the devices, such as flat TV displays and pocket-size computers. The devices can be produced cheaply in sizes as small as 0.005 of an inch across.

WIDE-RANGE ELECTROSTATIC HORN

A really new type of loudspeaker—an electrostatic horn—was described to the 20th Convention of the Audio Engineering Society, held recently in New York City. It was developed by engineers of the Technical University of Prague. Josef Merhaut, of that university, explained the speaker to members of the society.

Electrostatic speakers, he stated, have been noted for their wide frequency range. But because the impedance of the air ahead of them drops with decreasing frequency, they become less efficient on the lower ranges, and most direct-coupled electrostatic speakers are supplemented with a cone-type speaker for the bass and part of the mid-range.

By using plugs somewhat reminiscent of the phase-equalizer plug in a diaphragm-type horn speaker, it is possible to couple a number of comparatively large-area moving diaphragms to the horn throat, thus greatly increasing the impedance presented to the foil diaphragm. The resulting horn speaker has reasonably high efficiency in its low-frequency range and is subject only to the ordinary cutoff limits of horn-type loudspeakers.



RAINBOW READOUTS

A digital-display vacuum tube for alphanumeric readout that offers high intensity and low power consumption can also be filtered for any color from red through yellow, green, blue, violet, and white. Called the Digivac S/G by its manufacturer, Tung-Sol, the tube utilizes a cold cathode and seven anodes coated with phosphorescent material that glows pale green when supplied with 10 to 40 volts. Small-quantity sales will be about $5 each through dealers. R-E

ELECTRONIC MUSIC

Making your own electronic music is easier than you think. To learn nine new techniques for doing it yourself, see the feature article starting on page 38. It's written by an expert and details a whole flock of tricks you can do at home. You'll use your tape recorder.

The absolute end of an old fear.

ANNOUNCING: The new B&K Sweep/Marker Generator. Does for TV sets what no other instrument or instruments can do. It makes alignment of color as well as black & white TV sets simpler, easier than ever.

We've remembered all your old fears about TV alignment. Especially color. So now you can forget them.

In the past, a marker generator and a separate sweep generator were used with a marker adder and a bias supply. All four of these now are combined in one easy-to-use instrument.

(We've made benchwork so much simpler by doing away with the need for hooking together a lot of cables and costly instruments.)

The Sweep/Marker Generator is both an instrument and a guide. As a guide, the bandpass and chroma bandpass curves are visually reproduced and the individual markers are clearly indicated by lights—right on the front panel—for quick, easy reference.

As an instrument, the Sweep/Marker Generator not only generates the marker frequencies (all crystal controlled), but also sweeps the chroma bandpass, TV-IF, and FM-IF frequencies.

See it soon at your B&K distributor or write us for advance information on the product that makes TV alignment procedures of old a fearless operation: simple, fast, accurate. The new Sweep/Marker Generator, Model 415.

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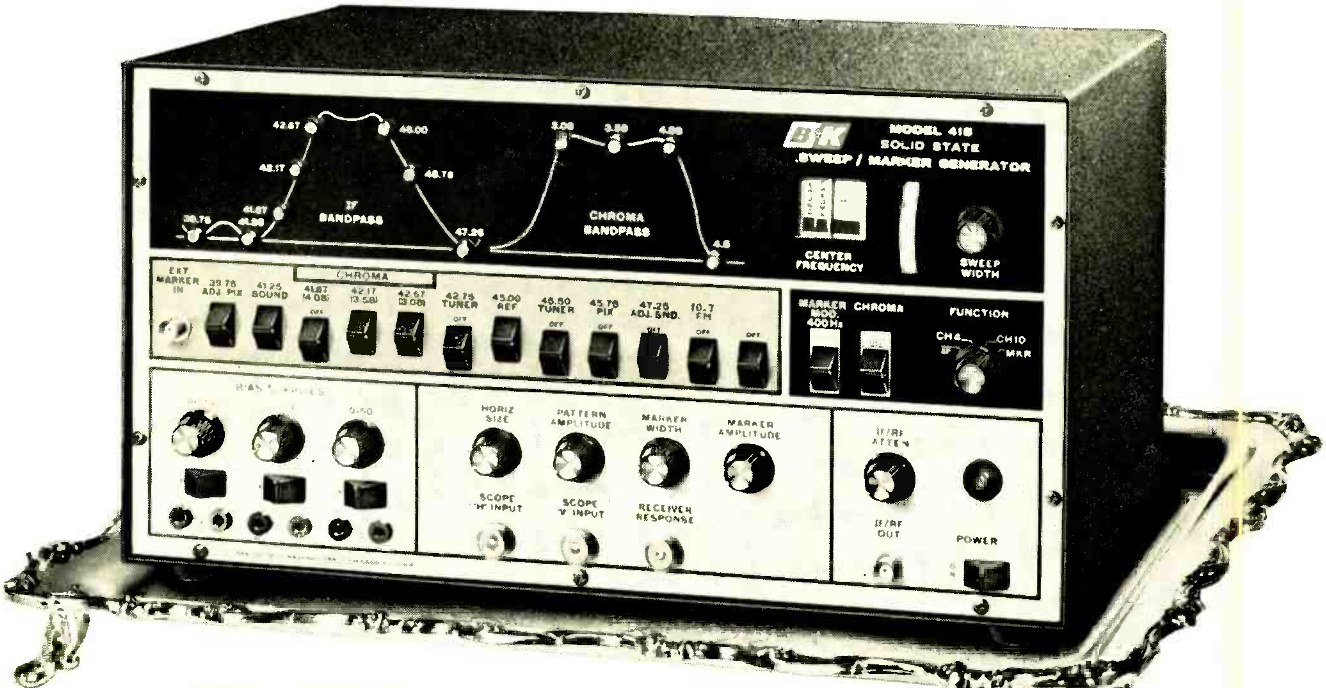


New B&K Sweep/Marker Generator.

Circle 12 on reader service card

Correspondence

WIPER PAUSE CONTROLLER

With regard to the problem of not being able to turn off the wiper pause controller (July 1968) there is a remedy that does not require extra parts. Connect the cathode of D1 to the +12-volt supply point, and to one end of S1. Connect the other end of the switch to the junction of the 33,000- and 1,000-ohm UJT resistors. When the switch is opened, all voltage is removed from the UJT, and it cannot fire.

It is not advisable to remove D1, as the diode provides suppression of inductive turn-off transients generated by the wiper motor. Without D1, these transients may quickly damage the SCR.

The pause controller as described will not operate on many foreign cars, in particular the Volvo. These cars use a three-contact park switch which also grounds the motor winding at the park position. On–off switching is done in the positive supply lead, and there is no point which, if grounded, will cause the wiper motor to start. (I am testing a version of the controller to overcome this difficulty by also switching the positive side, but it is not yet completed.)

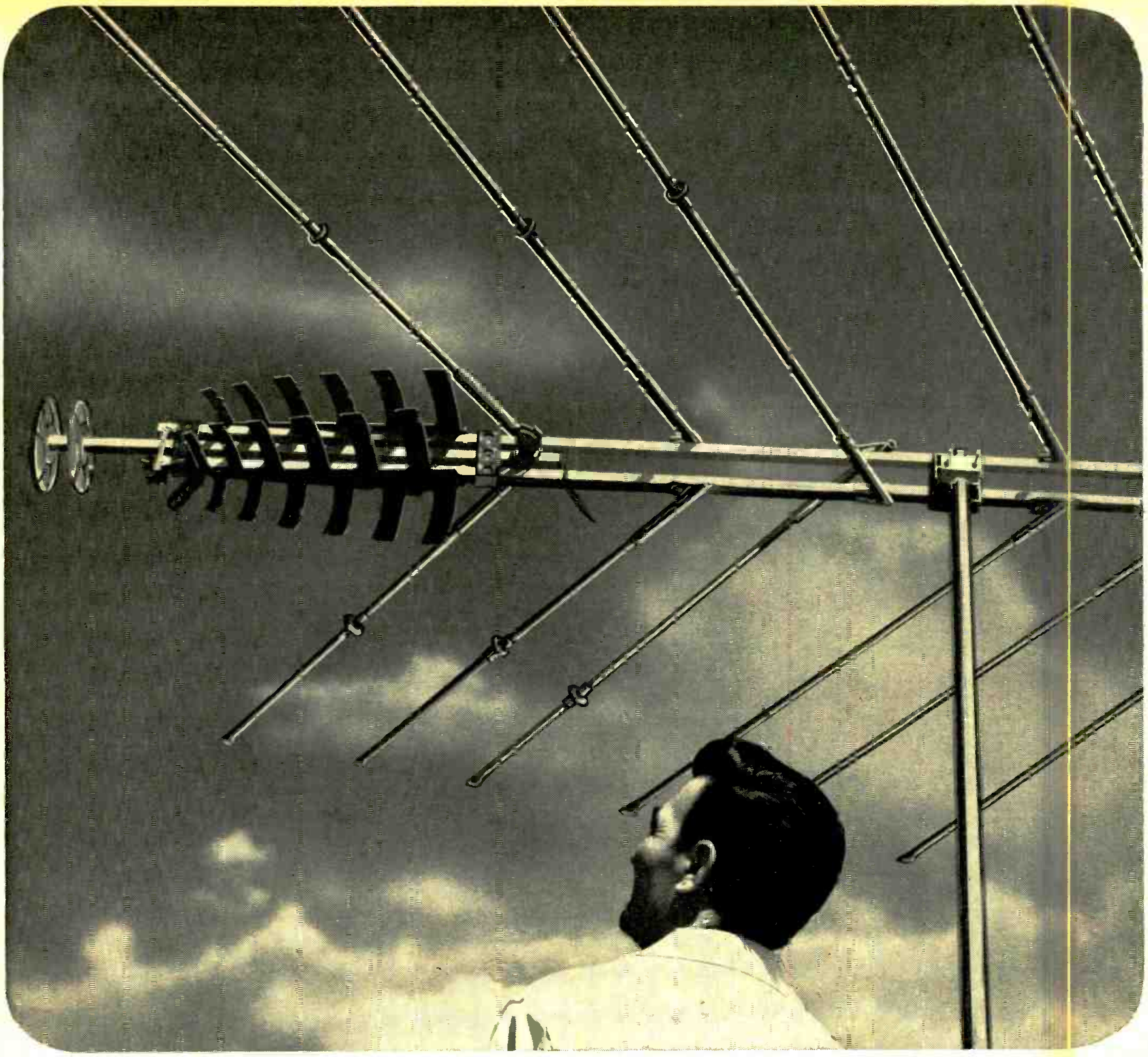
RICHARD A. STANLEY
Captain, USA Signal Corps
Fort Monmouth, N.J.

If there's anyone out there who is still having troubles with the Windshield Wiper pause controller you better read Captain Stanley's letter carefully. We've asked the captain to send us his solution to the three-contact switch problem when he's ready.

I LIKE R-E

I imagine you hear from your readers mostly when they have complaints. Well, for a change, here is a ludo. I have been a subscriber to RADIO-ELECTRONICS for so many years that it has gone through many name changes, and consider it most valuable as a source of state-of-the-art material.

In particular, I refer to such articles as Don Lancaster's DOTnBAR



Professional installers count on antenna gain not the numbers game.

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And that's where JFD Color Laser and Log Periodic antennas outclass all other all-channel antennas. Only patented JFD capacitor-coupled perform *double duty* — respond on the fundamental *and* harmonic modes. Actually *multiply* gain and signal-to-noise ratios over larger multi-element *(but less efficient)* antennas.

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Did you know that JFD now markets a great new line of solid state Snow-Plow and Program Center amplifier-distribution systems? Ask your distributor!

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Circle 14 on reader service card

pattern generator in the July 1967 issue—I built this with complete satisfaction, and wish you would pass this acknowledgment on to him. The intellect that can produce this complex device deserves all the recognition we can give—the design of the printed circuit board was a major achievement, and there were no mistakes in it.

I have just finished the "Dipper and Crystal Oscillator" in the August 1968 issue, with splendid results. It is a professional instrument, and I can think of no way that it could be better. As a matter of interest, I eliminated C1, C3, C4, C5 and C6 and replaced them all with a two-section broadcast superhet variable capacitor. It works just fine and readily goes as low as 200 kHz and as high as 38 MHz. Naturally, the 365-pF section replaces C6 and the oscillator section replaces C3, and the single broadcast capacitor then takes the place of all the other capacitors except C2. Battery positive must be run direct to the drain through rfc or you will not be able to use my method with crystals instead of a coil.

I need to add a color bar function to my DOTnBAR generator. Mr. Lancaster mentioned that it could be done but thought it too expensive. I had no trouble making a stable oscillator, but don't know where to inject it to get bars—I can get fine colored lines with the function switch set on vert lines and injecting my offset carrier just ahead of the channel 3 oscillator, but how do I get a bar pattern?

ARTHUR R. RICHARDS
Belleville, Ill.

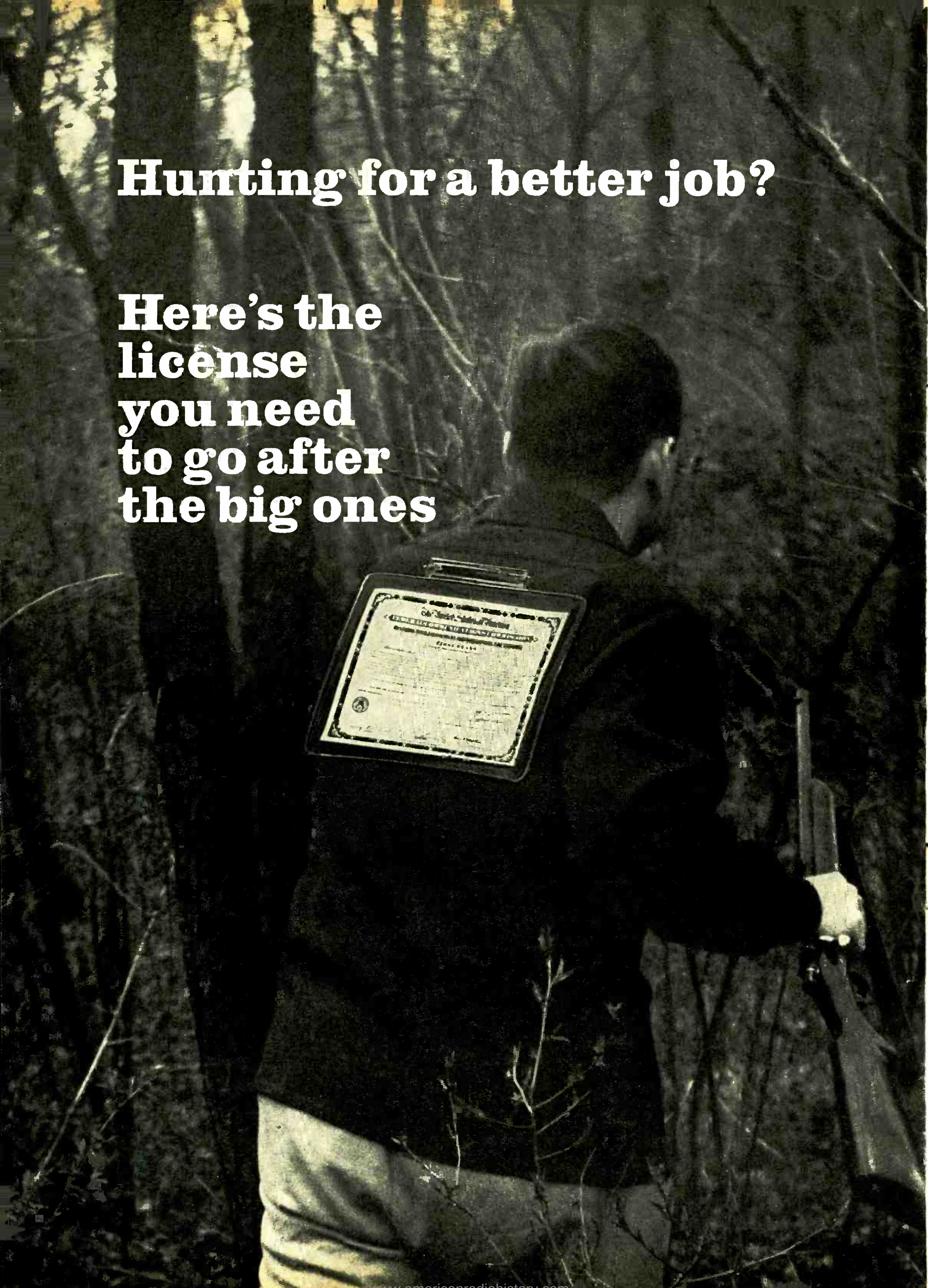
Many thanks for the kind words, Arthur, but I'm afraid that adding the color bar function is extremely difficult. We'll forward your letter to Don Lancaster. Perhaps he can help you out.

AUDIO TECHNICIANS—WHERE ARE YOU?

I may as well admit right now that I am not a really regular reader of your magazine—I buy it only when you include articles on musical instrument amplification.

I suppose this is the best place, though, to bring up a small problem of mine. I just called the biggest repair shops in town, about a dozen in all, to find none able to fix my bass amplifier.

I don't know how this sounds from the technician's point of view, but it seems to me that anyone who can perform surgery on a solid-state


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

color TV can surely figure out a simple 50-watt amplifier. I'm not mad at anyone, but there are sure a lot of amplifiers in this town, and the guy who could do good work on them could clean up.

And now that the manufacturers are going to solid-state, it looks like things can only get worse.

Since I'm here, I might also mention that I still haven't found any speakers capable of 50 watts of bass. Heck, I use an EV SRO-15 and two Jensen Bass Lifetime twelve's and can't turn the volume above a quarter of the way without death distortion. I must admit, I haven't tried JBL's, which are the *only* speakers to use for any kind of power. I guess they're my last chance.

Well, thanks for hearing me out, and say thanks to Jack Darr for me. He's hip.

HIL PAPROCKI
Rochester, N.Y.

I WANT A PREAMP

Many readers must have tape decks which have preamplifiers, but no provision for monitoring with 8-ohm headphones.

When making recordings away from the amplifier with which the deck is usually used, I need a small amplifier which will be fed by the deck preamps and which will drive 8-ohm phones. It must be good enough to enable judging the quality of the tape recording. It should also be able to drive two small speakers. But it must be as simple and inexpensive as possible. Volume controls usually necessary, tone controls optional, no frills.

How about giving us a design for a simple, practical stereo amplifier which will serve this purpose?

CARL HARTMAN
E. Lansing, Mich.

We'd like to Carl, but don't have a unit that meets all of your specs. As soon as we do get an article on such a unit we'll rush it into print. **R-E**

COMING NEXT MONTH

Don't miss February's special photography features—two construction projects and a look at the latest electronic camera circuits.

- **Build A Professional Electronic Photoflash**
- **Digital Photo Enlarging Timer**
- **Electronics in Photography**

There's nothing wrong with the set.

You fixed the picture a week ago, now you're back repairing your repair job. And paying for it.

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Like Arcolytic capacitors do.

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Then you won't have to do repair jobs twice. If the lady in the set seems to be missing something, a week after you've done a repair job, it's her problem. Not yours.

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Circle 19 on reader service card

In the Shop . . . With Jack

By JACK DARR
SERVICE EDITOR

MORE ON SIGNAL TRACING COLOR CIRCUITS

LAST MONTH, WE TALKED ABOUT signal tracing through the color amplifier and demodulator stages. Now let's go back to the bandpass amplifiers and the burst circuits. These can cause some funny problems—funny-peculiar, definitely not funny-ha ha. Things like intermittent color sync on weak signals and weak color on all stations.

If you have weak burst or sync, the bars won't lock as tightly as they should. Turn the color control on the bar-dot generator down to at least half-normal and make sure the bars do hold steady. Your scope patterns will have a tendency to jitter horizontally, too. This can usually be cured by picking up a pulse from the TV's horizontal sweep (clip a test lead to the yoke leads, etc., and feed this into the scope's "Ext Sync" jack).

Here is a place to check that interaction between the horizontal hold control and the color sync. The basic symptom shows up when the horizontal hold control is turned too far on either side. You do not lose horizontal sync, as you would expect, but you do lose color sync.

Like all such problems, it's simple once you find out what's causing it. Here it is. The burst signal is always gated. Keyed on by the gating or keying pulse from the flyback, it's the same as gated agc. The difference is that the color burst is very slim, about 4 to 6 μsec.

In an agc circuit the gating pulse has to hold the gate open only long enough to let the agc tube sample the peak value of the horizontal sync voltage. So, the sync and the gate pulse can slide back and forth for a comparatively long interval before they get completely out of step and the picture will hold horizontal sync over a wide range of movement of the hold control.

Not so with the slim slick color burst, though. It won't wait around for the gate. The horizontal pulse must open the gate at *exactly* the right moment or this burst pip won't get through. The gate will slam shut and we lose the burst, leaving the 3.58-MHz oscillator free to wander.

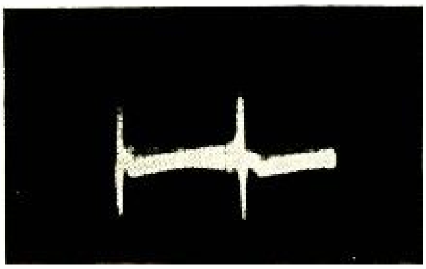


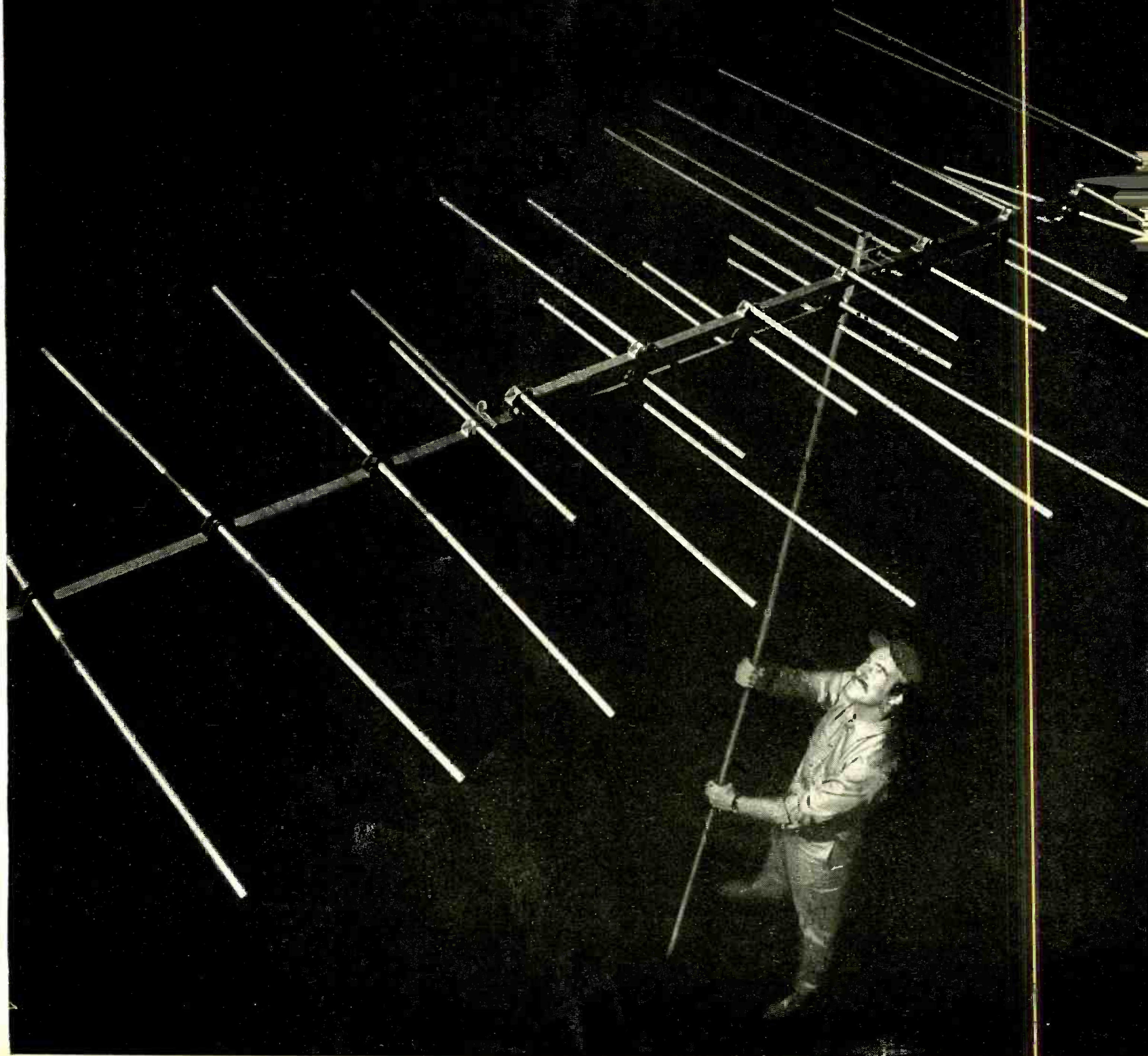
Fig. 1—Burst pulse at color afpc diode.

So check the burst pulse at the output of the gated amplifier. A good place to do this is at the color afpc phase detector diode. It looks like Fig. 1, a very sharply peaked pulse with a straight base line. There is nothing here but burst. You might also check the gate pulse on the burst amplifier grid. It comes from a small winding on the flyback and is positive-going, at about 50 volts p-p in RCA's along about the CTC16's. Motorola comes out with about 80 volts p-p on the phase detector diode, and the gating pulse is 175 volts p-p. Check the schematic for the correct amplitude on your set.

Probably the best fix for this problem is a careful horizontal oscillator setup, including the ringing coil. Then make sure that the hold control is set near the center of its rotation, so the gating pulse and burst are as

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

If you're really stuck, write us. We'll do our best to help you. Don't forget to enclose a stamped, self-addressed envelope. Write: Service Editor, Radio-Electronics, 200 Park Ave. South, New York 10003.



near to centered, or in time, with each other as possible. You can also check the gating pulse for shape.

The normal pulse is a pretty sharply peaked, tall waveform. If the peak is too narrow, check all components between the pulse source on the flyback and the burst amplifier grid. A slightly leaky capacitor or a resistor that's changed value can distort the pulse, adding to the confusion and possibly cause a reduction in the pulse amplitude.

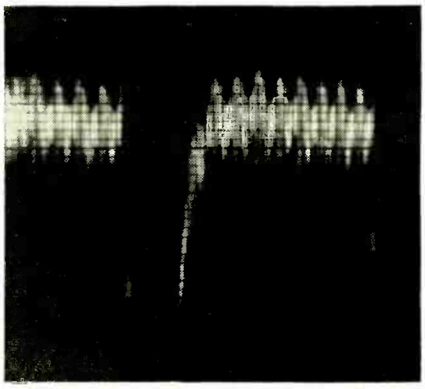


Fig. 2—"Comb" pattern of a color-bar generator taken at bandpass amplifier plate. The gap is the horizontal blanking pulse, which goes off scope screen.

If you think the color signal is weak, you'll find the normal amplitude on the schematic, in the bandpass amplifier grid circuit. If this is a two-stage amplifier, grid and plate p-p voltages will be given. You'll recognize the waveform the instant you see it. It makes the familiar comb pattern when a color-bar signal is used (Fig. 2).

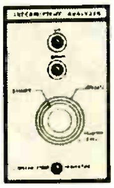
For example, in the 908 Motorola series, we find 11.0 volts p-p on the grid of the first color i.f. tube and 27 volts p-p on its plate. Then, with a 1.3-volt p-p signal on the second color i.f. grid (through transformer, accounting for the voltage loss), we should have 18 volts p-p on the plate, a gain of about 13.

Even the 3.58-MHz CW signal can be traced. A narrow-band scope won't show you individual cycles of this high-frequency wave, but you will see a straight-topped bar. Its amplitude can be checked. Try your scope out on a color set that is working and you'll be able to tell what normal amplitude ought to be.

For the phasing of the CW signal, you won't need the scope. Just look at the screen. If red is red and green is green, phasing is ok! It doesn't have to go off very far before you can spot phasing error. Also, the high-bar test mentioned last month uncovers phasing troubles. **R-E**

Another benchwarmer?

Not this one. Our new B&K Diagnostic Oscilloscope is more than re-engineering of an old model to keep pace with TV technology. It is instead a basic departure from all other oscilloscopes. A departure that has simplified a complex instrument to make it easier for you to use. But there's something else.



What this oscilloscope has is exclusive. An Intermittent Analyzer with electronic memory—and optional remote Audio/Visual Alarm.

With it, the elusive intermittent conditions that make so many TV sets tough dogs can now be detected and identified in your absence. Preset one control. When the faulty stage is detected, you'll know about it as soon as you come back from service calls. Then run the scope overnight to check another set for an intermittent condition.

All this adds up to greater shop efficiency, more time for profit-making service calls and a lot more mileage out of a very fine diagnostic oscilloscope.

An oscilloscope that shows vector patterns exactly as specified by color TV manufacturers. (All vectorscope inputs and controls are conveniently located on the front panel.) Also allows you to read peak-to-peak voltages in all ranges on a double-scale calibrated screen—just by turning a switch. (As the range is selected, the appropriate scale lights automatically.)

Automatic synchronization locks in all patterns at any signal level or frequency. There are also fewer controls and these are positioned for easier operation.

Give our Diagnostic Oscilloscope some thought. It's worth it not to be sidelined with a benchwarmer. See your B&K Distributor or drop us a note for detailed literature on Model 1450 and our full-line test equipment catalog, AP-24.

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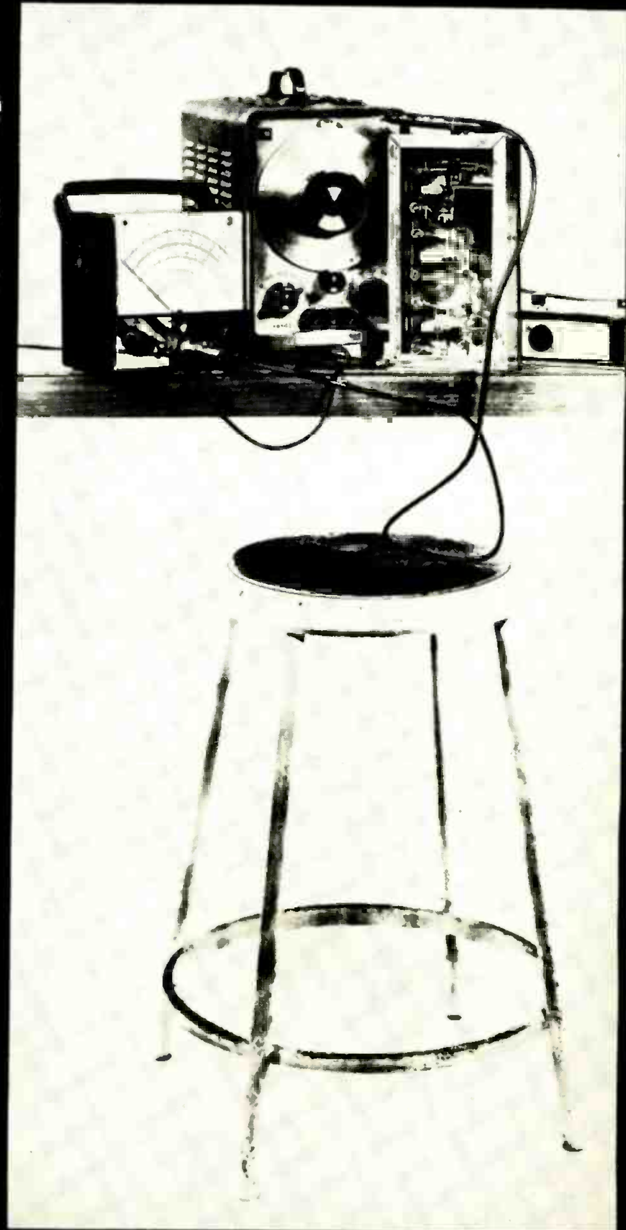
Circle 23 on reader service card

Someone should develop an easy way to learn electronics at home



RCA Institutes did!

Here is a whole new approach to learning electronics at home! RCA Institutes, one of the nation's largest schools devoted to electronics, has developed a faster, easier way for you to gain the skills and the knowledge you need for the career of your choice. Here for the first time is a student-proved, scientifically designed way to learn. If you have had any doubts in the past about home training in electronics—if you have hesitated because you thought you might not be able to keep up—or that electronics was too complicated to learn—here is your answer! Read how RCA Institutes has revolutionized its home training ideas!

NEW CAREER PROGRAMS BEGIN WITH "AUTOTEXT" INSTRUCTION METHOD!

Start to learn the field of your choice immediately! No previous training or experience in electronics needed!

With this new revolutionized method of home training you pick the career of your choice—*and RCA Institutes trains you for it.* RCA's Career Programs assure you that everything you learn will help you go directly to the field that you have chosen! No wasted time learning things you'll never use on the job! The Career Program you choose is especially designed to get you into that career in the fastest, easiest possible way!

And each Career Program starts with the amazing "AUTOTEXT" Programmed Instruction Method—the new, faster way to learn that's almost automatic! "AUTOTEXT" helps even those who have had trouble with conventional home training methods in the past. This is the "Space Age" way to learn everything you need to know with the least amount of time and effort.

CHOOSE A CAREER PROGRAM NOW

Your next stop may be the job of your choice. Each one of these RCA Institutes Career Programs is a complete unit. It contains the know-how you need to step into a profitable career. Here are the names of the programs and the kinds of jobs they train you for. Which one is for you?

Television Servicing. Prepares you for a career as a TV Technician/Serviceman; Master Antenna Systems Technician; TV Laboratory Technician; Educational TV Technician.

FCC License Preparation. For those who want to become TV Station Engineers, Communications Laboratory Technicians, or Field Engineers.

Automation Electronics. Gets you ready to be an Automation Electronics Technician; Manufacturer's Representative; Industrial Electronics Technician.

Automatic Controls. Prepares you to be an Automatic Controls Electronics Technician; Industrial Laboratory Technician; Maintenance Technician; Field Engineer.

Digital Techniques. For a career as a Digital Techniques Electronics Technician; Industrial Electronics Technician; Industrial Laboratory Technician.

Telecommunications. For a job as TV Station Engineer, Mobile Communications Technician, Marine Radio Technician.

Industrial Electronics. For jobs as Industrial Electronics Technicians; Field Engineers; Maintenance Technicians; Industrial Laboratory Technicians.

Nuclear Instrumentation. For those who want careers as Nuclear Instrumentation Electronics Technicians; Industrial Laboratory Technicians; Industrial Electronics Technicians.

Solid State Electronics. Become a specialist in the Semiconductor Field.

Electronics Drafting. Junior Draftsman, Junior Technical Illustrator; Parts Inspector; Design Draftsman Trainee Chartist.

SEPARATE COURSES

In addition, in order to meet specific needs, RCA Institutes offers a wide variety of separate courses which may be taken independently of the Career Programs, on all subjects from Electronics Fundamentals to Computer Programming. Complete information will be sent with your other materials.

2 CONVENIENT PAYMENT PLANS

RCA Institutes offers a unique tuition plan that lets you progress at your own pace. You only pay for lessons as you order them. You don't sign a contract obligating you to continue the course. There's no large down-payment to lose if you decide not to continue.

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Companies like IBM, Bell Telephone Labs, GE, RCA, Xerox, Honeywell, Grumman, Westinghouse, and major Radio and TV Networks have regularly employed graduates through RCA Institutes' own placement service.

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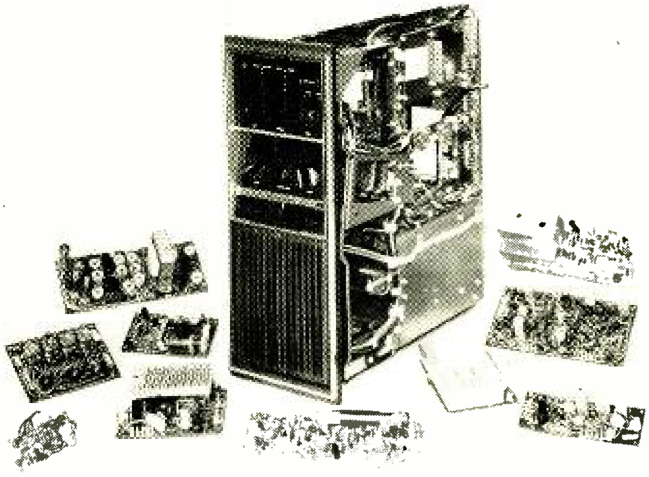


step toward tomorrow with QUICK-CHANGE MODULES

By LARRY STECKLER
MANAGING EDITOR

TV ON THE BLINK? AND YOU'RE GOING TO HAVE TO WAIT two weeks to get the set back? And that big basketball game is *this* Saturday? Sure hope you have a good friend or two around.

But this kind of situation is on its way out. More and more TV sets are being built around plug-in subassemblies that permit almost "instant" repair, right in your home. This is especially important to the color set owner as these sets tend to be large, bulky, and heavy.

The first steps to plug-ins

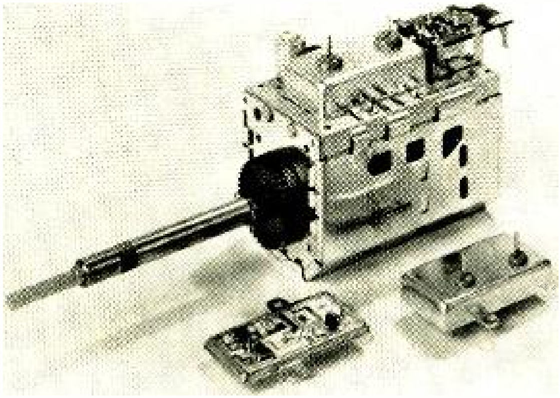
Setchell-Carlson started the ball rolling a few years back when they introduced a set made up of several plug-in subchassis. Their intention was that the set, should it break down, could easily and rapidly be put back into service. All the technician had to do was to locate the defective section, unplug it, and plug in a good replacement section.

However, this system did have one drawback. Few technicans actually carried replacement plug-in chassis. Notwithstanding, these sets are still being made in both a black-and-white and color chassis.

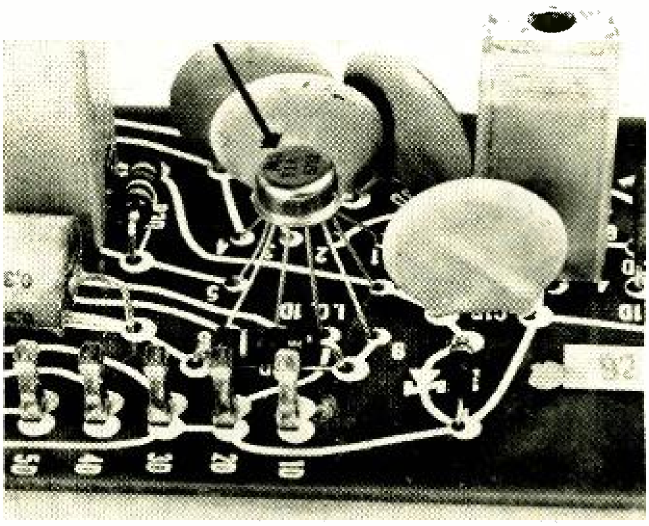
Sony tried it next. They're selling a black-and-white portable in which the entire works is on a single, large circuit board. They have two reasons in mind—one is faster service and the other, even more important, easier access to the chassis. If you've ever seen how crowded the insides of some portables get, you'll know what I mean.

Quick-change circuit boards next

Now Motorola is the newest member of the club. They've come up with a plug-in approach in their Quasar chassis. You know the one, the set "with the works in the drawer." This chassis consists of 10 plug-in sections. Each one is completely contained on a single printed-circuit



This vhf tuner (above) has a plug-in hybrid IC that contains all the active components essential to proper tuner operation. It's made by Oak Electronics and should be turning up in TV sets soon. The photo at the right shows an IC on a plug-in Quasar circuit card. One day soon that IC may replace the card.



board that "plugs into" the main chassis frame. Again the theory behind this move is that this set is one that won't ever have to go to the shop.

Instead, should the solid-state circuit act up, the technician has only to locate the defective board, unplug it, and replace it with a new one. To repair the defective board, rather than having to cart an entire color chassis to his shop, he has to take only the board along. I understand that Motorola is providing a repair service for technicians for defective boards—probably on some kind of exchange basis plus a flat-rate repair charge. Also Motorola has available a special Quasar caddy that contains a complete set of replacements for this set.

Will everyone be doing it?

It is more than likely that in the near future almost every set maker will be following the plug-in approach in one form or another. The result may not be at all like the Setchell-Carlson subchassis or the Motorola circuit boards, but some system is likely. Some set makers are already talking about an all IC (integrated circuit) color set. In such a receiver the plug-ins would be the IC's themselves.

If this sounds like pie in the sky to you you missed the announcement of the new Oak Electronics TV tuner. It incorporates a plug-in hybrid IC that contains every active transistor, resistor and capacitor essential for complete vhf TV tuner operation. Should something other than the switching elements in the tuner fail, the entire module is replaced, in minutes, right in the customer's home.

Is the cost of such a module high? Yes. But look at the savings that counterbalance it. The technician doesn't have to take the tuner apart and then perhaps ship it off to some tuner repair service center, wait till it comes back, and then reinstall it. As a result, the total cost of this kind of tuner repair would probably remain the same. But the set wouldn't have to be removed from the set owner's home nor would it be out of service for a full week or two.

Picture the same situation scaled up to a color receiver with, oh say, 12 plug-in IC's. Sure there'll be problems. Sure there'll be a multiplicity of plug-in modules and stocking problems. But like it or not, problems or not, this is a probable picture of the future.

Will picture tubes get larger?

The only way picture tubes, color picture tubes, are likely to get larger is if someone comes up with an entirely new approach. The vacuum-tube CRT in use today is probably as large as it is practical to build this type of tube. I know there was and still is a 27" black-and-white CRT—but not very many are in use. And are they ever expensive!

Our first step toward really larger screens will very possibly come in the form of some kind of projection technique. It will probably work, but it is just as probable that it would not be accepted by the viewing (and set buying) public. Remember, we once had black-and-white projection systems. But the optics that went into those systems were no end of trouble. Even so simple a task as cleaning the mirror and lens was a job to be avoided.

Flat tubes are likely

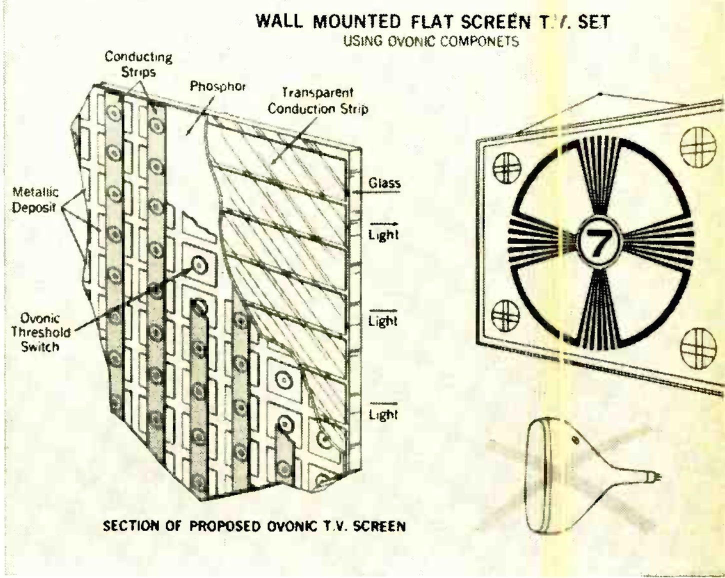
A more practical approach, and the one that must eventually develop, is the flat picture tube. It may not be as far away as you think. One version of a flat black-and-white CRT, made by Hughes Aircraft, is currently being used by the Air Force. It's built right into the windshield of some of our new jet fighters that are flying today.

Several other forms of flat color picture tubes have also been described. There may not be any in use today, but they are coming. Personally, I look forward to the day that a color screen is just unrolled when you want to watch and folded up out of sight when you're through watching.

The most recent development that might lead to a flat television picture tube is the Orshinsky effect. A sketch of a flat TV screen made by this process is shown below. It's only a dream today, but tomorrow?

Smaller sets too

But TV is going in two directions. Sets are getting smaller just as fast as they are getting larger. These days it's almost safe to predict that the wristwatch TV, perhaps even a color wrist TV will be with us soon. It will take a lot more development work with IC's to make it so, but it is no longer in the realm of science fiction.



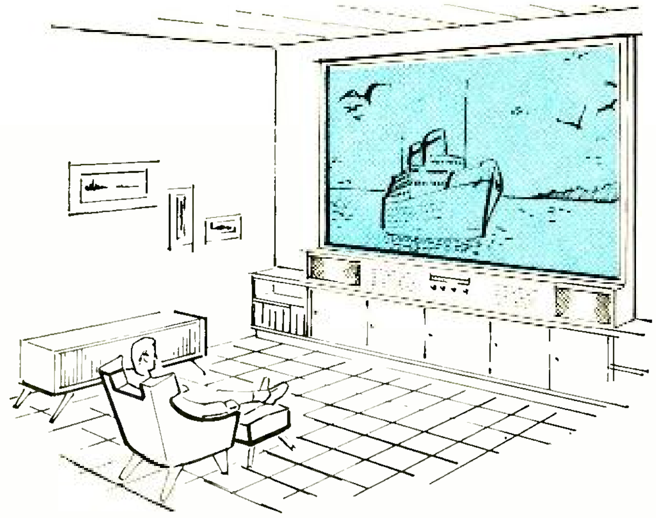
Flat screen TV? One possible approach is shown here. I'd like to be able to hang one of these sets on my livingroom wall now. But it's just a concept on the drawing board so I'll have to wait.

3-D TV is with us now

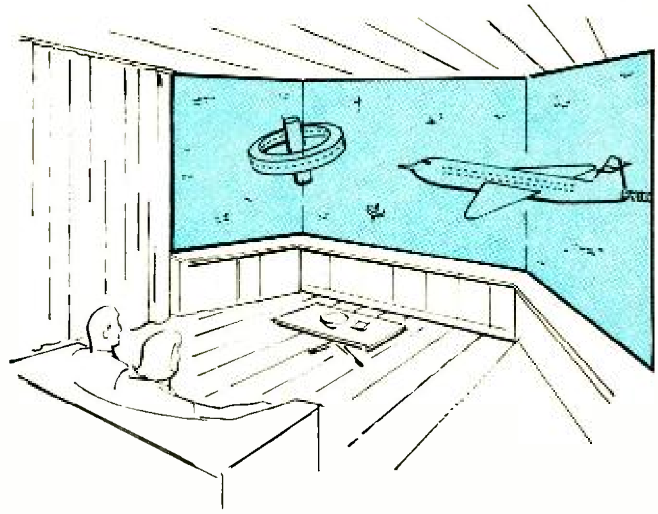
Three-dimensional TV systems are already being used by industry. They are particularly handy where remote control of some instrument or remote handling of some product is required. Existing systems are bulky, awkward and expensive. But better ones will come. One day it may be possible to wrap a screen around three corners of your "TV room" and watch the 3-D color picture float in front of your eyes. My only hope in this direction is that it's a direct-vision system. Not one with which you've got to wear special glasses. One side note: A patent has already been issued for a 3-D CRT. It uses a group of phosphor screens lined up one behind the other to create the depth illusion. I've never seen it work, but I have seen the proposal.

Color videotape recordings

We are currently seeing the beginning of the TV tape age. Several videotape recorders are being made for home use right now. One of the newest systems is built to look



When TV walls become possible this is what your TV room may look like, RCA did the sketch this scene is based on but they won't say when they'll make this set. Ten years is a good guess.



Even 3-D sets are possible. Some 3-D systems are actually in use today, but they are a far cry from the type of setup you see here. We turned our art department loose to dream up this one.

and behave like an 8-mm movie camera. It uses a 6-minute cartridge and plays back through any TV set. Just hook up to the antenna terminals. Its inventors claim that it can sell for about $500—that's about half the price of existing units. But let me stress one thing: This is a laboratory model. It is not yet in production nor has any manufacturer yet said that he would build the unit in quantities.

But the next step from this black-and-white system is a color video tape recorder (VTR). Here again future development of the IC is probably what it is needed to make such units available at a reasonable price. You may say impossible, but I remember when you had to pay $500 for a 7" black-and-white TV that was loaded with some 30 vacuum tubes and produced a ho-hum picture. Look at what you can get for $500 today in a large screen color set.

Color Picturephones

In most large cities today you can make arrangements to talk to someone, long distance, via Picturephone. In the not too distant future it may be possible to do the same thing right from your home. Carry that just one little step further and you can do it via a color Picturephone. Ridiculous, No! Future? Yes! That same color Picturephone will allow you to do your shopping without ever leaving your home. Dial (pardon me—punch out) the number for the supermarket, for example, and you'll see displayed the various items on sale that day. Using the telephone keyboard punch out the codes for the items you want and they'll be delivered later. You'll get your bill for them too. The same process would also hold true for any other kind of shopping you might care to do.

Color TV today is just scratching the surface. Perhaps it's just starting to scratch the surface. Either way I'm sure my predictions will tend to underestimate rather than overestimate future developments. Either way it's going to be fun to see how my final score comes out. **R-E**

Late Breaking Color-TV News

In the preceding article projection color TV systems were mentioned briefly. However, there is one such system now under development. Some prototype color receivers have already been built by the firm, Harries Electronics Corporation. They first showed versions of this set a couple of years ago. At that time it fared rather badly as the picture appeared dim and not as good as what was already available.

However, Harries now says they have a newer version of the set in operation in New York and have offered RADIO-ELECTRONICS an opportunity to see the set in operation. We are taking them up on their offer and will deliver a complete report on this set as soon as we have seen it.

New kind of color CRT

From France comes word of a "new" kind of color CRT. The tube, a variation of the Chromatron is said to offer two advantages over the American-style shadow-mask tube—it offers double the brightness and has a flat faceplate (this means the screen has no curvature at all . . . the tube itself is not a flat "hang-on-the-wall" type).

It does, however, differ from the Chromatron. One major difference is that the post acceleration grid is actually imbedded in the glass faceplate. It is not "hung" inside the tube in front of the screen. The added sturdiness of this arrangement makes a 23-inch version of the tube possible.

Reports from Europe indicate that substantial numbers of these tubes have already been made. Obviously the French manufacturer would like to interest US set makers in the new tube, but we don't know how successful they have been. A more detailed report on this new tube and how it works is also scheduled. Our reporter in France is working on it now. . . .

How Color TV Works

Color TV fundamentals can be easy

By MATTHEW MANDL

CONTRIBUTING EDITOR

TRUE OR FALSE?

- Both black-and-white and color use 15,750 Hz for the horizontal scan.
- Both systems use 60 Hz for the vertical sweep frequency.
- The 3.58-Mhz color subcarrier is received simultaneously with the black-and-white video carrier.
- As with b-w, a color receiver uses a single detector for both video and sound demodulation.

If you said "true" to any one of these statements you were wrong! Every statement is *false!* This little quiz emphasizes some of the important differences between color TV and b-w TV. The more we know about such differences, the easier color TV is to understand. The nice part is that we don't have to delve into complex math either to explain or understand the basic principles.

The color signals

The optical system of a color television camera filters the colors it gets from a given scene and breaks them into three primary colors. For the *additive* color mixing process that is used, the primary colors are *red, blue,* and *green.* Thus, camera pickup tubes produce individual ac signals which represent red, blue, and green, and vary in amplitude according to the individual color intensities.

Like black-and-white signals, color signals must modulate a carrier so they can be transmitted to the receiver. Normally, if we use a specific bandwidth for transmission, there wouldn't be room to include a new set of signals. Fortunately, in black-and-white transmission, the sideband signal information tends to cluster around the harmonics of the 15,750-Hz horizontal sweep frequency. This signal bunching leaves separate gaps in the frequency spectrum into which we can sandwich the color signals.

Since we already have a black-and-white carrier, we call the color carrier the *subcarrier.* This subcarrier must have a frequency just right to put the color signals in the spaces between the clusters of sidebands horizontally related. Mathematically, a subcarrier which is an odd multiple of one-half the horizontal sweep frequency would do the trick.

An approximately satisfactory subcarrier frequency is obtained when we take one-half the horizontal sweep frequency and multiply it by 455. But we run into trouble because of interference with the sound carrier. To avoid this, 15,734.264 Hz is used for the horizontal sweep frequency for color transmission. To keep the vertical sweep properly related, it operates at 59.94 Hz. The result is a subcarrier frequency of 3.579545 MHz (approximately 3.58 MHz) which is just right for odd-harmonic relationships for both picture and sound carriers.

The 15,734-Hz horizontal sweep frequency and the 59.94-Hz vertical sweep are close enough to the 15,750 Hz and 60 Hz of black-and-white to maintain good sync lock.

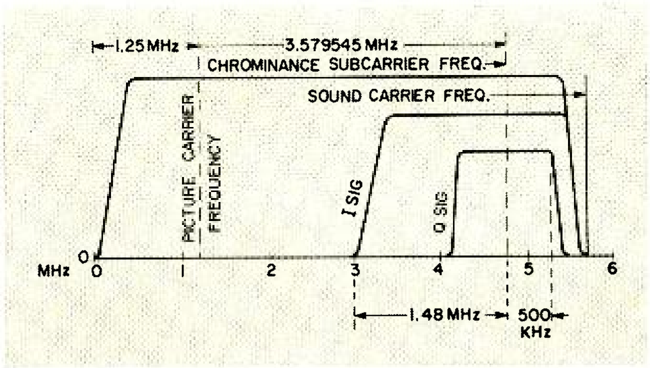
Using a 3.58-MHz subcarrier didn't solve all problems. If the subcarrier (with its sidebands) is received at the set, the subcarrier can cause interference and other problems. Hence, the subcarrier is not transmitted—only the sidebands of color signals. This *suppressed-carrier* type transmission is often used by other services for narrow-band interference-reducing practices.

Suppressing the subcarrier means that the color receiver must have a separate oscillator to generate the missing color carrier for insertion into the sidebands for proper detection of color signals. This is done with a crystal-controlled oscillator to maintain the necessary stability.

Still another problem was the overabundance of modulating signals (red, blue, and green). To reduce these, the individual color signals were changed into a combined set of two called the *I* and *Q* signals. To reduce cross-talk during color reception, the I signal is sent with one sideband extending to 1.48 MHz and the other side consisting of a vestigial section of about 500 kHz wide. The Q, however, is transmitted in double-sideband fashion, each sideband 500 kHz from the suppressed subcarrier as shown in Fig. 1.

The 3.58 MHz oscillator in the receiver must be kept in sync with the subcarrier at the transmitter, or false color rendition results. To do this, a special signal consisting of about 9 cycles of 3.58 MHz is transmitted during each horizontal blanking. This signal is called a *burst* and occurs during blanking following the sync signal (Fig. 2).

To make color compatible so the program produces a picture on a b-w set, a *luminance* or brightness signal designated as Y is included. The Y



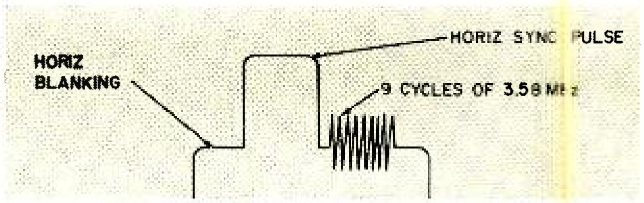


Fig. 1—(left) Color information in the American 6-MHz channel width is carried in a suppressed subcarrier—a picture modulated sideband 3.58 MHz above the picture carrier. Fig. 2—(above) A burst of about 9 cycles at 3.58 MHz is transmitted after each horizontal sync pulse. It is used to sync the 3.58-MHz color oscillator in the TV receiver.

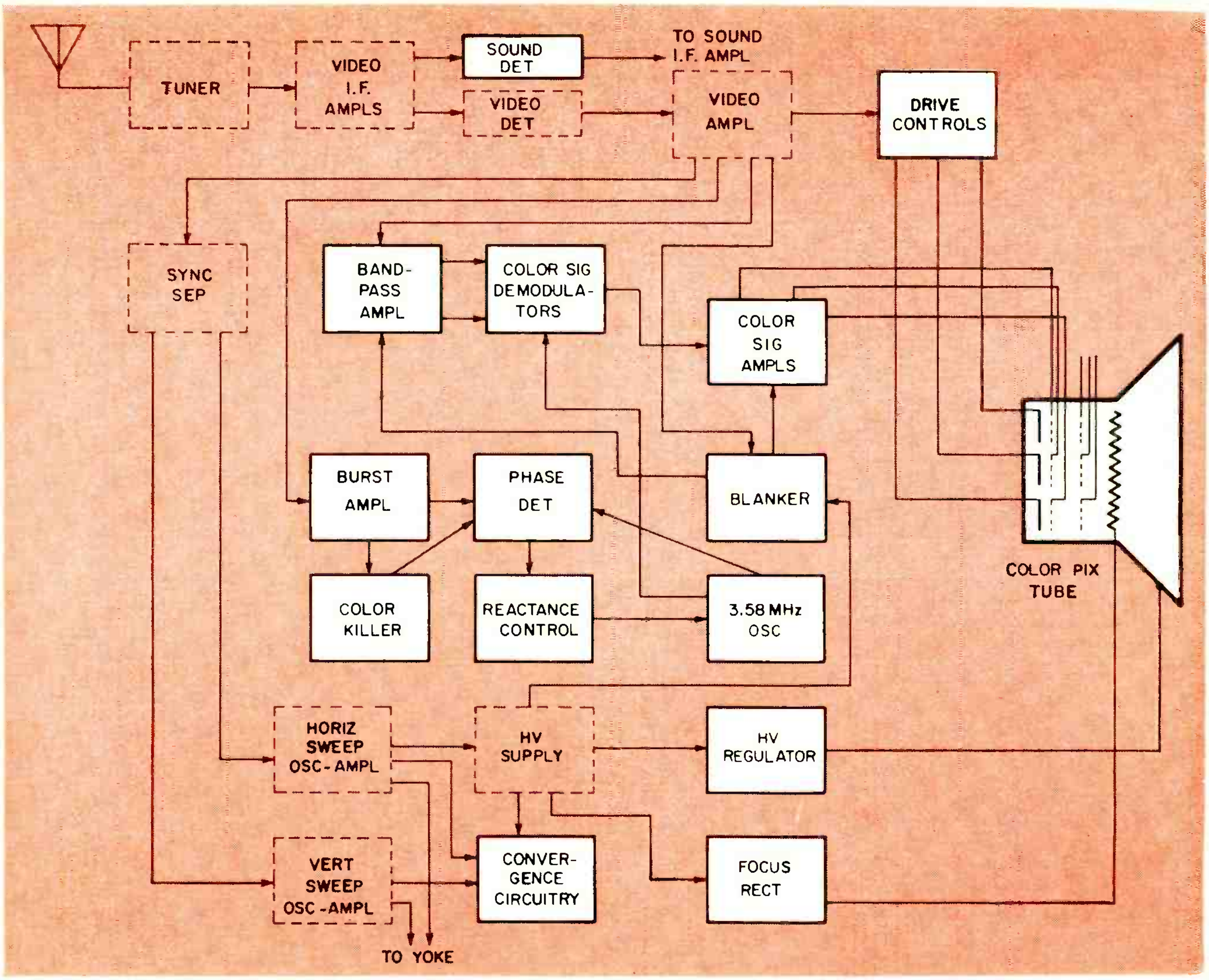


Fig. 3—Color elements added to circuits normally found in black-and-white receivers.

signal is a composite of the three color signals, but not in even proportions. When the average person looks at three saturated primary colors (of equal intensity) some colors appear brighter than others because of the pecularities of the human eye. Hence, the Y signal uses uneven proportions of color signals to equalize this difference in perception.

Color signals appear on a black-and-white set as varying degrees of gray (gray scale) from white to black. Each color produces its own shade of gray. In color sets the Q and I signals have minus quantities of green and hence green must be restored by mixing the Q and I signals in a resistive (matrix) network. After demodulation, the color (chroma) signals are G−Y, B−Y, and R−Y. These are applied to individual grids of a three-gun color tube. The Y (luminous) signal is applied to the cathodes.

The color circuits that are added to those normally required for black and white are shown in Fig. 3. Also, the sound i.f. signal is much weaker after the video detector. Hence, a separate detector is used for sound takeoff, prior to the normal video detector.

A burst amplifier (see Fig. 3) brings the 3.58-MHz sync signal up to the level required. A phase detector samples the 3.58 MHz oscillator frequency and compares it with the incoming burst. If there is any difference, the phase detector causes a reactance control circuit to correct the subcarrier oscillator frequency slightly.

Bandpass & blanking

A typical bandpass amplifier and blanking circuit are shown in Fig. 4. The bandpass amplifier not only brings the chroma signals to the proper level for demodulation, but also prevents sync and burst signals from riding through to the picture tube. This is done by gating the bandpass amplifier into periodic *nonconduction* by a special switching circuit known as a *blanker*. A gating pulse is obtained from the horizontal output section for triggering purposes. Note that the bandpass amplifier has a common cathode resistor with the blanker.

When the blanker is not conducting, the bandpass amplifier functions normally. When the grid of the blanker receives a positive pulse from the horizontal sweep output, the blanker conducts heavily and the resultant cathode current flows through the bandpass cathode resistor. This makes the bandpass cathode more positive than its grid (high negative bias) and cuts off the bandpass tube. Because the horizontal pulse coincides with the blanking and burst occurrence, only the video chroma signals pass through the bandpass amplifier.

Color killer

When a color receiver is tuned to a black-and-white transmission, the b-w signals would go not only through the luminance (Y) stages, but through the bandpass amplifier and color amplifiers as well and cause undesired contrast effects and interference. To prevent this, the signals must be kept out of the bandpass amplifier during black-and-white reception. The circuit which does this is known as the *color killer* (Fig. 5).

The video signal input is applied to both the grid of the burst amplifier and the bandpass amplifier. A high positive potential is applied to the cathode of the burst amplifier, making the grid relatively negative and normally cutting off this tube. A positive pulse is applied to the grid and causes conduction. Since this pulse comes from the horizontal output system, it occurs only during horizontal blanking, permitting the 3.58-MHz sync burst to be amplified and applied to the phase detector of the subcarrier oscillator circuitry.

When the phase detector receives the burst signal it develops a negative potential which is applied to the color-killer tube grid and keeps this tube cut off.

A positive pulse from the horizontal system is also applied to the plate of the killer tube. Since no positive B voltage is applied to this anode, the pulse takes its place. Since the grid is held at cutoff, however, no current flow occurs through the tube.

When there is no burst signal (during reception of a black-and-white picture) the phase detector receives no signal and no cutoff bias is applied to the killer tube. Now this tube conducts. Electron flow from cathode to plate and down through the 220,000-ohm resistor to ground sets up a negative polarity at the grid of the bandpass amplifier as shown in Fig. 5. Thus, the bandpass amplifier tube becomes nonconducting for the video signal.

The shunting capacitor acts to filter the pulse voltage at the anode of the killer tube to convert it to fairly steady-state dc. A color-killer manual control is usually placed in the grid circuit of the killer tube for critical adjustment of killer function.

In addition to the color-handling circuitry described, diode-resistor-coil combinations are used for convergence purposes For a color receiver to show white, the red, blue, and green beams must converge into one area to produce white. If any single beam is misaligned, color fringing occurs.

For color, approximately 25 kV is essential for large-screen brilliance. Similarly, several thousand volts are necessary for application to the focus electrode. To maintain constant high voltages, regulators are used in the high-voltage section. A portion of the high voltage is tapped for focus purposes, or a transformer tap is used with either a tube or stacked selenium rectifiers. **R-E**

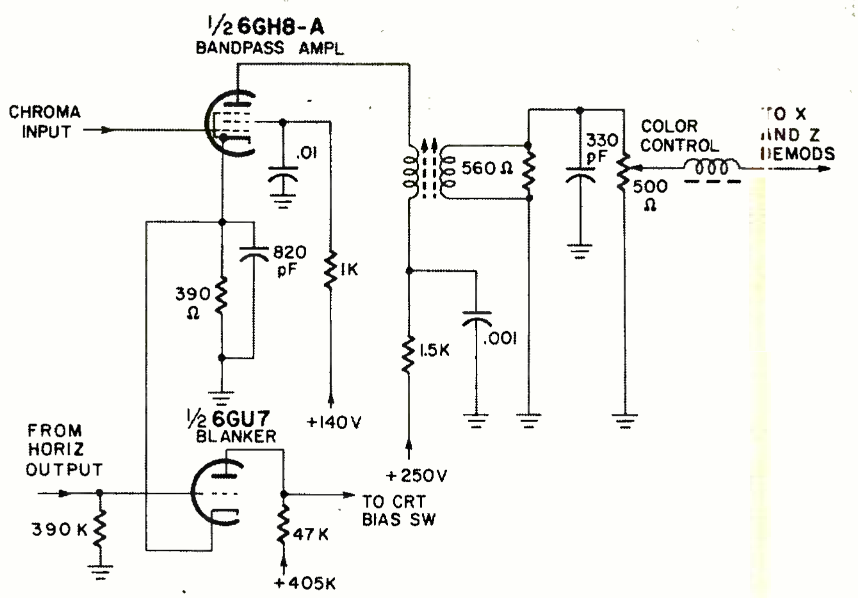
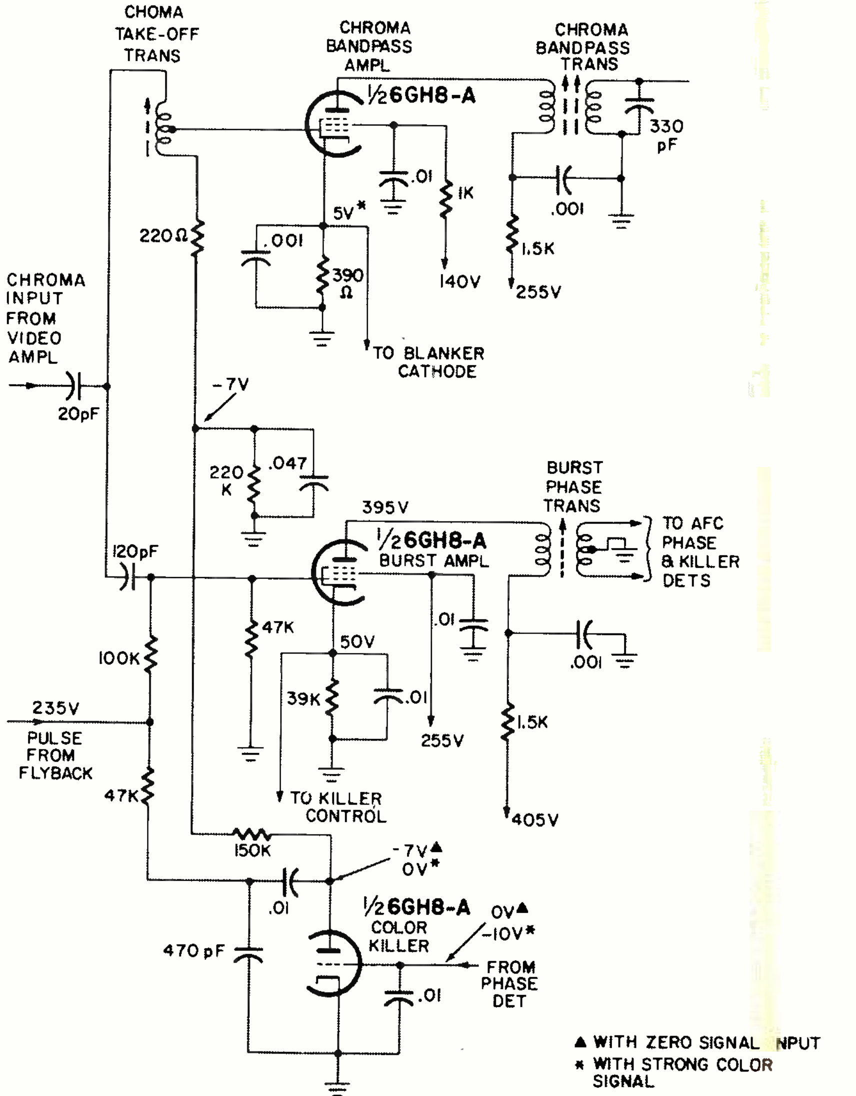


Fig. 4—Bandpass amplifier prevents sync and burst signals from reaching CRT, and boosts color signals for demodulation. Bandpass amplifier is gated off by the blanker, which conducts only when it is triggered by horizontal sweep output pulses.

Fig. 5—Typical color killer is normally biased off through burst signal action. Tube conducts only during b-w transmission, cutting off the bandpass amplifier.



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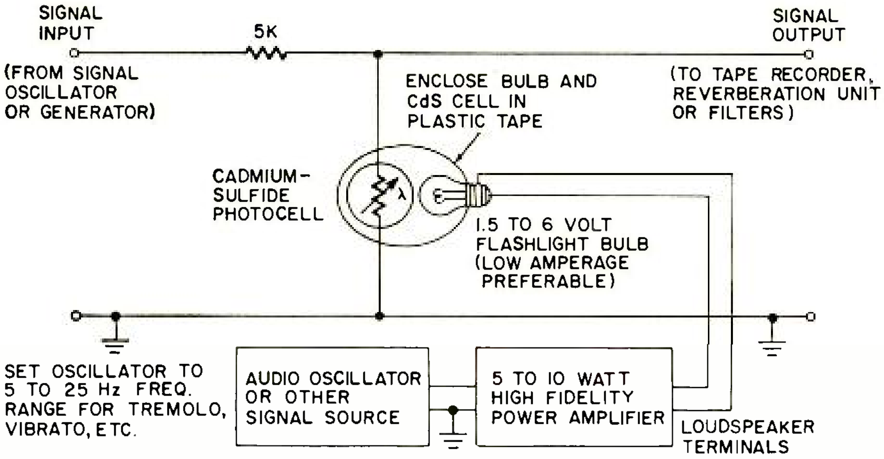


Fig. 3—A modulator and envelope controller can be built with a low-current bulb and cadmium sulfide cell. Frequency response is imited by the bulb response time.

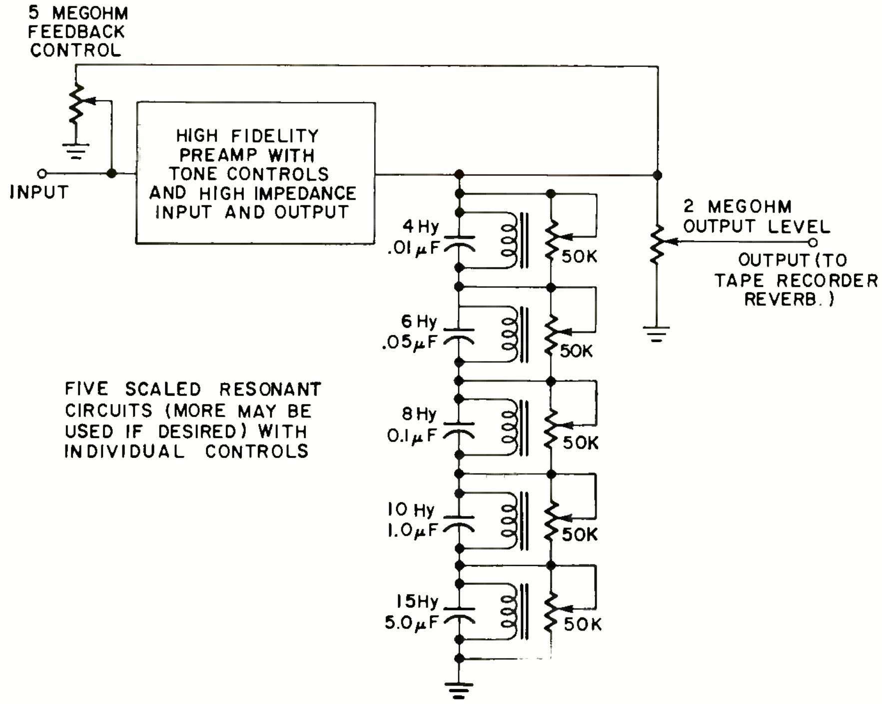


Fig. 4—Resonant equalizers use LC circuit string and a preamplifier with positive feedback. For high-Q filters, impedance at tie-in point must be sufficiently high.

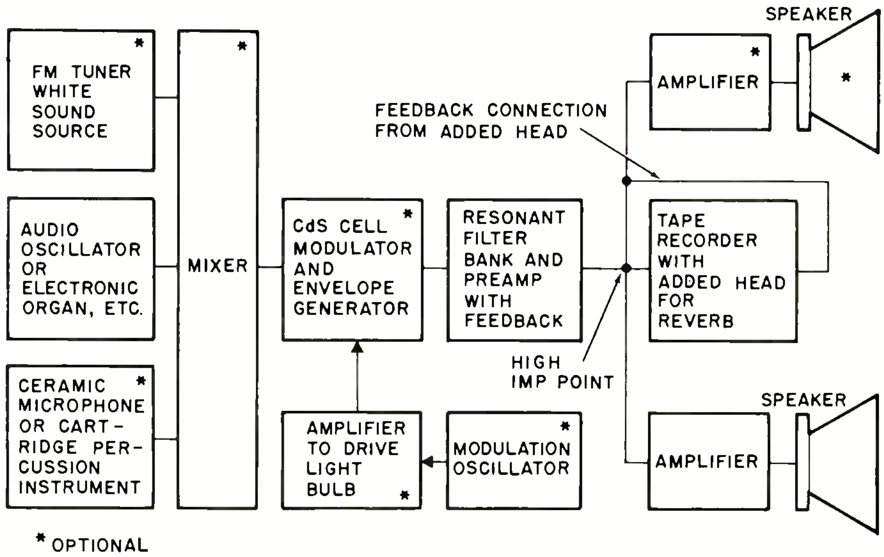


Fig. 5—Block diagram shows suggested interconnections of devices described.

two. In fact, one well-known electronic music laboratory (Brandeis University) used a bank of oscillators with each one connected to a key on a keyboard. The oscillators are preadjusted to the desired frequency and amplitude wanted from each one. Then the oscillators may be played from the keyboard as a regular musical instrument.

Build a CdS-Cell Modulator. A light-controlled volume control is easily assembled with cadmium sulfide photoelectric cells (Fig. 3). By using a high-fidelity amplifier to drive a light bulb, a type of amplitude modulation can be produced. The frequency response of the modulation channel is limited by the response time of the light bulb, so use a small, low-current bulb (such as a flashlight bulb) that responds faster than larger bulbs.

Build a Resonant Filter. Resonant filters are easily made by putting a paper capacitor (0.1 to 5 μF) in parallel with an iron-core choke of the type used in power supplies (2 to 15 henries). A bank of these filters can be made up easily from parts found in most experimenters' junk bins.

Put the smallest capacitor across the smallest inductor and grade the sizes up to the biggest (Fig. 4). Put a potentiometer across each parallel-resonant circuit, and wire the circuits in a series string from a high-impedance point in the audio circuit to ground. If the impedance at the point is too low, the Q of the resonant filters will suffer. The ideal point is the input to a typical vacuum-tube amplifier, which usually has an impedance of 470,000 ohms.

You may want to try connecting a filter bank at a point between two stages in a preamplifier or after the first stage of the power amplifier. The higher the impedance, the better the resonance achieved in the filters. For this reason, transistor amplifiers usually won't work with the circuit unless it is isolated with special vacuum-tube or FET amplifiers.

FM Tuner for White Sound. The smooth hiss heard between stations on a sensitive FM tuner or television receiver is white sound. It is a basic sound for synthesizing various percussive sounds (by filtering and modulating as described later). Simply tune a receiver off station and feed its output into a mixer, filter or tape recorder. The de-emphasis network must be disabled.

Preamp Resonant Filter or Oscillator. Connecting the output of a preamplifier with tone controls back to the input will cause the preamplifier to oscillate at the frequency of maximum amplification (set by the tone controls and equalizers). If the feedback connection is made through a potentiometer, the amount of feedback can be controlled and set to a point just below oscillation.

This will convert the preamplifier into a resonant equalizer, adding a great deal of color to sounds passing through the preamplifier from tape recorder, microphone, records, etc. If this technique is combined with the resonant filter bank described earlier some very sharp resonant-filter bandwidths can be achieved. Use a vacuum-tube preamplifier (like the old McIntosh with equalizers and tone controls), and connect the resonant filter bank across the output before the feedback potentiometer (Fig. 4).

One word of caution with respect to the feedback circuit: if the phase is not correct, negative feedback rather than positive feedback will result. Insert the feedback signal into the cathode circuit rather than the grid input of the first preamplifier stage (a solder connection rather than the input jack). Negative feedback causes a reduction in amplification, while positive feedback yields an increase in amplification and a tendency to oscillate.

These nine techniques are all available to the amateur experimenter, and most can be assembled inexpensively and with little effort. Combined with the simplest audio sound system, all the basic techniques of an electronic music synthesizer can be available to the beginner or the experimenter with a limited budget. These basic techniques of electronic music synthesis are:

- Signal generation (oscillators, white-sound sources, etc.)
- Modulation and envelope control
- Filtering
- Reverberation
- Tape manipulation (dubbing, splicing, tape loops, speed changes, reversal, sound overlays)
- Recording and high-fidelity reproduction

Interconnecting components

Once the experimenter has acquired or built some of the devices listed above he is ready to interconnect them and start synthesizing electronic music. If he has a sound generator or two (an oscillator and an electronic organ for example), a modulator, a resonant filter, a tape recorder with a reverberation head added and a high-fidelity sound system, he is ready to start.

In comparing the electronic music gear described here with commercial synthesizers, the main deficiency of our equipment is in the area of controls. Professional synthesizing equipment permits much more variety in external controls, and in the capability of modulating and interconnecting units. The following are recommended ways of interconnecting various components described in this article:

Sound Sources and Amplitude Modulation. It is desirable to have two sound sources and a simple amplitude modulator. The sound sources are used as an *audio* signal source and a *modulation* signal source, which does not have to be in the audible range. In the case of the simple modulator described earlier, frequency range is limited by the response time of the light bulb. Thus, only low-frequency modulation (such as vibrato or tremolo) and envelope-control modulation (where the amplitude of one signal follows the envelope of another signal) is available.

Filtering and Reverberation. After passing through the modulator, the signal should pass through the filters and then to the tape recorder reverberator (Fig. 5). The final sound product will then be recorded on the tape for future use.

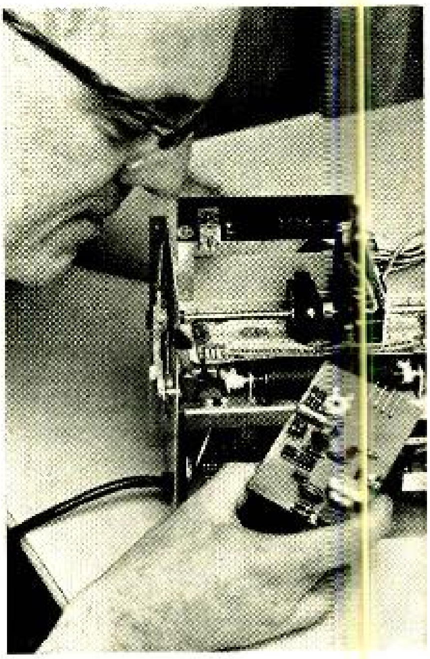
If the user has two tape recorders, one can be used for reverb and the other to record the final product. The reverberation tape recorder, incidentally, can be any old machine since quality requirements are greatly reduced if it doesn't produce the final recording as well as reverberation. Of course the recording should be made on the best tape recorder available.

Dubbing, Splicing and Reproduction. It will probably be desired to copy material from one tape to another. To do this only one tape recorder is required. A second tape deck can be used with any high-fidelity preamp with equalization for tape heads. For splicing applications it is desirable to have a tape deck with removable head covers.

If the original recording is monaural, try simulating stereo by splitting the highs into one channel and the low frequencies into another with two preamps or the tone controls on a stereo preamp. Also try dubbing the tape into two channels and simulate moving sound sources by advancing one record level while reducing the other. **R-E**

IC's Foil Change Cheaters

COFFEE-BREAK COUNTERFEITERS WITH photocopied bills and professionals who regularly cheat vending machine bill-acceptor mechanisms may soon become a thing of the past. Using two new integrated circuits developed by Texas Instruments, this plug-in amplifier is being used by Transmarine Corp. to make bill-changer mechanisms that are foolproof.

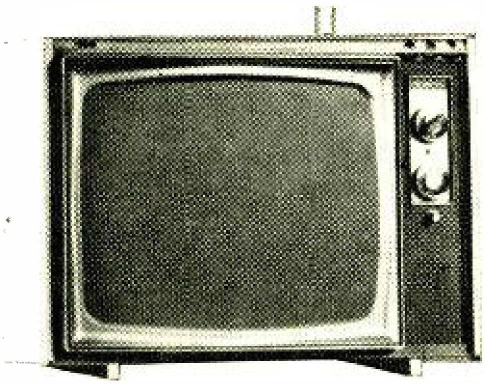


High temperatures, humidity, line-voltage changes and soiled bills won't disrupt the new changers. Earlier devices depended on photocell arrays to measure light on the face of a bill. Signals from the cells fed to unstable transistor amplifiers sometimes accepted photocopies and *rejected* genuine bills.

The new acceptor analyzes the intaglio printing detail of bills. As a tray containing the bill is pushed into the acceptor, a sensing switch turns on an infrared radiation source. This radiation passes through the moving bill at a selected point in the bill design, through an exact replica of the area and strikes a silicon cell. The cell then generates electronic pulses, but only a real bill generates the correct number and size of pulses. The IC can even differentiate between signals generated by infrared penetration of U.S. Mint ink and paper, and the best ink-paper combination that is available to counterfeiters.

The plug-in amplifier, which can update the circuits in some of the company's older machines, can be modified to accept "foreign" pulses. A version used in Sweden, for example, lets motorist operate self-service gas stations. **R-E**

BUYER'S GUIDE TO



RCA Candidate model EL-442.

Compiled by Len Buckwalter

THE NEW 1969 COLOR TV'S HAVE ARRIVED AND THE MAN OR WOMAN LOOKING to buy a set will find there are more than 500 different models to pick from. We've selected a group of more than 100 sets that we consider most representative of those available and have detailed all of their most important characteristics here. We don't list every feature of every set, but do list those that we feel are important when you decide on the set you want to buy.

Screen sizes are advertised in one of two ways—diagonal measurement or total square inches. We've presented only the diagonal measurement but for a quick guide remember that 295 sq. in. is a 23-inch diagonal; 227 sq. in. is a 20-inch diagonal; 180 sq. in. is an 18-inch diagonal; 102 sq. in. is a 14-inch diagonal and 75 sq. in. is a 12-inch diagonal.

MANUFACTURER	MODEL	CHASSIS	SCREEN SIZE (DIAG. IN.)	TYPE SET				TYPE CIRCUIT			FEATURES											PRICE
				COMBINATION	CONSOLE	TABLE	PORTABLE	TUBE	TRANSISTOR	HYBRID	PRINTED CIRCUIT	HAND WIRED	AUTO FINE TUNING	FINE TUNING INDICATOR	AUTO DEGAUSSING	AUDIO TAPOFF	TONE CONTROL	INSTANT PLAY	COLOR FIDELITY	AUTO COLOR CONTROL	REMOTE CONTROL	
Admiral	8T100	6H10	18			•		•			•				•						•	$ 349.95
	2T106C	12H10	20			•		•			•		•		•		•				•	$ 399.95
	2L111	12H10	20		•			•			•		•		•		•				•	$ 429.95
	3T306C	4H12	23			•		•			•		•		•		•		•		•	OPEN
	3L361	4H12	23		•			•			•		•		•		•	•	•		•	$ 529.95
	3ST351	4H12	23	•				•			•		•		•		•		•		•	$ 850.00
	4009P	K10	14				•	•		•	•		•		•			•				$ 279.95
Andrea	VCX325-5	—	23		•			•			•				•	•	•				•	$1065.00
Arvin	80K56-14	—	23		•			•				•			•		•					—
	70K45-12	—	20		•			•				•	•		•							—
Cardinal	6-102-2	—	23		•			•			•	•	•		•		•					—
	7-101-2	—	23	•				•			•	•	•		•		•					—
Clairtone	4011	—	23		•			•													•	—
	5041	—	23	•				•													•	—
Electrohome	Barcelona	—	23	•				•				•	•		•		•				•	$1495.00
	Conestoga	—	23		•			•				•	•		•		•				•	$ 749.00
	Cabaret	—	22		•	•		•				•	•		•		•					$ 549.00
DuMont	55T01	—	23			•		•				•			•		•		•			$ 499.95
	55C29	—	23		•			•				•			•		•		•			$ 550.00
Emerson	35P03	—	15				•	•							•					•		$ 279.95
	29P08	—	18			•		•							•					•		$ 329.95
	20C06	—	20		•			•							•							$ 429.95
	26T05	—	23			•		•					•		•					•		—
	26C36	—	23		•			•					•		•					•		$ 499.95
General Electric	WM210HBR	—	10				•	•			•				•							$ 189.95
	WM230GBG	—	14				•	•			•				•							$ 269.95
	M275EPM	—	18			•		•			•		•		•			•				$ 399.95
	M364EWD	—	20			•		•			•		•		•			•				$ 429.95
	M932EPN	—	23		•			•			•		•		•		•	•				$ 639.95

1969 COLOR SETS


Toshiba Spectrum III C3A.

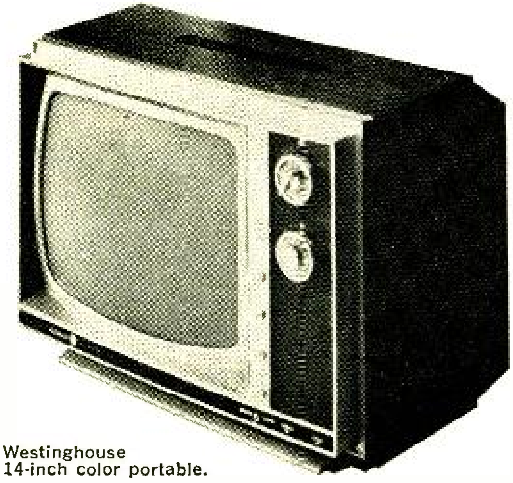
Three basic types of sets are available—all transistor, all tube, and hybrids that are a combination of both tubes and transistors. The all-transistor sets tend to be more costly, top-of the line models. In return for the higher price tag you normally get longer trouble-free service and a set that requires less power to operate. Also, you'll find many of the smaller screen sets use transistor circuits to keep heat to a minimum and to cram-in all the needed circuitry.

But the really important news for 1969 is in the features. You've got a choice between hand-wired and printed-circuits. Here, you've got to decide for yourself. There are advantages on both sides, but don't let this be the only deciding factor. Don't forget to look at the other features too.

Take automatic fine tuning for one. This is an extra that can save you

MANUFACTURER	MODEL	CHASSIS	SCREEN SIZE (DIAG. IN.)	TYPE SET: COMBINATION	CONSOLE	TABLE	PORTABLE	TYPE CIRCUIT: TUBE	TRANSISTOR	HYBRID	FEATURES: PRINTED CIRCUIT	HAND WIRED	AUTO FINE TUNING	FINE TUNING INDICATOR	AUTO DEGAUSSING	AUDIO TAPOFF	TONE CONTROL	INSTANT PLAY	COLOR FIDELITY	AUTO COLOR CONTROL	REMOTE CONTROL	PRICE
Heath Co.	GR-681	—	23		•			•			•		•		•	•				•	•	$ 499.95*
	GR-295	—	23		•			•			•				•	•				•	•	$ 449.95*
	GR-227	—	20		•			•			•				•	•				•	•	$ 399.95*
	GR-180	—	18		•	•		•			•				•	•				•	•	$ 349.95*
Hitachi	CNA-24T	—	18			•		•			•				•					•		$ 369.95
	CFA-550	—	14				•			•	•				•	•		•		•		—
JVC NIVIVO	7208	—	—				•			•	•				•					•		$ 299.95
	150	—	18				•			•	•				•					•		$ 329.95
	151	—	18			•				•	•				•					•		$ 339.95
Magnavox	IC6250	—	18			•		•			•				•		•					$ 369.50
	IC6300	—	20			•		•			•				•		•					$ 429.50
	IC6402	—	21		•			•			•				•		•					$ 398.50
	IC6800	—	23			•		•			•				•		•					$ 479.50
	IC6902	—	23		•			•			•		•		•		•					$ 559.50
	IC7011	—	23		•			•			•		•		•		•			•	•	$ 815.00
	IC7600	—	23	•				•			•		•		•		•			•		$ 750.00
	IC7645	—	23	•				•			•		•		•		•			•	•	$1095.00
Midland	15-218	—	18		•			•			•				•							$ 369.95
Motorola	CP468EN	C14TS-924	14				•	•			•				•							$ 299.95
	CT550EW	C18TS-921	18			•		•			•				•		•					$ 379.95
	CT670EW	K20TS-921	20			•		•			•		•		•		•					$ 439.95
	CT800EN	N23TS-921	23			•		•			•				•		•					$ 469.95
	CU868EW	P23TS-921	23		•			•			•		•		•		•					$ 499.95
	LK837EW	M23TS-921	23	•				•			•		•	•	•	•	•					$ 925.00
	WU870EW	C23TS-915	23		•				•		•		•	•	•		•					$ 649.95
	TL853ES	AC23TS-915	23		•				•		•		•	•	•		•				•	$ 789.95
	MD850EW	E23TS-915	23	•					•		•		•	•	•		•					$1275.00
Muntz TV	24811P	—	18		•			•	•		•				•							—
	3322M	—	22		•			•	•		•				•							—
	5581	—	23	•				•	•		•				•							—
	5453	—	23			•		•	•		•				•							—

* Cabinet and remote control are additional



Westinghouse
14-inch color portable.

the task of making that final adjustment to deliver maximum signal into the color circuits. It is especially important in locations more distant from the station transmitter. While it's certainly not a must it is a convenience. Some sets even have a fine-tuning indicator to tell you when the station is properly tuned. This may be an indicator light, special tuning bars in the picture or possibly a meter.

Automatic degaussing is included in just about every set made today. There is only one set that does not include this feature because it does not need it. It is the Sony 7010. But this set uses a special picture tube that does not require degaussing.

An audio takeoff permits easily picking the sound off your color set and feeding it into your hi-fi system. Only a few sets incorporate this feature and if good sound is important you must consider it. Of course even sets without this feature can be coupled to a hi-fi system, though not as readily.

Tone controls, instant play and color fidelity controls are probably best considered niceties. They make good bonus features but are not vital to good performance. They should be considered but are really convenience features and should not have a major effect when selecting your color set.

Automatic color control can be important by contrast. For it will prevent several trips a night to the set to adjust the color control when programs

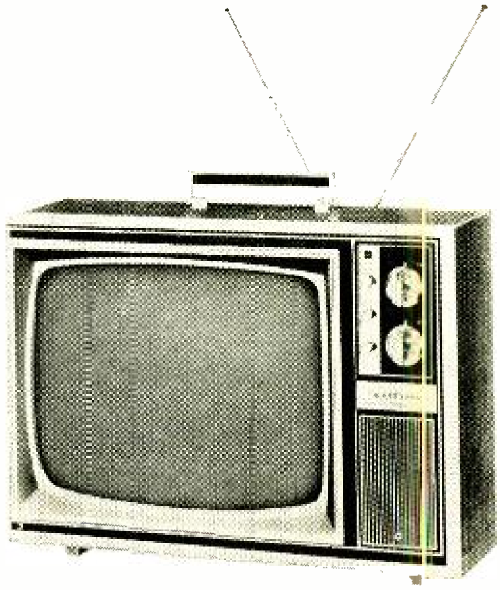
MANUFACTURER	MODEL	CHASSIS	SCREEN SIZE (DIAG. IN.)	TYPE SET				TYPE CIRCUIT			FEATURES											PRICE
				COMBINATION	CONSOLE	TABLE	PORTABLE	TUBE	TRANSISTOR	HYBRID	PRINTED CIRCUIT	HAND WIRED	AUTO FINE TUNING	FINE TUNING INDICATOR	AUTO DEGAUSSING	AUDIO TAPOFF	TONE CONTROL	INSTANT PLAY	COLOR FIDELITY	AUTO COLOR CONTROL	REMOTE CONTROL	
Olympic	CT911	CT911	18			•		•			•				•							—
	CC5400	CTC31	23		•			•			•			•	•							—
	CK5414	CTC30	23	•				•			•			•	•	•	•					$ 850.00
Packard Bell	CR634	—	18			•		•			•				•							$ 369.95
	CR932	—	23			•		•			•				•							$ 475.00
	CQ951	—	23		•			•			•				•						•	$ 559.95
	CQ968	—	23		•			•			•		•		•		•				•	$ 875.00
	CRW804	—	23	•				•			•				•		•				•	$1295.00
Panasonic	CT-21P	—	12				•			•					•			•				$ 309.95
	CT-62P	—	15				•			•					•							$ 329.95
	CT-93P	—	18				•	•							•							$ 369.95
	CT-91T	—	18			•		•							•							$ 379.95
	CT-92D	—	18		•			•							•			•				$ 399.95
Philco	533BR	—	18			•				•	•				•							$ 369.95
	560BR	—	20			•				•	•				•		•					$ 429.95
	5477WA	—	20		•					•	•				•		•					—
	6202BK	—	23			•				•	•				•							$ 449.95
	6598WA	—	23		•					•	•				•		•					$ 499.95
	635WXA	—	23	•						•	•			•	•				•			$ 799.00
RCA	EL-418	—	14				•	•			•				•							$ 329.95
	EL-442	—	18			•		•			•		•		•							—
	FL-508	—	20			•		•			•				•		•				•	$ 429.95
	FL-520	—	23		•			•			•				•		•					$ 459.95
	GL-550	—	20		•			•			•				•		•				•	$ 439.95
	GL-611	—	23		•			•			•				•		•					$ 499.95
	GL-702	—	23		•			•			•		•		•		•				•	$ 775.00
	HL-818	—	23	•				•			•		•		•		•				•	$ 975.00
Setchell-Carlson	2200W	—	18		•			•				•			•		•					$ 499.95
	2900MO	—	18				•	•			•	•			•							$ 429.95

change. It will automatically keep the color setting constant throughout changes of cameras, programs and program materials. Set makers are working on an automatic tint control, but haven't come up with one.

Remote control is again a convenience and in color sets an expensive convenience. It will add more than $50 to the price of the set. One suggestion here. A remote control for a color set must do more than just permit channel selection and volume control. It should also control color and tint. If it doesn't you'll find yourself having to get up from your easy chair to make these adjustments.

Since most controls do include these adjustments, modern color remotes tend to be 7-channel or 7-button devices. They are elaborate and delicate—you can't just throw them around any old way. But used properly they can prove very handy.

Price, though listed last, is probably considered first. It often is the limiting factor. Prices shown here are recommended factory list prices and will vary somewhat from store to store and city to city. As with any other major purchase, once you've decided on the make or model you want to buy, it pays to dicker and shop. Only one warning though . . . once you've decided on the set you want don't let yourself be switched. But do get the set you like at the best possible price. R-E



Panasonic Palerno model CT-93P.

MANUFACTURER	MODEL	CHASSIS	SCREEN SIZE (DIAG. IN.)	TYPE SET: COMBINATION	TYPE SET: CONSOLE	TYPE SET: TABLE	TYPE SET: PORTABLE	TYPE CIRCUIT: TUBE	TYPE CIRCUIT: TRANSISTOR	TYPE CIRCUIT: HYBRID	FEATURES: PRINTED CIRCUIT	FEATURES: HAND WIRED	FEATURES: AUTO FINE TUNING	FEATURES: FINE TUNING INDICATOR	FEATURES: AUTO DEGAUSSING	FEATURES: AUDIO TAPOFF	FEATURES: TONE CONTROL	FEATURES: INSTANT PLAY	FEATURES: COLOR FIDELITY	FEATURES: AUTO COLOR CONTROL	FEATURES: REMOTE CONTROL	PRICE
Setchell-Carlson	2400MO	—	23		•			•				•			•		•					$ 730.00
	2500COX	—	23		•			•				•	•		•		•					$ 795.00
Sharp	C[illegible]-50P	—	12				•				•				•							$ 269.95
	CN-52T	—	18			•					•				•							$ 349.95
Sony	7010	—	7				•		•		•											$ 429.95
Sylvania	CB30GY	D11	14				•	•			•				•					•		—
	CD13W	D05	18				•	•			•				•					•		$ 369.95
	CE31W	D06	20			•		•			•				•					•		$ 429.95
	CF500E	D08	23		•			•			•				•					•		$ 449.95
	CF507W	D12	23		•					•	•		•		•		•			•	•	$ 499.95
	CF240CR	D10	23		•					•	•		•		•		•			•	•	$1200.00
	CFNP20BT	D13*	23		•					•	•		•		•		•			•		$ 995.00
Symphonic	TCT195	—	18			•		•					•		•							—
West-inghouse	CP84A19	—	14				•				•				•							$ 329.95
	CP88A19	—	18			•					•				•							$ 389.95
	CP90A19	—	20			•					•				•							$ 399.95
	CP90A39	—	20			•					•		•		•							$ 459.95
	CK93A49	—	23		•						•		•		•							$ 549.95
	CC93A67	—	25	•							•		•		•							$ 900.00
Zenith	Z3504-1	15Y6C15	14				•	•				•			•		•					$ 329.95
	Z3906	16Z7C19	18			•		•				•			•		•					$ 369.95
	Z4203	20Y1C50	20			•		•				•			•		•					—
	Z3208	16Z7C50	20			•		•				•	•		•		•					—
	Z4501J	20Y1C50	23			•		•				•			•		•					$ 469.95
	Z4512	20Y1C50	23		•			•				•			•		•					$ 529.95
	Z4507	20Y1C50	23			•		•				•	•		•		•				•	—
	Z8530	16Z7C50	23	•				•				•	•		•		•				•	$ 975.00
	Z8550	16Z7C50	23	•				•				•	•		•		•				•	$1225.00

*Color Slide Theatre

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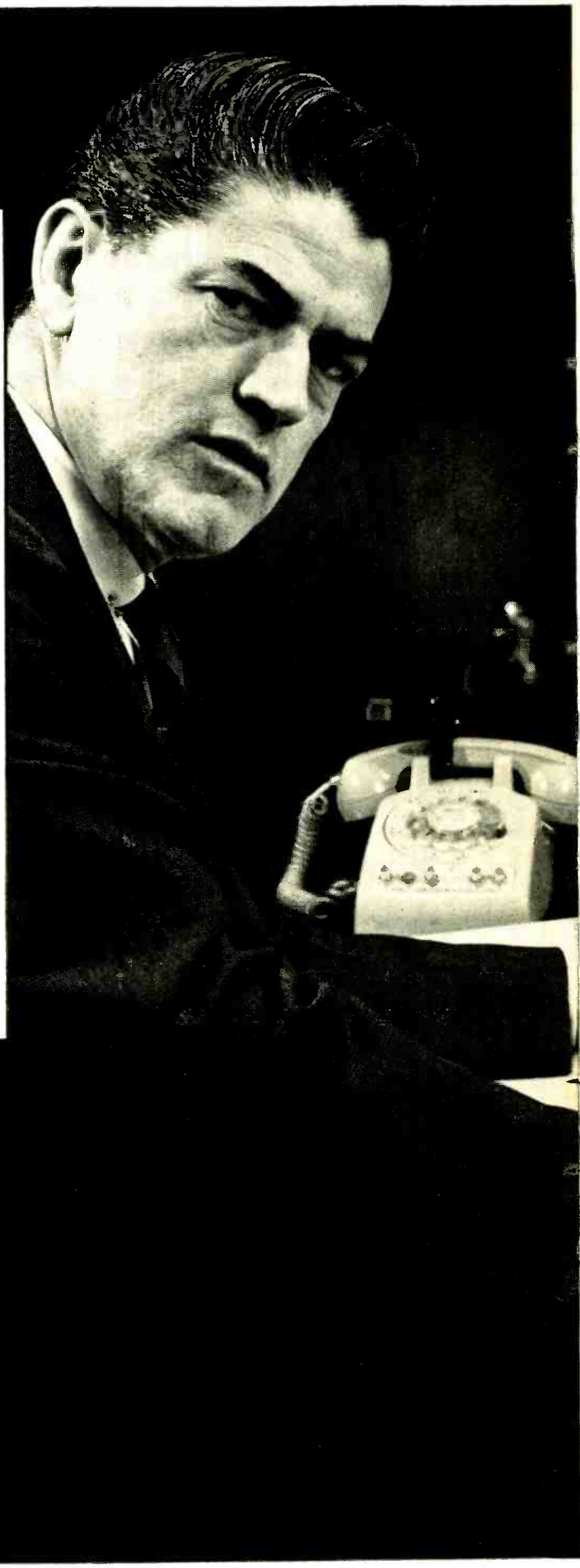

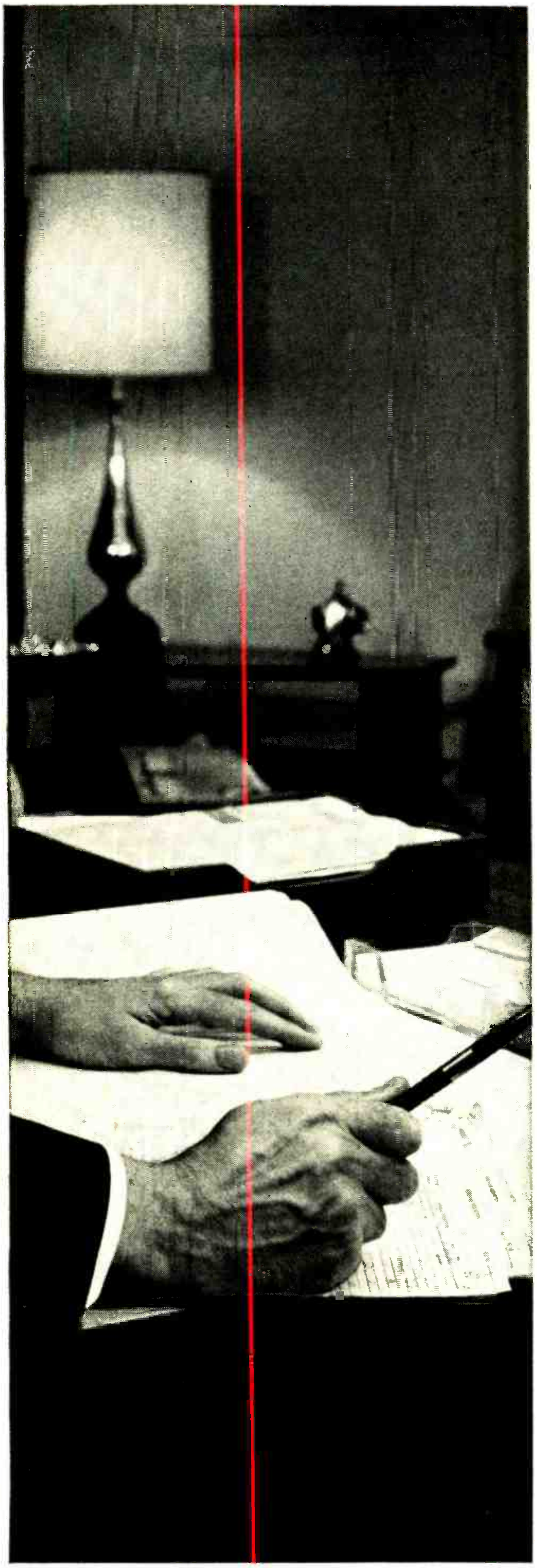

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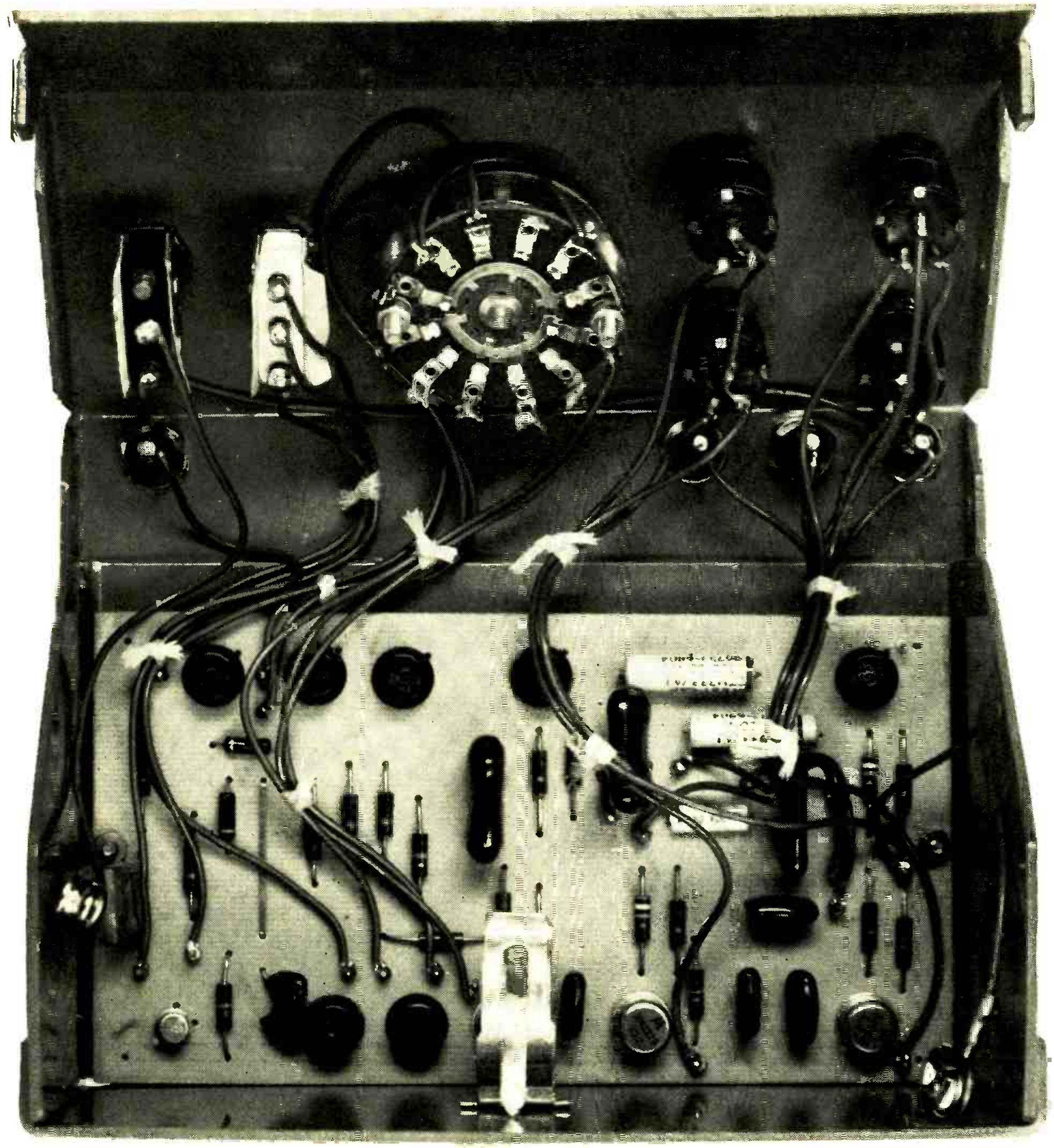


BUILD BEGINNER'S

Get top quality pictures from your color TV

By BENNETT C. GOLDBERG

IF YOU'D LIKE AN INEXPENSIVE, functional and compact Dot-Bar generator to insure your color set always has "hi-fi" color, this project is for you.

Construction is simplified with the actual-size printed-circuit drawing shown. The unit (Fig. 1) operates on a 9-volt battery, fits in a small metal box, and puts out horizontal and vertical lines, dots and a cross-hatch pattern.

A second similar circuit (Fig. 2) is a Cross-Hatch generator that can be installed in any set with a service switch. It can be used when convergence circuits are adjusted.

How does it work?

The function of the Dot-Bar Generator is shown in the block diagram in Fig. 3. The circuit is straigatforward and explained as follows:

Transistors Q1 and Q2 form a free-running multivibrator which produces a square wave output. Because of the variation in tolerances of the components, one transistor will conduct before the other.

An increase in collector current for transistor Q1 causes a decrease in its collector voltage and a corresponding reduction in regenerative feedback through capacitor C2 to the base of transistor Q2. As a result, the current

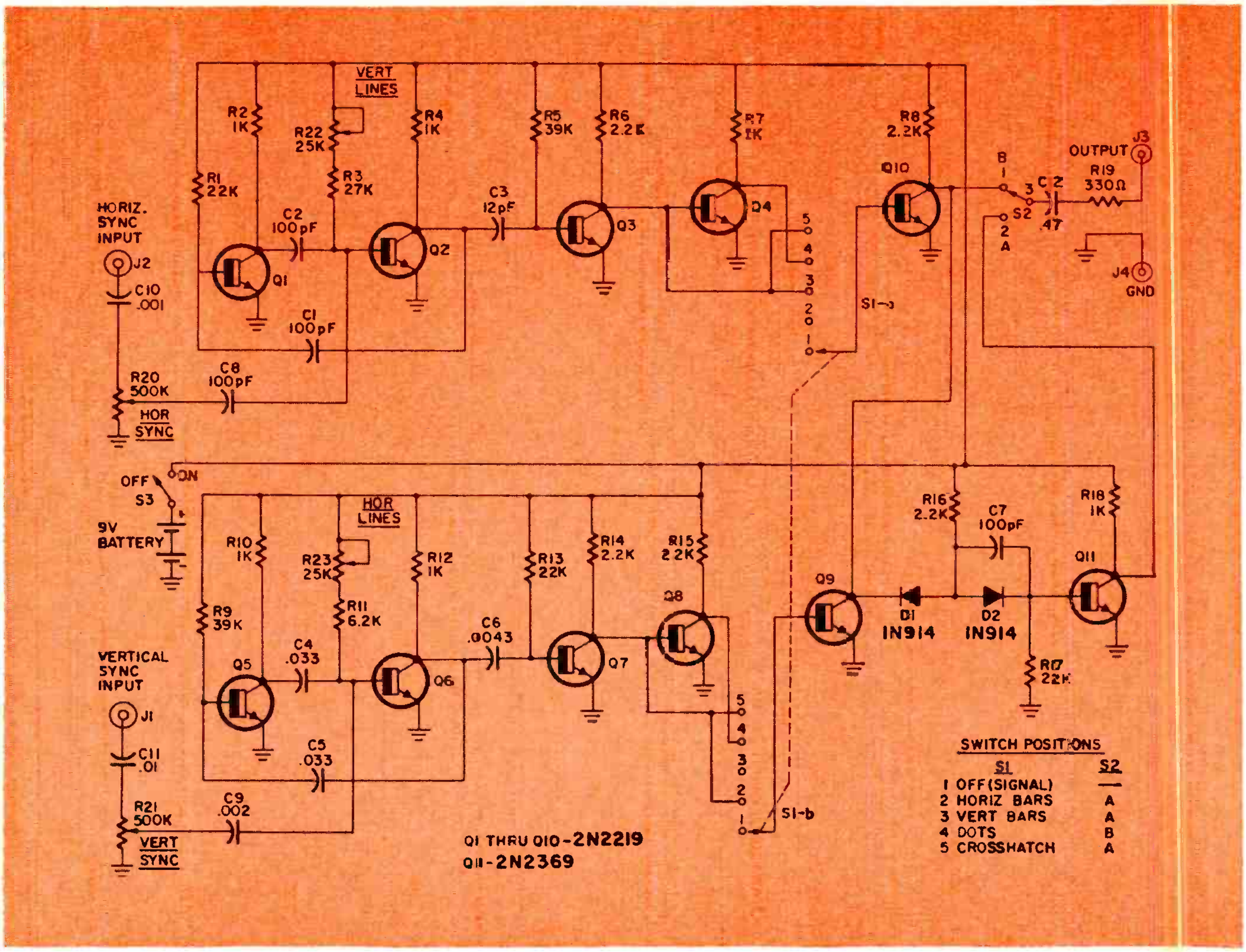


Fig. 1—Circuit for Dot-Bar generator. Transistors Q1–Q2 form a free-running multivibrator synchronized by 15,750-Hz horizontal sweep pulses, and Q5–Q6 operate as a 900-Hz multivibrator, synced by 60-Hz pulses from the vertical sweep circuit.

PARTS LIST

Resistors ¼ watt or more, 10%
R1, R13, R17—22,000 ohms
R2, R4, R7, R10, R12, R18—1000 ohms
R3—27,000 ohms
R5, R9—39,000 ohms
R6, R8, R14, R15, R16—2200 ohms
R11—6200 ohms
R19—330 ohms
R20, R21—500,000-ohm ½-watt linear potentiometer, Mallory SU-50 or similar
R22, R23—25,000-ohm ½-watt linear potentiometer, Mallory SU-29 or similar

Capacitors
C1, C2, C7, C8—100 pF, 100V, 10% mica
C3—12 pF, 100V, 5% mica
C4, C5—0.033 μF, 50V, 5% disc ceramic
C6—0.0043 μF, 100V, 5% mica
C9—0.002 μF, 100V, 10% mica
C10—0.001 μF, 500V, 20% mica
C11—0.01 μF, 500V, 20% disc ceramic
C12—0.47 μF, 50V disc ceramic

Semiconductors
Q1–Q10 (Fig. 1), Q1–Q8 (Fig. 2)—2N2219
Q11 (Fig. 1), Q9 (Fig. 2)—2N2369
D1–D2—1N914 diodes

Switches
S1—2-pole, 5-position, nonshorting rotary. Centralab PA-1003 or equal
S2—Spdt
S3—Spst

MISC—11 transistor sockets, 9-V battery (NEDA No. 1600 or equivalent), tip jacks and plugs, circuit board, sloping-panel case at least 5¼" wide, 3" deep and 2¾" high, test leads and clips.

DOT-BAR GENERATOR

through Q2 decreases steadily as the current through Q1 increases until Q2 is cut off. Capacitor C2 then discharges until forward bias is re-established across the base-emitter junction of Q2. Current through Q2 then decreases until Q1 is cut off. Capacitor C1 is coupled from the collector of Q2 to the base of Q1 so the cycle is repeated.

A positive input trigger pulse, 15,750-Hz, from the horizontal sweep circuits of the television receiver is used to sync the multivibrator. The frequency of the multivibrator is set for a multiple of 15,750 Hz by adjusting R22.

The multivibrator operates at 180 KHz, which produces approximately 12 lines. There is enough variation in the adjustment of R22 to provide more or fewer lines as desired.

Transistors Q5 and Q6 operate as a 900-Hz multivibrator. Its frequency is adjusted by R23. A 60-Hz positive trigger pulse from the vertical sweep circuits of the receiver is used to sync this multivibrator.

Transistor Q3 is a pulse shaper. Capacitor C3 and resistor R5 are connected as a differentiator network. Transistor Q3 is biased on by R5. The negative-going differentiated edge of the square wave of multivibrator Q1 and Q2 turns transistor Q3 off. This produces a positive, 0.1-μsec-wide, 180-kHz pulse.

Transistor Q7 is also used as a pulse shaper, but a 50-μsec-wide, 900-

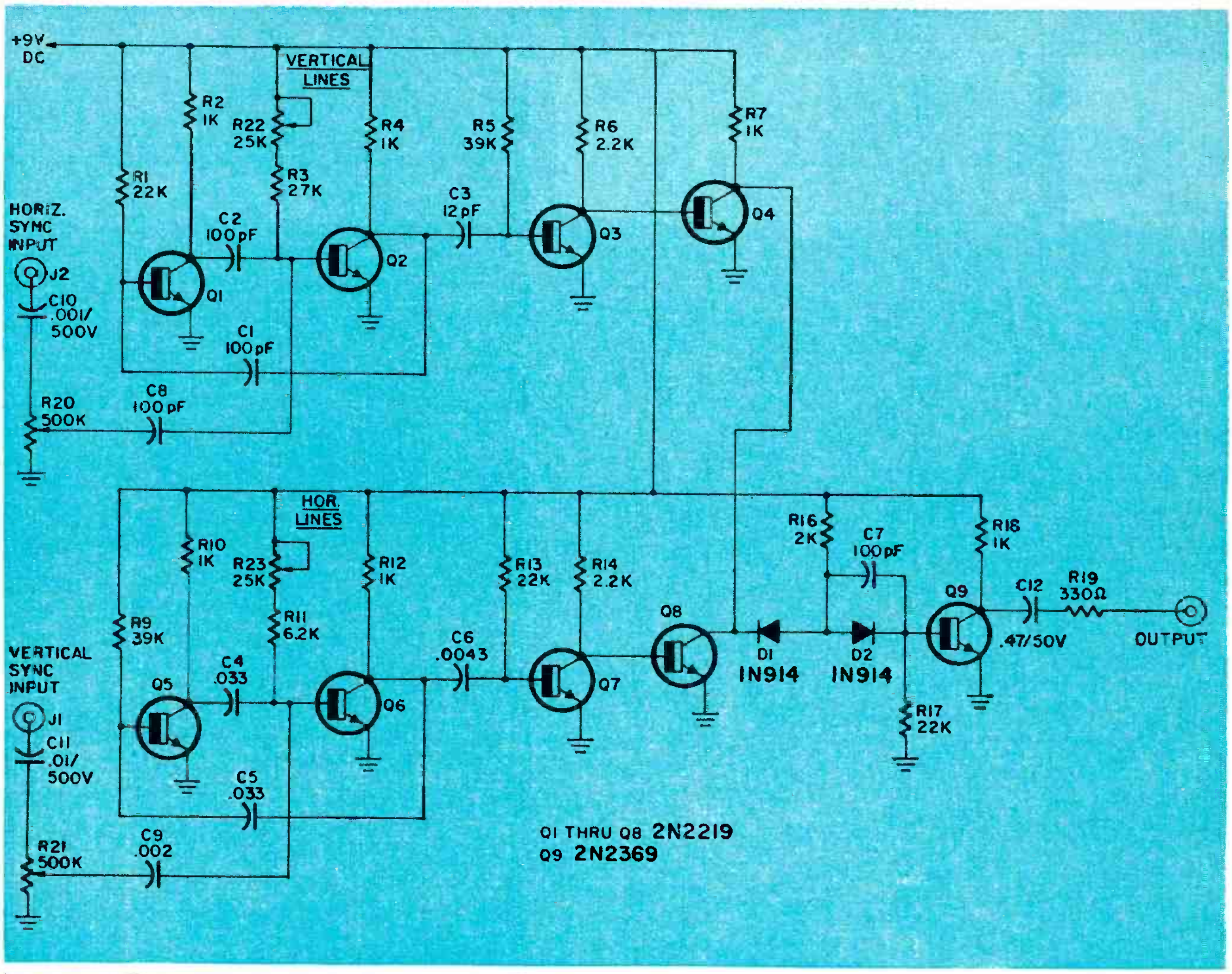
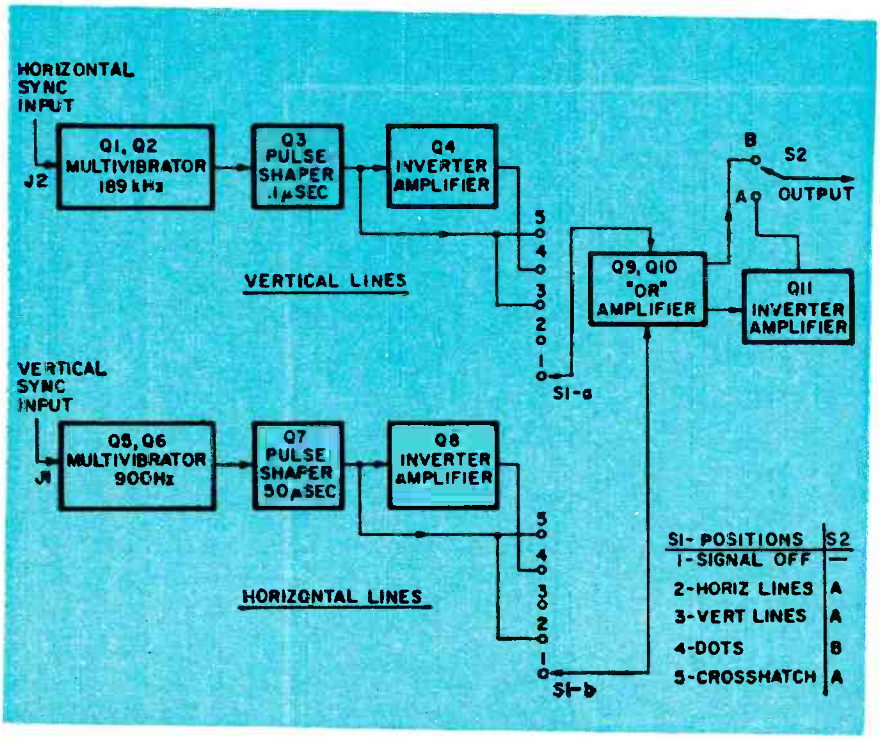


Fig. 2—Cross-Hatch generator circuit that can be installed in sets with service switches. The 180-kHz output of Q3 and 900-Hz Q7 output are combined at R7. The signal is inverted and fed to the last video amplifier of the set through the service switch.



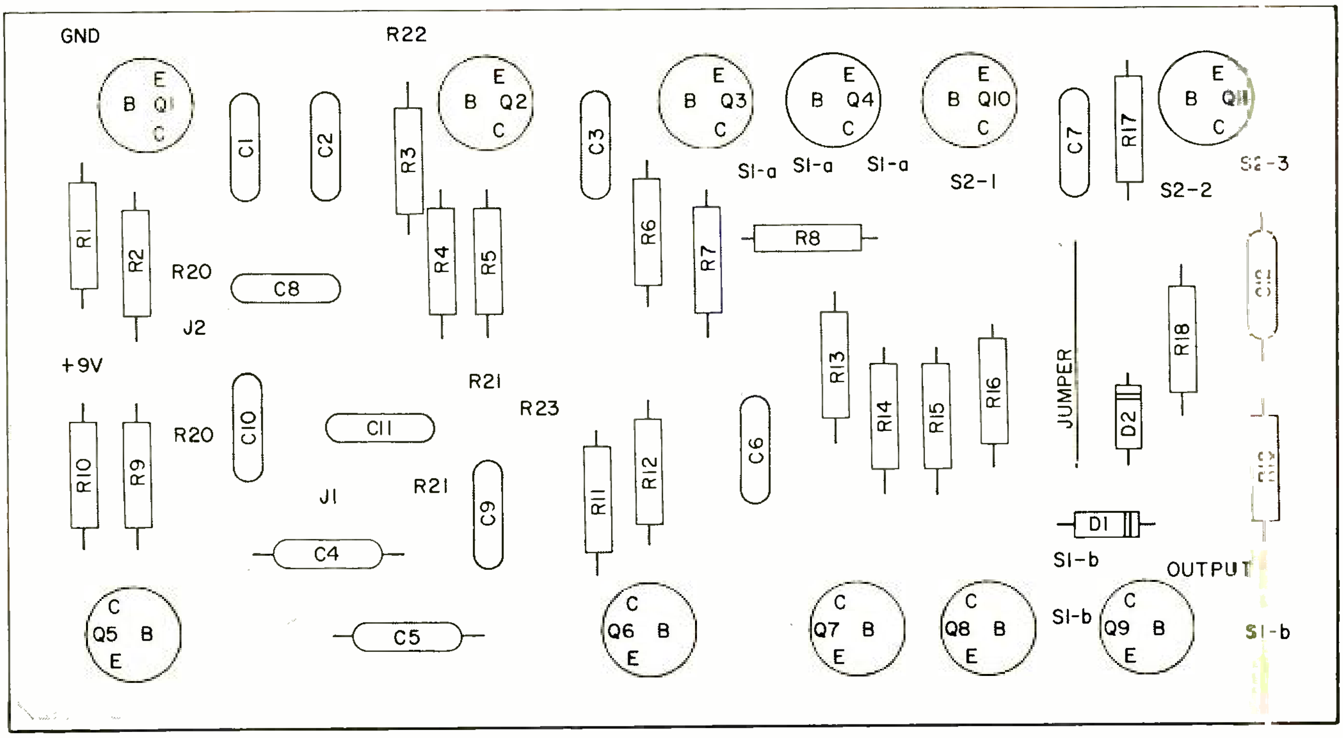
Hz rate positive pulse is obtained.

Transistors Q4 and Q8 are inverting amplifiers. Transistors Q9 and Q10 have a common-collector load and perform an "OR" function. Transistor Q11 is a low-impedance inverting output driver.

Switch S1 selects the required mode of operation to form the desired output signal to the bases of transistors Q9 and Q10. Switch S2 selects the correct output phase to the receiver.

Circuit operation of the cross-hatch generator (Fig. 2) uses transistors Q1 and Q2, Q5 and Q6 as multivibrators. Transistors Q3 and Q7 are pulse shapers, Q4 and Q8 is the OR

Fig. 3—Block diagram shows operation of Dot-Bar generator. After shaping, both multivibrator outputs are inverted and amplified by Q4 and Q8. Transistors Q9–Q10 operate as an OR amplifier with function switch S1. S2 selects output phase.



Placement of components on PC board as seen from component side.

amplifier and Q9 is the inverting and output amplifier. Since the switches are eliminated in this circuit, the outputs of Q3 (a 0.1-μsec, 180-kHz positive pulse) and Q7 (a 50-μsec, 900-Hz positive pulse) are applied to the bases of Q4 and Q8 combining these two frequencies at the common collector R7. This produces a cross-hatch pattern and is inverted by Q9 to give the proper output phase.

How to build it

A printed circuit was developed for Fig. 1, but it can also be built using breadboard material such as Vector board. All parts should be of good quality, but nothing is critical to the circuit except C3 and C6. Since they determine the pulse widths, they should be as close to the specified value as possible.

The transistors are silicon npn small-signal high-frequency types having excellent rise and fall times. I did not try any of the economy planar passivated transistors such as the 2N3855 or the 2N3856, but do not see why they won't work in this circuit as they are very similar to the 2N2219 and the 2N2369 transistors.

After completion, apply power and check the current. It should be near 50 mA for the dot-bar circuit and about 40 mA for the cross hatch circuit.

Using the generator

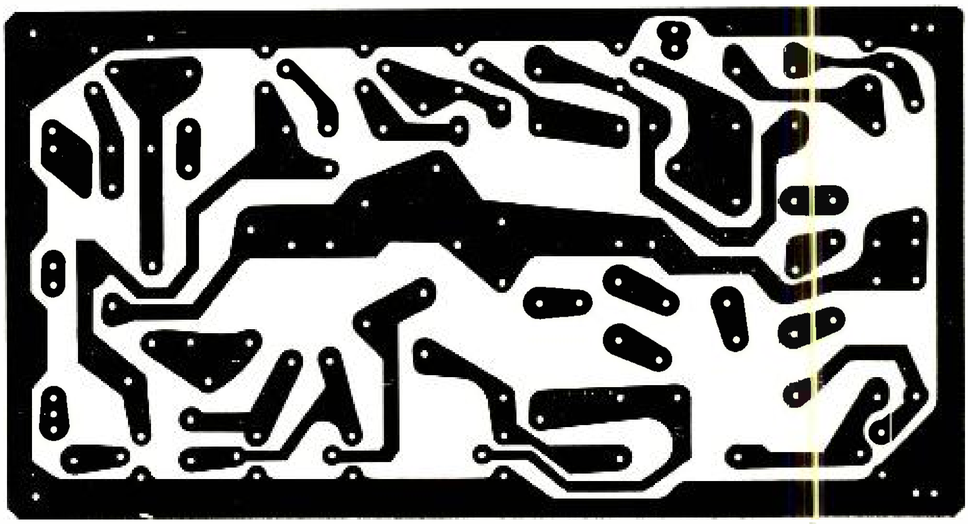
Both generators require external horizontal and vertical synchronization. To provide it, clip the horizontal lead, J2, of the generator to the insulation on the red lead of the deflection yoke (*clip only, do not solder*). Clip the vertical lead, J1, of the generator to the insulation on the yellow lead of the deflection yoke. If you have any problem with vertical sync, connect clip J1 to any of the leads of the vertical output transformers or terminal "C" on the convergence board of color receivers like the RCA CTC-15, 16 series.

Connect the ground lead of the generator to the receiver chassis. Connect the output of the generator to the grid of the last video amplifier using a test socket adapter.

Now set the channel selector to a local station. This will provide synchronization for the sweep circuits of the receiver and generator. Next set generator circuit to cross-hatch pattern and adjust R20, R22 and R21, R23 until the pattern stays in sync.

There should be 12 horizontal and 15 vertical lines when the generator is in sync. Some minor adjustment of the vertical hold on the color receiver may be required.

Adjust brightness and contrast controls for the sharpest patterns. Now you can set S2 to position B for dots and A for other modes. This applies the correct phase signal to the video amplifier grid, producing white lines and a black background on the receiver picture tube. Program pictures will also be in the background. **R-E**



Reproduction of PC board used by author. Board is shown actual size as it is used.

How the J-K Flip-Flops

Four steps to understanding a useful IC logic device

By LEONARD E. GEISLER*

BASIC LOGIC CIRCUITS SUCH AS THE AND, OR and NOT operate without memories. The AND circuit, for example, will provide a logic ONE output only when all inputs to the circuit are also logic ONE simultaneously. Otherwise, the circuit remains in a logic ZERO state.

Logic circuits that can be placed in either of two stable states and "remember" this state until switched to another are called *bistable* or flip-flop.

In various combinations these bistable circuits form register, counter, storage and other essential digital circuitry. The JK flip-flop described is ideal for counting and divider circuits since it has one output pulse for each two input pulses.

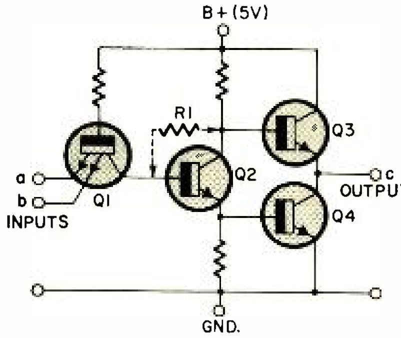
Basic NAND circuit

Study the circuit diagram of the basic two-input NAND element (Fig. 1). Assume input terminals *a* and *b* are at ground potential; Q1's base is tied to B+ through a biasing resistor, causing forward bias as long as one or both input terminals are grounded. The forward bias applied to Q1's base causes Q1 to go into saturation, grounding Q2's base. (Q1 cannot draw much collector current because of the very high reverse base–collector resistance, R1, internal to Q2.)

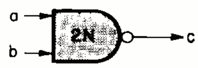
With Q2 cut off because of the ground level at its base, its collector potential rises toward B+ and its emitter potential falls to ground. Transistor Q3's base, tied to Q2's collector, sees the positive rise in potential; Q3 saturates, carrying terminal *c* toward B+. At the same instant Q4 sees virtual ground potential and cuts off. If either of the input terminals is raised from ground, Q1 operating conditions do not change. But if *both* input terminals are raised from ground, Q1 cuts off and the current previously flowing through the base–emitter diode in Q1 now flows through the base–collector diode path to Q2's base, causing Q2 to saturate.

As Q2 saturates, its collector potential drops toward ground and its emitter potential rises toward B+. Transistor Q2's ground-going collector potential causes Q3 to cut off. Now Q2's rising emitter potential pulls Q4 into saturation (Q4 draws collector current from B+ through an external load), and Q4's collector potential drops to virtually ground level.

*Publication engineer, Bryant Computer Products.



A- BASIC 2-INPUT NAND ELEMENT (INSIDE THE IC CHIP)



B- BASIC 2-INPUT NAND LOGIC SYMBOL (POWER CONNECTIONS USUALLY OMITTED FOR SIMPLICITY)

Fig. 1—With one or both inputs grounded, Q1 is at saturation, holding NAND off.

In computer designer jargon, a ground-level signal is usually called "logic ZERO" and a high-level signal is called "logic ONE." To simplify descriptions, the ZERO condition at an input or output terminal is signified by a bar above the terminal designator. Thus, ā means that terminal a is at virtual ground level (or logic ZERO). Absence of the bar indicates the signal input is at the high level (or logic ONE). In Boolean algebra, the input conditions required for a NAND to produce either a high (logic ONE) or low (logic ZERO) output can be shown in the following formulas:

$$(a \cdot \bar{b}) + (a \cdot b) + (\bar{a} \cdot \bar{b}) = c \quad (1)$$

and

$$a \cdot b = c \quad (2)$$

Note that only (2) above produces a logic ZERO output. The dot signifies "and" and the plus sign "or."

Two NANDs make a flip-flop

To produce a simple "set–reset" flip-flop, two two-input NANDs are connected as shown in Fig. 2. The cross coupling insures that the flip-flop will toggle (change states) only when the correct input conditions are present.

For example, assume that NAND 2N1's output is high and NAND 2N2's output is low (this is indicated in the figure by numeral 1 next to terminal c of 2N1 and *0* next to 2N2 terminal c). What conditions exist at the input terminals to produce the outputs shown?

By examining the formulas and the flip-flop logic diagram we conclude that 2N2 must have terminals a and b high for a ZERO output, satisfying formula (2). In practice, 2N1's terminal a is also high; both inputs are

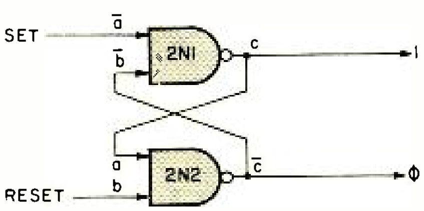
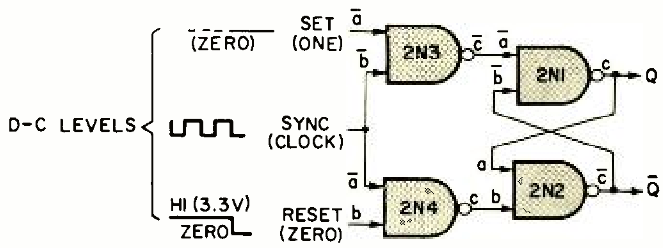


Fig. 2—Two NAND elements connected as shown make a set-reset (RS) flip-flop.

Fig. 3—Addition of two more NANDs will provide for clock-pulse sync of the RS flip-flop. Flip-flop toggles whenever clock pulse occurs simultaneously with data pulse.



high at all times except when the flip-flop is toggled to the other state by momentarily grounding the appropriate input terminal.

Clocked RS flip-flop

The simple set–reset (RS) flip-flop is used generally where simple pulse-train counting or frequency dividing is required without regard to either output state or synchronism with other pulses in a system. For more precise applications two more NANDs are added to the RS flip-flop (Fig. 3), and one input is tied each to a clock-pulse source.

Now when the clock pulse occurs while either input is being pulsed, the flip-flop toggles (provided, of course, the set or reset pulse is applied to the side opposite the one which is high). Note that addition of the two NANDs reverses the sign of the activating pulses; now a positive-going pulse is required to toggle the flip-flop.

By adding another input to the NAND flip-flop elements of Fig. 3 (removing the two-input NANDs and substituting two three-input NANDs), the clocked flip-flop (Fig. 4), is improved considerably since the output can be set or reset to a desired state before starting the counting operation. This means, for example, a count can always be started at zero, or a given quantity can be counted or recorded, and the counter can then be reset to zero for the next counting operation.

JK flip-flop

All the flip-flops described have one common failing: they can be tricked into "racing" or dithering between states if both signal inputs are pulsed simultaneously. The JK flip-

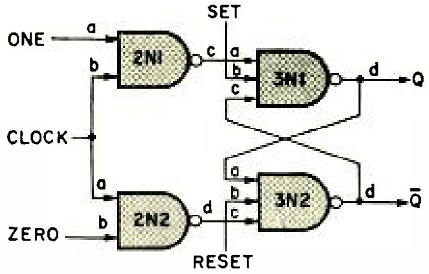


Fig. 4—By using 3-input NANDs in place of the NANDs in Fig. 3, flip-flop can be started at zero independent of input.

flop has been developed to correct such a problem (Fig. 5). Adding another flip-flop to the circuit in Fig. 4 makes a master–slave device that responds in a very predictable fashion to simultaneous input pulses; it simply toggles each time the clock pulse coincides with the data pulses (complementary inputs).

The logic elements and connections comprising a JK flip-flop are in Fig. 5. Two three-input and one one-input NANDs, 3N1, 3N2 and 1N1, together with two two-input NANDs, 2N1 and 2N2, form the "master" flip-flop element. Two more two-input and two three-input NANDs form the "slave" flip-flop element (2N3, 2N4, 3N3 and 3N4). Slave output is cross-coupled back into the master input for combining with J and K inputs and clock pulses.

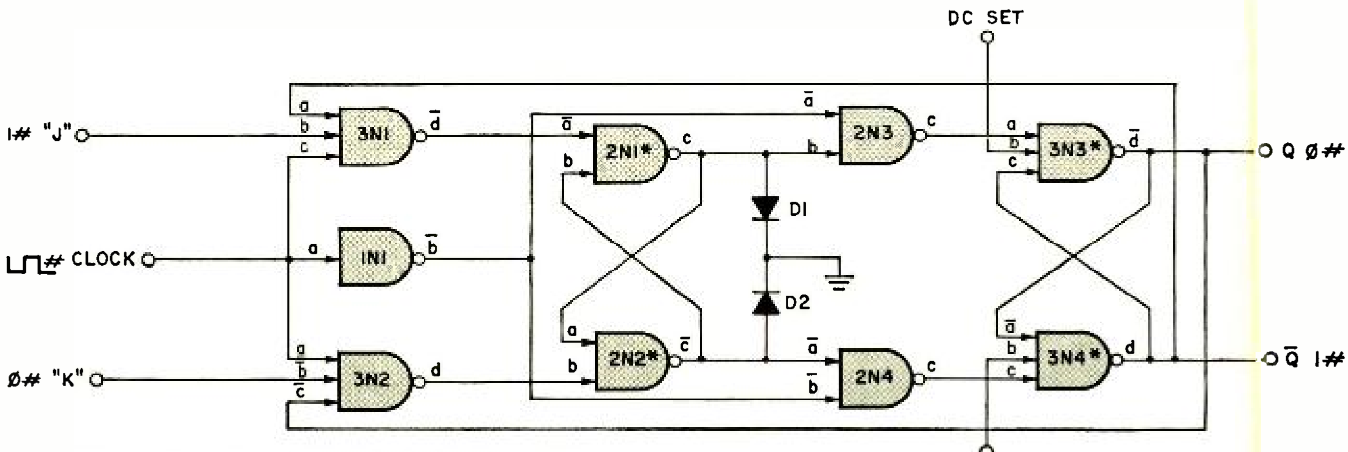
Internal quiescent levels of all individual logic elements are shown by the lower-case letters next to each element terminal. Remember, a bar above a letter signifies that the designated terminal is at the logic ZERO level, and letters without the bar indicate logic ONE level at the designated terminal. The flip-flop operates in the following manner.

Assume dc reset has placed Q low, Q high, and the clock pulse (train) has just gone high and J is high. The dc conditions within the circuit package are indicated by the various lower-case letters at this moment in time.

As the clock pulse falls to ZERO, 3N1-d goes high, adding to 2N1's input. 2N1-c starts to go low, but the stored charge in D1 holds 2N1-c high just long enough that the ONE coming from 1N1-b can add at 2N3's input, subsequently setting 2N3-c low to shift 3N3-a high. By now D1 has discharged and 2N2-a can go low with 2N1-c to complete the toggling of the master flip-flop (2N2-c high). At this moment, the clock pulse has again gone high and 1N1-b has already gone low, and 2N4-c remains high so as to not interfere with the other ONEs at 3N4's inputs.

Earlier, the Q-output, ZERO-level feedback to 3N2-c changed to a ONE level, making the K input ready to accept a data-ONE level (whether one is forthcoming is immaterial at the moment). The Q-output, ONE-level feedback to 3N1-a when Q goes to ZERO cancels the effect of the J ONE level.

This means that only a ONE level at the K input will reset the flip-flop to its former state. Should the J-input level stay at ONE as the K level shifts to ONE, the flip-flop will toggle as just stated. If both J and K levels remain at ONE, the flip-flop will toggle again on the next negative-going clock-pulse edge, and will continue toggling as long as both inputs are high. If the J, K and clock inputs are tied to B+ and the dc set and reset terminals are used, the flip-flop works as an RS flip-flop. **R-E**



* THESE ELEMENTS ARE SOMETIMES SHOWN AS NORs.
\# INPUTS AND OUTPUTS SHOWN AT A MOMENT IN TIME.

Fig. 5—Functional logic diagram of the J-K flip-flop. Additional flip-flop (see Fig. 4) prevents simultaneous input "racing."

ABC's of

by SYLVANIA TECHNICAL STAFF

DEFECTS IN TRANSISTOR CIRCUITS CAN BE LOCALIZED BY MEASURing the voltage on the transistor terminals, since the defective component often upsets the current drawn by the stage. The change from normal causes a different voltage to develop across the resistive components in the circuit.

A typical transistor circuit with voltmeter checkpoints is shown in Fig. 1.

The emitter resistor is common to both the input and output circuits, so voltage drop V_m, across the resistor, is a result of the total transistor base and collector current. This voltage drop is a good indicator of transistor current. Collector current can be determined by simply measuring the voltage drop across decoupling resistor R4 and using Ohm's law.

If the voltage across the emitter resistor, R3, is off, we then want to know if the transistor can control current. If we determine that the transistor base is not capable of control, we can assume the transistor is defective. If we find the base is capable of current control, we would then assume that the stage is biased incorrectly, indicating a defective bias resistor or other component such as a shorted coupling capacitor.

One way of determining if the transistor base is capable of controlling the current is by temporarily adding to or subtracting from the bias voltage and noting if there is a corresponding change in voltage drop across emitter resistor R3 or decoupling resistor R4 (see Fig. 2).

Suppose the emitter voltage is higher than normal. Since the current must be high, we temporarily remove the forward bias from the stage and determine if this will reduce the voltage drop across R3. One common way of removing forward bias is to short the base and emitter together using a small screwdriver. This may not, however, always give a clear indication of current control.

A more certain way is to use a short piece of jumper wire to connect the base back to the same source potential as the emitter, which in (Fig. 2) is ground. This positively removes any ofrward bias.

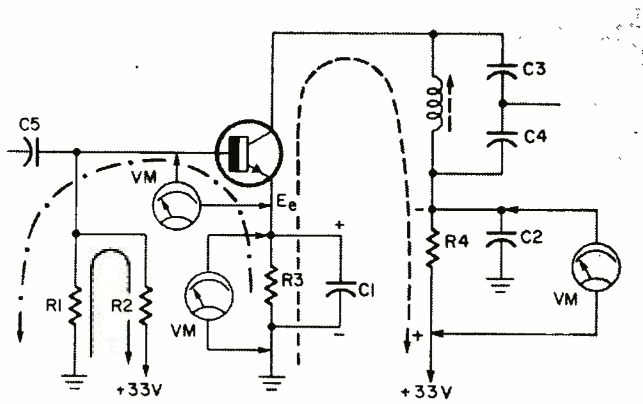
If, after the forward bias is removed, as indicated the drop across the emitter resistor does not fall to a low value, the base element is not able to control the current and the transistor is probably defective. If the voltage drop across the emitter resistor does fall to a very low value, the base can control current, the transistor is probably good.

If measuring the emitter voltage discloses an abnormally low reading, try increasing the forward bias temporarily to determine if the base element can control the current (see Fig. 3). Temporarily connect the base to the collector through a series resistor R similar in value to bias resistor R2. Obviously, first make sure that collector voltage is present.

If the transistor base element has control of the current, connecting the resistor as shown should increase the voltage drop across resistor R3. This indicates that the transistor is probably good and a biasing defect such as R1, R2, or a shorted C5 is indicated. If attaching the resistor as indicated does not increase the current, the transistor is open.

The procedure can be simplified for most transistor in-circuit testing by the following procedure.

Measure collector voltage. If it is lower than the supply voltage, the transistor is conducting. With the meter still on the collector, short the base to the emitter. If collector voltage rises to the supply voltage, the transistor is not shorted and can be turned off. This simplified procedure will not always work; i.e., a collector connected to ground. But as experience in servicing transistor circuits is gained, it becomes easier to see



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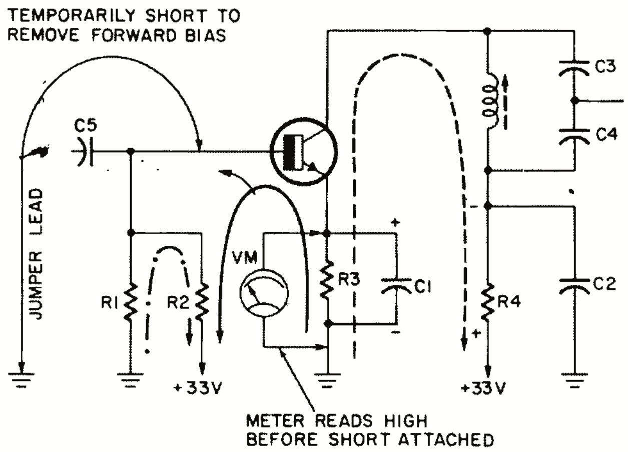

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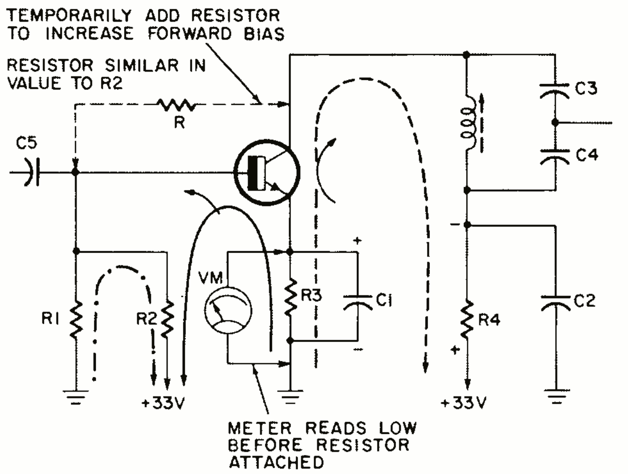

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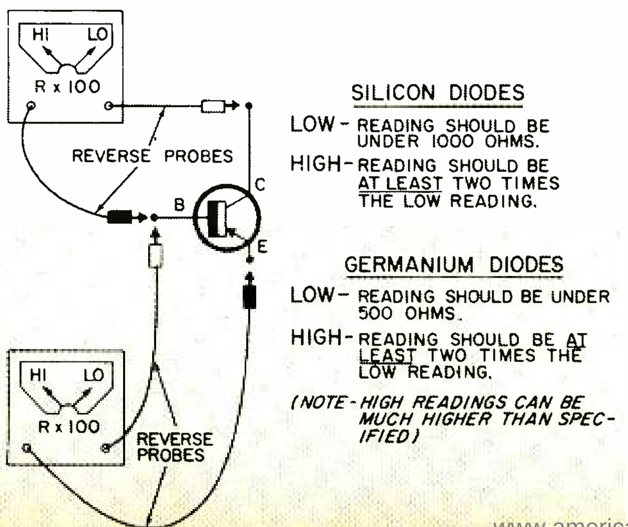


Transistors

where this technique is applicable and it certainly is a fast, simple way to evaluate a transistor without removing it.

Once you are sure the transistor cannot control current, it is usually advisable to remove the transistor. This will allow you to measure the bias resistor values without the inaccuracies of having the transistor junctions across them. Every effort should be made to determine that a particular stage does contain a defect before removing the transistor. If a transistor appears to be open by the above checks, before removing it from the circuit, check it as follows.

In-circuit diode checks

Use an ohmmeter on its R times 100 scale to check each of the two diodes in a transistor (Fig. 4). To check the collector diode, connect one lead to the base and the other to the collector and note the reading. Reverse the leads and note the second reading.

The lowest reading should be under 500 ohms for germanium transistors and under 1000 ohms for silicon transistors. The high readings should be at least two times the low reading. Perform the same test on the emitter diode to check the transistor completely. Make these checks with power removed from the circuit. Detector and agc diodes can be checked in the same manner.

Transistor operating class C

In a class C stage where collector current flows for relatively short intervals of time, dc voltage measurements on the transistor differ from those in a class A stage.

Check forward bias on pnp transistors by connecting the positive voltmeter lead to the emitter and the negative lead to the base (see Fig. 5). Read the bias indication directly on the meter. Measuring the emitter and base voltages to ground, and subtracting them, is not reliable or accurate.

The collector will vary as a function of base voltage and input signal (see Fig. 6). The input signal has the same magnitude in all three cases. When the base voltage is 0.65 volt, the input signal adds to and subtracts from the base voltage and we get a linear output. This is class A operation and the average collector current is a constant value.

When base voltage is 0.5 volt, only the positive-going half cycle of the input signal effectively adds to the base voltage, causing an increase in collector current. The negative portion of the input signal drives the transistor into cutoff. This can be likened to class B operation where collector current flows for only one-half the cycle.

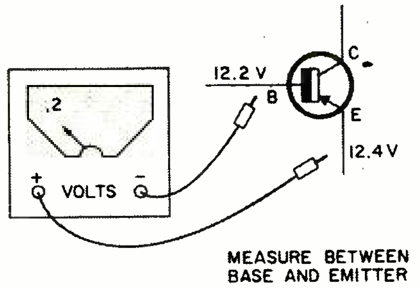
When base voltage is 0.4 volt, the transistor is in cutoff and no collector current flows. Only the most positive portion of the input signal causes collector current which is in pulses representing the positive peaks of the input signal. A class C stage is usually biased into cutoff so no collector current flows until the input signal turns the stage on.

It becomes apparent that the amount of base to emitter voltage or forward bias measured on a stage will depend upon whether the stage is operating class A, B or C.

To demonstrate how voltages will vary from a class A stage to a class C stage, we can make the class A amplifier into an oscillator as shown in Fig. 7.

The usual forward bias will not be found on converter and oscillator transistors since bias varies with frequency of oscillation. The emitter and base voltages of oscillators and converters are shown nearly equal on the schematics, although they do vary somewhat. If a radio converter has a steady 0.2-volt bias when it is tuned, the oscillator is probably not functioning.

That's it on transistor stage checking. Next time we'll take a detailed look at transistor tests and circuit applications. **R-E**



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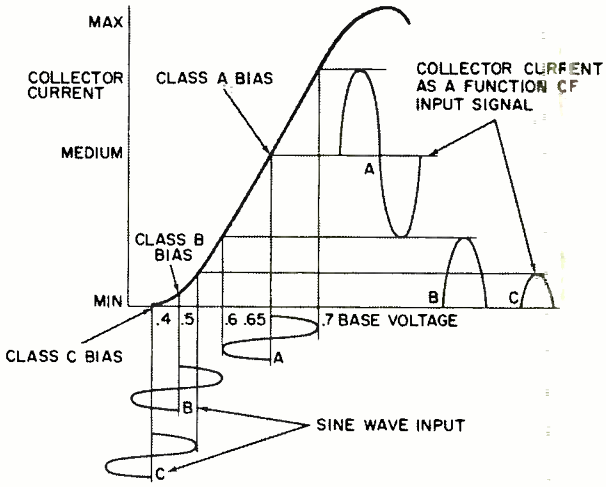

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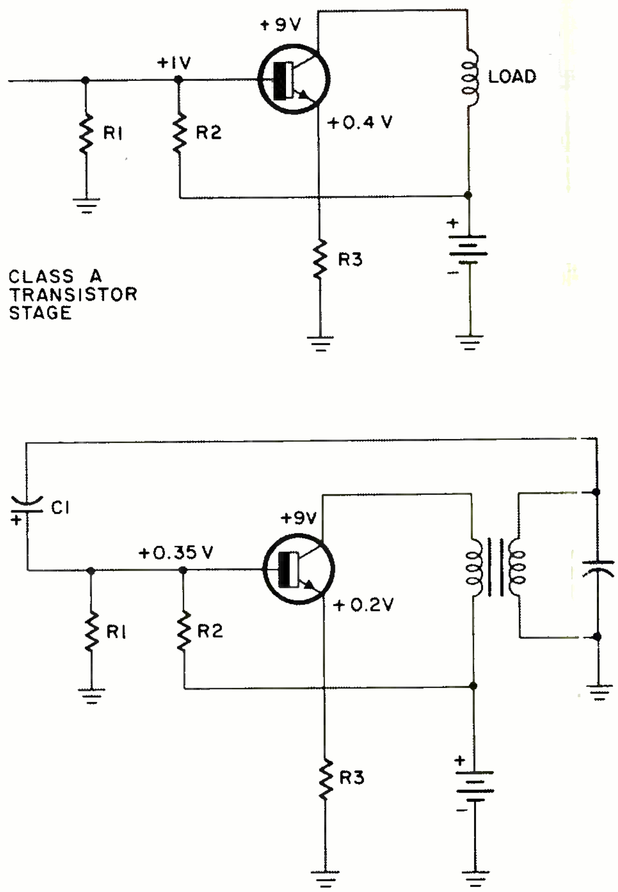


TRANSISTOR OSCILLATOR

7

Spot Color Faults Fast

Simple tests with meter and scope pinpoint color troubles

By MATTHEW MANDL
CONTRIBUTING EDITOR

RAINBOW, CROSSHATCH AND DOT GENerators are useful to set color balance, check chroma circuitry, adjust linearity and correct convergence. Frequently, however, our old standbys, the vtvm and scope, are all you need to localize many color circuit faults. Similarly, tube and transistor checkers are a must in any fully equipped shop, but this doesn't mean they are vital to every servicing job.

When we have a general idea of circuit function and can relate it to trouble symptoms, we can simplify tests. In many instances we can pinpoint defective parts with minimal test equipment this way.

Bandpass and burst amplifiers

In color sets amplified video signals from the last video amplifier must have the 3.58-MHz burst and sync signals removed before they reach the chroma amplifiers and picture-tube grids. At the same time video signals must also be removed so only the burst signal is applied to the 3.58-MHz oscillator. This signal treatment and routing is done by the bandpass and burst amplifiers in the color circuits.

A typical system is shown in Fig. 1. It is used in the Westinghouse V2656 color receiver chassis. The amplified video signals are applied to both the burst and bandpass amplifier grids. The 3.58-MHz burst signal occurs during the last part of the horizontal blanking, hence a pulse from the horizontal output circuit is used to gate the burst amplifier *on* only during blanking.

For the circuit shown in Fig. 1 this is done by initially establishing a high bias between grid and cathode by using a high-value cathode resistor (82K). Plate current flow increases cathode voltage and makes the grid relatively negative with respect to the cathode.

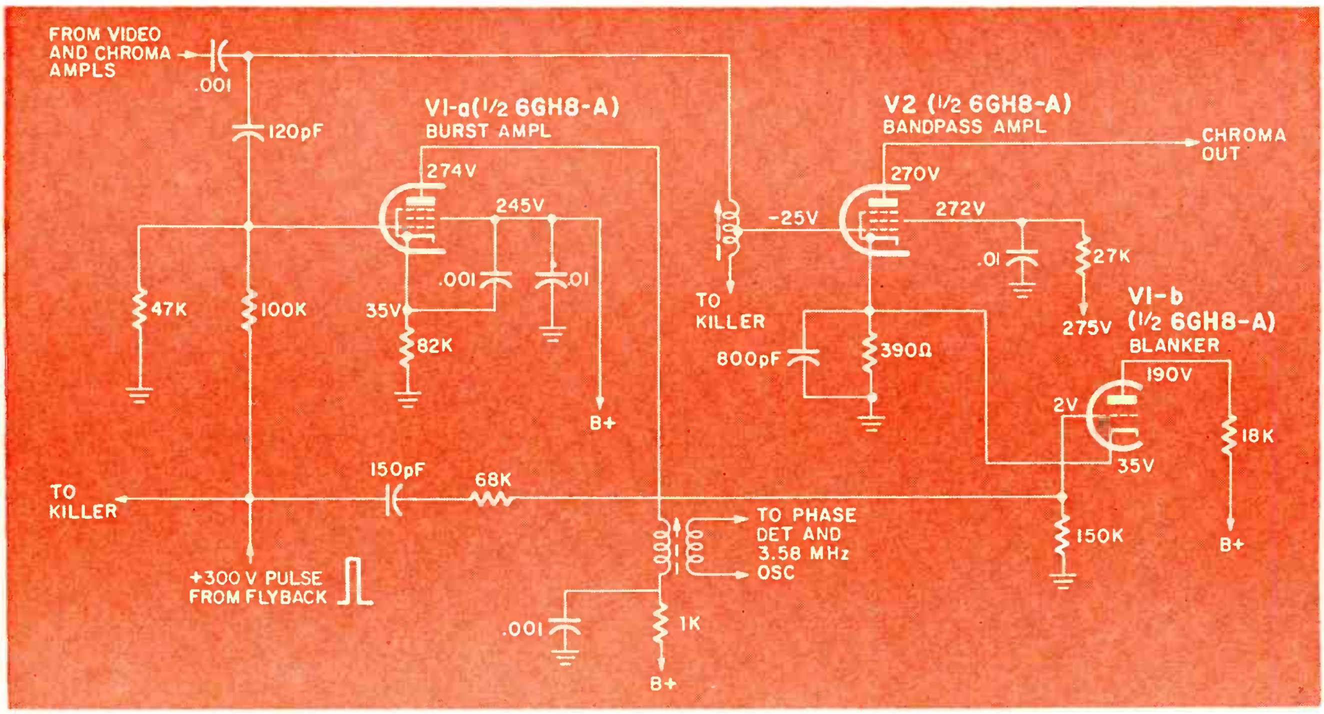
With high bias, amplification is down and, if an additional dc signal is present at the grid, the tube cuts off. During the horizontal blanking interval, however, a high-voltage positive pulse is applied to the burst amplifier's grid. This decreases bias and raises conduction and amplification. The synchronizing 3.58-MHz burst now appears in the anode circuit of the burst amplifier and is applied to the 3.58-MHz phase detector and oscillator tube.

For the bandpass amplifier the bias is set so the tube conducts and amplifies normally between horizontal blanking pulses. When blanking occurs, the bandpass amplifier tube is driven into cutoff and the sync and burst signals are removed from the output. Sometimes the blanking signals are applied directly to the cathode.

Often, however, a separate blanker is used to bring the pulse to the level needed for proper bandpass tube triggering. As shown in Fig. 1, the high-voltage positive pulse is applied to the grid of the blanker tube. Current flow through the blanker must go through the common-cathode resistor shared by the bandpass amplifier.

Thus, when the horizontal pulse appears at the grid of the blanking tube, it causes a high current flow. This current increase through the 390-ohm common-cathode resistor increases bias for the bandpass amplifier tube and cuts it off. The sync and burst are removed from the output chroma signals. The latter are then applied to the X and Z amplifiers and finally to the red, blue and green amplifiers preceding the color CRT.

Fig. 1—Burst amplifier V1-a, gated by flyback pulses, passes only burst signals to the phase detector and 3.58-MHz oscillator.



Troubles in the burst amplifier can cause loss of color sync, incorrect colors and color bands diagonally across the screen. Bandpass amplifier troubles can cause loss of color, herringbone interference lines or poor color contrast. If such troubles appear suddenly in a set which has been working properly, don't adjust phase controls in the 3.58-MHz section or turn the slug in the chroma takeoff coil to the bandpass amplifier until you've made other tests. It is highly unlikely that these would be mistuned suddenly. (This can occur because of shorted turns or excessive heat expanding coil forms.)

After the set has been on a while, if you find a lukewarm or cold tube, you've found the trouble. If you suspect tubes you can interchange similar types with others in the receiver to see if faults are transferred to the interchanged circuit involved or remain with the original circuit. If faults remain in the same circuit, chances are the tube is OK.

If the trouble still persists, check for the horizontal pulse at the grids of the burst and blanker tubes. The scope pattern will appear as shown in Fig. 2. For the receiver shown, the peak-to-peak voltage at the grid of the burst amplifier should be 67.5. Less than this will not provide sufficient conduction and amplification of the burst.

The peak-to-peak voltage of the pulse at the grid of the blanker should be 185. Because of the series 150-pF capacitor, the waveshape at the blanker grid will be modified somewhat, but will still resemble Fig. 2. If no signal

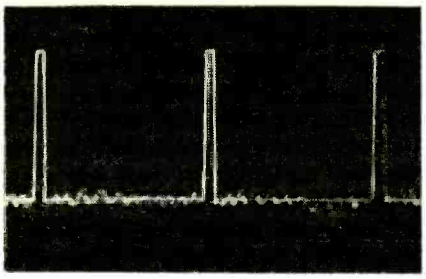


Fig. 2—Horizontal pulse on burst and blanker tube grids. Signal voltage on V1-a should be 67 volts p-p.

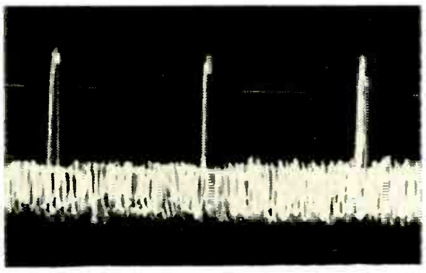


Fig. 4—Composite video as it appears on the plate of chroma amplifier in circuit below. Spikes are blanking and sync.

appears at this grid, look for an open 150-pF series capacitor or an open 68,000-ohm series resistor.

If pulse amplitudes are normal, use your vtvm to check voltages indicated on the schematic. Low anode or screen voltages call for a check of series resistors. Improper cathode voltages affect bias and are caused by defective cathode resistors or leaky (or shorted) cathode bypass capacitors. The voltage at the cathode of the bandpass amplifier, for instance, is 35 while grid voltage is −25 Thus, *grid bias* is actually 60 volts (read between grid and cathode) and any change here affects bandpass operation. If a series resistor is overheated (such as the 27,000-ohm screen resistor in the bandpass amplifier) look for shorted bypass capacitors which are bleeding excessive current through the resistor. Don't replace such a resistor without first checking the bypass capacitor.

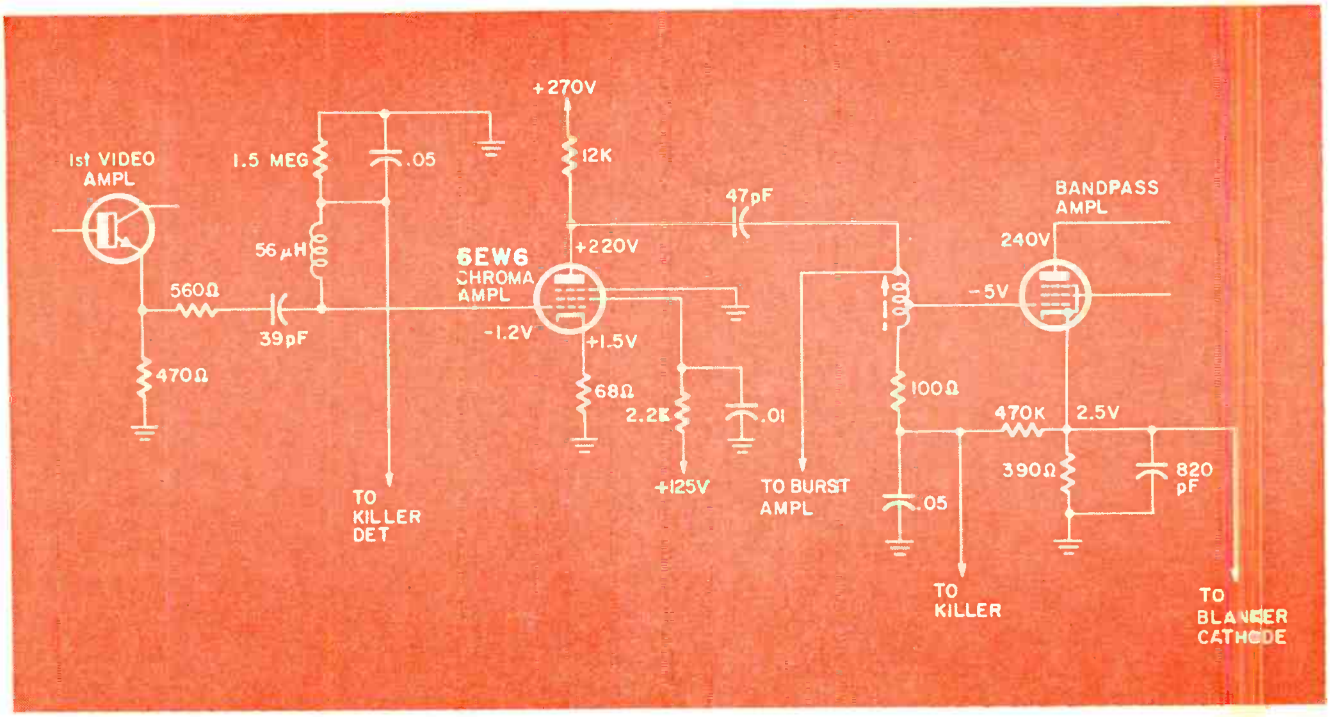
Chroma amplifier

In a number of sets the bandpass amplifier is preceded by a chroma amplifier that boosts the signal level. A typical one used in the Sylvania DO-9 chassis is shown in Fig. 3. This is a hybrid receiver, using both transistors and tubes. The chroma amplifier receives its signal from the first video amplifier emitter circuit.

Again, a quick scope test at the anode of the chroma amplifier can cut troubleshooting time. Here the composite video waveform should appear as shown in Fig. 4. The high-amplitude pulse signals represent the blanking and sync which accompany the video signal. To obtain this waveform the receiver must, of course, be tuned to a station. If this signal appears at the chroma amplifier output the circuit is OK, provided phase is correct. Sometimes an inoperative tube will have enough interelectrode capacitance to pass a signal to a sensitive scope, but the pulse will be inverted.

If trouble symptoms are still present, voltage checks will help pinpoint the faulty component. Make

Fig. 3—Chroma amplifier in hybrid Sylvania DO-9 chassis receives signal from first video amplifier. Fig. 4 shows 6EW6's output.



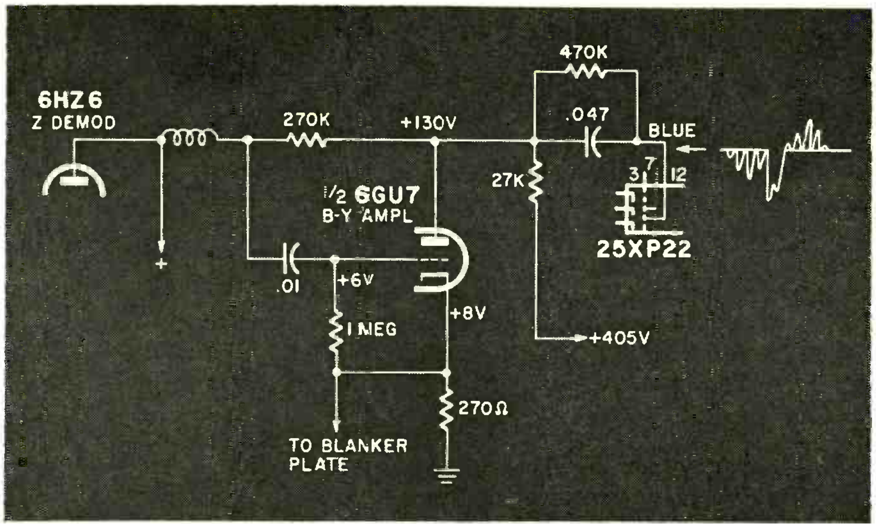


Fig. 5—Typical B—Y amplifier (RCA CTC35 series). Set uses two dual-triode 6GU7's.

sure the coupling capacitor between the chroma amplifier and the bandpass amplifier is not leaky, for it will change bias on the bandpass stage. Voltages may vary slightly from those shown on schematics, but if they are off by more than 5% or 10%, check resistor valves and bypass capacitors (for leakage or shorts).

B—Y amplifier troubles

A typical B—Y amplifier stage is shown in Fig. 5. Color distortion appeared on the screen as an absence of blue tones. This receiver uses two dual-triode 6GU7 tubes in this section, one for the R—Y and B—Y amplifiers and the other for the G—Y amplifier and the blanker.

To save tube-checking time two 6GU7 tubes were interchanged, but the symptoms did not change. The chroma-signal waveform at pin 12 of the picture tube should have had the general appearance indicated in Fig. 5. However, a scope test produced instead the pattern shown in Fig. 6. This indicated an intermittent condition, with an output signal produced only periodically. The waveform was also distorted and did not have the necessary gradual rise and decline of positive signals.

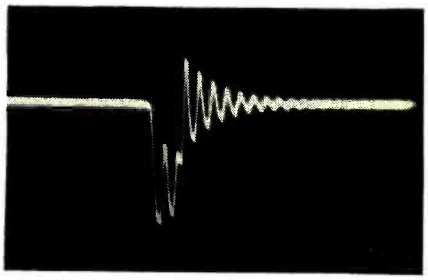


Fig. 6—Cold solder joint caused B—Y distortion in this oscilloscope display.

A voltage check indicated a high cathode voltage. with an occasional intermittent voltage flicker. The resistor was removed and checked. Its value was correct. Instead of replacing it with a new one, the old one was resoldered into the circuit and proper operation was restored. From the appearance of the original soldered joint near the cathode end it was logical to assume that a cold-solder joint caused the trouble.

Agc defects

The same simplified servicing techniques can, of course, be applied to other stages of a color receiver, including those not directly associated with color signals. In an agc system, for instance, the vtvm and scope will again check every signal, voltage and component.

Modern receivers use *keyed* automatic gain control to minimize noise interference and reduce flutter from passing airplanes. A typical system using the pentode section of a 6GH8-A is shown in Fig. 7. Note the cathode voltage is higher than both the grid and plate voltages. The plate voltage must be higher than the cathode voltage for conduction to occur.

Similarly, the grid voltage must be raised to be nearer the cathode voltage so the reduced bias will permit conduction. Hence, *both* plate and grid voltages affect tube conduction.

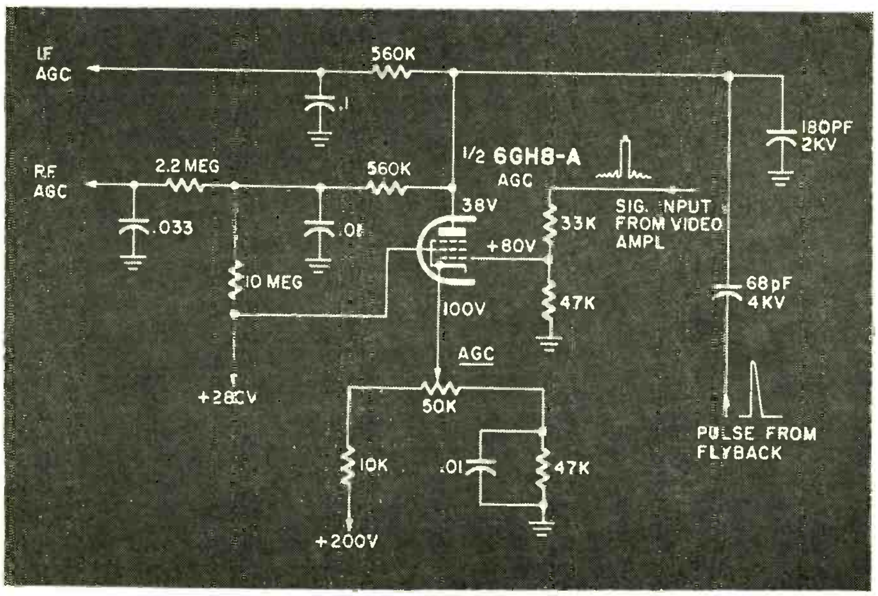
A positive spike-type pulse is obtained from the horizontal output stage and applied to the plate of the agc tube. The video signal is applied to the grid but isn't strong enough to overcome the cutoff bias of the agc tube. The blanking and sync tips, however, have a high amplitude and overcome grid bias. Because the sync tips synchronize the horizontal oscillator, they occur at the same time as the spike-type pulse applied to the plate. Hence, only during this time does the tube conduct.

The signal at the grid is amplified and inverted at the plate (negative direction) and filtered by the resistor–capacitor networks at the output into dc bias for the rf and i.f. stages.

If the incoming station fades slightly, sync tips will be lower and less current will flow through the tube. Hence, less agc bias is developed and the i.f. and rf stages have increased gain to compensate for the signal fading. Since the filter network need only smooth out the 15.750-KHz ripple, a short time-constant circuit is used and the system diminishes the effects of rapid signal-amplitude changes caused by varying signal reflections from airplanes.

The simplified checks we've discussed are intended to serve as guidelines for shortcuts in servicing. You will save time if you understand circuit function and logically approach test procedures. **R-E**

Fig. 7—Keyed agc circuit in Magnavox T924 cuts interference from passing airplanes.



New Color TV Circuits

The '69 sets are really new. Here's a look at the circuits that make them work

By **ROBERT F. SCOTT**
SENIOR TECHNICAL EDITOR

IF YOUR KNOWLEDGE OF COLOR TV circuits stops with the CTC 16 and you have found this good enough for most servicing problems, you are in for a rude awakening. It looks like 1969 is the year of the color TV revolution and you'll have to get on the ball if you expect to keep up with the game.

Nearly every manufacturer has something new and different in at least one of his models and many have almost all new lines. Descriptions of all the new circuit innovations would be more fitting as the title of a book than a single magazine article. Many of the new circuits are the result of transistorization. Several sets are now all solid state and a great many are hybrid models using tubes and transistors or integrated circuits (IC's).

From time to time, in the past, one or two manufacturers have come out with something new in the way of circuitry but a few new circuits a year never overwhelmed anyone. This year, it is different. There are many more new circuit developments this year and almost as many versions as there are manufacturers using them. Some of the new circuits you'll find in 1969 sets include:

- Automatic fine tuning
- Solid-state tuners
- Low-voltage focus CRT's
- Automatic brightness limiters
- Multi-stage agc systems for solid-state tuners and i.f. amplifiers
- Solid-state video i.f. amplifiers
- Transformerless ("hot-chassis") sets
- Line-voltage selectors
- Fine-tuning indicators
- Improved color-killer circuits
- Hybrid vertical and horizontal deflection circuits

Let's select some of the more interesting circuit innovations and give them a rapid once over.

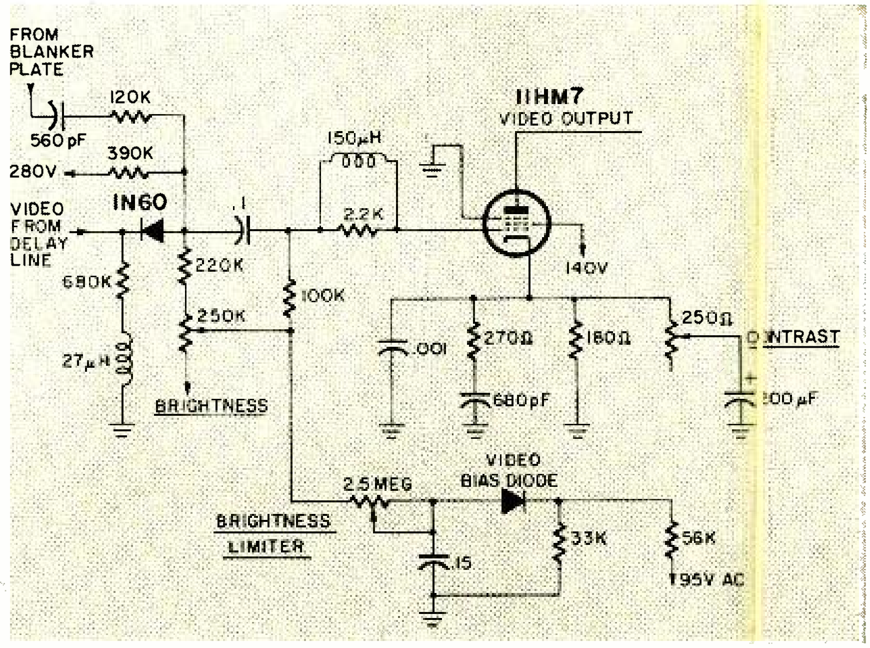


Fig. 1—There's an automatic brightness limiter built into the new RCA CTC 36 color chassis. It insures that picture brightness does not shift with line voltage variations.

The automatic brightness limiter used by RCA in their CTC 36 chassis insures that picture brightness does not shift with variations in line voltage. The brightness control circuit (Fig. 1) is in the grid return of the second video amplifier. Negative grid bias for this stage is developed by rectifying approximately 95 volts ac tapped off the series heater string. The BRIGHTNESS LIMITER control sets the negative bias voltage level and thus determines the maximum brightness that can be reached by adjusting the BRIGHTNESS control.

If line voltage rises, the input to the video bias (rectifier) diode increases. This boosts the bias on the video output tube and cuts back the drive to the CRT cathodes, reducing brightness to the proper level. When line voltage drops, the picture tends to dim and the bias on the 11HM7 falls. This increases the tube's plate current, increasing the drive to the CRT and restores brightness to normal.

The automatic brightness limiter circuit is adjusted at the factory under controlled conditions. When resetting is needed, do it in the shop, if possible. However, you can do the job in the field. Make sure that screen and drive controls are properly adjusted. Then turn the BRIGHTNESS control to maximum and the CONTRAST control to minimum. Use a small "hex" tool or insulated screwdriver to adjust the BRIGHTNESS LIMITER control so the picture just blooms. Now, return CONTRAST and BRIGHTNESS controls to normal.

Do not attempt to use the BRIGHTNESS LIMITER control to compensate for drastic brightness changes. Instead, locate the source of the trouble and correct it.

The Motorola version

Automatic brightness limiting is built into the Motorola TS-915 and TS-919 solid-state color chassis. Its purpose is to eliminate the possibility of excessive beam current which shortens the life of the picture tube and to prevent excessive loading on the horizontal sweep circuit which generates high voltage for the picture-tube anode and focus electrode through a conventional flyback power supply.

The circuit is shown in Fig. 2.

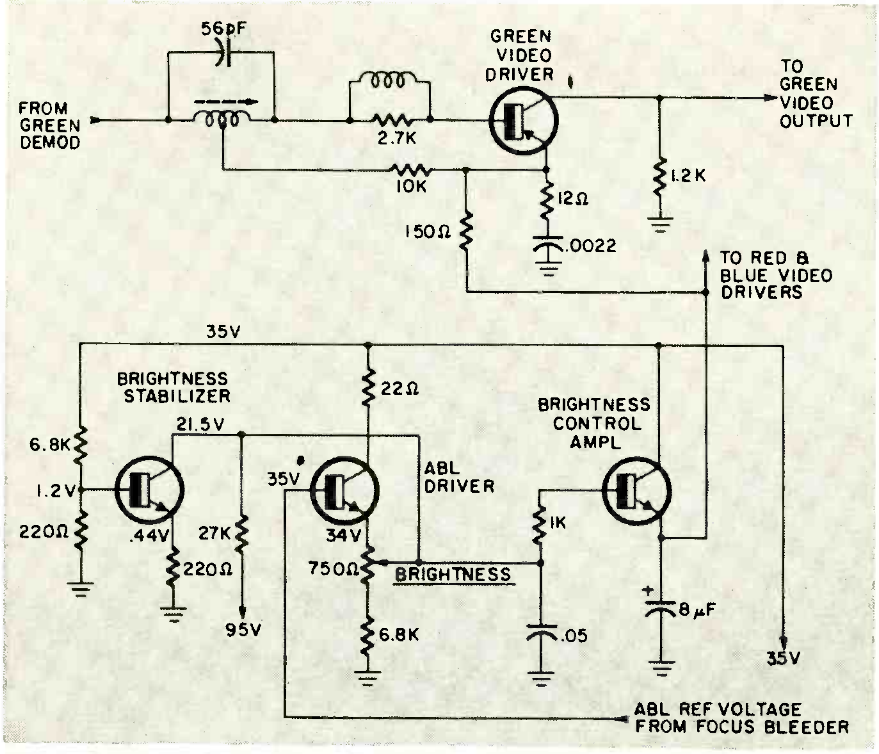


Fig. 2—Brightness in the Motorola RS-915 and TS-919 is controlled by varying the emitter bias on the color drivers which are direct-coupled to the color CRT cathodes.

Brightness is controlled by varying the emitter bias on the three color drivers which are direct-coupled to the CRT cathodes through the color output stages. The manual brightness control is in the emitter return of the abl *(automatic brightness limiter)* transistor. Advancing the control turns on the color video drivers and causes the three color video output stages to pass more current. This increased drive on the CRT cathodes increases picture brightness.

The abl reference voltage tapped off the focus voltage divider determines the relative CRT beam current. As the focus voltage increases, the abl driver begins conducting and causes the brightness control amplifier to draw more current. Its emitter circuit is the source of emitter bias for the three color video drivers. Thus, the increase in control-amplifier emitter current increases conduction in the video drivers and picture-tube cathodes. This raises the beam current and the resulting load on the high-voltage source drops the focus and reference voltages to the predetermine level.

If the focus voltage drops—indicating excessive beam current or horizontal sweep circuit loading—the abl driver and brightness control amplifier draw less current. This reduces the forward bias on the color video amplifiers and increases CRT bias, thus compensating for the initial increase in beam current.

The brightness stabilizer regulates the voltage applied to the abl circuit to prevent variations in brightness with B-plus voltage changes.

Solid-state agc keyer

The Packard Bell 98C18 and 98C19 are hybrid color chassis using vacuum-tube tuners and a three-stage video i.f. using npn transistors. Most sets with solid-state i.f. amplifiers are designed to use forward agc. That is, an increase in forward bias reduces circuit gain. But, since the vacuum-tube tuner requires a negative agc voltage, reverse (negative-going) agc bias is used on the i.f. amplifiers. The circuit of the Packard Bell keyed agc system is shown in Fig. 3.

Transistor Q207, the agc keyer, operates in the same way and performs the same functions as a vacuum-tube agc keyer. Composite video is fed to its base and a positive keying pulse from the flyback is fed to the collector through a blocking capacitor and diode D1. The base-emitter junction is back-biased so the transistor conducts only during the 1/15,750th of each second when the horizontal sync and flyback pulses appear simultaneously on the base and collector. The amount of agc bias voltage developed in the collector return circuit depends on signal strength as determined by the sync-pulse level.

Under "no-signal" conditions, the keyer transistor is cut off and the i.f. agc line is biased positive at around 1.5 volts from two 140-volt voltage dividers. One divider consists of R256, R260 and R254-a (in parallel) and R253. The other consists of R258, R259, D2 and R253. D2 is forward biased.

When a signal is tuned in, the keyer conducts and develops a negative voltage—determined by signal strength—at the anode end of D2.

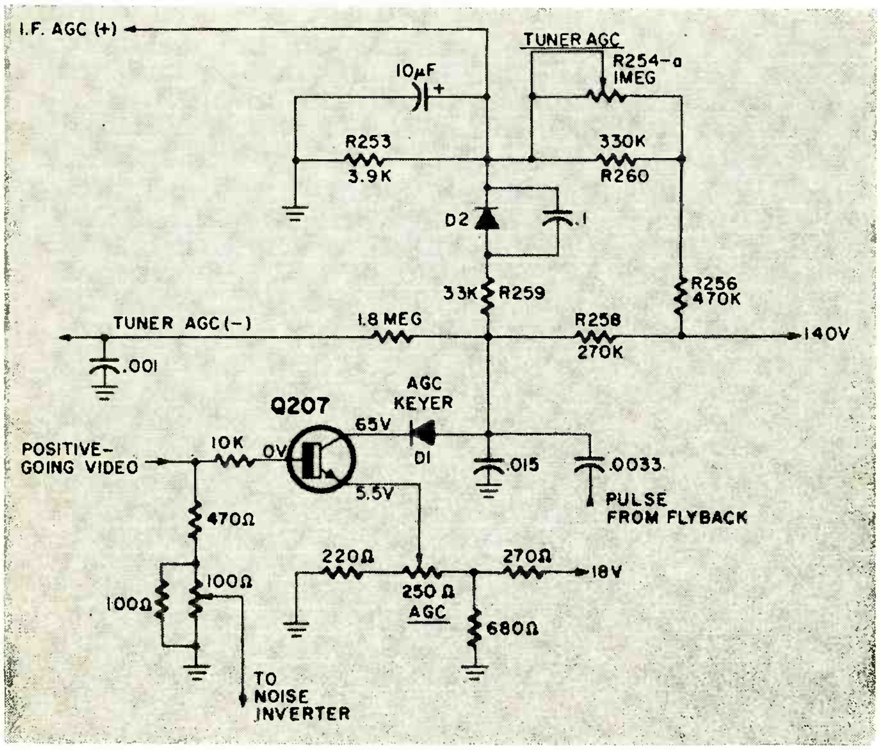
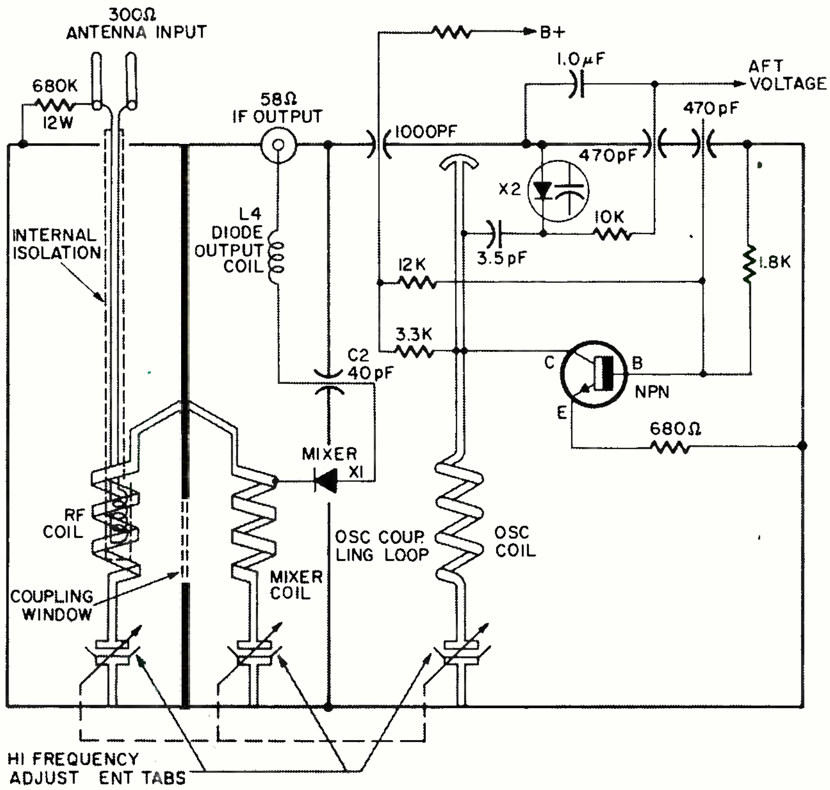


Fig. 3—Keyed agc for the Packard-Bell 98C18 and 98C19 chassis must provide both negative and positive agc voltages. Negative agc goes to the tuner. Positive agc to i.f.



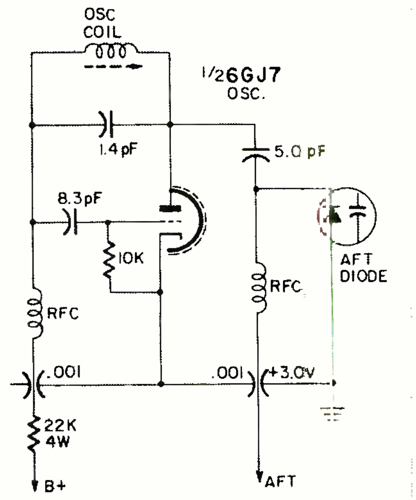


Fig. 5—Here's a basic aft tuner circuit (above) as it is used in a vhf tuner. The variable-voltage capacitance diode is again connected across the oscillator coil.

Fig. 4—This uhf tuner (left) has automatic fine tuning. The circuit is quite similar to the afc circuits used in FM receivers. A voltage-variable capacitance diode is connected across the oscillator coil.

This negative voltage causes the voltage on the i.f. agc line to drop to a less positive level. When the i.f. agc voltage drops to around 0.8, D2 stops conducting and clamps the voltage on the i.f. agc line at this level. The tuner now receives a negative agc voltage that varies in level with signal strength above D2's cutoff point. The greater the signal strength, the greater the tuner's agc bias.

To adjust agc, set the tuner agc control for maximum snow in the picture and then back off to just pass the point where snow disappears. Then, adjust the MASTER AGC control for optimum performance on the weakest channel without overloading on the strongest.

Automatic fine tuning circuits

Automatic fine tuning (aft) circuits in TV receivers are quite similar to afc circuits in FM receivers. A

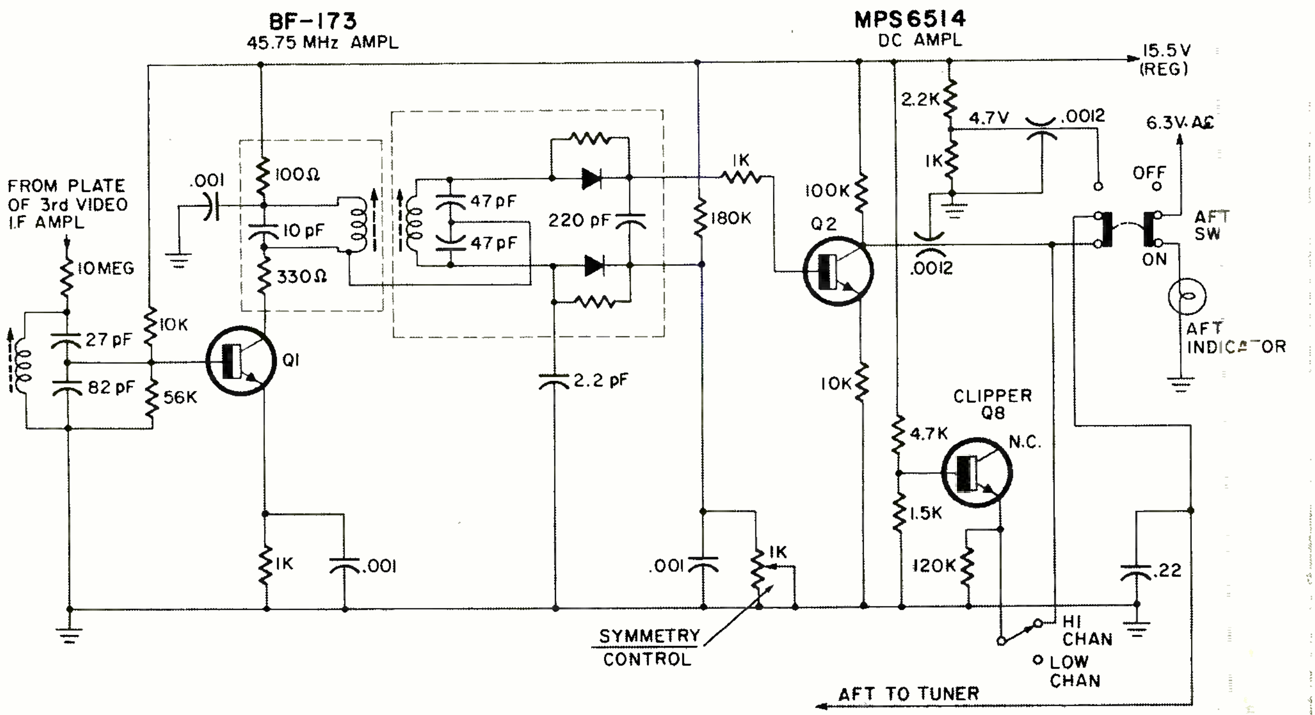
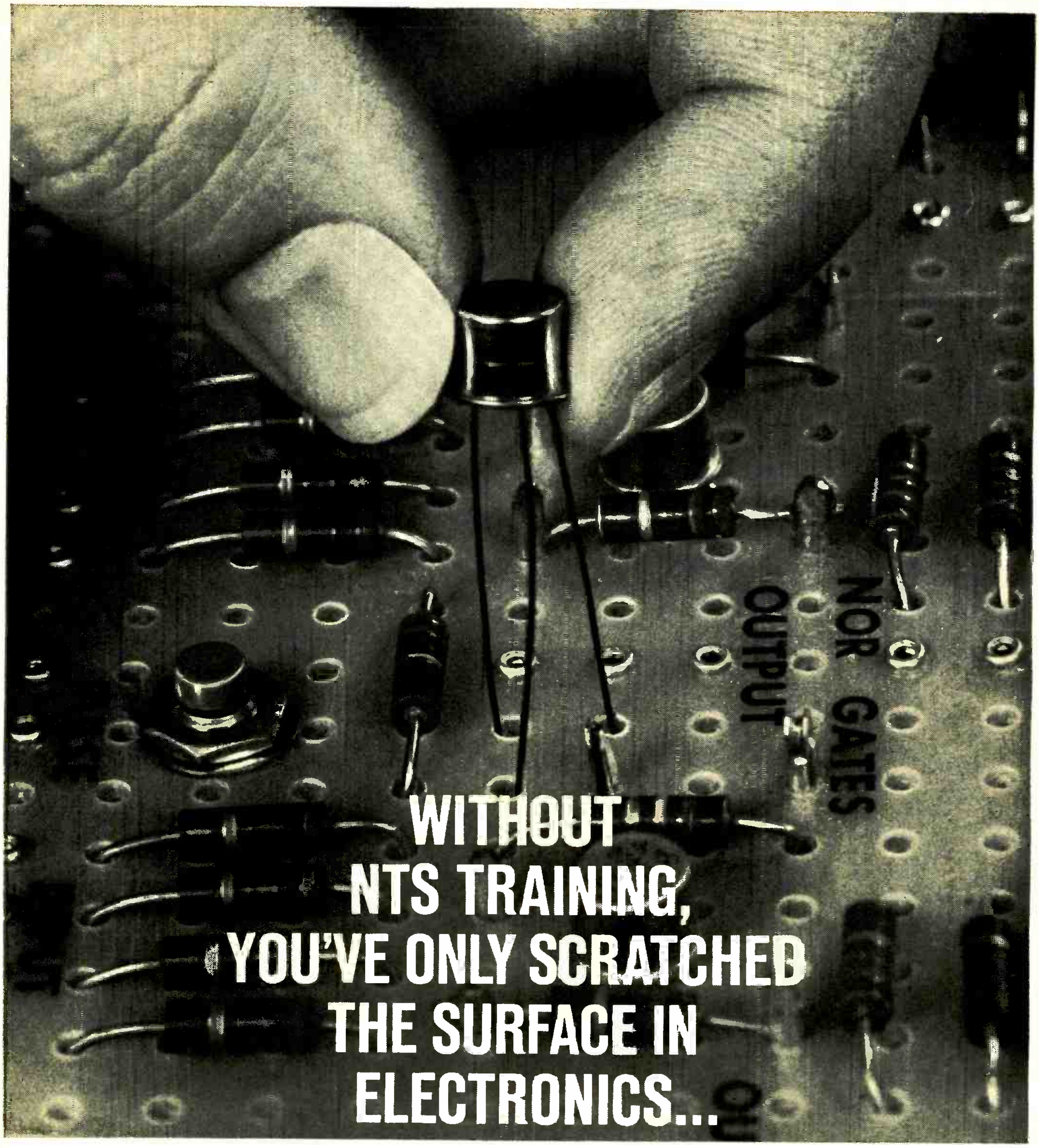


Fig. 6—In Electrohome's C5 chassis automatic fine tuning is built into the 45.75-MHz video i.f. circuit. A signal taken off the discriminator is amplified, clipped and then fed to the tuner as a correction signal that pulls the oscillator to the correct frequency.



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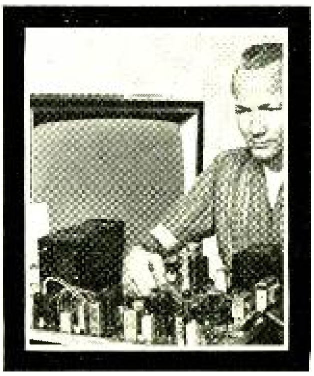

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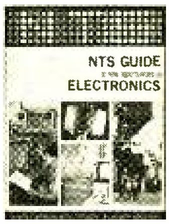

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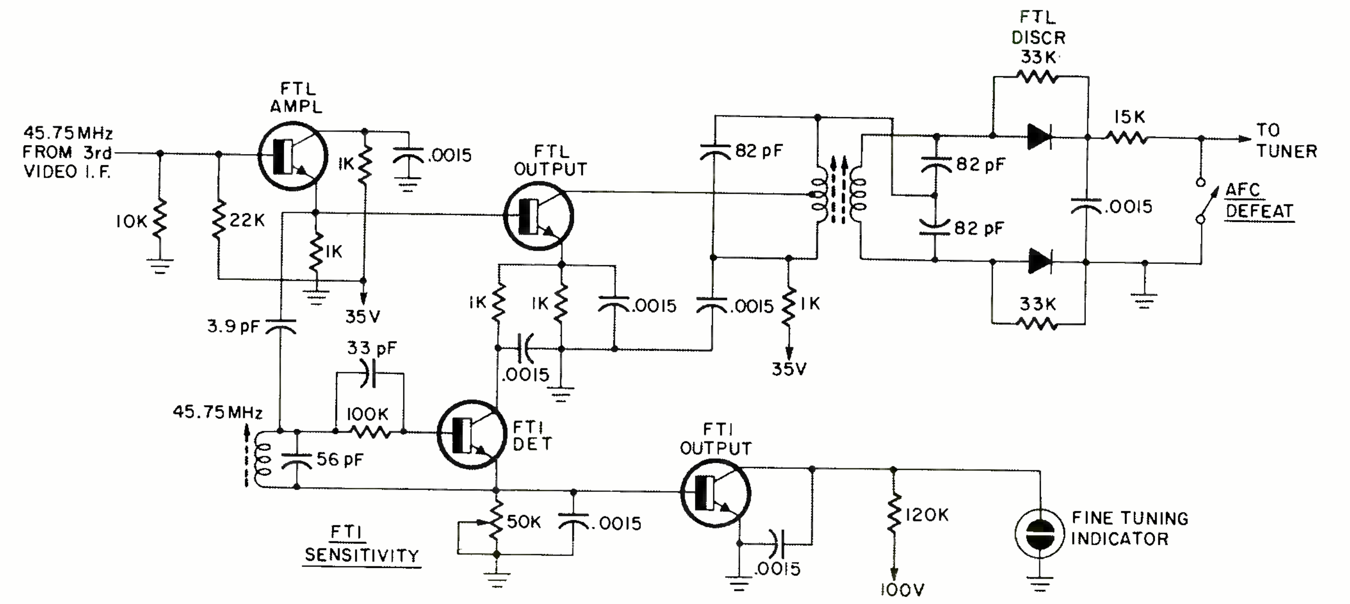


Fig. 7—This aft circuit has a tuning indicator which lights only when the automatic tuning circuit is misadjusted. The circuit is used in the Motorola TS-915 and TS-919 solid-state chassis. The switch across the discriminator output should be marked AFT, *not* AFC.

voltage-variable capacitance diode is connected across the oscillator coil in the tuner.

When the oscillator is exactly on frequency the video i.f. carrier is precisely at 45.75 MHz and the output of an aft discriminator is zero. When the fine tuning control is set too high or too low, the video i.f. shifts away from 45.75 MHz and the discriminator applies a positive or negative correction voltage that varies the diode capacitance in the direction needed to retune the oscillator to the correct frequency. The circuit of a uhf tuner with aft is shown in Fig. 4 and basic circuit of the oscillator in a vhf tuner is shown in Fig. 5.

Electrolock aft is one of several new features introduced in Electrohome's C5 chassis. The fine-tuning range is controlled to prevent the user from gross mistuning and to insure that the automatic fine tuning circuit locks in on the correct channel when the aft button is pushed.

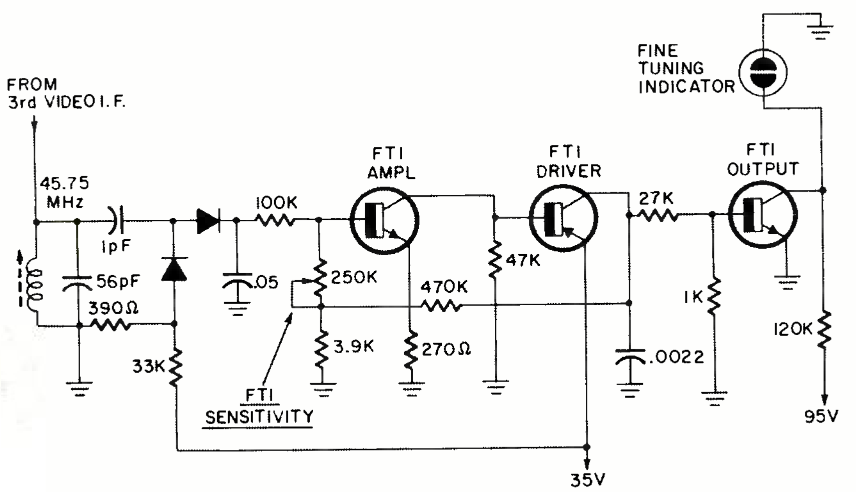
The solid-state aft circuit in this hybrid chassis is shown in Fig. 6. A part of the 45.75-MHz video i.f. carrier signal is amplified by Q1 and then fed to a Foster-Seeley discriminator. The discriminator output is a dc voltage that varies above or below a constant "on-channel" reference point when the fine tuning control is incorrectly set. This dc voltage is amplified and then applied to voltage-variable capacitance diodes in the vhf and uhf tuner oscillators.

When the aft circuit is turned off the capacitance diodes are biased from a regulated 4.7-volt source. When the aft is turned on and the set tuned to one of the low vhf channels, the aft control voltage follows the voltage at the collector of Q2. When the set is switched to one of the high vhf channels, Q3 is switched in to the circuit to limit aft range and prevent lockout. Its emitter-base junction is used as a Zener clipper, limiting control voltage swing to 5.6 volts.

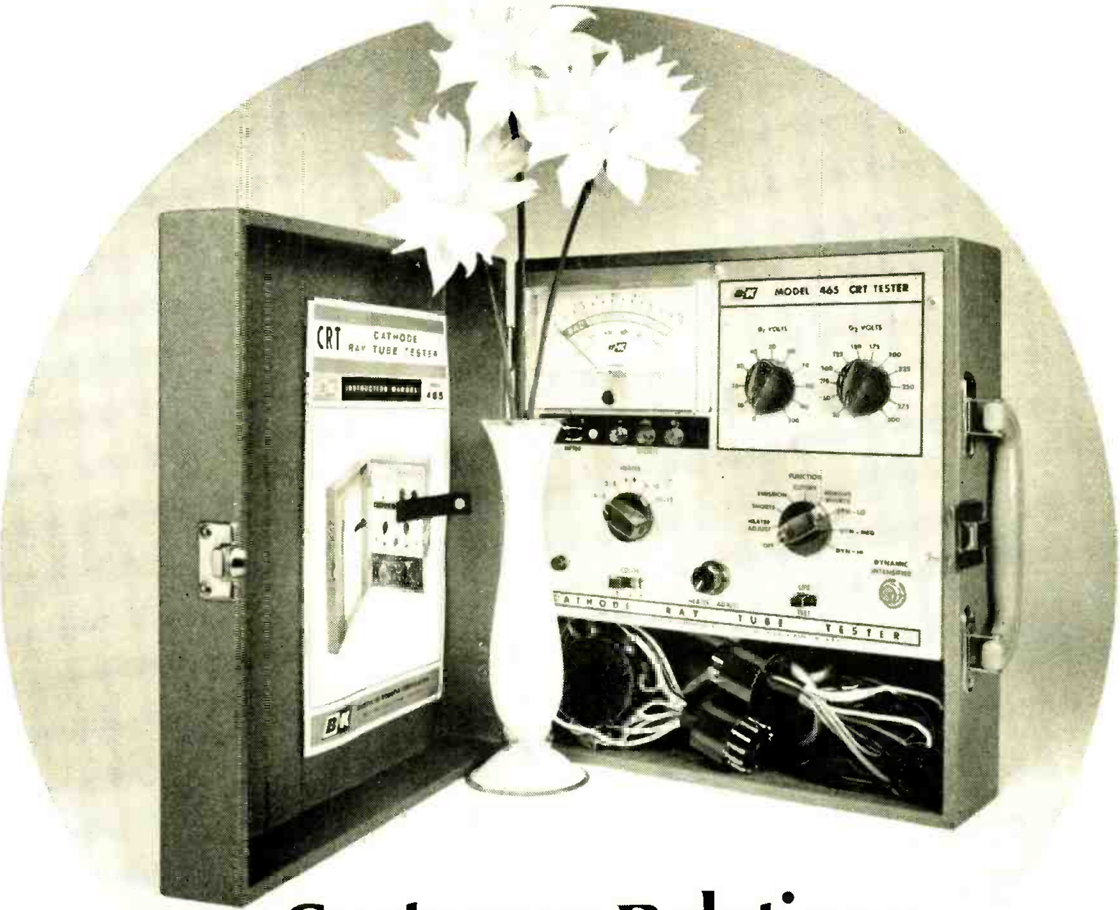
Fine Tuning Lock (FTL) is what Motorola calls the aft circuit in the TS-915/919 chassis. The circuit, which has a tuning indicator, is shown in Fig. 7. The emitter-follower couples the 45.75-MHz video i.f. carrier to the output stage which drives the discriminator. The discriminator is tuned for zero voltage output when fed with a 45.75-MHz signal. Incorrect tuning causes the video i.f. carrier to fall above or below 45.75 Mhz so the discriminator produces a correction voltage that automatically pulls the tuner oscillator to the correct frequency.

The emitter follower also feeds the video i.f. carrier to the FTI (Fine-Tuning Indicator) detector. If the fine tuning control is set at the correct point, the 45.75-MHz video i.f. carrier is rectified in the base-emitter junction of the detector and biases the transistor on. The positive voltage developed across the FTI SENSITIVITY control turns on the FTI output stage. The voltage drop across the 120,000-ohm collector resistor is so large that the neon FTI indicator lamp cannot fire. If the fine tuning control is misadjusted while the AFT DEFEAT switch is closed, the detector output drops, the FTI output stage turns off and the indicator lamp comes on.

The fine-tuning indicator used in some models is in Fig. 8. When the



· *is a variation of the circuit of Fig. 7. As before, when the circuit* ·*rly, the lamp does not light. It's also used by Motorola in 1969.*



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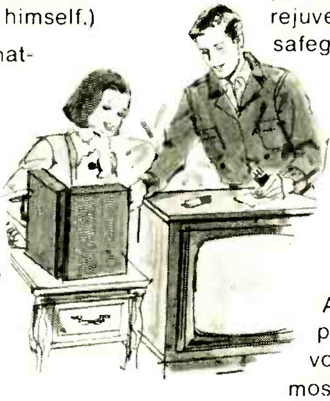

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to 25% higher than the figure obtained in a continuous sine-wave test. Remember that a *doubling* of power (100% increase) is a 3-dB increase in loudness, which is just audible. So a music-power measurement seems to be little else but a clever way of quoting a superficially more impressive figure, despite all the labored technical rationalizing.

The difference between 90 and 110 watts is insignificant from an audio standpoint, but apparently not from a sales standpoint. So music power, or dynamic power, will probably hang on, even though a number of manufacturers have refused to play the game and continue to rate their amplifiers by the continuous sine-wave method.

Distortion you can hear

The term distortion usually refers to the spurious products generated by *nonlinearity*.

Two kinds of phenomena occur when signals are applied to a nonlinear amplifier. For one thing, harmonics (integral multiples) of the input signal are generated. When a 1,000-Hz tone is fed into any real amplifier, some energy appears at 2,000, 3,000, 4,000 Hz and so on. Because all hi-fi amplifiers use push-pull output circuits, the even harmonics generated in the output circuit (in this case 2,000, 4,000, etc.) are cancelled if the output stage is properly balanced. Of course, even harmonics generated in an earlier, single-ended stage are not cancelled by a subsequent push-pull stage.

The other thing that happens is *modulation*. Any nonlinearity results in spurious signals equal to the sum and difference of the original tones. These are sidebands, produced by modulation. Exactly the same phenomenon produces an AM radio wave. and is also responsible for the i.f. in a superheterodyne receiver.

Such spurious tones. called *intermodulation distortion* (*IM*), are more likely to be irritating than simple harmonics are. because they don't correspond to tones in the overtone pattern of musical instruments. Amplifier-produced harmonics are somewhat masked by the harmonics generated by the musical instruments themselves, but modulation sidebands are not.

Although these two phenomena always occur together, they can be measured separately and by different methods. A harmonic distortion measurement is the older of the two, and is still held by many engineers to be the most valid check on an amplifier's nonlinearity. But an IM measurement has much to recommend it too, and neither will probably ever emerge as a clear favorite.

Neither method tells all. In fact, both measurements together can still leave some important things unsaid. The trouble is that the usual, simple method of measuring harmonic distortion says nothing about the kinds of harmonics that are present, or their relative magnitudes.

Higher, odd-order harmonics (like fifth, seventh, ninth and so on) tend to be more audible for a given power level than lower, even-order harmonics (second, fourth). Because the harmonic distortion meter simply nulls out the fundamental and reads what's left, there is no way of knowing, from the meter scale alone, whether that 0.5% reading represents mostly second harmonic or mostly thirteenth. This is one point at which specs take leave of listening quality, and shows one way in which two amplifiers, identical by measurement, can sound quite different.

A more informative way to check the effects of nonlinearity is to measure each harmonic separately with a wave analyzer. This is much more time-consuming, and the results are a bore to read. All good manufacturers do it, but none seem to publish the results, which would go something like "0.01% second, 0.08% third, unmeasurable fourth, 0.01% third, unmeasurable higher order distortion."

The amount of distortion that is tolerable has never been definitely established. It depends on the kind of distortion, the kind of program material, the loudness, the frequency range, the acuteness of the listener, the noise level in the room, and probably other factors. Although the fact that the distortion percentages in top-quality equipment have decreased a whole order of magnitude in the past 10 years seems significant, it is a moot question whether the ordinary listener can hear even 1% of low-order harmonic distortion at full output. Typical maximum-power distortion figures for good amplifiers are now in the vicinity of 0.1%.

Power bandwidth

For about the past 10 years, many hi-fi manufacturers have been specifying power bandwidth for a given percentage of harmonic distortion. This ingeniously ties together three important ratings, which, being interdependent anyway, ought to be given in such a way as to show their relationship.

A complete power bandwidth spec might read as follows: Power bandwidth 20 to 20,000 Hz at 1% THD (total harmonic distortion). Notice that nothing is said about flatness (a plus/minus dB figure) or power output. What that spec means is that over the range from 20 to 20,000 Hz this amplifier will put out not less than half its rated power (say 50 watts, at 1% harmonic distortion). In practice, this usually means it will put out a full 50 watts over most of the audio range, but the power available at 1% distortion will fall to 25 watts at the extremes of 20 Hz and 20 kHz.

If that sounds dreadful, it isn't really. Half power is only 3 dB down, and 3 dB is about the smallest change in loudness that can be detected reliably in program material. All other things being equal, 25 watts would sound just noticeably less loud than 50.

Power bandwidth, then, is defined as the frequency range bounded by the two frequencies at which the power falls to half its midrange value.

All this can be shown most convincingly by a graph, but it is seldom published in that form because graphs take up space and many people don't know how to read them anyway. Even so a power bandwidth spec is more meaningful than a frequency response spec, which is often taken at 1 watt or some very low power. It is, after all, *power* that counts when pushing a speaker cone back and forth. It is important to know what strength an amplifier can muster at its frequency extremes.

Sensitivity, gain and overload

The difference between power output and gain is important. A mike or phono preamp, for example, has lots of voltage gain (typically 40 to 50 dB, or a factor of 100 or more), but negligible power output, in terms of what's needed to drive a speaker (perhaps a milliwatt at most). In effect, the gain, or sensitivity, of an amplifier establishes how much signal voltage is required at the input to drive the amplifier to its full rated output. Typically this figure is between 1 and 5 mV for tape-head, mike and phono inputs, and 100 mV to 1 volt for high-level (tuner, auxiliary or tape-monitor) inputs, regardless of the power output rating of the amplifier.

To the extent that every currently manufactured amplifier has enough gain to accommodate just about every common input device, sensitivity is not an important specification. What is more to the point is the *overload margin* of the input stages. The preamp part of an amplifier comes before the volume control; so if the signal is great enough to overload the input stage, there will be distortion that cannot be eliminated by turning down the volume.

The output of a phono pickup is rated by playing a record with a known, standard level of modulation—usually a few millivolts but sometimes as high as 25 mV. (I am not talking here about replacement type crystal or ceramic pickups, whose output can go as high as several volts.)

What is often forgotten is that modern recordings have a very wide dynamic range, and heavy groove modulation (assuming the pickup can trace it in the first place) can generate pickup terminal voltages of 100 mV or more. So it is important to be sure that the preamp stages of a hi-fi amplifier will not be overloaded by the highest probable signal voltages. A complete amplifier specification should state that the preamp will generate negligible distortion with input voltages up to 150 to 200 mV.

The other end: noise

It's useful to think of an amplifier's capability in terms of *dynamic range*: the amplitude range between the loudest and softest sounds. At the loud end, dynamic range is limited by overload and the onset of distortion. At the low-level end, the dynamic range is limited by *noise*. Strictly, noise is anything undesired in the reproduction, but it is usually used to mean residual noise in the absence of any signal. Hum, hiss, shot noise, and frying noises due to parasitic oscillations are all examples. Because the noise is usually broad-band in character, something like white noise, any signal quieter than the noise will be masked and inaudible.

In a good amplifier, the noise level ought to be at least 65 dB below rated output, through the phono or tape-head input. Even 70 dB is not uncommon. It should be even better through the high-level inputs (75 to 85 dB). The figure that tells how far below maximum output the noise is, is also the dynamic range of the amplifier.

The dynamic range of a symphony orchestra is between 70 and 80 dB, so you can see that modern, low-noise, low-distortion equipment is just about adequate to handle it. However, that raw dynamic range is often compressed somewhat to accommodate the limitations of commercial recording and broadcasting.

Stability and overload recovery

Everyone who has worked with electronics knows that an amplifier can become an oscillator, given the right gain, feedback and phase. At certain points in the frequency range of an audio amplifier, the negative feedback—which tends to make the amplifier self-correcting, reduces certain forms of noise and distortion and broadens the bandwidth—can turn positive. Then the feedback has precisely the opposite effects. Even if the amplifier doesn't oscillate continuously, it may produce short bursts of oscillation at a high frequency on certain kinds of signal waveforms, or it may be triggered into a damped low-frequency oscillation by a sudden overload, or it may develop a peak in its response curve. Sudden changes in power-line voltage can also trigger instability. Every inductive or capacitive device is a phase shifter, as are transistors.

So in addition to striving for low noise and distortion, the design engineer must make sure his amplifier is inherently and unconditionally stable. This means testing it with a variety of inductive and capacitive loads, since real speakers are hardly ever purely resistive. Conventional speakers usually look inductive to an amplifier, a situation that is complicated by the inductors and capacitors in the crossover networks, while electrostatic speakers are capacitive. Some amplifiers cannot be used with electrostatic speakers. A complete set of specs will talk about stability, even though it is difficult to establish stability criteria in numbers.

Another inscrutable that can make two otherwise identical amplifiers sound different is *overload recovery*. Largely because of time constants in coupling, decoupling and filtering circuits, curious things can happen when an amplifier is socked with a high-amplitude transient. One typical effect in tube amplifiers occurs when a signal is big enough to drive a grid positive. The grid-cathode circuit rectifies the signal and charges the coupling capacitor in such a way as to cut off (or at least overbias) the tube until the grid resistor allows the charge to leak off. In this way, a momentary overload for half a cycle can spoil the quality of the sound for perhaps a full second after the overload disappears. Feedback compounds the trouble rather

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than reducing it. During the process, the power supply voltage has probably dropped 20% and risen again.

There are no standards for gaging overload recovery, and few amplifier makers say anything about it. But how quickly the amplifier recovers, and just how it responds to an overload in the first place, has a profound effect on its listening quality. The "model" amplifier spec with this article gives a concise and meaningful statement about overload recovery.

Impedance and damping

There's confusion here, too, because of the two meanings of the expression "output impedance." A tube amplifier with an output transformer has output taps marked 4, 8 and 16 ohms. These figures indicate the nominal value of load impedance the amplifier should "see" so that the output tubes will operate as they were intended.

But the speaker, looking back into the amplifier, sees a very different impedance—perhaps a fraction of an ohm—because of negative voltage feedback. The smaller this looking-backward impedance, the more nearly the speaker feels short-circuited when it tries to move independently of what the amplifier tells it to do, and the better damped it is. Nominal speaker impedance divided by the looking-backward source impedance of the amplifier is *damping factor*.

Most modern speaker systems are inherently well damped, so there is a legitimate question as to whether a damping factor in excess of 10 offers any benefit. Some claim it does, others claim it only reduces the bass output of the speaker. Either way, when the internal resistance of the amplifier gets down to a small fraction of an ohm, it is swamped by the unchangeable resistance of the speaker voice coil and of the connecting leads to the speaker. Some amplifiers have damping factors of 100 or more, but anything greater than 10 or 20 is not much use.

There's more

We've covered only a few of the many things that can be measured and described about an audio amplifier, but these are probably the most significant in terms of listening quality. Other things that can be important are transient response (rise time), measured with square waves or, better, with tone bursts; tone control range and slope; rumble and scratch filters, short-circuit protection and the desirability of certain features. We can talk about those in another article. **R-E**

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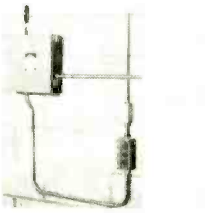
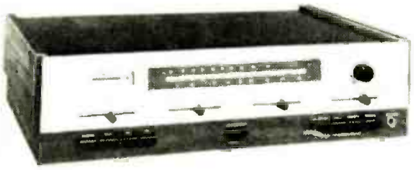


RADIO CONTROL LINE. Designed for remote automatic operation of garage and warehouse doors, lighting, conveyors, alarms and pumps. Consists of 10 systems of 1-, 2- and 3-channel receivers. Each includes a portable, single-channel test transmitter and a receiver for distances up to ½ mile. During signal transmission, systems can be used for momentary, on–off switching or as a combination. Receiver responds to proper pulsed coding signals only.—**Perma-Power Co.**

Circle 46 on reader service card

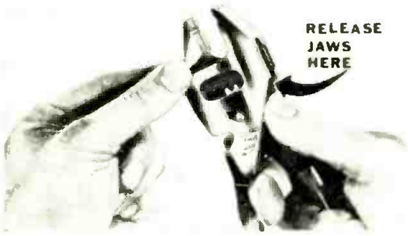
AM/FM STEREO RECEIVER, *Model DB250,* all-silicon, solid-state, has a rated output of 75 watts; FM selectivity at 60 dB provided by ceramic filters; harmonic distortion of 0.8% at full rated output; frequency response from 20 to 20,000



Hz. AM section includes mechanical filter for improved selectivity. Amplifier section couples directly to 4 loudspeakers. Earphones can be used alone or with local/remote speakers. $279.95 with enclosure.—**Bogen Communications**

Circle 47 on reader service card

PLIERENCH, made of forged steel with black oxide finish and polished head, is a complete workshop in one tool. Its parallel jaws and 10-to-1 gear ratio provide 1-ton gripping power in all positions so it can replace most types of wrenches and pliers. Also used as wire cutter and tool-



maker's clamp. Ideal for mechanic and maintenance man as well as for the home workshop fan. *Model 86060,* $6.25, is 7" long with 3 accessory jaws available. *Model 86070* is 8½" long, lists at $7.95. —**Vaco Products Co.**

Circle 48 on reader service card

TELEPHONE DIALING ALARM. *Tele-Larm, Model T-10* is an automatic warn-

ing unit which notifies by telephone a responsible person whenever a condition

Circle 107 on reader service card

Circle 108 on reader service card

Circle 109 on reader service card

dangerous to human life or property arises. Serves as a burglar or fire alarm when tripped by any switch; it will call the police or the fire department and then the person concerned. Multiple calls are recorded by using a standard cartridge of 2-track, 20-minute recording tape with an adapter and a plug-in telephone on a 12-V lantern battery.—**Electro-Photo Products Co.**

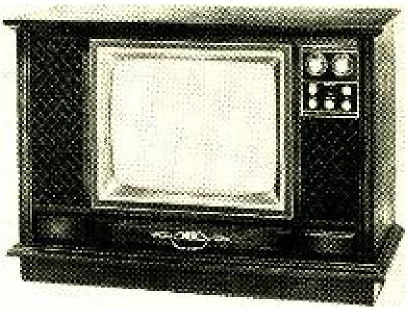
Circle 49 on reader service card

STEREO TAPE RECORDER, *Model RK-825,* 4-tracks, solid-state circuit. Frequency response ±3 dB, 40–15,000 Hz at 7½ ips; ±3 dB, 40–10,000 Hz at 3¾ ips; wow and flutter under 0.23% rms at 7½ ips; under 0.35% at 3¾ ips. Three

speeds: 1⅞, 3¾ and 7½ ips. Input sensitivity: mike, 0.5 mV; aux., 100 mV. Monitor output: 16-ohm speaker or low-impedance stereo headphones. Complete with two 600-ohm mikes. $139.95.—**Lafayette Radio Electronics**

Circle 50 on reader service card

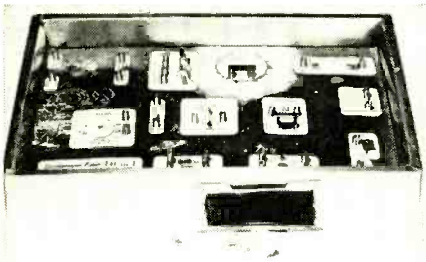
COLOR TV KIT. *Model GR-681 TV* with 295-sq. in. screen, vhf/uhf channels 2 through 83. Built-in power vhf channel selection and cable-type remote control and ac line taps for voltages higher and lower than 120. $499.95. Ac-



cessory kit *Model GRA-681-6,* a wireless remote control consists of a remote receiver and a transmitter. Changes volume and vhf channel and adjusts color. $59.95.—**Heath Co.**

Circle 51 on reader service card

10-IN-1 ELECTRONIC PROJECT KIT *No. 28-202* contains parts and illustrated instructions for building a germanium-diode radio, transistor amplifier, germanium-diode radio with transistor, code-practice oscillator, low-signal oscillator, radio–TV signal generator and two-person code practice oscillator, transistor ra-



dio, signal tracer and wireless mike. Completed projects powered by a battery or light-sensitive solar energy cell. $7.95 less battery.—**Radio Shack**

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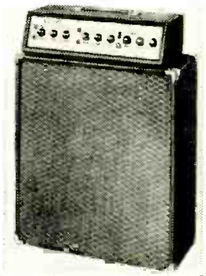

90-WATT INSTRUMENT AMPLIFIER, *KG-387*. 5⅞" x 19⅞" x 8⅜", solid-state, with a speaker system including two 12" speakers. May be used for one instrument or a combination. Dual channels, each with 2 inputs. Normal channel has volume, treble and bass controls. Second channel has reverb and tremolo with separate intensity and rate controls. Signal-to-noise ratio: 60 dB below rated power output; input sensitivity: 40 mV for rated output; input impedance: 500,000 ohms. $169.95 with case and speaker system.—**Allied Radio Corp.**

Circle 53 on reader service card

SOLDER PRODUCTS. *Depend-a-Bond* line of solders is designed for the novice for electrical work and for joining all types of metal surfaces. Comes in handy

blister packs, individual cartoned spools and bars with easy-to-follow instructions and a comprehensive list of applications. —**Alpha Metals Inc.**

Circle 54 on reader service card

BELL PA AMPLIFIER, *MOD Series*, consists of 4 models for 20, 45, 90 and

200 watts. Solid-state, all have automatic output circuit protection (with indicator

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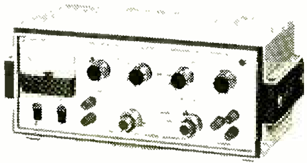
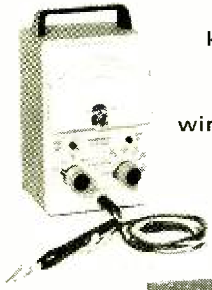
wired IGW-18
$99.50



HEATHKIT IG-18 Solid-State Sine-Square Wave Generator

A precision source of sine or square waves at a low kit price . . . that's the new solid-state IG-18 from Heath. Delivers 5% accuracy thru the wide range of 1 Hz to 100 kHz. The sine wave section features less than 0.1% distortion thru the audio range, 8 output voltage ranges from 0.003 to 10V, switch-selected internal 600 ohm load or external load and metered output of both voltage & dB. The square wave section has a 50 nS rise time and three output voltage ranges from 0.1 to 10 V P-P. Both sine & square waves are available simultaneously and the frequency is switch-selected for constant repeatability and fast operation. Circuit board construction makes the new IG-18 easy to build . . . new Heathkit styling and engineering excellence make it easy to use. Put the new IG-18 on your bench now. 10 lbs.



kit IM-18
$28.50
wired IMW-18
$47.95

HEATHKIT IM-18 VTVM

The new Heathkit IM-18 continues the features that made the IM-11 famous . . . 7 AC and 7 DC voltage ranges that measure from 0-1500 volts full scale . . . 7 ohms ranges for measurements from 0.1 ohm to 1000 megohms . . . the convenience of a single probe . . . 11 megohm input impedance . . . ± 1 dB 25 Hz to 1 MHz response . . . precision 1% resistors . . . DC polarity reversing position on the function switch . . . RMS & P-P AC voltage and dB measurement capability . . . precision 4½", 200 uA meter for extra sensitivity. In addition, the new IM-18 has 120 V. or 240 V. AC wiring options, new Heathkit styling and a 3-wire line cord for safety. 5 lbs.

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HEATHKIT IM-28 "Service Bench" VTVM

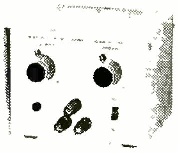
The new Heathkit IM-28 has the same performance specifications as the new IM-18 above, but it also has other features that put it in a class by itself, like a large, easy-to-read 6" meter . . . extra 1.5 & 5 volt AC ranges for additional accuracy . . . convenient gimbal mounting . . . "Set and Forget" calibration — all controls are adjustable from the front panel with a screwdriver . . . smooth ten-turn vernier control of Zero and Ohms Adjust for greater accuracy and easier setting . . . 120/240 VAC wiring options . . . safe 3-wire line cord. The new look of Heath instrumentation styling is evident too —handsome brown & beige color scheme, and new knobs that are easy to grip and fast to read. 7 lbs.

kit IM-38
$39.50
wired IMW-38
$54.95

HEATHKIT IM-38 Laboratory AC VTVM

For all around general service work, audio design or laboratory analysis, there isn't a better value than the new Heathkit IM-38 AC VTVM. Here's why — 10 voltage ranges measure from 0.01 to 300 volts RMS full scale . . . extended frequency response of 10 Hz to 500 kHz at ± 1 dB . . . 10 megohm input on all ranges for higher accuracy . . . . wide —52 to +52 dB range . . . VU-type ballistic meter damping . . . very low AC noise . . . 120 or 240 VAC wiring options and new Heathkit styling in sharp beige & brown with an easy-to-grasp, easy-to-read knob. 5 lbs.

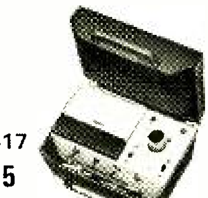
kit IP-18
$19.95



HEATHKIT IP-18 1-15 VDC Power Supply

If you work with transistors, this is the power supply for you. All solid-state circuitry provides 1-15 VDC at up to 500 mA continuous. Features adjustable current limiting, voltage regulation, floating output for either + or — ground, AC or DC programming, circuit board construction, and small, compact size. 110 or 220 VAC. 5 lbs.

kit IT-18
$24.95



kit IM-17
$21.95

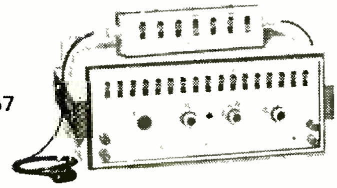
HEATHKIT IT-18 In-Circuit Transistor Tester

In-Circuit transistor testers don't have to be expensive, and the IT-18 is proof of that . . . . tests DC Beta 2-1000, in or out-of-circuit . . . leakage Icbo and Iceo current 0-5000 uA out-of-circuit . . . identifies NPN or PNP devices . . . tests diodes in or out-of-circuit for opens & shorts . . . identifies unknown diode leads . . . matches PNP & NPN transistors. The IT-18 is completely portable — runs on just one "D" cell. Easy to use too . . . rugged polypropylene case, attached 3' test leads, big 4½" 200 uA meter, all front panel controls, 10-turn calibrate control. 4 lbs.

HEATHKIT IM-17 Solid-State Volt-Ohm Meter

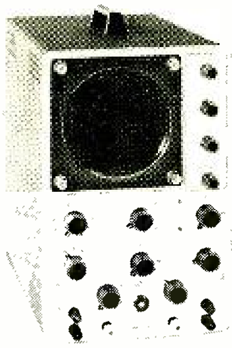
Another very popular volt-ohmmeter from Heathkit engineering and it's easy to see why — all solid-state circuitry . . . high impedance FET input, 11 megohms on DC, 1 megohm on AC . . . 4 AC voltage ranges . . . 4 DC voltage ranges . . . 4 ohm ranges . . . 4½" 200 uA meter . . . 3 built-in test leads . . . DC polarity reversing switch . . . zero-adjust & ohms-adjust controls . . . continuous 12-position function switch. And that's not all — the IM -17 is battery powered for complete portability and comes in a rugged polypropylene case with built-in handle. Simple circuit board assembly. 4 lbs.

kit IG-57
$135.00
wired IGW-57
$199.00



HEATHKIT IG-57 Solid-State Post Marker/Sweep Generator

The new IG-57 plus a 'scope is all you need . . . no external sweep generator required. Switch selection of any of 15 crystal-controlled marker frequencies (you can view up to six different frequencies on one 'scope trace). Select the sweep range and you are ready to instantly see the results of any changes you make. Four markers for setting color bandpass, one for TV sound, eight at IF frequencies between 39.75 & 47.25 MHz plus picture and sound carrier markers for channels 4 & 10. Three sweep oscillators produce the 5 most-used ranges . . . color bandpass, FM IF, color & B&W IF and VHF channels 4 & 10. Save hundreds of dollars and put full alignment facilities in your shop too — order your IG-57 now. 14 lbs. Kit IG-14, same as IG-57 w/o the sweep, 11 lbs. $99.95.



kit IO-18
$84.95
wired IOW-18
$139.95

HEATHKIT IO-18 Wide-Band 5" 'Scope

The New Heathkit IO-18 is destined to be the world's most popular 'scope, just as its predecessor, the IO-12 was. Features 5 MHz bandwidth, the famous Heath patented sweep circuit — 10 Hz to 500 kHz in 5 ranges, two extra sweep positions which can be preset to often-used rates, frequency compensated vertical attenuation, built-in P-P calibration reference, Z-axis input, retrace blanking, wiring options for 120 or 240 VAC operation and new Heathkit styling in beige and brown. 24 lbs.

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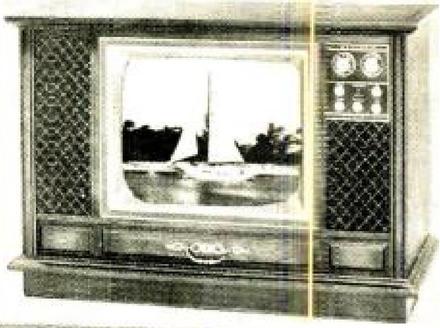
GRA-295-4, Mediterranean cabinet shown.................... **$119.50**
Other cabinets from $62.95



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Big, Bold, Beautiful . . . and packed with features. Top quality American brand color tube with 295 sq. in. viewing area . . . new improved phosphors and low voltage supply with boosted B + for brighter, livelier color . . . automatic degaussing . . . exclusive Heath Magna-Shield . . . Automatic Color Control & Automatic Gain Control for color purity, and flutter-free pictures under all conditions . . . preassembled IF strip with 3 stages instead of the usual two . . . deluxe VHF tuner with "memory" fine tuning . . . three-way installation — wall, custom or any of the beautiful Heath factory assembled cabinets. Add to that the unique Heathkit self-servicing features like the built-in dot generator and full color photos in the comprehensive manual that let you set-up, converge and maintain the best color picture at all times, and can save you up to $200 over the life of your set in service calls. For the best color picture around, order your "295" now.

GRA-295-1, Walnut cabinet shown........................... **$62.95**
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Deluxe "227" Color TV . . . Model GR-227

Has same high performance features and built-in servicing facilities as the GR-295, except for 227 sq. inch viewing area. The vertical swing-out chassis makes for fast, easy servicing and installation. The dynamic convergence control board can be placed so that it is easily accessible anytime you wish to "touch-up" the picture.

GRA-227-1, Walnut cabinet shown........................... **$59.95**
Mediterranean style also available at $99.50

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(less cabinet)

Deluxe "180" Color TV . . . Model GR-180

Same high performance features and exclusive self-servicing facilities as the GR-295 except for 180 sq. inch viewing area. Feature for feature the Heathkit "180" is your best buy in deluxe color TV viewing . . . tubes alone list for over $245. For extra savings, extra beauty and convenience, add the table model cabinet and mobile cart.

GRS-180-5, table model cabinet and cart....................... **$39.95**
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now only
$349.95
(less cabinet)

Now, Wireless Remote Control For Heathkit Color TV's

Control your Heathkit Color TV from your easy chair, turn it on and off, change VHF channels, volume, color and tint, all by sonic remote control. No cables cluttering the room . . . the handheld transmitter is all electronic, powered by a small 9 v. battery, housed in a small, smartly styled beige plastic case. The receiver contains an integrated circuit and a meter for adjustment ease. Installation is easy even in older Heathkit color TV's thanks to circuit board wiring harness construction. For greater TV enjoyment, order yours now.

kit GRA-681-6, 7 lbs., for Heathkit GR-681 Color TV's.......... **$59.95**
kit GRA-295-6, 9 lbs., for Heathkit GR-295 & GR-25 TV's...... **$69.95**
kit GRA-227-6, 9 lbs., for Heathkit GR-227 & GR-180 TV's...... **$69.95**

New Wireless TV Remote Control
For GR-295, GR-227 & GR-180
$69.95

New Wireless TV Remote Control
For GR-681
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1969 CONSOLE HANDBOOK. *"At Home with Stereo,"* 20 pages, fully illustrates the new line of Scott stereo consoles in decorator-styled room settings. Included are many informative features on hi fi, choosing the correct model for individual room decor and complete explanations in non-technical terms.—**H. H. Scott Inc.**

Circle 59 on reader service card

PRECISION TOOLS for electronics, telecommunications and industry are illustrated in detailed drawings with dimensions and specifications in *Catalog No. 200A*, 24 pages. Over 500 various spring adjusters, gauges, burnishers and miscellaneous hand tools are described. A convenient metric-to-inches conversion chart included.—**Jonard Industries Corp.**

Circle 60 on reader service card

PRECISION VOLTMETERS. 16 pages with 18 questions and answers on voltage measurement as well as the difference between digital and differential voltmeters, speed of measurement, the relationship between accuracy and resolution, ac measurements and specmanship.—**John Fluke Mfg. Co.**

Circle 61 on reader service card

ANTENNAS AND PREAMPLIFIERS. *Form Nos. 836 and 913* describe antennas in the *Channel-Spanner* Series, 82 channels, uhf/vhf/FM, for suburban to medium fringe areas. *Form 928* features the *Colorstar Series*, for color TV in the medium and extreme fringe areas. Specs and price list of five models of *Level-line* preamplifiers are available in a 1-page catalog.—**Antennacraft Co.**

Circle 62 on reader service card

SPEAKER SYSTEMS of exceptionally smooth overall frequency response and very low bass distortion are featured in 4-page *Form No. HK-033-C*. Two models: *HK-40*, 50 watts with impedance of 4 ohms, and *HK-20*, 35 watts, 8 ohms. Dimensions and prices are listed—**Harman-Kardon**

Circle 63 on reader service card

HI-FI EQUIPMENT designed to produce the finest sound reproduction are featured with specs in a 4-page short-form catalog. Stereo power amplifiers from 70–200 watts include *Models 35D, 80 MRM, 35 MRM* and *911* as well as preamp *Models CC-1, CC-2* and *CC-50S*. —**C/M Laboratories**

Circle 64 on reader service card

TV-FM ANTENNAS to fit any requirements in any geographical location, from fringe to urban, with special emphasis on full-frequency focus are described with color diagrams in 12-page brochure *A-100-81.3*. Construction and component parts are briefly outlined and illustrated. Prices listed.—**Sylvania Electronic Products Inc.**

Circle 65 on reader service card

Write direct to the manufacturers for information on items listed below:

1969 CATALOG. *FR-69*, 304 pages, a buyers guide of all major GC products, lists a complete selection of electronic components, test leads, chemicals, tools, TV hardware, antennas etc. Numerical and alphabetical indexes provide easy reference.—**GC Electronics**, 400 S. Wyman St, Rockford, Ill. 61101 **R-E**

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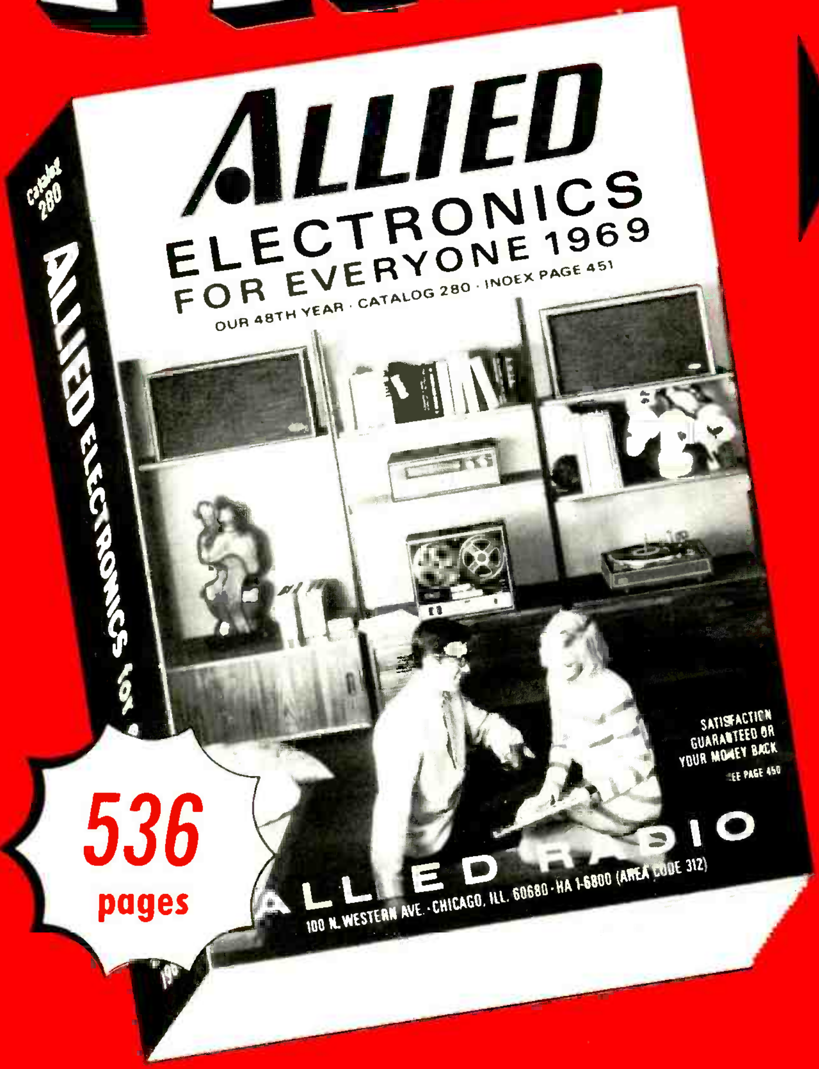

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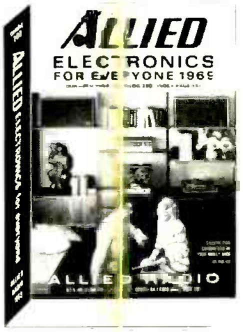

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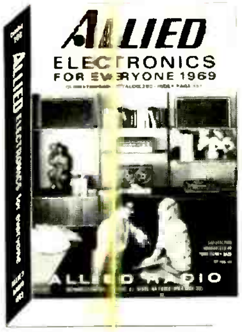

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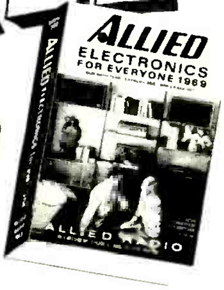

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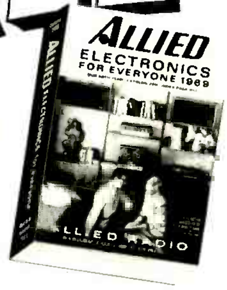

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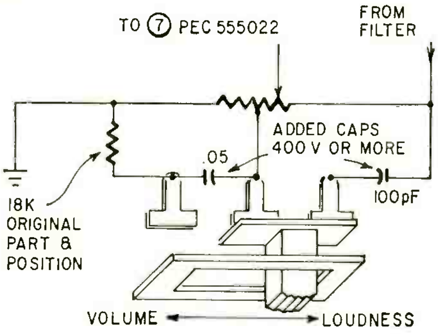
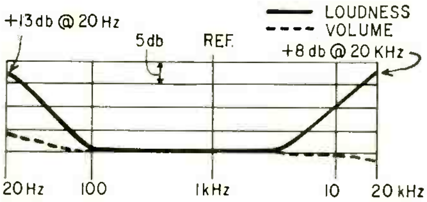
TECHNOTE

DYNACO SCA-35 AMPLIFIER

For owners who want some high-frequency boost along with the bass boost provided by the loudness switch, I suggest they try the following modification adapted from the Scott model 299.





The dpdt VOLUME–LOUDNESS has one unused leg in each channel. The diagram (one channel) shows how capacitors are added. I feel that the modification more closely compensates for normal losses at low volume levels. The graph shows the circuit response. There is a slight rise (3 to 5 dB) at 20 Hz with the switch in the volume position.
—*Joseph A. Kaufman* **R-E**

Service Clinic

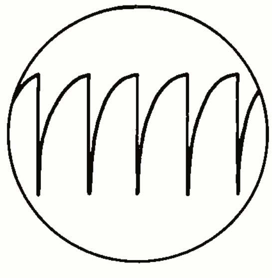
By JACK DARR

SERVICE EDITOR

Drive "Slipping", CTC5 Color TV

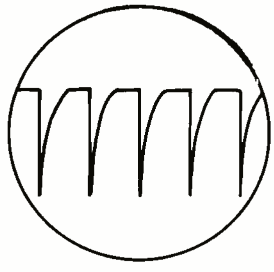
In an RCA CTC5 color TV chassis, I get about 18 KV when the set is turned on. After about 2 minutes, my grid drive, on the 6CB5 horizontal output tube, is −34 volts, after 5 minutes it's down to −28, and about 10 minutes later, it's zero and the 6CB5 plates are red-hot.

Another technician has replaced almost everything on the output side of the 6CB5 trying to fix this. The waveform on the 6CB5 grid looks at first like (a), then in 5 minutes like (b) and then like (c). What do you think this is?—R. B., Los Angeles, Calif.

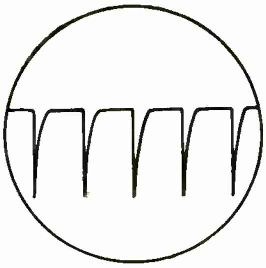


A

This looks more like horizontal *oscillator* trouble! You can see from the flattening of the drive waveform that something is happening in that grid circuit. Several possibilities: First, check out that horizontal oscillator all the way through. To make sure, you could kill the oscillator, and substitute a drive signal from a working TV set, feeding it directly to the 6CB5 grid through a small blocking capacitor. (Many 90° and 110° black-and-white sets have high grid-drive voltages, and will give you plenty of drive—at least enough to help you decide whether this is a drive problem or something else.)



B



C

The trouble might be gas or grid emission in the 6CB5 itself, or a slight leakage in one of the capacitors in the grid circuit, or a drifting resistor. Note the flattening of the tops of the wave; this means that something is not letting this signal reach normal peak amplitude.

Floating Bar in Raster and Picture

We have several sets, mostly color, and the same problem shows up on all of them. It's a light-colored horizontal bar, wider than a blanking bar, that floats slowly up the screen without seeming to affect the picture. Colors seem to shift slightly as the bar goes past them. Since these are all in the same building, it may be something in the wiring. What do you think?—R. F., Baltimore, Md.

I have a deep suspicion, although you didn't mention it, that these sets are all on a master antenna system! If so, and the symptom is common to all of them, I'd go through some of the line and distribution amplifiers and look for one with a very poor power supply filter!

This has happened in several instances on community antenna systems, and the cure is the same: better filtering in the broad-band rf line amplifiers. Hum here will cause the B+ voltage on the tubes to change at a 120-cycle rate and give you a sort of AM on the rf signal. Some of the smaller amplifiers use resistors in the B+ instead of a choke. Replacing them with a small choke seems to stop the bars every time. (You can tell which amplifier to check first by checking to see which sets in the building are affected and following the signal distribution lines back toward the amplifiers and antennas.) **R-E**

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

If you're really stuck, write us. We'll do our best to help you. Don't forget to enclose a stamped, self-addressed envelope. Write: Service Editor, Radio-Electronics, 200 Park Ave. South, New York 10003.

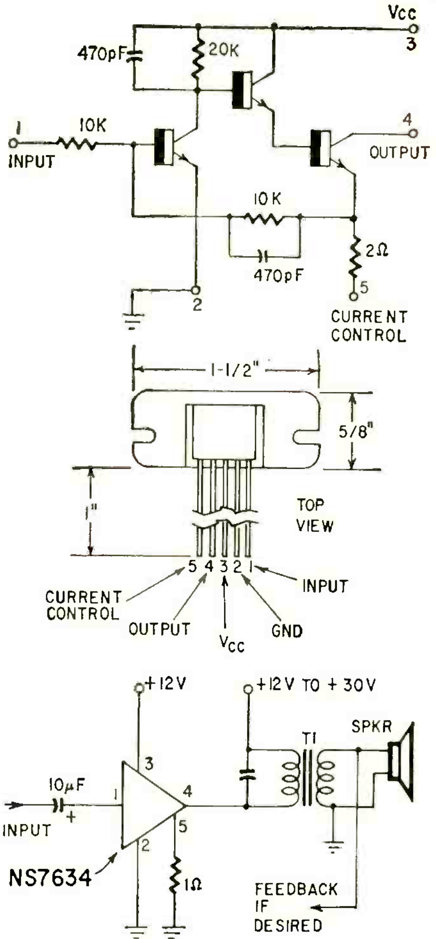
NEW TUBES AND SEMICONDUCTORS

IC POWER AMPLIFIER

Designed for power amplifier applications from dc to 30 kHz, the NS7634 can be used either as a single-ended class-A amplifier or, by using a pair, in class-B service. It uses thick-film resistors and silicon transistors on a ceramic substrate and is mounted on an integral heat sink. Over 3 watts of audio can be obtained in class-A operation and up to 15 watts per pair in class B.

The schematic and basing diagrams and the circuit of a 2-watt amplifier are shown. For 2 watts, the output supply voltage is 24, and the primary impedance of the power transformer is 120 ohms. Typical characteristics are: Output current 300 mA, bias supply current (current to input stages) 5 mA, input resistance 10,000 ohms, transconductance 0.5 mhos, input voltage for maximum output swing 0.35 V rms, frequency response (power output 3 dB down) 35 kHz.

Full specifications and application notes can be obtained from National Semiconductor Corp., Santa Clara, Calif.



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The 2N5190 through 2N5195 make up a series of 40–80-volt, 40-watt, 4-ampere silicon power transistors for power amplifier and switching circuits. The 2N5190 through 2N5192 are npn's and the 2N5193 through 2N5195 are pnp's. Each of these Motorola transistors has its complementary in the series. Power dissipation is 40 watts at 25°C and must be derated 320 mW/°C above 25°C. Junction and storage temperature range is −65°C to +150°C. Other pertinent characteristics of these complementary pairs are:

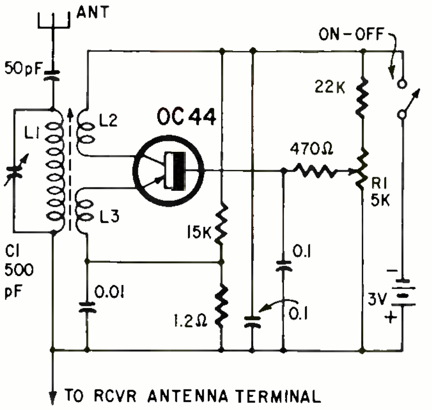
Maximum ratings	2N5190 2N5193	2N5191 2N5194	2N5192 2N5195
V_{CEO}	40 Vdc	60 Vdc	80 Vdc
V_{CB}	40 Vdc	60 Vdc	80 Vdc
I_C	4 amp	4 amp	4 amp
I_B	1 amp	1 amp	1 amp
I_{CEO}	1 mA	1 mA	1 mA
I_{CEO} ($T_C = 125°C$)	2 mA	2 mA	2 mA
I_{CBO}	100 μA	100 μA	100 μA
h_{FE}, min/max $I_C = 1.5$ amp $V_{CE} = 2$ V	25/100	25/100	20/80

R-E

NOTEWORTHY CIRCUIT

ULTRA-SHARP ANTENNA TRAP

Most of us are, by now, familiar with the use of Q-multipliers as a means of increasing the i.f. selectivity of inexpensive ham-band and general-coverage all-wave receivers. Within recent months, I've run across two circuits in which a Q-multiplier was used to increase the selectivity of antenna wavetraps and one in which it was used to sharpen an LC-type audio filter. One of the wavetraps was designed to eliminate broadcast interference from strong local stations. The other was used to attenuate interference from a French TV station whose video carrier was within the passband of a desired Swiss TV station.



The broadcast-band wavetrap described here was taken from *The Radio Constructor* (London, England). The wavetrap (see diagram) consists of L1–C1, a parallel-tuned circuit connected in series with the outside antenna and the antenna coil on the receiver and tuned to the interference frequency. The transistor is a common-base amplifier with feedback winding L2 in the collector circuit.

Potentiometer R1 is the regeneration control. As the slider is moved toward the negative end, the transistor bias and gain increase until the circuit breaks into oscillation. If the control is set just below the point of oscillation, the regeneration increases the effective Q of the trap and interference rejection is around 20 dB better than with L1–C1 alone.

The original circuit used a commercial coil designed for a regenerative broadcast receiver. This type coil is not available in this country so you'll have to "roll your own." You might start with a two-winding antenna or rf transformer salvaged from an old broadcast receiver. Use the primary—the antenna or plate winding—for L2; the secondary—the tuned winding—for L1, and random-wind about 30–40 turns of No. 28–30 enameled wire for L3. If the circuit does not oscillate at any setting of the regeneration control, try reversing the connections to *either* L2 or L3. If this doesn't work, try interchanging connections to L2 and L3.

European type OC44 and OC170 transistors worked well in the prototype. Almost any germanium pnp transistor designed for AM mixers, oscillators or converters should work.

The tuned circuit is very sharp, so use a vernier tuning dial on C1. To adjust the circuit, tune in the interfering signal with the Q-multiplier turned off. Set C1 for maximum attenuation. (The receiver should have a tuning indicator or S-meter because it is hard to make the adjustments by listening tests alone.) Set R1 to the positive end of its range and turn on the Q-multiplier. Rock C1 while slowly advancing the regeneration control to the point of maximum attenuation. Above this point, attenuation drops just before oscillation. **R-E**

Circle 128 on reader service card

Circle 129 on reader service card

SCHOOL DIRECTORY

Coming Next Month

In February R-E talks photography. We lead off with a roundup of what's new and exciting from an electronic standpoint. Then we follow up with two construction articles—a high-power electronic photoflash and a digital darkroom enlarging timer.

But that's not all. There's also an article on how to outwit electronic snoopers. It tells you how the eavesdropper works, about the equipment he uses and how to foil his efforts to listen in.

Then there are complete plans for a 4-channel mixer to go with the guitar amplifier you built last November. And there's a hang-on attachment for your vom that turns it into a direct-reading picofarad meter.

Don't miss these exciting features plus lots more in the February issue of RADIO-ELECTRONICS.

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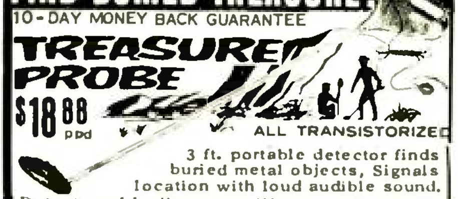

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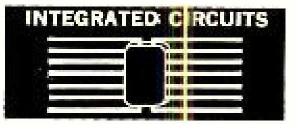

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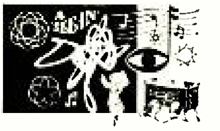

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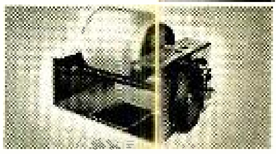

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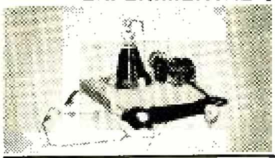

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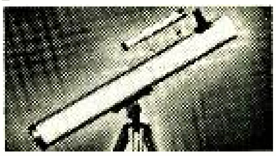

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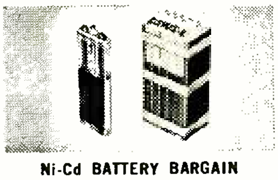

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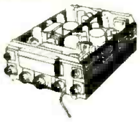

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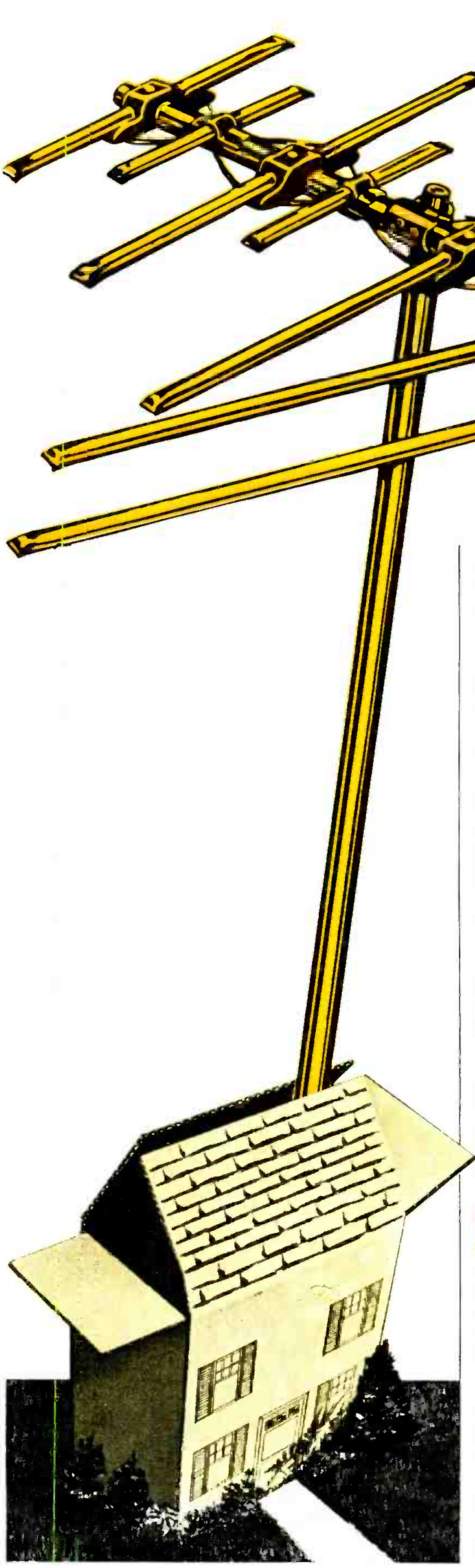

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Most competitive antenna elements are hollow, but cycolac, the toughest plastic known to man, is used to brace Gavin antenna elements internally. Cycolac is the plastic used for golf club heads and timber splitting wedges. It keeps Gavin antenna elements from buckling even in the highest winds.

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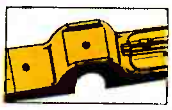

Cycolac is also used for V-Yagi separators. Thus, V-Yagi separators don't melt in the summer or crack in the winter. Also, the natural spring of cycolac, together with insert cups on rivets and heavy duty washers, insures positive element contact. Once contacts are snapped into place, the spring action forms a point-contact, with electrons actually migrating across the junction to make the contact corrosion proof.

PRE-STRESSED ROUND BOOM

Square booms may please-the-eye, but round booms really work better on an outdoor antenna. Round booms shed water easily, minimizing ice loading. Gavin V-Yagi booms are pre-stressed to keep elements in line, assuring optimum performance over the life of the antenna.
Also, improved boom braces damp the natural resonance of the boom.

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You can tell just by looking that Gavin U bolts and other mounting hardware are more rugged than those used on other antennas. What's more, they're made of non-rusting plated steel.

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While many 82 channel antennas are simply a UHF antenna stuck onto the front of a VHF antenna, Gavin V-Yagis use fully integrated UHF and VHF elements. Not only does this result in better performance initially but smaller size makes V-Yagis better able to withstand the elements.

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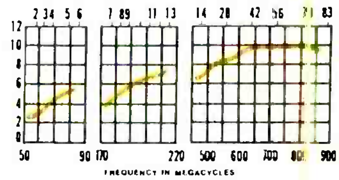

The higher the channel number, the harder it is to receive from a given distance. To offset this natural law, Gavin V-Yagis are designed to provide more gain where it is needed the most.

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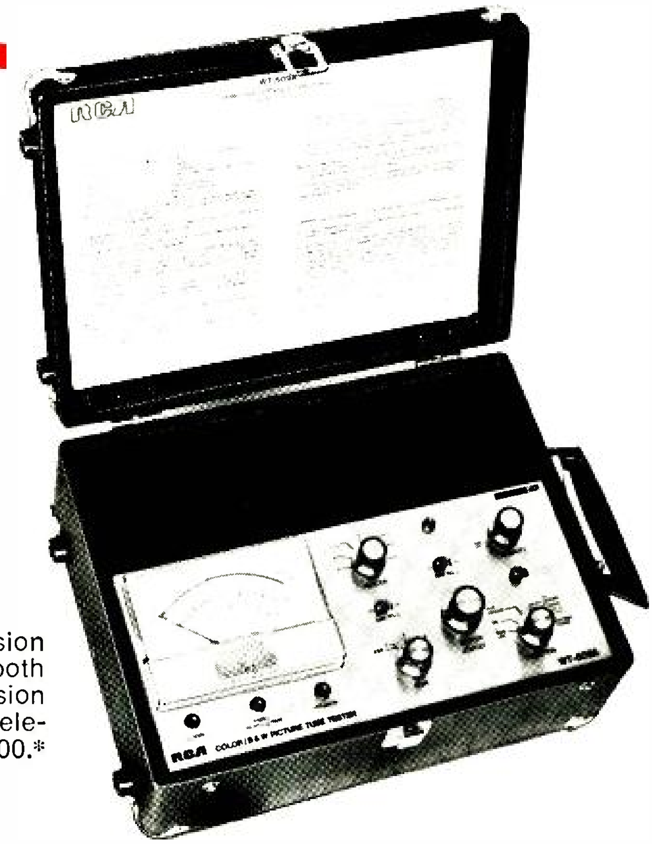

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