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NOVEMBER 1968
LOOKING AHEAD

By DAVID LACENBRUCH
CONTRIBUTING EDITOR

'New' color tubes

A 21-inch (viewable diagonal) shadow-mask color tube which has proved popular in Europe is being introduced in the U.S. and Canada. Manufactured by Philips Lamp Works of the Netherlands, it differs from American 20-inch tubes in shape and contour, although its total viewing area is almost exactly the same. The new tube has a very square-cornered screen and a flatter face than American types. In addition, its aspect ratio (height-by-width) more closely approaches the 3-by-4 dimensions of home slides and movies than does the 4-by-3 ratio of most picture tubes. The new tube is featured in two sets made by Electrohome of Canada; demonstrations to U.S. television set manufacturers had just begun at press time.

General Electric's pioneer mini-color 10-inch picture tube has been redesigned to produce a picture sharper, brighter and more contrasty than its predecessor, which has been in service for more than three years. Resolution has been enhanced by increasing the number of aperture-mask holes per square inch to 1820 from 1080, and reducing phosphor dot size to 14.7 from 18.7 mils. A higher-contrast faceplate and brighter rare-earth phosphors have been added, along with a new electron gun. The in-line gun configuration has been retained. The new tube is physically and electrically interchangeable with the older version.

Taped music boom

Prerecorded music on tape is now becoming an important medium, and in terms of retail dollar volume it could be close to one-quarter the size of the phonograph record market this year. Ampex Stereo Tapes, which duplicates and distributes recorded tape, has raised its estimate of the 1968 market by 50% to $250 million from its previous forecast of $160 million.

The growing circulation of 8-track automobile stereo players is largely credited for the increase in sales. Ampex's estimates now indicate that 8-track cartridges alone will sharply exceed $160 million in sales this year, with 4-track cartridge sales running about the same as last year's $27 million, and reel-to-reel tapes declining a modest 5% from 1967 to $19 million. Sales of pre-recorded tape in the 2-reel cassette format is not a serious factor yet, according to Ampex. It's estimated that as many as three million 8-track tape players will be in use by the end of 1968, tripling the number in a single year. Most of them probably will be in automobiles, but sales of both home and battery-operated portable players are said to be rising. Although cassette recorder sales are picking up at an even faster pace, the principal use of the cassette machine so far is as a portable recording medium, while the 8-track cartridge unit—which can't record—relies solely on pre-recorded material.

Last year's recorded tape sales totaled about $160 million. Phonograph record sales in 1967 exceeded $1 billion.

While we're on the subject, the output of phonograph records has increased so rapidly that just keeping up with new releases would be a full-time job. If you spent eight hours a day, six days a week listening to every one of the 7,231 single discs and 4,328 LPs issued in the United States in 1967, it would take you exactly a year. (With Sunday off to replay favorites.)

Electronics vs. noise

Already beset by the radar speed trap, the careless motorist soon will have another worry—the electronic noise trap. Seeking a method to establish legal evidence of violations of its anti-noise-pollution law, the state of Connecticut has awarded a $69,000 contract to CBS Laboratories to develop a vehicle noise detector-recorder whose readings will stand up in court and provide positive identification of offenders.

CBS Labs' design is for a suitcase-sized device that can be operated from a police car at roadside. A recording decibel meter makes a chart of the noise level of a passing vehicle. If the volume exceeds the legal limit, a camera snaps a picture of the offending vehicle's license plate and, on the same frame, a photo of the chart. The resulting split-screen photograph, in the opinion of the state's legal authorities, will be lawyer-proof.

Q-&-A via FM

You soon will be able to take courses at home from an FM set you can answer back to—and it will tell you whether your answer is right or wrong, and why. A new firm, Educasting Services Inc., has already tested such a system with approval of the FCC and now says it is ready for large-scale home teaching operations.

Educasting combines programmed learning techniques with teaching-by-radio. When a student signs up for a course, he receives his regular lesson books plus a special leased radio (the first 10,000 units have already been built by Sylvania). The fixed-tune FM set has four pushbuttons. With button number one depressed, the student hears the instructor give his lecture—and ask questions. The student can select one of three possible answers by pushing button number two, three or four. After he chooses and presses the answer button, he hears the instructor's voice tell him whether his answer was right or wrong and why. Button one then restarts the lesson.

Educasting courses can be broadcast by any FM station without interfering with regular monophonic programming. The system makes possible the simultaneous transmission of four multiplex subcarriers, one for each of the pushbutton channels, in addition to a regular entertainment program. The special receiver picks up only the multiplex subcarriers. In the studio, a four-track tape feeds lessons to the four subcarriers. R-E
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Member Institute of High Fidelity.
Radio-Electronics is indexed in Applied Science & Technology Index (formerly Industrial Arts Index).
Low-Cost 8mm Sound Movie System

New camera system announced by Bell & Howell puts lip-sync sound in 8-mm home movies. The new Filmsound 8 system coordinates camera and projector with a portable cassette recorder that tapes sound accompanying the filming and plays back during projection. The cassette machine records and plays 4-minute tape cassettes, the filming time for a standard super 8 cartridge.

During filming, sounds from the microphone are recorded magnetically on the audio track of the cassette tape while an 18-frame-per-second pulsed signal is recorded on the synchronous control track of the tape. The pulsing signal serves as a speed control for the projector, keeping both picture and sound in frame-by-frame sync.

The complete system consists of the Autoload 442 camera ($159.95), Autoload 458 projector ($169.95) and Filmsound 450 recorder ($99.95).

DEAFENING MUSIC?

The guinea pig says yes. Tests at the University of Tennessee subjected a guinea pig to go-go music recorded at a local discotheque, played at high levels (120 db) to duplicate the sound level of the discotheque. After 88 hours of listening, spread over a three-month time, the sound-sensitive cells in the guinea pigs ears began to deteriorate.

True, guinea pig ears are not human ears, but there is some evidence that there is a connection. A recently completed study at the University of Tennessee revealed an unusually high proportion of students with measurable hearing loss. The hearing of many freshman students had already deteriorated to a level of the average 65-year-old person.

MOTH JAMMING

Electronic sensors in the antennae on this night-flying Cecropia moth are remarkably similar to the radar detectors first used in World War II. Instead of reacting to radar, however, the detectors are so microscopically small (0.0026" long and 0.00026" in diameter) they are sensitive to light waves. This property was discovered by Dr. Philip S. Callahan, a U.S. Department of Agriculture scientist, during studies to find a signal that would attract the crop-damaging corn earworm moth. The scientist found that moths drop to the ground as a defense when exposed to light because the light-sensitive detectors "short circuit" their antennas, blocking impulses from several other sensory antenna spines. Dr. Callahan reported his findings in the publication, Applied Optics.

TRANSISTORS ON PAPER

This array of 100 tellurium transistors deposited on a playing card may be the forerunner of mass-produced semiconductors costing a penny each or less. Experimentally produced in Westinghouse labs, these thin-film flexible transistors have been formed on a variety of substrate materials. They have stable operating charac-

...teristics and have worked at 60 MHz. Over 600 of the devices can be deposited in a one-square-inch area. Although commercial applications are several years off, the devices should greatly reduce the costs of toys, novelties, hobby kits, teaching aids and other items where high power, high temperature, and very high frequencies are not present. The company also predicts applications of highly flexible electronic circuits.

EYES FOR SPACE

Four viewing methods to permit future spacecraft crews to see earth during reentry are under test by NASA pilots. This system, produced by Kollsman Instrument Corp., mounts in a...
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Asked to referee the raging debate, a factory spokesman declared, "The best reason for choosing Quam baffles is value. Whether the emphasis is on good looks, good performance, or good construction—not to mention good sound—Quam buyers know they get their money's worth!"

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The baffles are available if desired with speakers (and transformers) premounted. Any of 10 Quam 8" background music, public address, or outdoor speakers can be selected. There is no charge for the mounting. You pay only for the components themselves.

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Circle 10 on reader's service card

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(continued on page 12)

Series of micro-graphs show the bonding of a piece of flat glass to a piece of flat silicon. The bonded area (beginning in photo 1) moves across the chip in a wave-like motion behind the light interference fringes—seen as dark wavy lines.
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November 1968
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RADIO-ELECTRONICS
CURTAIN OF SOUND

Get the most out of a stereo recording session—put the mikes in the right places!

By WINSTON THARP

WHEN STEREOPHONIC RECORDING WAS first developed, one of the early theories tried was to place a number of unidirectional microphones in front of the musicians. The mikes formed a “curtain” and so did the playback speakers. Soon it was found that good space/sound illusion could be preserved with only two mikes. The only question—how far should they be separated?

Since then, several two-channel systems have been used. The binaural arrangement uses directional mikes spaced about 6 or 7 inches apart—approximately the distance between your ears. Playback is through headphones. Obviously 7-inch mike spacing is incorrect for material to be played back through relatively wide-spaced speakers. But how far apart to place the mikes then? A couple of feet might do for a small, three-piece band. A full symphony orchestra, on the other hand, might require 10 feet or more.

Moreover, loudspeaker spacing varies with each home listener. Good miking deals with this.

Critical stereo angle

To preserve the curtain of sound illusion, it’s necessary to construct an imaginary isosceles triangle, with the performers along the base and the listener at the apex. The angle formed by the two equal sides should be between 30° and 45°. The mikes are then placed along the two equal sides and equidistant from the performers.

A bit of elementary trigonometry discloses that for an apex angle A, width of performing group W, distance from mike to group D, and mike spacing S

\[ S = W - 2D \tan \frac{A}{2} \]

\[ D = (\frac{1}{2} \cot \frac{A}{2}) (W - S) \]

Taking the extreme values of A, we see that for \( A = 30° \)

\[ S = W - 0.5358D \]

\[ D = 1.86605 (W - S) \]

For \( A = 46° \) (a little easier to compute than 45°)

\[ S = W - 0.8490D \]

\[ D = 1.17795 (W - S) \]

For all practical purposes we may approximate these equations. For \( A = 30° \)

\[ S = W - D \]

\[ D = 2(W - S) \]

For \( A = 46° \)

\[ S = W - 5D \]

\[ D = 10(W - S) \]

For instance, if the sound source (the musicians) is spread across 10 feet of stage, and you want the mikes within 10 feet, simply plug these values in a formula: For an angle of 30°,

\[ S = 10 - 5 = 10 - 5 = 5 \]

Therefore, you would place the mikes 5' apart, 10' from the musicians.

Given a width of performing group and either distance from performers to mikes or mike spacing, you can easily compute the unknown dimension with these formulas. The recordist usually has little control over the width of the performing group. In many instances the distance from group to mikes or mike spacing may be fixed by such factors as availability of mike supports, esthetic considerations (some performers just don’t like mikes), or desire on the part of the recordist to minimize audience noise.

Theoretically, the mikes should be spaced 6 to 10 feet apart to match the spacing of the speakers used for playback, but as long as the correct angular relationship is maintained the effect will be correct. Spacing the mikes closer than 3 feet or farther than 50 feet from each other may result in insufficient or excessive separation due to the time differences of sounds from opposite sides of the performing group hitting the mikes.

The value of angle A is determined by acoustical conditions and the type of group to be recorded, with the larger angle (and shorter D) for recordings emphasizing “presence” and the smaller angle (and longer D) more “liveness.”

The preceding rules hold for ideal recording conditions. Note, however, that unless good cardioid mikes are used (and possibly even then) mikes will have to be closer than half the total distance from “width” line to apex. Otherwise, room noise and reverberation will probably degrade the recording—certainly the separation.

Remember also that, especially with omnidirectional mikes and in a small room, reproduced stereo may be “off center” because of absorption or reflection from the walls. This is particularly true if the recording setup is asymmetrical.

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For a complete catalog with descriptions and specifications for all RCA test instruments, write RCA Electronic Components, Commercial Engineering, Dept K39WA, Harrison, N.J. 07029.

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Correspondence

TV DX-ER WANTS INFO
I have been dx'ing the television bands for about six months and I've been trying to collect information on TV dx'ing, TV dx'ers, antennas and equipment for use in TV dx'ing. Can any of your readers help?

Mark J. Kozlowski
306 Riverside Ave.
Buffalo, N.Y. 14270

Dx'ers, how about giving Mark a helping hand? We've sent him a list of dx'ing articles that have appeared in R-E. Now it's your turn to sock it to him.

MORE WINDSHIELD WIPER COMMENT
I read and enjoyed S. B. Grynke-wicz's article in the July 1968 issue "Automatic Windshield Wiper Pause Controller." I built and installed the
motor and the battery. Some modifications were required to get the circuit operating properly for me. They are circled in the diagram.

C3, R6, and D1 filter out voltage transients from the wiper motor. C4 and R5 prevent the filter from interfering with proper operation of the timing network. Now the circuit works fine, except that the normal wiper cannot be turned on while the controller is operating.

HENRY L. HESS
Colorado Springs, Colo.

Ok, all you 1964 Valiant owners. Henry has shown you how to get the pause control to work for you. If you've been holding off waiting for this solution you can start building your pause controller now.

MINI-AMP IS HOT

From the announcement of the Guitar Amplifier that was presented in the September issue I must confess that I visualized a 60-70-watt, transformerless, all-silicon job. But let's not minimize Mr. Gill's cute 2-watt mini-amp. It has a number of good points like the CA-3020 and the diode gimmick that saves a switch by blocking reverse current from half of the 12-volt battery.

But now, let's have that same CA-3020 followed by a good class-AB power silicon complementary pair with 50-watt output into 8 ohms or 70 watts into 4 ohms.

TONY ROCCO
Bonita Springs, Fla.
Tony, elsewhere in this issue you'll find a step in the right direction—a higher-wattage guitar amplifier. And within the next few months we'll show you a flock of accessories you can build to use with it or most other guitar amplifiers. Included will be a vibrato, reverb, region box, mixer, inverter, hongos and—you guessed it—a 50-watt booster amplifier. So all you guitar amplifier fans, watch these next issues of R.E. closely.

READER SERVICE NOTES

Why don't I always get replies from all the manufacturers whose product codes I circle on your Reader Service Card?

WARREN ROY
Brooklyn, N.Y.
It just takes time Warren. It takes time for us to get your name to the proper manufacturers. It takes them time to get out the necessary brochure. It takes time for the post office to get that brochure to you. So don't give up, you'll get all the material you requested.

NOVEMBER 1968 17

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Circle 17 on reader's service card

In the Shop . . . With Jack
By JACK DARR
SERVICE EDITOR

Solid-State Rectifiers

At regular intervals, technicians come across funny-shaped components in radio, TV, stereo and other equipment. From their shape and size, you can't tell beans about them. But you can tell their purpose from what they're connected to. These "unidentifiable" are silicon rectifiers used in a solid-state power supply.

You may find one, two or four small units mounted on a terminal strip. Large stud-mounted rectifiers may have leads going off in all directions, or a unit may be just a featureless black blob in a rectangular case, tightly mounted on a PC board.

It doesn't matter what they look like, they all do the same thing: supply dc power for transistors or tubes. Trace the leads from an unknown unit to determine its function. If one lead goes to an electrolytic capacitor and others go to the ac source, it's the rectifier.

Three rectifier types are used in ordinary circuitry: half-wave, full-wave and bridge. You can tell which type it is by counting the number of leads on the "package." Two leads—it's a half-wave (single) rectifier. Three leads—it's a full-wave (two rectifiers with a common connection). A bridge will always have four leads. Fig. 1 shows the schematic of each.

The identification confusion results from packaging. Many rectifiers have unmarked cases with leads, prongs or studs. All you can do is look to see where they're connected.

Half-wave (2 leads): One lead will always go to the ac supply, and the other to a big electrolytic capacitor. From the capacitor, another lead will go on to the main B+ (dc) voltage circuits. Hint: Look for the power output stage. This is the point where the highest dc voltage will always be used (audio output in radios, stereo, horizontal output stage in TV, etc.)

In tube equipment, the dc voltage output will always be positive. In transistor equipment, it can be positive, negative, or both, depending on the transistor types used. In a positive supply, the cathode of the diode will always go to the positive (insulated) end of the electrolytic capacitor that acts as a ripple filter.

On the very small silicon diodes now used, the cathode will be marked. This mark may be a rounded end, a band or dot of paint or, in some cases, the maker may have been thoughtful.

Fig. 1—Schematics of three basic rectifier types used in modern equipment.
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Color-TV Servicing Guide by Robert G. Middleton. This fine book is a quick, effective servicing tool for color-TV. Shows how to apply fast troubleshooting procedures, based on an analysis of trouble symptoms. Includes many full-color pictures, tube photos illustrating various operating troubles, accompanied by clear, concise explanations of probable causes and diagnosis procedures. The last chapter explains in detail how to test and troubleshoot with color-bar generators. 112 pages. Order 20058, only $4.25

Transistor TV Training Course by Robert G. Middleton. Provides a complete understanding of modern transistor television circuitry by progressive analysis of each stage of a typical receiver. Includes review questions. 128 pages. Order 20619, only $3.95

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Fig. 4—Full-wave bridge rectifier always has 4 leads. This type has many case designs. The stud-mount case on bottom is for heat-sink purposes only. The leads are connected directly to the rectifier will be the input filter, and you can determine polarity from this. Rectifier size is an indicator of its current rating. You can get the PIV (peak inverse voltage) rating by measuring the applied ac voltage, even with the rectifier disconnected. In small units, such as stereos, etc., you'll probably find 1-amp rectifiers. These are common; even small silicon rectifiers now have 1-amp ratings. Rectifiers such as the stud-mount type on Fig. 4, with a heat sink, will probably be from 2 to 4 amps.

To make sure of current ratings, you can disconnect the main dc voltage-supply lead from rectifier to filter capacitor, and read the full-load current. This is a good idea with "unknown" rectifiers. For instance, if you decide there should be 2-ampere rectifiers and you read a load current of about 2.5 amps, yank those rectifiers out of there and put in 4-amp types. Use an adequate safety factor.

For bridge rectifier replacements, you can always use separate units, mounted on a four-terminal strip. This doesn't take up too much room on even the most crowded chassis. If necessary, use top-hat types and put transistor heat sinks on them. However, a generous safety factor for current may eliminate heat-sinking.

Fig. 3—Three leads designate a full-wave rectifier. Lead marked "+" is output; other leads go to ac transformer.

RADIO-ELECTRONICS
Pattern Bounce in dc scope

I'm thinking of buying a dc scope. Someone told me that the trace of his dc scope would bounce all the way off the screen when he touched the probe to any circuit carrying dc voltage. Is this normal?—B. F., Reading, Pa.

Sure is! The position of the trace on a dc-coupled scope depends on the dc voltage present at the probe tip! You can even use the scope for a dc voltmeter, if you've got it calibrated. The action you describe is perfectly normal.

In the ac-coupled scope, the type used in most service shops, the pattern will jump when the input blocking capacitor is being charged up. It should return to its original position if the capacitor isn't leaky.

Two-color convergence

We can't get an RCA 21CD7856 color TV chassis to converge properly. The green and blue lines are straight but reds are curved. This happens on horizontal and vertical lines; beyond the range of the adjustments! What causes this and what can we do to correct it? —J. Z., Aliquippa, Pa.

Try the red-green method. Turn the blue off, and work on getting the red and green to converge to yellow. You have many adjustments on the blue, so it's easier to pull it over than to move the other two.

Watch out for one thing (it happened to me not too long ago): The red was actually "one square too far over" on a fine crosshatch pattern! Cause: incorrect adjustment of static magnet. I (continued on page 30)

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NOVEMBER 1968
IT'S BEEN A FULL YEAR SINCE THE TV X-RAY SCARE STARTED AND THAT SCARE IS JUST NOW FADING AWAY. SET MAKERS WERE PROMPT IN THEIR REACTION, AND THE NEW SETS DON'T PRODUCE ENOUGH X-RAYS TO WORRY ABOUT. EVERY MANUFACTURER HAS TAKEN DRAMATIC AND THOROUGH STEPS TO AVOID ANY POSSIBLE RECURRENCE. AS A RESULT, THE DANGER TO COLOR TV VIEWERS IS ALMOST NONEXISTENT.


• NEVER OPERATE COLOR PICTURE TUBES THAT DO NOT HAVE A BONDED FACEPLATE WITHOUT A SHEET OF SAFETY GLASS IN FRONT OF THE SCREEN.
• DON'T OPERATE A BLACK-AND-WHITE PICTURE TUBE IN A COLOR SET UNLESS YOU USE A SHEET OF SAFETY GLASS IN FRONT OF THE FACEPLATE.
• DON'T OPERATE A COLOR PICTURE TUBE WITH ITS PURITY SHIELD REMOVED.
• NEVER RAISE THE HIGH VOLTAGE ABOVE THE MANUFACTURER'S RECOMMENDATIONS.
• ALWAYS REPLACE SHIELING AND PROTECTIVE DEVICES.

FOLLOW THESE SIMPLE SAFETY RULES AND YOU'LL BE SAFE FROM X-RAY EXPOSURE.

X-RAYS ARE DANGEROUS. COLOR TV PRODUCES X-RAYS. THEREFORE—COLOR TV IS DANGEROUS

LOGICAL BIT OF LOGIC, ISN'T IT? HAPPILY, IT'S NOT ALL THAT LOGICAL. FOR ALL X-RAY EXPOSURE IS NOT HAZARDOUS. THE REAL HAZARD DEPENDS UPON THE LEVEL OF INTENSITY. THE NATIONAL COUNCIL ON RADIATION PROTECTION AND MEASUREMENT HAS SET UP A MINIMUM SAFE LEVEL OF RADIATION FROM ANY TV SET. IT STATES THAT THE MAXIMUM EXPOSURE RATE AT ANY READILY ACCESSIBLE POINT 5 CM (ABOUT 2 INCHES) FROM THE SURFACE OF ANY HOME TV RECEIVER SHALL NOT EXCEED 0.5 mR (MILLIROYANTS) PER HOUR.

THIS RADIATION LEVEL IS ABOUT HALF THE OUTPUT OF MOST LUMINOUS DIAL WATCHES. OBVIOUSLY THESE ARE VERY CONSERVATIVE FIGURES. DR. VICTOR P. BOND, ASSOCIATE DIRECTOR OF THE BROOKHAVEN NATIONAL LABORATORY, HAS SAID THAT THESE RATINGS "ARE DELIBERATELY CONSERVATIVE, AND ARE SET WELL BELOW THE LEVELS OF EXPOSURE THAT CARRY A SIGNIFICANT PROBABILITY OF MEDICAL EFFECTS . . . " IN OTHER WORDS, THERE'S NOT ENOUGH RADIATION TO WORRY ABOUT.

BUT, AND THIS IS THE BIG BUT, NO ONE HAS EVER DEMONSTRATED THAT X-RAYS CAN DO US ANY GOOD—OTHER THAN THOSE A DOCTOR MAY USE PROFESSIONALLY FOR SPECIFIC MEDICAL PURPOSES. AND IT IS MY BELIEF THAT THE FEWER X-RAYS I AM EXPOSED TO, THE BETTER. NONE OF US WOULD CARE TO DISCOVER, 20 YEARS FROM NOW, THAT THOSE LOW-LEVEL X-RAYS WERE DANGEROUS AFTER ALL.

OF COURSE, THE SERVICE TECHNICIAN WHO WORKS ON COLOR SETS A GOOD PART OF THE DAY AND THE HOBBISt WHO GETS A LOT CLOSER TO HIS SET THAN AN ORDINARY VIEWER RISK BEING EXPOSED TO MUCH HIGHER LEVELS OF RADIATION FOR LONGER PERIODS OF TIME THAN THE AVERAGE PERSON.

WHAT CAN BE DONE? QUITE A BIT, AND MOST OF IT HAS ALREADY BEEN DONE. THE MAJOR X-RAY PRODUCER IN TV IS THE HIGH-VOLTAGE SECTION. WHEN A HIGH-VOLTAGE VACUUM TUBE IS SUBJECTED TO 20,000 VOLTS OR MORE, IT BECOMES AN X-RAY SOURCE.

AND SHOULD THE VOLTAGE IN THE SET JUMP FROM SAY, 25,000 VOLTS, TO 30,000 VOLTS, X-RAY OUTPUT MAY JUMP 10 TO 20 TIMES.

TO DATE, THE BIGGEST CULPRIT IN COLOR SETS HAS BEEN THE SHUNT REGULATOR TUBE. BUT NEW CIRCUITS AND TUBE DESIGNS HAVE JUST ABOUT ELIMINATED THIS PROBLEM.

THE HIGH-VOLTAGE RECTIFIER IS ANOTHER POTENTIAL TROUBLE SPOT. ONE SOLUTION IS TO REPLACE THE VACUUM-TUBE RECTIFIER WITH A SOLID-STATE RECTIFIER THAT CANNOT PRODUCE RADIATION AT ANY VOLTAGE LEVEL. ANOTHER ALTERNATIVE IS PROPER SHIELDING.

ANOTHER POSSIBLE SOLUTION IS COLOR PICTURE TUBES, LIKE THE SONY TRINITRON, THAT DO NOT REQUIRE THE HIGH-VOLTAGE LEVELS THAT PRODUCE RADIATION.

IN THE MEANTIME, TV SERVICE TECHNICIANS MUST INSURE THAT THE HIGH VOLTAGE ON EACH COLOR SET THEY REPAIR IS PROPERLY SET. MANUFACTURERS MUST CONTINUE TO DESIGN SETS THAT CANNOT PRODUCE X-RAYS.

COLOR TV'S CAN PRODUCE X-RAYS. BUT THE X-RAY OUTPUT OF THESE SETS IS STRICTLY LIMITED AND MANUFACTURERS ARE CHECKING THEIR SETS CAREFULLY BEFORE THEY LEAVE THE FACTORY. IF AND WHEN THE X-RAYS CAN BE COMPLETELY ELIMINATED, I BELIEVE THAT THEY CAN BE, WE WON'T HAVE TO THINK ABOUT THEM AT ALL.

—LARRY STECKLER, MANAGING EDITOR
SIMPLE DETECTOR SPOTS TV X-RAYS

By RICHARD K. STOMS & EDWARD KUERZE

WE NEEDED AN INSTRUMENT TO measure X-ray emission from TV sets. It had to measure levels as low as the exposure rate listed in the NCRH (National Center for Radiological Health) recommendation which states: "The exposure dose rate at any readily accessible point 5 cm from the surface of any home TV receiver shall not exceed 0.5 mR per hour under normal operating conditions."

The detector had to be portable and make accurate measurements rapidly, under field conditions. To meet these requirements we developed the instrument described here. Several were built by the Cincinnati, Ohio, facility of Electronic Products Radiations Laboratory of the NCRH.

How it works

The detector directly integrates and measures the electrical current represented by the GM (Geiger Muller) tube pulses. Its circuit is shown in Figs. 1, 2 and 3. The main circuit is in Figs. 1 and 2 and the audio circuit is in Fig. 3.

In Fig. 1, transistor Q8 is a constant-current generator that supplies a stable reference voltage for potentiometers R14 and R20. These pots equalize the steady-state zero-signal voltage at points B and C (about 3 volts). FET (field-effect transistor) Q4 and transistor Q5 and resistor R26 compose what amounts to a source follower with the voltage at point B following Q4's gate voltage. On all range settings, gate voltage is developed across the series combination of R12 and R13 shunted by C4 as a result of the electrical charge collected from the pulses in the 1B85 GM tube. The number of these pulses, and hence, gate voltage, is related to the X-ray field incident on the 1B85.

The calibration resistor (R12 and R13) is a series combination of a 3.3-megohm resistor and 5-megohm potentiometer or a selected resistor between 3.3 and 6.8 megohms and a 1-meg pot, depending on availability of potentiometers. The pot is adjusted so the base voltage range across the meter and its range resistor on the 3K range is 0.3 volt. Thus the 10K, 30K and 100K ranges have a voltage range of 1.0, 3.0 and 10.0 volts full scale (Fig. 2).

If voltages at B and C vary equal amounts in the same direction, there will be no meter deflection. If Q7's gate were made to follow the changes of point B, then point C would also follow these changes and the meter reading would not change. Time-constant capacitor C5 is connected between point B and Q7's gate. In conjunction with R17 it determines the time constant. This capacitor allows relatively fast changes to couple to the Q7 gate but not slow or dc voltages.

It is convenient when using this instrument, which has an appreciable time constant, to occasionally revert to a fast response for a short time to allow the meter to assume its approximate reading and then return the instrument to its longer time constant. This is done by pressing pushbutton switch S5 located on the front panel near the meter face. This shorts R17, reducing the time constant. Note that an additional "base" time constant is provided by R12 and R13 and C4.

Position 1 of range switch S3 is
the off position. Position 2 reads battery voltage under its normal load. Position 3 checks the high-voltage supply. The meter current is a portion of the GV3A 900-volt shunt regulator current. Any “on scale” reading indicates that there is shunt regulator current and that the high-voltage supply is on and regulating. Note that in this position all other circuits are off (battery voltage being blocked by D4). Position 4 is the zero check position. In this position the high-voltage supply is disabled. Positions 5 through 8 are the ranges previously described. At this point, operation with only one GM tube has been considered. If in Figs. 1 and 2 six units identical to the sensor unit shown are paralleled and proper adjustments made, the meter will indicate only the current in the tube seeing the highest X-ray exposure rate. This happens because the increase in voltage at point B due to an increase in gate voltage on one (or more) Q4 transistor will tend to cut off current through the remaining Q4, Q5 transistors. Switch S1 is provided on each of the sensor units so that each unit may be zero-set individually and also to facilitate troubleshooting. GM tube No. 6 (tube farthest from meter) receives its high voltage directly from the high-voltage supply while tubes 1 through 5 are supplied through S2. Pushing S2 disconnects the high voltage from tubes 1 through 5 and discharges the stray capacitance so that only tube No. 6 is operational. S2 must be kept depressed by the operator to deactivate tubes 1 through 5. When released, it is spring-return to normal. If cost is important a unit with only a single GM tube can be built. This slows down scanning time but cuts the cost by about $50.

The high-voltage circuit in Fig. 2 is fairly simple. A UJT (unijunction transistor), Q9, is operated as a relaxation oscillator. The ramp voltage at Q9’s emitter is capacitively coupled to the base of the normally off Q10. The result is a series of square-wave current pulses through the primary of transformer T1, a UTC 0-2. The frequency is approximately 2 kHz. Use of the UJT oscillator provides a very reliable means of self-starting, compared to the usual methods of feed back oscillators using a transformer tap.

The secondary circuit uses a standard voltage doubler and a GV3A 900-volt Corotron (Victoreen Instrument Company) shunt regulator. R34 is in series with the shunt regulator so
when S3 is in position 3, the meter will indicate a part of GV3A current. An audible signal can be produced for a preselected X-ray level as shown in Fig. 3. This is not a mandatory part of the circuit but is useful. Potentiometer R1 is connected to point B of Fig. 1 so the emitter voltage of UJT Q1 is related to X-ray exposure. R3's value is selected so the maximum setting of R1 just barely keeps Q1 from oscillating when the zero-signal voltage at point B is present. Any increase in voltage at point B increases emitter voltage at Q1 and cause oscillation. The frequency is a function of emitter supply voltage, which results in an increasing audio tone as X-ray exposure increases. Q2 and Q3 comprise a monostable multivibrator. In its normal state, both Q2 and Q3 are off. A positive pulse from Q1 coupled into the base of Q2 will turn Q2 and Q3 on. Feedback network R9 and C3 provide the positive feedback required for monostable multivibrator action and controls the "on" time. The speaker receives a pulse of energy for every pulse produced by Q1.

Using the instrument

Start by turning the range switch to the battery check position. The meter should show a reading of 21 volts. Change the batteries if the reading is 18 volts or lower.

Turn next to the HV position. Any "on scale" reading indicates that the high-voltage supply is operating.

Now check the meter by placing the range switch on the zero position. Use the screwdriver adjust pot (R20) below the meter face.

Most readings will be made with the time-constant switch set to F. The longer time constant may be selected if desired. Depressing the button switch next to the time-constant selector switch reduces the time constant to its shortest value. This can substantially reduce the time required for a reading.

An audible signal is incorporated and may be used at the operator's discretion. The sound is turned off by turning the audio control completely clockwise. Other positions of the control determine the level or amount of X-ray exposure that the audio circuit will respond to. A radioactive check source emitting X-rays or gamma rays can be used to obtain any desired meter reading. The control can then be set so that an audible signal can just be obtained. A decrease in X-ray exposure below this value will produce no sound. Increasing exposure over this level will result in a sound of increasing frequency. The sound is not that obtained by producing a click or sound pulse for every Geiger-tube pulse. The time-constant selector does not affect the response time of the audio signal which always operates on the shortest time constant.

Field tests and maintenance

A radioactive source emitting X-rays or gamma rays can be used to check the operation of the instrument. When the source is successively placed adjacent to the GM tubes, fairly consistent readings should be obtained. Differences in readings between tubes or between readings taken on both sides of the same tube may be caused by small variations in the short "source to tube" distance. These differences are minimal when the source is more (continued on page 91)
The Case of the Mysterious Glitch-Hausen

Some unusual TV ailments can be catching

By JACK DARR
SERVICE EDITOR

CHARLEY SNARLED. I SNARLED BACK.
Neither of us was in good humor at that moment. I'd been beating my brains out all morning on a G-E KC color TV chassis, and he'd been doing the same thing on a middle-aged Philco b-w.

I had colored "sparkles" on the right side of my picture. He had what looked like the worst case of Barkhausen oscillation I'd ever seen, though it didn't look just right. We stopped and went out for coffee, leaving the sets on.

In the coffee shop we moaned about our problems. "I'm damned if I can figure this thing out," I said. "I've got plenty of high voltage, and it looks for all the world like an arcing resistor in there. But this set hasn't got a filter resistor in the high-voltage lead! I can't see any corona, any arcovers, or nothin'. I've been sitting there an hour trying to hear corona with that little plastic tube. Nothing. It just sits here and sparkles at me!"

"Me, too," said Charley. "That blankety-blank thing looks for all the world like Barkhausen, but I've changed horizontal output tubes three times, the damper and everything else I can think of. No corona on mine, either. It just sits there and makes bars at me!"

We went unwillingly back to the shop. There they sat, side by side, sparkling and streaking at us. I lit a cigarette and Charley moodily chomped on a second doughnut. We sat there glaring back at the sets.

"Well," I said, "don't just sit there, do something! I'm going to yank that thing out and look for a carbon track on the PC board around the boost connections."

I yanked the cheater cord from the G-E. Then I went straight up in the air, for there was a loud screech from behind me. Charley was pointing at his Philco. There was the prettiest picture you ever saw!

I plugged the G-E back in, and when it warmed up there they were again: big, fat black bars on the Philco. I ran to the tube shelf and grabbed a new 6JS6 horizontal output tube. After some confusion, the new tube was plugged in, and we watched with fingers crossed. The high voltage sizzled and there we were. No more bars on the Philco. I peeked over the top of the G-E. No more sparkles, either! Just a beautiful, clear picture.

I put the old 6JS6 back and waited. Bars again, and sparkles. Suddenly, I reached over to Charley's set and took the antenna clip off. Hmmmm. No bars now! I put the new 6JS6 back, turned it on, and there we were. Two beautiful pix. We headed back for the coffee shop.

Ten minutes and several paper-napkin schematics later, we had puzzled it out. The horizontal output tube in my G-E had been causing a form of Barkhausen oscillation, and this had been so strong that it had been coupled into the antenna input of Charley's set. Being on the common shop antenna, this had been more than enough.

Ordinary Barkhausen oscillation shows up as black wiggly bars about an inch or two from the right side of the screen. In other words, just a little bit before the horizontal output tube reaches peak conduction. However, this thing must have been making an oddball oscillation just as the tube reached the peak, or perhaps during the first split microsecond of actual "flyback." It must have been similar to what TV transmitter engineers call a "glitch"—a burst of very-high-frequency oscillations at the cycle peak (Fig. 1).

So, you might call what we'd had a very severe case of "Glitch-Hausen oscillation!" Back at the shop, we tried it one more time. The G-E had a beautiful picture: no trace of sparkles or bars, etc. Since the set's owner had been complaining about "funny-looking color pictures" for some time, when it went home it had a brand-new 6JS6 in it.

Fig. 1—High-frequency oscillations or "glitches" apparently developed as the horizontal output tube reached a peak.
Go-Go Guitar Amplifier

If you’re an electronics buff and you enjoy playing the guitar, here’s a unit you can build that will make it possible for you to combine both hobbies. Although the amplifier isn’t hi-fi, its gain and response characteristics do make it an excellent choice for both guitar or public address use. The amplifier has dual inputs and can deliver a continuous 10 watts of music power output. And if this isn’t enough, a future issue will describe a compatible 50-watt booster amplifier.

A host of other electronic gadgets are also coming and they are all related to this unit. They include an input mixer, tremolo, bongos, reverb amplifier, fuzz box and a 12 Vdc to 115 Vac inverter. For more details about these other units see page 40.

Why the dual input? Because it adds (text continued on page 40)
Fig. 1—Dual input to preamplifier section (top) adds versatility. The power amplifier develops up to 10 watts of music power.

ELECTRONICS PARTS LIST
Q1, Q2, Q3, Q4, Q6—HEP 250 (Motorola)
Q7, Q8—HEP 230 (Motorola)
RECT—diode bridge assembly HEP 175 (Motorola)
D1—HEP 154 (Motorola)
T1—Filament transformer, Primary 117 Vac, Secondary 26.8 Vac, 1 A (Triad F10X or equiv.)
C1, C11, C15—0.033 µF, 600 Vac (Mallory SX230 or equiv.)
C2—0.47 µF, 100 Vac (Mallory PVC1047 or equiv.)
C6—500 µF, 15 Vac 100 Vac (Mallory TC1550 or equiv.)
C13, C14—0.05 µF, 100 Vac, disc ceramic
C3, C4, C5, C9, C10, C12, C16, C17, C18, C20, C22—10 µF, 25 Vac, electrolytic (Mallory TC52 or equiv.)
C7—0.033 µF, 100 Vac (Mallory PVC1133 or equiv.)
C8—2000 µF, 15 Vac, electrolytic (Mallory TC1520 or equiv.)
C19—0.001 µF, 600 Vac, (Mallory SX210 or equiv.)
C21—120 µF, 600 Vac (Mallory SX312 or equiv.)
C23—29 µF, 35 Vac, electrolytic (Mallory MTA131 or equiv.)
C24—4500 µF, 50 Vac, electrolytic (Mallory CG52US1001 or equiv.)
R1—470 ohms, 1/2 W
R2, R13, R24—390 ohms, 1/2 W
R3, R25—1 ohm, 1 W
R4—22 ohms, 1/2 W
R5, R7, R37—47,000 ohms, 1/2 W
R6, R8, R16, R17—1,700 ohms, 1/2 W
R9—22,000 ohms, 1/2 W
R10—2,200 ohms, 1/2 W
R11, R19—10,000 ohms, 1/2 W
R14, R18, R20, R29, R31—10,000 ohms, 1/2 W
R15—12,000 ohms, 1/2 W
R21—6,800 ohms, 1/2 W
R22—2,700 ohms, 1/2 W
R23—120,000 ohms, 1/2 W
R26—10,000 ohms, 1/2 W
R27, R28—39,000 ohms, 1/2 W
R30—1000 ohms, 1/2 W
R33—1,500 ohms, 1/2 W
R34, R35—potentiometer, 50,000 ohms, 2 watts (IRC 11-123 or equiv.)
R36—potentiometer, 10,000 ohms (IRC 13-116) or equiv.
L1—pilot lamp, No. 313
F1—1/4 A fuse, type 3AG
J1—phone jack (switchcraft 11) or equiv.
J2, J3—phone jack, N.C. (Switchcraft 12A or equiv.)
Heat sinks for Q7, Q8—HEP 500
Fuseholder
Pilot lamp holder (Milco 81410-112-201)
Transistor sockets (6) (Elco 6F3304 or equiv.)
Transistor socket rings (6) (Elco 547202 or equiv.)
Power transistor sockets (2) (Motorola HEP 450 or equiv.)
AC line cord
SPKR—8-ohms (Utah MI-88C or equiv.)
Knobs, grommets, 5/8" x 3-13/16" x 18 gage aluminum chassis, 9-7/8" x 4-1/4" x 18 gage aluminum control panel, terminal strips and misc. hardware.
Fig. 2—Top view shows component layout. Where indicated, use hookup wire leads to external parts.

Fig. 3—Bottom view shows point-to-point wiring. Hole numbers correspond to numbers above.
versatility. It makes it possible to place the guitar in front of a full recorded orchestra or, if you wish, combine your instrument with that of a friend. And the 10-watt output is ample for large group meetings or even a teen-age dance.

Two parts to the circuit

The guitar amplifier actually breaks down into two units—a preamp and a power amplifier. These are both shown in Fig. 1. You will note that the preamp provides both voltage gain and tone control while the power amplifier develops about 10 watts of music power.

In the preamp, audio input signals are combined in a summing network consisting of resistors R27 and R28. This is then coupled to buffer amplifier Q1. The output from this transistor amplifier is applied to a tone compensation network that controls the frequency response of the preamp and in turn the amplifier.

When both the BASS and TREBLE controls are set to mid-range, the response curve of the amplifier is "flat". Varying the setting of BASS control R34 changes the amplitude of the low frequencies applied to

ONLY THE BEGINNING

Here you have the basic guitar amplifier. But there's more to come in this exclusive R-E series.

In December

- Dc to ac inverter that makes the guitar amplifier a portable unit.

In Following Months

- Reverb unit to give your guitar amplifier that "big" sound.
- Fuzz box to produce those "in" fuzz effects used by today's hot recording groups.
- Vibrato to add a pulsating rhythm to your music sound.
- Electronic mixer to get those "special" hard to duplicate effects.
- Booster amplifier delivers 50 watts of audio power to handle even the larger party.
- Electronic bongos to round out your electronic music system.

RADIO-ELECTRONICS
transistor Q2. The high frequencies are controlled in a similar fashion. Rotating TREBLE control R35 affects the high-frequency response.

The power amplifier

Two cascade, common-emitter amplifier stages (Q2 and Q3) follow the tone compensation circuit to increase the signal level to that required to drive the power amplifier. The power amplifier itself is a single-ended class-B circuit that has a low output impedance. This makes it possible to drive the speaker directly without any need for an output transformer.

The signal that appears at the wiper of VOLUME control R36 is coupled to complementary transistors Q5 and Q6 through amplifier transistor Q4. Since transistor Q5 inverts the signal and transistor Q6 does not, properly phased outputs are developed to drive power transistors Q7 and Q8. Positive and negative feedback are introduced by resistors R23 and R12, and capacitor C23, to compensate for the unsymmetrical output stages. This allows the positive signal peaks to approach the same amplitude as the negative signal peaks. Capacitor C21 was selected in test to produce optimum output response. Resistor R4 and capacitor C7 are incorporated to prevent phase shift at the upper frequency limits due to the rise in output impedance. Dc power for the power amplifier and preamp is developed by a brute-force bridge rectifier circuit that provides well-filtered —35 volts for the power amplifier and —15 V for the preamp.

The amplifier is fun to build and even more fun to use. The instructions and diagrams are complete and no additional data is needed. All parts are readily available from most large suppliers. Build this one fast so you can be ready for the other seven-add-ons that go with it.

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**CABINET PARTS LIST**

| 1. BOTTOM 8 x 17 x 1/2” plywood |
| 2. TOP 6 x 17 x 1/2” plywood |
| 3. END 8 x 15 x 1/2” plywood (2 required) |
| 4. FRONT 2 x 17 x 1/2” plywood |
| 5. BACK 14 x 17 x 1/2” plywood |
| 6. SPEAKER COVER 9-3/4 x 17 x 1/2” plywood |
| 7. CLEAT 1/4” x 1 x 17 (4 req.) |
| 8. CLEAT 1/4” x 1 x 8-1/2 (2 req.) |
| 9. CLEAT 3/4” x 1 x 12 (2 req.) |
| 10. HANDLE ASSEMBLY |
| 11. BACK INSULATION 1” x 13 x 16 glass fiber |
| 12. SPEAKER INSULATION 1” x 8-1/4 x 16 glass fiber |
| 13. BOTTOM INSULATION 1” x 5-1/4 x 17 glass fiber |
| 14. END INSULATION 1” x 5-1/4 x 12 (2 req.) glass fiber |
| 15. CONTROL PLATE 4 1/2” x 18 16-gauge aluminum |
| 16. PLATE MOUNTING WOOD SCREWS ROUND HEAD |
| 17. WOOD SCREWS OVAL HEAD 1” (8 req.) |
| 18. WASHERS (8 req.) |
| 19. RUBBER FEET (4 req.) |
| 20. WOOD SCREWS, ROUND HEAD (4 req.) |
FOR YOUR CAR

Aircraft Weather Receiver

Easy AM tuner conversion brings in FAA weather reports

By LAUREN A. COLBY

THROUGHOUT THE UNITED STATES, THE FEDERAL AVIATION Agency maintains a system of low-frequency broadcast stations transmitting recorded weather information in the 200-kHz to 400-kHz band. These stations transmit aviation weather forecasts and regular hourly observations of the actual weather conditions at selected cities within a radius of about 200 miles of the station. While intended for pilots, the information available from these FAA stations can be extremely interesting to anybody who wants to study weather patterns and the flow and movement of weather systems. A list of the stations now in operation and their transmitting frequencies is in the table.

I wanted to install a receiver for aviation weather in my car, so that I could listen to the broadcasts while commuting to work. However, the only available commercial units which would tune the 200-400-kHz band cost $40 or more, were not designed for use with a vehicle-mounted antenna and were not readily adaptable to dash mounting. So I decided to build my own receiver. I modified a transistor AM broadcast tuner to produce a three-stage i.f. receiver, fixed-tuned to the 332-kHz weather broadcast band in my area.

My unit is sensitive enough to run off a short antenna, such as a regular broadcast-band auto antenna. It is fixed-tuned, so it comes on with a simple throw of a switch. Thus, mounting on my already cluttered dashboard is unnecessary. Instead, the unit is installed in a cigar box and simply rests on the back seat. It is completely independent of the car radio or the car wiring. And the total cost of the entire unit was around $20.

To build your own aviation weather receiver, you need one of those little Japanese AM broadcast tuners, such as the one sold by Lafayette Radio for $7.95, catalog No. 99 H 9040. You also need six 100-pF disc ceramic capacitors and a "universal"-type transistor i.f. transformer (Radio Shack No. 273-515). Finally, you need an audio system of some sort. Mine consists of a modular 3-watt amplifier, Lafayette Radio 99 H 9132, driving a 3-inch, 8-ohm speaker, hung from the coat hook in the car.

The circuit of the tuner is in Fig. 1. After gathering all the components, the first step is to "pad down" the 445-kHz i.f. transformers to the approximate frequency you wish to receive. To do so, connect 100-pF disc ceramic capacitors across the tuned windings of all the i.f. transformers (see Fig. 2). Solder the capacitors to the printed wiring on the bottom of the circuit board. If the frequency of the station you are trying to receive is very low, you may need 150-pF capacitors.

Next, disable the tuner's oscillator by disconnecting

Transcribed, Continuous Weather Reports

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Parts for aviation receiver cost about $20. Author used an AM tuner (right) and a modular 3-watt amplifier for his unit.

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Fig. 1—Modifications to basic tuner circuit include "padding" of i.f. transformers, disabling the oscillator, and a new antenna coil, and removing the 0.005-µF capacitor which runs from the emitter of the mixer transistor to the tap on the oscillator coil. Then connect the tuner to a 9-volt source and to your audio system.

To prevent motorboating, use a separate battery to power the audio amplifier, and decouple the tuner from the amplifier by installing a 50,000-ohm resistor between the tuner output and the amplifier input.

Now connect a signal generator to the base of the mixer transistor. Using a modulated signal, tune the generator from about 300 kHz to 400 kHz to determine the resonant frequency of the i.f. strip, now that you’ve padded it down. It should be about 360 kHz. Bring it down or up to the desired frequency by adjusting the slugs in the tops of the i.f. cans.

Remove the ferrite antenna coil and the tuning capacitor assembly. In their place, mount a miniature printed-circuit i.f. transformer. This transformer, which serves as the antenna transformer, is mounted by drilling 1/16" holes in the printed-circuit board, in a pattern corresponding to the lugs on the transformer. To accommodate the transformer, you will have to remove some of the unused printed circuitry on the bottom of the board. Cut the copper with a knife or sharp-pointed tool, and pry it away from the board. If you break any connections which are still to be used when the receiver is completed, bridge the gaps with hookup wire.

Only the primary or tuned winding of the transformer is used. Pad it down with a 100-µF capacitor and connect it as shown in Fig. 2. Make the connections with lightweight stranded wire. (The lugs on printed-circuit components are very delicate, and the tension from regular No. 20 hookup wire will break them.) I used a short length of twisted-pair phonograph pickup wire to make the connection from the transformer to the transistor, soldering the connections at one end to the transformer lugs and at the other end to the terminals left by the removal of the original ferrite antenna coil.

Be sure to ground the transformer shield, preferably by locating the shield tabs in such a way that one of them passes through a section of grounded circuitry and then soldering it to ground.

Having installed the new antenna coil and the antenna capacitor, bring the signal generator output lead near the antenna lead and peak the antenna coil. Next connect a

(continued on page 97)
Look What They're

BY L. GEORGE LAWRENCE

When a low-voltage, pulsating current is passed through certain regions of the human head, sleep is induced. It takes special electronics and wave pulses to make it possible.

"ELECTROSLEEP" IS AN OFFSPRING OF ELECTROANESTHESIA, first practiced by the French scientist S. Leduc in 1902. Leduc used a direct pulsating current to obtain narcosis first on a dog and later on himself.

Contemporary electrosleep methods and equipment evolved in Russia, and Western buyers purchased early instruments through the trade outlet V/O Sojuzchimonexport, Moscow. Advanced versions of the sleep-inducing pulse generators were the Elektrodorm I and Elektrodorm II models used by Russian and European clinics.

Aside from providing restful, healthy sleep, electrosleep has been used with good results in the treatment of schizophrenia, a disease many scientists believe results from overexhaustion of the nervous system. In these and similar situations, sleep therapy apparently affords the brain cells a good opportunity for complete rest and restoration.

The electrosleep instrument provides monotonous, rhythmic stimulation. Pulse frequency is set within the limits of the cyclic impulse frequencies that occur under physiologic conditions—that is, normal electroencephalogram rhythms. Typically, these are the high-amplitude and low-frequency shape of the alpha or rest rhythm of the human brain.

Sleep generators

A basic electrosleep generator circuit is shown in Fig. 1. The instrument uses a multivibrator, pulse clipper and cathode follower, with provisions for metering output. The absence of coupling capacitors enables a galvanic or direct-current component to be obtained at the patient electrodes. Switch S1 and potentiometer R1 determine multivibrator frequency. Pulse duration is adjusted with R2.

In these and similar electrosleep generators, a rectangular waveform is produced that is not unlike the pattern of the alpha wave mentioned previously.

Current-induction electrodes are placed near the eyes. Typically, a good working impulse lasts from 0.2 msec to 0.3 msec. The mean current might have a magnitude ranging from 6 µA to 12 µA or from 1 mA to as much as 8 mA. Some scientists have used frequencies up to 34 Hz, 16 volts peak-to-peak at 600 µA.

A typical experimental situation is shown in the drawing above. A mechanical timer governs the length of the generator's run. Initial treatments in a clinical situation usually last about 30 minutes. Later, time is increased to as much as 2 to 3 hours. After about 15 to 20 treatments have been given to an individual, the course may not be repeated for 2 or 3 months—this changes from case to case. Once the current has been turned off,
Doing With Electrosleep

A person might "sleep on his own" for 3 to 4 hours or more.

Generally, the ability of the pulsating current to invoke a sleep-like inhibition of the nervous system depends on several factors:

- The environment in which the current is applied.
- Frequency of treatment repetition and duration of a session.
- Characteristics of the current, including direction, frequency, duration, wave envelope, mean pulse strength, electrode placement and so on.

The technique works in the majority of cases, though not with every individual.

**Dream modulation?**

Efforts to alter dreams and dream content by means of electrosleep-type electronics are being explored. Subliminal techniques applied in the past consisted of little more than a loudspeaker placed beneath the pillow to provide playback of prerecorded programs.

The fact that scientists observe voltage fluctuations in electroencephalograms (EEG) and find actively discharging neural units in the brain, indicates the brain or at least part of it is not at rest during sleep. Although many hypotheses have been formulated, biochemical and biophysical studies during sleep have failed (except for a few promising leads) to yield information about the nature and location of those fundamental processes that determine the basic role of sleep and dreaming.

A neon-type square-wave generator with simple provisions for impressing a speech pattern (or music) on patient electrodes is in Fig. 2. The wave trains, as derived from the square-wave system, are of much lower magnitude than those of electrosleep systems. However, since these trains affect the nervous system, it was hoped the subject's susceptibility to "cue" information (speech and music) could be increased! The idea certainly would be a bestseller on the commercial market—if safe and functional.

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**Fig. 1—Output of Russian-developed sleep inducer resembles brain's alpha rhythms.**

**Fig. 2—Pulse generator for experimental dream modulation has lower output than electrosleep unit. Cued information fed in at T1 may be in speech or music form.**

\[ \Delta F + \Delta B + \Delta C (\text{or } F + EC) \]

**NOTE:** R1 AND C1 DETERMINE FREQUENCY; R2 DETERMINES PULSE WIDTH; R3 DETERMINES HEIGHT OF OUTPUT AMPLITUDE; T1 TRANSFORMER FOR INSERTION OF PILOT TONE.
PHOTOTACH FOR YOUR SHOP

Non-contact device measures operating rpm of any rotating shaft

By BRICE WARD

How would you like to do this without fiddling with dials or knobs?

This little hand-held tachometer measures rpm this way: Place a contrasting mark on the shaft, pulley, capstan or what have you, and make sure a steady illumination falls on it (from an incandescent lamp or flashlight). Aim the probe, press a push-button switch and read the rpm directly from the calibrated meter.

Too simple you say? Well, some setups may require your ingenuity and a little juggling. I’d like to hear about any different uses of either the complete tachometer or any portion of the circuitry. I would also like to see installation ideas devised by readers for this skeleton system.

How it works

The sensing circuit uses a cadmium selenide cell designed to respond quickly to changes in light level. Other cells could probably be used, but the Clairex unit (see parts list) will provide excellent response out to the limit of the rpm range and probably beyond this range.

Output from the photocell is coupled through capacitor C1 to Q1, used as an amplifier with a voltage gain of about 50 (Fig. 1). The amplified voltage pulse is coupled through C2 to the multivibrator (Q2–Q3).

Transistor Q1 and the photocell, then, form the sensing element circuit. Any device that can deliver a 1-volt or better, positive-going pulse to the multivibrator could be used to drive the meter circuit.

A pulse standardizing circuit utilizes a monostable multivibrator followed by a Zener diode. The monostable multivibrator, variously called a one-shot or univibrator, has only one stable state, determined by the feedback arrangement used. Here, the pulse width is determined by the variable time constant of C3–R7, and the pulse height is clamped to a 5.2-volt level by Zener diode D3.

Pulse counting is achieved with a simple half-wave rectifier. It applies the average power of the pulses to the meter, which smooths the pulses by acting as an integrator. A series of waveforms illustrate what occurs in the circuit. All waveforms are positive-going above and negative below the applied zero reference line.

The voltage at point A in Fig. 1 is negative-going with an amplitude of
about 0.8 volt starting from a 4.2-volt level. This 4.2-volt level will change with the light level on the photocell or the voltage applied to the circuit. (An 18-volt supply should give a 1.6-volt negative-going signal, permitting the probe to be moved back from the pulsing light source.)

Since a fluorescent lamp temporarily extinguishes on each half-cycle of 60-Hz line voltage, pulse frequency is 120 pulses per second, or (multiplying by 60) 7200 rpm. This gives a good source for examining circuit operation, and was used to calibrate the phototachometer.

This voltage pulse output of the cell is coupled by C1 to the base of Q1 (B), overcoming the positive bias on Q1 and cutting it off. The result is decreased current flow through R4 and a consequent reduction in the voltage drop across R4. Since R4 and Q1's collector–emitter resistance represent a voltage divider to ground (from the 9-volt source), if the voltage across R4 decreases, the voltage across Q1's collector–emitter increases and the voltage on the collector of Q1 (C) increases with respect to ground.

**Multivibrator operation**

In the multivibrator, Q2 is normally cut off and Q3 is conducting. The collector–emitter current of Q3 is then determined by the resistance of R8. With a low Q3 collector voltage, less voltage is returned to the base of Q2 (D) than is required to cause forward base–emitter junction bias.

When the signal on the collector of Q1 swings positive, the voltage rises on the coupling capacitor C2. In trying to charge to this rising voltage, C2 draws current through Q2's base–emitter junction, causing Q2 to conduct and its collector voltage to drop (E).

Collector C3, which was charged to about 7.6 volts, begins to discharge through R7, and drives the anode of D1 (F) sharply negative, cutting the diode off. Since Q3's base–emitter current path (G) is through D1, Q3 is cut off and the voltage at point H rises to a level controlled by D3. The 5.2-volt pulse developed serves to drive the metering circuit, and supplies regenerative bias to Q2.

As long as Di's anode remains negative with respect to its cathode, Q3 will remain cut off, and the length of time that the anode remains negative is determined by the time constant of C3–R7.

In short, the multivibrator has developed a pulse of a width determined by the C3–R7 time constant and a height determined by the Zener diode at its output. On completion of the C3 discharge, the voltage on the anode of D1 goes positive with respect to its cathode and begins to draw current through Q3's base–emitter junction. Next, the voltage drops on Q3's collector feed a negative-going voltage back to the base of Q2, causing Q2 to begin cutting off. The positive-going voltage developed on Q2's collector starts to charge C3, reinforcing the switching cycle by positive feedback.

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**Fig. 1**—Using a fluorescent lamp as a signal source, negative-going, 120-Hz input from R1 (A) is 0.8V (from 4.2 level). At B, dc level shifts; base–emitter drop is 0.6V. Pulse amplification is shown at C (2V/cm). As pulses go positive (above reference line) at D, multivibrator–transistor Q2 conducts. As conduction begins in Q2 (E, top), regeneration drives it into full conduction (5V/cm). Negative pulse width at F is a function of the C3–R7 time constant. Q3's base–emitter current path (G) is through D1. Since D1 is cut off by the signal at F, Q3 is also off. Voltage at H rises to a level that is controlled by Zener diode D3.
Switching times for Q3 are extremely fast (probably in the nanosecond range), and the entire standard pulse is generated in about 0.56 msec.

Figure 1-h shows pulses generated at 7200 rpm, while Fig. 2 shows them generated at 3600 rpm. The 7200-rpm pulses appear 8.5 milliseconds apart. This means that roughly 14 more pulses could be generated between existing pulses, or a pulse rate equivalent of 100,000 rpm.

At this rate, due to the extra energy generated, the meter range would have to be increased to 500 µA to read the total current.

As the system is set up, 10,000 rpm is the upper limit, and R9 is adjusted to give a full-scale reading on the meter.

Construction

For ease of construction, the unit was built on a circuit board. Before installing R7, adjust it with an ohmmeter to about 3500 ohms or, if you prefer, use a 3600-ohm resistor. The photocell (R1) can either be installed on the board or connected with a two-conductor cable for remote location.
use. Connect the negative battery lead to point A (Fig. 3) and the positive lead to point B. Points C, D and E can be used to raise the voltage on the photocell.

To do this, remove R2 from its present location and install it from point C to point D. Install a second battery with the negative lead going to the old R2 connection (extension from point B) and the positive lead to point E. With this arrangement a pair of 9-volt batteries will apply 18 volts to the phototransistor (increasing its sensitivity), but the circuit still receives only 9 volts.

With 18 volts on it, the probe can be moved farther from the device being measured. Depending on the amount of light striking the rotating shaft, surrounding ambient light and other circumstances, a 9-volt probe will function about 6" from the shaft. With the extra battery, this distance could probably be increased to 12".

The meter is installed with the plus (+) terminal to point G and the minus (−) or unmarked terminal to point H.

If you’re a “scratch” builder or experimenter, the transistors and other circuit components are not critical. For example, any reasonably good npn silicon transistors should work in the circuit. Reversal of all polarity-sensitive elements and the battery should allow operation with npn types of transistors.

The Zener diode is not critical either. If it’s rated at less than the voltage on the collector of Q3, and clamps the pulse amplitude, this can be corrected by adjustment of R9. The metering diode should be germanium, but this diode and D1 would probably work with silicon devices.

The phototachometer can be used without a case, but since the meter movement supports the circuit board it could be mounted in a case. Make a cutout for the meter and allow the meter to support the circuit board inside the case.

A larger meter movement could be used by drilling holes spaced a little farther apart on the printed circuit board and again hanging the circuit board on the meter.

Adjusting your tack

If you use a graduated 50-µA meter, every reading will have to be multiplied by 200. (This is done quickly by adding two zero’s and doubling the result.) As mentioned earlier, a fluorescent lamp will provide a 7200-rpm pulse source. Since we want to determine what the meter should read for 7200 rpm, we reverse the procedure: divide 7200 by 2 (3600) and remove two zero’s (36) to obtain a setting point for our calibration.

Hold the light cell about 12 inches from the fluorescent light and move it in. The meter should jump to some intermediate value, and then double this value as the probe is moved a little closer. It appears to be characteristic of fluorescent lamps that the light pulse output is higher on one cycle than the other. Therefore, the first meter jump represents a reading of every other pulse from the lamp or 60 cycles per second (3600 pulses per minute).

At the point where the meter value doubles, adjust R9 for a reading of 36 on the meter, and the tachometer is calibrated. By proper adjustment of R9, the phototachometer should be capable of reading pulses out to the equivalent of 100,000 rpm. The photocell response time may become a limiting factor at or before this rate is reached.

Trying it out

First, in reading something like the propeller on a model airplane engine, remember that if the prop has two blades the indicated rpm will be twice the true rpm since the light is being chopped at twice the actual rpm. And if a disc has 30 segments the indicated rpm will be 30 times the actual.

This applies for any rotating device. Determine the number of full cycles for each revolution and divide the rpm reading by this figure to obtain true shaft rpm.

If you measure very high-speed devices, such as a model airplane engine, it might be necessary to reduce the overall pulse width by reducing either C3 or R7, and to reset R9 to indicate, say, 50,000 rpm full scale.

Other possibilities? Connect the photocell to the circuit board using a long cable. The very small probe can then be mounted at a remote location to monitor some shaft rpm not otherwise easily read.

The unit could be used as a failsafe. The univibrator pulses could be applied to a rectifying system used to energize a relay. If monitoring shaft rotation, the relay would de-energize and sound an alarm when rotation stopped.

In short, the potential uses for the circuitry are restricted only by your imagination.

R-E

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**Parts List**

C1, C2—0.1 µF, 75-V Mylar capacitor
C3—0.22 µF, 100-V El-Menco 1DP-3-224 or equal
R1—Clarex CL903C fast-response photocell
R2—1-megohm, 1/2-watt resistor
R3—3.3-megohm, 1/2-watt resistor
R4, R5—22,000-ohm, 1/2-watt resistor
R6—47,000-ohm, 1/2-watt resistor
R7—10,000-ohm, Bourns EZ Trim No. 3067-103 potentiometer
R8—1500-ohm, 1/2-watt resistor
Q1—2N712 transistor (QG-E)
Q2, Q3—2N697 transistor
CR1, CR2—1N456 germanium diode
CR3—1N709 silicon zener diode
M1—50 µA, 1 9/16" square dc meter (Lafayette Radio 99 H 5049 or equiv)
MISC—Circuit board, battery clip, 9-V battery

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**Diagram**

Fig. 3—Component placement on the PC board. Text explains letters A–H.
What's New in FM Tuners

*IC's and crystal filters in the Heathkit AR-15 and AJ-15—Zero-gain front end in the Marantz 18*

By PETER E. SUTHEIM

Rapid advances in semiconductor devices have worked their way into the FM tuner. Amplifier circuits were easily conquered by the semiconductor, but FM tuners took longer. The requirements are much more stringent than in an audio amplifier. And the need for extremes in frequency response, sensitivity, and signal-to-noise ratio are still rather demanding. However, as you saw last month, FET front ends and ceramic filters have gone a long way toward making FM tuners a new conquest of the semiconductor. Fact of the matter is that the specs on some of the new semiconductor tuners far exceed those attained with vacuum tubes in top-of-the-line tuners of a few years ago.

But now let's look into some more special features and interesting circuitry. IC's are also starting to appear in modern tuners. A good example of IC use is the Heathkit AJ-15 tuner. (The same circuit is also used as the FM tuner section of the Heathkit AR-15 receiver). Here, conventional transistors are used as input and output stages of the i.f. strip (figure above) to provide linear amplification where it is needed. But all the limiter stages are included in two integrated circuits (IC's) and crystal filters are used in place of conventional i.f. transformers.

Want to see what's inside those two IC's? Take a look at the schematic diagram shown below. It is the diagram of
the CA3012 IC. It contains 10 transistors, 7 diodes and 11 resistors. In effect, each of these IC's contains three cascaded emitter-coupled amplifiers which symmetrically clip the 10.7 MHz i.f. signal to provide hard limiting. Much of the pioneering in the use of IC's in FM tuners was done by the H. H. Scott Company.

The specially designed quartz crystal filters replace conventional i.f. tuner circuits and eliminate the need for i.f. alignment, excepts of course for the detector coil. These crystal filters provide a steep-skirted, flat-topped bandpass with very linear phase characteristics at all signal levels.

Zero gain front end

Stereo tuner front-ends have seem several interesting circuits. But one of the more remarkable circuits to found in today's FM tuners is in the Marantz 18. Unlike the conventional front end, their circuit provides absolutely zero gain. In fact, it doesn't have any transistors, tubes, or other active devices except for the transistor in the local oscillator circuit (see figure below). With their special design, Marantz claims a sensitivity of 2.5 µY for 30 dB quieting. This is not spectacular but is still excellent. What is at least as important, the receiver shines at the other end of the dynamic range scale—its spurious response rejection is a remarkable 100 dB. For all practical purposes this means there is no possibility of cross modulation.

A $1050 FM tuner

Another most unusual FM tuner is the CM Laboratories model 804. It introduces digital readout tubes to replace the conventional FM dial. Tuning is said to be positive, to the exact center of the channel. Drift, misalignment and mistuning are eliminated. The new technique pinpoints the frequency since the tuner can be tuned only to the 100 discrete channels designated by the FCC for FM broadcasting. It does this with a crystal frequency synthesizer which produces 100 separate and stable crystal-controlled frequencies. An FET front-end, linear ramp detector and stable L-C filters instead of i.f. transformers round out the circuits. But at the $1050 price, it's certainly not the tuner for everyone.

R E
Solid-State Rectifier Repairs

Expert tips help you pinpoint semiconductor troubles in modern rectifier circuits

By MATTHEW MANDL
CONTRIBUTING EDITOR

Silicon rectifiers outlast tube types, are smaller, can handle high currents and need no filament or heat-er voltages. Consequently they are making the tube rectifier obsolete. A silicon rectifier, mounted in an octal-base housing, is even available for direct replacement of an old standby, the SU4-G.

Generally, silicon rectifiers have replaced selenium types in power supplies, although some seleniums are still used in new equipment (focus rectifiers in some color sets, auto battery chargers, etc.). The simplicity of solid-state rectifiers, however, can be misleading. They are not trouble-free, and when defects appear an understanding of their characteristics is necessary to make proper tests and replacement. Common failures include opens, shorts, arcing and intermittent operation.

**Rectifier testing**

Silicon rectifiers can be checked easily with a volt or vtm. On the R×1K scale, an ohmmeter should show virtually infinite resistance with reverse polarity, and approximately 500 to 1500 ohms with forward polarity. An infinite resistance reading in both directions shows an open unit, while a low resistance reading in both directions shows a shorted or otherwise defective unit.

Seleniums present more of a problem since they don't have infinite-ly high resistance in the reverse direction. Even on the RX1-megohm scale, readings are misleading. Also, seleniums may continue to rectify, though their internal resistance builds up. Consequently, a higher voltage drop occurs across the rectifier, and output voltage declines.

Thus, it's best to read the output voltage of selenium rectifiers while they are in the circuit and compare it with the specified value. Also check to see that the power supply load is not excessive, because this would also cause a voltage decline.

If you suspect an open or shorted rectifier, you can test it with the setup shown in Fig. 1. A 12-volt filament transformer is used, plus a resistor of about 500 ohms. If the rectifier is shorted, a sine wave appears on the scope. If the rectifier is all right, a half-wave pattern similar to Fig. 2 will appear.

The polarity of the rectifier terminals applied to the tester will make no difference. In one position the pattern of Fig. 2 will be inverted, but still indicates proper rectification. If the rectifier is open, some capacitance leakage may still produce a pattern on the screen, but it would again be a sine wave, indicating a defective unit. (It is a good idea to check new seleniums in this manner—sometimes "new" ones may have deteriorated if they've been in stock for some time.)

**Tips on replacement**

Don't replace a silicon or selenium rectifier with one having lower voltage or current ratings. You can, however, use a higher-rated replace-
ment if the larger unit doesn't take up too much room. Make sure the peak inverse voltage rating is the same (or higher) in the new unit, or the replacement will not last long.

Peak inverse voltage development is shown in Fig. 3. A basic half-wave rectifier circuit is shown at (a). When a positive half-cycle of ac appears across the secondary, electrons flow in the direction shown by the arrows, and the rectifier conducts. The capacitor is then charged to the peak voltage across the secondary. During the negative alternation (b) the charged capacitor can be considered in series with the transformer-secondary, as a voltage-doubling circuit. The rectifier doesn't conduct, but at the peak of the negative alternation the combined voltages (secondary plus charged capacitor) apply 1000 volts to the rectifier (peak inverse or peak reverse voltage). If the rectifier doesn't have a high enough rating, it will be quickly damaged.

If you read 500 volts across an ac source, the meter reads the effective rms value and not the peak. The peak is 1.41 times the rms value. Thus, for Fig. 3, if the 500V represents an rms value, the actual peak voltage across the rectifier will be 500 × 1.41 × 2 = 1410V.

**Typical circuitry**

Three basic types of power supplies are found in modern TV receivers. One is the half-wave type shown in Fig. 3, where only half cycles are rectified. It requires more filtering for smooth dc output, but needs no transformer center tap. A second method is full-wave rectification. Two rectifiers are needed and a center-tapped transformer. To avoid the center tap, four rectifiers can be used in the bridge arrangement we'll discuss later. A third method is to use a voltage-doubling system for obtaining a higher potential than that available from a given secondary.

Half-wave systems are not always as simple as Fig. 3. A typical example is the low-voltage supply used in the RCA KCS-158 receiver shown in Fig. 4. Here, L1 and L2 do not form a transformer; instead these are separate filter chokes that minimize noise pickup from the line, and reduce interference fed into the line from the receiver. Capacitor C1 is a low-pass filter, also for noise signals.

The power transformer is an autotransformer and tap 1 is a voltage stepup terminal for supplying the B+ supply system with a potential higher than line voltage. Tap 2 supplies full voltage to the series heaters. Tap 3 supplies the heater string with a lower-than-normal voltage to keep it warm and provide an "instant-on" picture when the set is turned on. (The master switch must be in the on position for this operation.)

The half-wave silicon rectifier feeds a filter network consisting of a series choke and two filter capacitors. The circuit breaker protects the system from power supply shorts, while the fuse opens for higher-current faults contributed by the filament string.

"Instant-on" troubles call for a check of the double-pole switch and connections to transformer tap 3. An open circuit breaker calls for testing for shorted filter capacitors or excessive current drain from the circuitry the power supply feeds.

Capacitor C4 is across the rectifier for protection against current surges and transients caused by on-off switching. In most applications using silicon rectifiers, these capacitors are connected across the input or output of the rectifier. Because of their small size, silicon rectifiers are easily damaged by voltage surges and heat. Heat is dissipated by using metal mounting flanges (or direct mounting on metal chassis). Because perfect flat-surface contact between the rectifier and heat sink is difficult to obtain, silicone grease is used to fill the air gaps and help make a good thermal contact.

Thus, when such rectifiers are replaced, coat the heat sink and flange of the rectifier with silicone grease to avoid heat damage. Also, do not replace a rectifier without the accompanying shunting surge capacitor.

A typical voltage-doubler power supply is shown in Fig. 5. When a positive alternation appears across the secondary, rectifier D1 conducts and charges C1 to the peak voltage. With a negative ac alternation across the secondary, D2 conducts and charges C2 to the peak voltage. Because D1 and D2 are in series, a doubled voltage is available across the two. Capacitor C3 shunts both C1 and C2, and hence stores the full double-voltage charge.

If output voltage is low from this supply and the rectifiers check out okay, look for defective charging capacitors. If either C1 or C2 can't hold a full charge, output voltage declines. The rate of discharge from C3 affects output voltage and regulation (ability to hold output voltage with current changes). If a partial short or other excessive current drain exists in the receiver circuitry fed by the power source, coating with silicone grease to fill air gaps could improve performance.
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Coming Impact of UHF

This demand for licensed operators and service technicians will be boosted again in the next 5 years by the mushrooming of UHF television. To the 500 or so VHF television stations now in operation, several times that many UHF stations may be added by the licensing of UHF channels and the sale of 10 million all-channel sets per year.

Opportunities in Plants

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57
supply, the output voltage will drop. If all parts in the supply check out, look for overloading caused in the receiver portion. A full-wave supply with center-tapped transformer is shown in Fig. 6. Here, each rectifier conducts alternately and thus each half-cycle is rectified for smoother dc output. Since this supplies a transistorized receiver, high-value filter capacitors are used to obtain minimum ripple voltage.

If one rectifier opens, ripple will increase and output voltage will drop. Open filter capacitors will also contribute to ripple, as will a current-drain overload from the supply. In this receiver the uhf-tuner section has no voltage applied except when the uhf tuner is set to the uhf position. Thus, if uhf reception is lost, check the switch operation and also look for a shorted capacitor (300 μF) that bypasses the 11.5-volt output. The 0.001-μF noise-filter capacitor shunting the ac line input was omitted from earlier models of this receiver, and should be included if it is found missing during servicing.

Note the switching for battery operation. If trouble occurs during battery operation, check the 12-volt battery under load and also check for proper switch operation.

A typical bridge rectifier system is shown in Fig. 7. Rectifiers D2 and D3 conduct when the upper terminal of the transformer secondary is positive. D1 and D4 conduct when it is negative. Note the high voltage value of the surge (transient) capacitors shunting the secondary. Make sure replacements have as high (or higher) rating to withstand peak voltages. Similarly, make sure replacement rectifiers are matched to the others and have sufficient peak inverse voltage ratings.

**Focus rectifiers**

In color receivers, the 5-kV focus voltage is taken off a tap on the horizontal output transformer, and rectified by either a tube or a solid-state rectifier. For the latter, selenium sections are stacked in sufficient number to handle the high voltage involved, and the circuit uses a filter-resistor network, plus a voltage-variable component such as a variable resistor or a slug-tuned inductor. A typical circuit is shown in Fig. 8.

Because of the high voltage, the selenium stack may arc and cause intermittent focus as well as stunts across the picture-tube screen. If this occurs, blow or brush out any dust accumulation on the stack, and also measure the voltage to make sure it isn’t excessive. If the trouble still persists, replacement of the rectifier will be necessary.

A strong odor indicates the unit is defective and sections are shorting out and overheating. Avoid prolonged breathing of this odor, because selenium can produce poisonous fumes. (Selenium itself is poisonous and for this reason the rectifier plates are painted or coated with a thin protective covering to avoid absorption by the skin during handling.)

If poor focus can’t be corrected by the focus adjustment, check for an open filter series capacitor (130 pF, 6 kV, in Fig. 8). Also check for an open series (4.7-megohm) resistor, and check for voltage at the pin of the picture-tube socket. If no open circuits or component defects exist, check the rectifier.

**Convergence rectifiers**

In addition to power supply and high-voltage rectifiers, rectification is
also used in the convergence circuitry of color receivers. Typical is the circuit shown in Fig. 9, which is a partial schematic of the Admiral G-13 color convergence board. Note that five solid-state rectifiers are used for the various convergence areas of the screen.

If convergence adjustments fail to produce results, rectifiers should be checked. If one is defective, associated circuit components should also be tested for defects that might have contributed to rectifier failure. Defective or intermittent rectifiers in the convergence circuitry can cause unstable convergence and the appearance of false colors surrounding sharp contrast changes in the televised scenes.

In one receiver an intermittent CR603 (Fig. 9) caused narrow red bands to appear around sharply defined objects in the picture. In another receiver a defective CR601A produced hue distortion on the screen that could not be corrected by adjustment of the convergence controls.

When one or more rectifiers in the convergence board must be replaced, a dot generator should be used to check convergence before closing the back of the set. This will insure convergence hasn't been even slightly affected by a new unit, or that other component troubles aren't contributing to poor convergence.

Don't expect perfect convergence, particularly at extreme tube edges, because new convergence rectifiers can't compensate for the many variables affecting convergence. If most of the screen area is converged, however, an excellent color picture will be obtained. Excellent (though not perfect) convergence is shown in Fig. 10, where only the dots along the borders are slightly off the true circle representation from the generator.

Fig. 9—Convergence circuitry in color receivers also makes use of rectifiers. Defective or intermittent diodes here can cause colors around sharp-contrast scenes.
Build a $10 Experimenter's IC Decimal Readout Module

By RALPH GENTER

THE ASSIGNMENT WAS Plain ENOUGH. GET Radio-Electronics readers a versatile decimal counting module. Give them a basic block that counts from zero through 9 and indicates it. Make it resettable and cascadable, so any number of units can be placed side by side to obtain any desired accuracy.

Now readers would have the modular heart with which they could build their own electronic counters, digital voltmeters, frequency counters, electronic stopwatches, photographic shutter testers, electronic piano tuners, ballistic velocity meters, adding machines, computers, dragstrip speed measurers... and heaven knows what else. Besides, there might be quite a bit to be gained simply by studying such a module, as its operating and service principles would be identical with much of the digital industrial electronic equipment in use today.

The trouble began when we started pinning down the specs on such a unit. It had to be small—not over 1" x 2" x 4", and a one-piece unit. It had to be near foolproof. It had to use integrated circuits—no neon bulbs, diodes, capacitors or critical pulse circuits allowed. It should be snappy, running anywhere from pushbutton speeds on up to 10 MHz. Less than 0.5 W per module of supply power would be nice. And, of course, it must be legible and easy to read, and must read out in plain numbers. Finally, if anyone was going to build one, it would have to cost less than $10 per decade—experimenter’s single-quantity cost.

$10 per decade?

This was the stickler. Off to the catalogs. Let’s see—Nixie tubes $8 each... DTL integrated decade counters $10 each... decoders $16 each... The IC boys are coming along just fine, but that’s almost $35 per decade, and we’re not through yet. No wonder the cheapest digital instruments start at $300 and work their way up—and up. ($600 is par for a good electronic frequency

Fig. 1—An input pulse advances the decade (base 10) counter one step. The tenth pulse resets counter to zero and generates a carry pulse. Decoder/driver sums currents for M1.

PC module is small (1" x 2" x 4") and mounts all readout components: decade counter, decoder/driver, and modified panel meter.

Fig. 2—One approach providing 10 precise currents for meter readout with 10 transistor stages. Regulated supply must be high enough not to be influenced by saturated transistor and meter voltage drops.

RADIO-ELECTRONICS
The transistors receiving current, and the number close for the meter as well as the sensitivity and hardness yet to read. So we start from scratch and find a "new" path.

This is easy enough. Let's draw the problem out in Fig. 1. We need three parts: an electronic decade or base-10 counter, a decoder and a readout. The counter has to work like a 10-position reseatable stepper, only at a speed anywhere from dc to 10 MHz. Each individual input pulse has to advance the counter one, and only one, count. When the count gets up to 9, the next input pulse has to reset the counter to zero, and produce a carry pulse to hit the next decade over. We also have to be able to reset the counter to the zero state anytime we like. This gets our instrument reading 0000 at the start.

We obviously have to have a readout. This is something that brightly and unambiguously indicates the state the counter is in. We suspect that a binary counter that is tricked into thinking it is a decimal counter is a good route to follow. Somehow, we must decode the counter to find out what state it is really in. The decoded output is an electrical signal that lights up or moves the readout to indicate the proper count. So that's it—we'll need a counter, a decoder and a readout.

The readout

We already voted against Nixie tubes for their price. Ten light bulbs would be nice, but that's at least $4 worth of driver transistors and $2 worth of lamps, jewels and panel work. This leaves little for the counter and nothing for the decoding.

How about a meter? For years, Hewlett Packard used ordinary milliammeters to indicate the least significant states on several of their larger industrial counters. The meters had special scales and the current through the meter was arranged so that the pointer could be only in one of 10 positions—but they were 3", $12 meters.

So, let's update this proved technique. Back to the catalog—Emico's Model 13 horizontal panel meters. All plastic, 3/4" wide and less than $3 each, if we do not pick the most sensitive ones. Let's take a 0–10 dc milliammeter and have a special vertical 0–9 scale put on it with boxes for each number—no scale markings. Overlap the boxes to gain legibility. Now, put a bright pointer on the whole thing. We have a readout for $2 or so that's as good as any vertical in-line readout going. And, yes, you can get them yourselves in single quantities—see the parts list.

Now, all we have to do is provide 10 discrete currents for the meter to indicate. These currents have to be pretty close—well under 5% if there is to be no question which number the meter is pointing to. We could start with 10 transistor switches, 10 resistors and a regulated power supply, perhaps as in Fig. 2. We'll use an 18-volt supply, high enough that the saturated transistor drops and the drop across the meter will not bother us. Now, we make each resistor provide a suitable current, say 1.1 mA, 2.2 mA, 3.3 mA, and so on.

To go one step better, we provide a little more current for each step than we really need and shunt some of the extra current around the meter with a calibration pot that lets you user and pointer positions exactly aligned.

Base current to any transistor provides the proper current to allow the meter to indicate which transistor is receiving current, and our readout is complete. Of course, transistor Q, really isn't doing anything, so we can leave it out entirely.

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Fig. 3—By summing currents through the transistors, only four stages are needed. A 1-2-4 sequence makes a "7" count. get rid of a few more? Suppose we sum the currents going through the meter, and allow more than one transistor to be on at any one time. If we can get the combinations to line up with the outputs of the base-10 counter, the meter will still give the right answer.

An obvious (but not the best) choice is to use only four transistors and weight the currents produced by each transistor in a 1-2-4-8 sequence. To get a 7, we turn on transistors 1, 2 and 4, but not 8, giving us 1.1 + 2.2 + 4.4 + 0 = 7.7 mMA, or count "7" on our readout. This is detailed in Fig. 3. Note that we save 6 transistors and 12 resistors over the original decoder/driver circuit.

Now we are getting somewhere. Let's refine this decoder/driver slightly, and then we can turn our attention to the counter. The weighting resistors really should be 1% units since most of our positional accuracy is going to be needed for the meter tolerance itself. Also it turns out a 1-2-2'-4' weighting is better than a 1-2-4-8 since it saves us a jumper or two on the circuit board and eliminates an awkward step between counts 7 and 8. We have two transistors weighted "2." Either the 2 or the 2'-transistor can provide 2.2 mMA of meter drive. Together they can provide 4.4 mMA. We still can get any number on the readout from 0 through 9. Our final decoder/driver circuit is shown in Fig. 4.

Let's turn to the waveforms we'll need at the bases of our driver transistors. One possible combination that is both weighted 1-2-2'-4' and is easy to get out of a counter is in Fig. 5. This is the one we'll use.

Notice that the 2 output comes up on count 2 and stays there for counts 2 through 9, while the 2'-output is used only on counts 4, 5, 8 and 9. The 1 output is used only on the odd counts (1, 3, 5, 7 and 9) and, finally, the 4 output is used only on counts 6 through 9. Taken together, everything adds up to get the right current for the right count.

Our $10 budget still has around $5.80 left after we
Fig. 5—Waveforms needed on driver bases for correct count.

Take out the meter and decoder/driver circuitry. Take out one more dollar for a circuit board, and that leaves $4.80 for a 1-2-2′-4 coded decimal counter. This is easy—we use RTL microcircuits. Two dual flip-flops and a dual gate, and we’re home free. Now, all we have to do is figure out how to hook up the counter.

Suppose we take four JK flip-flops and connect them as shown in Fig. 6. This gives us a four-stage binary divider that takes two dual IC’s to count to 16. The trick is to somehow convince this type of circuit that it is really a base-10 counter and make it forget the other six states it once knew. We might first note that this connection

Fig. 6—Four JK flip-flops form a binary divider for a 16 counter.

![Diagram of JK flip-flops](image)

Fig. 7—Connection provides 1-2-2′-4 circuit, but only 8 count.

![Diagram of connection](image)

Fig. 8—Hookup inhibits 2′ circuit and corrects 2 and 2′ count.

![Diagram of hookup](image)

Fig. 9—AND gate inhibits 2 counter for all counts but zero.

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8357 10810 13075 15905 18377
8290 10845 13269 15935 19025
8389 10951 13286 16000 19229
8555 10997 13526 17005 19323
8600 11035 13978 17073 19327
8723 11091 14007 17199 19423
8939 11111 14019 17231 20292
8981 11215 14101 17329 30897
9009 11380 14123 17362 33261
9048 11577 14179 17440 33397
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N O V E M B E R 1 9 6 8
would be a 1–2–4–8 type of deal, so we might rearrange the flip-flops in a 1–2–2′–4 circuit like Fig. 7. Right now, this circuit can count only to 8 and the 2 and 2′ flip-flops are apparently doing the exact same thing.

Now comes the black magic. By lifting some of the grounds on the inputs of the 2 and 2′ flip-flops and by replacing these grounds with signals that change from count to count, we can inhibit the operation of these two flip-flops. Look at the timing diagram. We want to inhibit the 2′ flip-flop only when the 2 flip-flop is up, so we add a wire jumper as shown in Fig. 8. That’s half the problem. Next, we want to inhibit the 2′ counter except for count 0.

We note that both the 2′ and 4 flip-flops are up simultaneously on counts 8 and 9 and thus will still be up while awaiting the next count 0. We can add an AND gate to allow this signal to inhibit the 2 counter for every count except count 0, as just shown in Fig. 9. Now, we simply combine both circuits, and out comes our complete 1–2–2′–4 counter in Fig. 10.

You’ll find the complete schematic in Fig. 11. IC1 and IC2 are the counter. As these IC’s also have a preset

---

Fig. 10.—AND gate and flip-flops form complete counter.

**Fig. 11.—Complete schematic of the counter module.** IC1 and IC2 are the two dual JK flip-flops and IC3 is the AND gate. Collector resistors on Q1–Q5 determine weighted current to the meter. Count pulses must have falltime less than 100 usec.

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**PARTS LIST**

<table>
<thead>
<tr>
<th>Component</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>IC1, IC2</td>
<td>MC790P dual JK flip-flop (Motorola)</td>
</tr>
<tr>
<td>IC3</td>
<td>LS14 dual two-input gate (Fairchild)</td>
</tr>
<tr>
<td>Q1, Q2, Q3, Q4</td>
<td>MPS2923 or similar npn silicon transistor (Motorola)</td>
</tr>
<tr>
<td>Note: Data sheets and distributor lists are available from the following respective sources:</td>
<td></td>
</tr>
<tr>
<td>Motorola Semiconductor</td>
<td>Box 9/5</td>
</tr>
<tr>
<td>Phoenix, Ariz. 85001</td>
<td></td>
</tr>
<tr>
<td>Fairchild Semiconductor</td>
<td>313 Fairchild Drive</td>
</tr>
<tr>
<td>Mountain View, Calif. 94041</td>
<td></td>
</tr>
<tr>
<td>R1</td>
<td>10,000-ohm, 1/4-watt carbon resistor</td>
</tr>
<tr>
<td>R2, R3, R4</td>
<td>470-ohm, 1/4-watt carbon resistor</td>
</tr>
<tr>
<td>R5</td>
<td>9,100-ohm, 5%, 1/4-watt carbon resistor</td>
</tr>
<tr>
<td>R6, R7, R8</td>
<td>470-ohm, 1/4-watt, 1% resistor</td>
</tr>
<tr>
<td>R9</td>
<td>2430-ohm, 1/4-watt, 1% resistor</td>
</tr>
<tr>
<td>R10</td>
<td>914-ohm, 1% resistor</td>
</tr>
<tr>
<td>R11</td>
<td>470-ohm, 1/4-watt, 1% resistor</td>
</tr>
<tr>
<td>R12</td>
<td>2430-ohm, 1/4-watt, 1% resistor</td>
</tr>
<tr>
<td>M1</td>
<td>0–10 dc vertical milliammeter</td>
</tr>
<tr>
<td>Circuit board</td>
<td>8 1/2″ x 11 1/2″ single-sided PCB</td>
</tr>
<tr>
<td>MISC</td>
<td>PC terminals (6), wire jumpers (3), No. 6 spade bolts and No. 6 nuts (2), solder</td>
</tr>
</tbody>
</table>

*Note: The following are available from Southwest Technical Products Inc., 217 West Rhapsody, San Antonio, Tex. 78216. Etched and drilled PC-1 $1.00; meter M1 with special scale $2.25; complete kit of all parts $10.00; postpaid in US.

---
input, we bring out a common lead that gives you the reset terminal that automatically resets the counter to 0.

IC3 is the AND gate. Transistors Q1 through Q4 drive the meter through weighted precision resistors R5 through R8. R1 had to be a bit bigger than the other base-driving resistors to eliminate a loading problem on IC1.

Two power supplies are required, a regulated 18 volts at 10 mA and a ripple-free +3.6 volts at 100 mA for the IC's. Your count signal should normally be positive, say from +1.5 to +4 volts, and abruptly drop to zero whenever a count is desired. This signal MUST come down only once per count and MUST come down faster than 100-nsec fall time. If you want to count anything but good square waves, you'll have to "process" your input signals in some simple circuitry we'll talk about later. You'll also find that pushbuttons and mechanical contacts will have to be made bounceless. Once again, this is easily accomplished in a simple circuit.

The carry output of any decimal counting module will directly drive the count input of the next module down the line, and you simply cascade as many counting units together as you wish. Four is typical, and allows measurement from 0.1% to 0.01% accuracy.

The reset input is normally left grounded. To reset the counter, simply apply +1.5 to +4 volts of dc to this input.

The integrated circuits used are guaranteed to operate at an 8-MHz rate, but all the modules we have tested go well beyond 10 MHz. You'll find the meter movement's inertia automatically blanks any high-speed counting, eliminating the need for the strobe or storage circuitry often used in fancier industrial designs.

Construction

Your decimal counting module can be built onto a 11 3/4" square printed-circuit board that mounts directly on the meter terminals. You can buy this circuit board ready to go, but if you prefer, you can lay out, drill and etch your own circuit card, simply by following the layout guide in Fig. 12. Three wire jumpers are needed as shown. The

(continued on page 94)

COMING

Next month, we'll talk about power supplies, input conditioning, time bases and other things that will show you how to build many practical digital readout instruments at a very low cost using these decimal readouts.
Electrons and Magnetic Fields

By James G. Holbrook

Basic electricity and magnetism theory often seems dull and dry. We're impatient to hurry on to things more practical and interesting, and consequently we often continue to learn electronics while still uncertain about elementary principles.

I've selected a few short problems which are useful to detect any uncertainty you may have about electronic motions in magnetic fields. Several of these questions have made research engineers and physicists reconsider basic theory.

Fig. 1-a shows the arbitrary but standard definition of the direction of magnetic flux lines as being from the North to the South pole of a magnet. Fig. 1-b thus implies there is a North pole somewhere above the page, with the crosses indicating flux directed into the page.

Stop! Before reading further, examine the two problems in Fig. 2. Part

A Research Fellow, University of Southampton, England

Definition of Flux Line

The definition of flux line is defined as being from North to South Pole.

Sheet of Paper

Normal to Flux Line

Fig. 1-a—Magnetic flux lines are arbitrarily defined as being from North to South poles of a magnet; (b) crosses represent field directed from above into page.

(a) is a Faraday disk generator, showing a conducting disk rotating clockwise on its axis, and with a uniform magnetic field into the page. The disk is of nonmagnetic material, and thus the field is uniform through, as well as around, the disk edges. Brushes touch the center and outer rim of the disk, and motion of the conducting disk in the field causes a voltage to appear at the terminals.

The problem is which terminal is positive and which is negative. Make a definite choice and don't change; there are of course only two possibilities. Use any method.

Next, look at part (b) which shows the face of a cathode-ray tube with the beam normally striking the exact center of the screen. However, with two magnets around the neck will the beam be deflected to position a, b, c or d? Again make a definite choice.

If you were uncertain about your answers, you will probably find the following new concepts interesting.

First, make a clean break with the traditional left- or right-hand rules. Just as many have done with the idea of an external current from positive to negative. Second, consider a new Electron Orbit Rule:

When an unstrained electron moves in a plane normal to a magnetic field, it will circle clockwise when the field is directed away from the observer.

This new rule is illustrated in Fig. 3. Part (a) shows the field directed away from the observer, and the electron, upon entering normal to the field, begins to circle clockwise. Part (b) shows a symbol which may be used to remember the rule: One flux line into the page, and the orbit or path of one electron. The following applications show how this concept is applied. This

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**Fig. 2-a—What is polarity of terminals touching rim and shaft of Faraday disk generator rotating in uniform magnetic field? b—With magnets fixed as shown, will light spot deflect to a, b, c or d?**

is called the "Electron Orbit Method." In Fig. 4 an enlarged view of a conductor is shown at rest in a magnetic field. Connecting wires to an external battery will cause a current of electrons to move from the negative terminal into the region of the field. But the Electron Orbit Rule says the electron must circle clockwise, thus it strikes the inside of the wire-to-air boundary (shown by the dotted line), and exerts a force to the right of the wire.

This particular electron is now at rest. It immediately begins to move again, however, because of the attraction from the positive end of the battery. As soon as it gets up speed, it

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agains circles clockwise in accordance with the rule, striking the wall. This boundary is very real, as the electron is free to move inside the wire, but strikes a solid wall at the boundary and cannot get through unless the wire is heated to emission temperature, as in a cathode.

You might wonder how a small electron could exert much force upon striking the inside boundary. But remember there are $6.28 \times 10^{18}$ electrons passing a given point on the wall each second for each amperage of current, and the combined effect is to move the wire.

A wire is shown at rest in Fig. 5-a. No connections are made to the ends. This wire is uncharged, and therefore its free electrons are uniformly distributed up and down the wire. One free electron is shown at the center. We again have a field into the page.

If this wire is physically pulled to the right (not rotated), the electron, being inside the wire, is pulled along with it to the right. But the Electron Orbit Rule says the electron moves clockwise. Hence the electron in the wire follows the clockwise dotted line as the wire moves to position (b). Of course all the free electrons behave in the same way, and the bottom of the wire becomes highly negative. The wire must be kept in motion, or the electrons will merely uniformly redistribute themselves.

The problem in Fig. 2 should now be simple. In part (a) choose any electron at rest in the disk, then start rotating the disk. This first starts the electron in a line normal to the radius. But once moving, it must, by our rule, circle clockwise (toward the axis) and thus the center of the disk, or the lower terminal, is negative.

In part (b), the field is directed downward to the right, and when viewed from alongside the South pole...
of the upper magnet goes through the glass away from us. The electrons are then rushing into the field from our left and circle clockwise, striking the screen at “c.”

With a little practice you can easily re-orient fields and electron orbits to any position. Try applying the new rule to a one-turn loop passing through a field. Remember, it really makes no difference whether the field moves toward the electron or the electron moves toward the field.

The technique will show what sort of potential difference appears on opposite sides of a wire in a field as current passes (the Hall effect in physics), and polarities of voltage induced in transformer secondaries, etc. New applications and even new ideas in electronics will occur as you become familiar with the interaction of electrons and magnetic fields.

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ROLLS RADIO, No. P685, is made of heavyweight hand cast metal antiqued in silver. Houses standard transistor radio. Ornamental 1933 Rolls replica, unit is battery powered. $29.95—Monogram Mail Order Sales.

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UHER TAPE RECORDER, Royal Deluxe Model 10,000, includes 4 speeds; built-in Dia Pilot for sound/slide synchronization; sound-on-sound; sound-with-
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AUDIO-VIDEO TAPE RECORDER, Model 1000 combines a 4-track stereo and a video tape recorder, utilizing 1/2" magnetic recording tape. Maximum reel size 7". Remote-control pushbutton selection for audio or vtr operation. For vtr operation: tape speed, 11/2 ips; recording time, 37 minutes; video input, 1.4 V p-p (sync negative) 75 ohms. For audio operation: tape speed, 7% and 3% ips; frequency response, 30 to 18,000 Hz ±3 dB at 3% ips; distortion, within 1.5% at 1kHz 0 VU; S/N ratio, better than 50 dB. Under $1000. Accessories, TV monitor and camera available.—Califone-Roberts Div. of Rheem Mfg. Co.

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ELECTRONIC THERMOTESTER, Thermy, measures temperature of any component from -80 to 400°F (−50 to 200°C). Sensitive unit at probe tip reacts instantly upon physical contact, reads out electronically in conjunction with a multimeter or calculator. Simple conversion scale translates values from ohms to degrees. Comes with banana pins and phone tip adapters. $12.50.—Mura Corp.

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PA AMPLIFIER, Model UT-35, has one microphone input, as well as a phone and auxiliary input. Power output is 35 watts on 120 Vac and 32 watts on 14.7 Vdc. Both outputs at less than 10% distortion. Output impedances are 4, 8, 16 ohms, plus 25 and 70 volt line. Measures 7" x 16" x 11" and weighs 25 lbs. $200.00.—Bell P/A Products Corp.

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Circle 64 on reader's service card

VIDEO TAPE RECORDER, Model 6402, with full-field, slant-track, two-head frequency-modulated recording system. Uses 8-in. magnetic tape at 95 ips tape speed for maximum 50 or 60 minute recording or playback tape on either 7 or 8½-in. reels. Audio re-record is possible without disturbing the video portion. Measures 18½ x 10¼ x 17¾-in., weighs 50 lbs $1200.—Craig Products Div. of Craig Corp.

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1969 ELECTRONICS CATALOG No. 289. 536-page illustrated buyer’s guide covering the latest range of TV sets and components, 2-way CB radio equipment, hi-fi systems, ham gear, tools, hardware, and electronic kits.—Allied Radio

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1969 ELECTRONICS CATALOG, No. 690, 512 pages. Fully illustrated with 57 pages in 4 color. Features hi-fi equipment, latest citizens band 2-way radios, test equipment, ham gear, optics, tools, books, musical instruments, and complete listings of all major lines of electronic parts.—Lafayette Radio Electronics

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MACHINED ALUMINUM KNOBS, Catalog K-65A. 6 pages. Details six new series of knobs including standard, miniature, skirted, deluxe and various knurled types. Anodizing process for colors of natural aluminum, ebony, or soft gold.—Also Electronic Products, Inc.

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ANTENNA EQUIPMENT, Catalog No. SYS-68, 16 pages. Covers broadband and single channel antennas: broadband and single channel head amplifiers, active and passive accessories: filters and traps: input, matching transformers and wallplates, preamplifiers, amplified couplet’s, connectors and cable.—JFD Electronics Co.

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ANTENNA ROTOR. 4-page catalog describes how Drive-Rotor combines solid-state circuitry and a spline drive for greater efficiency. Cutaway diagrams show how unit works.—Jeronn Electronics Corp.

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CAPACITOR CATALOG, 68/69. Component Selector devotes 119 pages to help user select proper stock items designed to meet his requirements. The capacitor reference data provide detailed background regarding capacitor, standardization and rating selection. It also includes application charts, type selector charts and standard-rating selector tables.—Cornell-Dubilier Electronics

Circle 76 on reader’s service card

ELECTRICAL COMPONENTS. Tabloid type 8-page catalog lists components such as tunnel diodes, integrated circuits, integrated amplifiers and many semiconductors. Fiber-optic devices, meters, switches and other components are also included.—Poly-Paks Inc.

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Be an expert on how to select the best automatic turntable.

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NEW HEATHKIT AD-27 FM Stereo Component-Compact

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Heath engineers took the stereo amplifier from the AD-27 above, matched it with the top rated BSR McDonald 400 Automatic Turntable and put both of these able performers in an attractive walnut cabinet. The result is the high performance, low cost AD-17. The all-solid-state circuit delivers 15 watts music power per channel — more than enough to drive any reasonably efficient system. Wide response of 12 Hz to 60 kHz ± 1 dB and harmonic & IM distortion both less than 1% at full output are your guarantee of clean, full range sound. Stereo headshell jack, parallel tape outputs and Tuner & Automatic Tunable. The BSR McDonald 400 Automatic Turntable features a cueing and pause control, adjustable stylus pressure, variable anti-skate control and manual or automatic operation on all four speeds. Comes complete with a famous Shure magnetic cartridge. The Heathkit manual makes it easy to build . . . the sound makes it a pleasure to own. Order yours now, 27 lbs.

NEW HEATHKIT AS-18 Miniature Acoustic Suspension System

This new AS-18 features famous high quality Electro-Voice® speakers — 6" woofer and a 2 1/4" tweeter. The wide frequency response of 60 Hz to 20 kHz and the clear, natural sound of these miniature systems will really amaze you. They're the ideal performance value to the Component Compact's above and are especially suited for apartments, mobile homes, offices, etc. — anywhere that you need super low stereo sound from a small space. Handles up to 25 watts program material and has a high frequency balance control so you can adjust the sound to your liking. Order 2 for superb stereo now, 16 lbs.

HEATHKIT AR-15 Deluxe Stereo Receiver

The World's Most Sophisticated, Most Praised Stereo Receiver. Here are just a few of the reasons why leading audio critics and testing organizations, as well as thousands of owners rate the AR-15 as THE stereo receiver. The all solid-state circuit with 89 transistors, 43 diodes and two external FM antenna connectors and one for AM, Tone Flat control, electronically filtered power supply and "Black Magic" panel lighting. Seven circuit boards and three wire harnesses simplify assembly and you can mount your completed AR-15 in a wall, your own cabinet or the Heath assembled walnut cabinet. For the ultimate in a stereo receiver, order your AR-15 now. 34 lbs. *Optional walnut cabinet AE-16, $24.95.

HEATHKIT AJ-15 Deluxe Stereo Tuner

For the man who already owns a fine stereo amplifier, Heath now offers the superb FM stereo tuner section of the AR-15 receiver as a complete unit. The new AJ-15 FM Stereo Tuner has the exclusive FET FM tuner for remarkable sensitivity, exclusive Crystal Filters in the IF strip for perfect response and no alignment; Integrated Circuits in the IF for high gain, best limiting; Noise - Operated Switch; Stereo-Threshold Switch; Stereo - Only Switch; Automatic Multiplex Phase, two Tuning Meters; two Stereo Phone jacks; "Black Magic" panel lighting. 18 lbs. *Walnut cabinet AE-18, $19.95.

HEATHKIT AA-15 Deluxe Stereo Amplifier

For the man who already owns a fine stereo tuner, Heath now offers the furnished amplifier section of the AR-15 receiver separately. The new AA-15 Stereo Amplifier has the same superb features: 150 watts Music Power; Ultra-Flat Harmonic & IM Distortion (less than 0.5% at full output); Ultra-Wide Frequency Response (21 dB, 8 to 40,000 Hz at 1 watt); Front Panel Input Level Controls; Transformerless Amplifier; Capacitor Coupled Outputs; All-Silicon Transistor Circuit; Positive Circuit Protection. 26 lbs. *Walnut cabinet AE-18, $19.95.
HEATHKIT MI-18 Solid-State Tachometer

The Professional Tach. That's the new Heathkit MI-18! In Design: breaker point. "tach" led or unique initiative pickup connection; use it with any spark-type engine and any ignition system, 2 cycle 1-6 cyl. engines or 4 cycle, 2-8 cyl. engines ... all electronics are in the tach itself. In Performance: 0-6000 & 0-9000 RPM ranges ... 250° edge-lighted dial ... temperature-compensated ± 1/2° accuracy from 0° - 120°F ... adjustable red line pointer ... 10.5 to 17.5 VDC operation. In Styling: stainless steel hardware, splash-proof black & chrome case and scratch-proof glass face for use in rugged conditions. The MI-18 mounts in your dash — requires only a 3/4" hole & 2 1/4" depth. The MI-18-2 comes with mounting case & hardware. Put a Professional Tach in your car, boat, dune-buggy, or bike now — the Heathkit MI-18! Shpg. wt. 3 lbs.

HEATHKIT GR-17 Solid-State AM-FM Portable Radio

Here's performance the others can't match. The new Heathkit GR-17 portable has a 12 transistor, 7 diode circuit with the same front end as used in Heathkit hi-fi tuners. AM or FM at the flick of a switch and what reception! Big 3 1/2" ferrite rod antenna, three tuned transformers and amplified AGC pull in more AM stations. The FM section features a collapsible 34" whip antenna, three IF stages and 5 uV sensitivity for reception over greater distances than you would expect from a portable. The 4" x 6" speaker and an audio output of 350 mW provides clean sound and the GR-17 will keep you entertained for up to 300 hours on a single set of batteries. For the greatest sound everywhere, get your GR-17 today. 5 lbs.

NEW HEATHKIT HW-100 SSB-CW 5-Band Receiver

The new Heathkit HW-100 has all the features and performance of the competition at a money saving kit price. And here's what it delivers: the receiver has sensitivity of less than 0.5 uV for a 10 dB S+N/N ratio for SSB. Crystal filter selectivity is 2.1 kHz at 6 dB down, 7 kHz at 60 dB down. Image & IF rejection are better than 50 dB. The transmitter has a 180 watt input on either USB or LSB and 170 watts on CW. It operates PTT or VOX on SSB and breaks-in CW work is provided by operating VOX from a keyed tone, using grid-block keying. Outstanding frequency stability — less than 100 Hz per hour after 30 minute warmup — less than 100 Hz variation under a 10% line voltage variation. The HW-100 is a really loud rig — solid-state (FET) VFO ... 80-10 meter coverage ... patented Harmonic Drive™ dial mechanism ... built-in 100 kHz calibrator ... TALC and much more. Put this hot rig in your shack — order your HW-100 today. 22 lbs.

HEATHKIT GR-104A Solid-State Portable B&W TV

The perfect portable ... that's the GR-104. Small and light enough to carry from room to room ... rugged enough to take it outside and the picture is the sharpest, most realistic you've ever seen, thanks to Heathkit total engineering. 74 sq. in. viewing area ... all solid-state circuit for extreme reliability and performance ... covers all VHF and UHF channels, 2-83 ... 2-speed UHF tuning ... remote VHF fine tuning ... 3-stage IF for maximum gain with controlled bandwidth ... gated AGC for steady, jitter-free pictures ... transformer regulated power supply ... circuit breaker protection ... one-piece swing out chassis for easy assembly and servicing ... runs on house current or battery power with the optional GRA-104-1 rechargeable battery pack, 27 lbs.

HEATHKIT GD-325C Low Cost Solid-State Organ

This money-saving kit form of the popular Thomas "Artiste" Organ can have you playing songs after just 50 hours of interesting, enjoyable assembly, thanks to the clear, easy-to-follow Heathkit manual and exclusive Thomas Color-Glo teaching method. Features 10 true organ voices ... variable repeat percussion ... 13 note bell, true bass pedals ... 2 overhanging 37 note keyboards, range C2 thru C5 each ... 73 watt peak music power amplifier ... 12" full response speaker ... Vibrato ... manual balance control ... the solid-state plug-in tape generators — the heart of the organ, are guaranteed for 5 years. Assembled walnut-finish cabinet included. Discover the fun and enjoyment of live music in your home — order your Heathkit/Thomas organ today. 172 lbs.
NEW HEATHKIT IM-18 VTVM

The new IM-18 is a direct descendent of the world's most popular VTVM — the Heathkit IM-11, and continues the features that made the IM-11 famous: 7 AC and 7 DC voltage ranges that measure accurately up to 1500 volts full scale; ± 7 ohms ranges for resistance measurements from 0.1 ohm to 1000 megohms — single probe convenience that permits test leads & enables you to change from AC to DC/Ohms measurements with a flip of the switch on the probe... the light circuit loading of 11-megohm input impedance; ± 1 dB 25 Hz to 1 MHz response; precision 1% resistors; DC polarity reversing position on the function switch... measurement capability for RMS and Peak-To-Peak AC voltages and dB... precision 4½" 200 uA meter for extra sensitivity. In addition, the new IM-18 includes wiring options for 120V or 240V AC operation and a three-wire line cord for added safety. 5 lbs.

NEW HEATHKIT IM-28 "Service Bench" VTVM

The new Heathkit IM-28 bears the proud tradition of the IM-13, and it has the same performance specifications as the new IM-18 above, an unbeatable combination! But it also has a number of features that put it in a class by itself; a large 6” meter with easy-to-read markings... extra 1-5 and 5 volt AC ranges for additional accuracy... zero-adjust and Ohms-adjust controls... continuous 12-position function switch. And that's not all — the IM-28 is battery powered for complete portability, and comes in a rugged polypropylene case with built-in handle. Simple circuit board assembly. 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 PET input, 11-megohm input, 1 megohm on AC... 4 AC voltage ranges... 4 DC voltage ranges... ± 7 ohms ranges... 4½" 200 uA meter... built-in test leads... ZERO polarity reversing switch... zero-adjust and 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.

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 2,000, 00, in or out of circuit... leakage leakage between 0-500 uA out of circuit... identifies PNP 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... rugged polypropylene case, attached 3" test leads, big 4½" 200 uA meter, all from panel controls, 10-turn control calibration. 4 lbs.

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 signal or ground, AC or DC Programming, Circuit board construction, and small, compact size: 110 or 220 VAC. 5 lbs.

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 two most-used ranges... color bandpass, FM IF, color & B&W IF and VHF channels 4 & 10. Same 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.

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, 2-axis input, retrace blanking, wiring options for 120 or 240 VAC operation and new Heathkit styling in beige and brown. 24 lbs.
NEW Deluxe Color TV With Automatic Fine-Tuning—Model GR-681 $499.95 (less cabinet)

The new Heathkit GR-681 is the most advanced color TV on the market. A strong claim, but easy to prove. Compare the "681" against every other TV — there isn’t one available for any price that has all these features. Automatic Fine Tuning on all 63 channels ... just push a button and the factory assembled solid-state circuit takes over to automatically tune the best color picture in the industry. Push another front-panel button and the VHF channel selector rotates until you reach the desired station, automatically. Built-in cable-type remote control that allows you to turn the "681" on and off and change VHF channels without moving from your chair. Or add the optional GRA-681-6 Wireless Remote Control described below. A bridge-type low voltage power supply for superior regulation; high & low AC taps are provided to insure that the picture transmitted exactly fits the "681" screen. Automatic degaussing, 2-speed transitor UHF tuner, hi-fi sound output, two VHF antenna inputs ... plus the built-in self-servicing aids that are standard on all Heathkit color TV’s but can’t be bought on any other set for any price ... plus all the features of the famous "295" below. Compare the "681" against the others ... and be convinced.

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

Deluxe "295" Color TV... Model GR-295 now only 

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
Other cabinets from $99.95

Deluxe "227" Color TV... Model GR-227 now only 

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

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

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
Other cabinets from $24.95

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 & 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 $59.95
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with complete instruction program

Here's a great new way to solve electronic problems accurately, easily...a useful tool for technicians, engineers, students, radio-TV servicemen and hobbyists. The Cleveland Institute Electronics Slide Rule is the only rule designed specifically for the exacting requirements of electronics computation. It comes complete with an illustrated Instruction Course. You get four AUTO-PROGRAMMED lessons...each with a short quiz you can send in for grading and consultation by CIE's expert instructors.

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Circle 115 on reader's service card

Equipment report

B&K 465 CRT Tester

For manufacturer's literature, circle No. 116 on Reader Service Card.

The B & K 465 CRT tester is another addition to the line of popular test instruments from this company. It will test any black-and-white or color picture tube, and is much more "obsolescence-proof" than the older CRT testers.

A big factor in this is the use of a five-step heater voltage switch, with a variable resistance in series. This allows setting the heater to any voltage between zero and 13 Vac. Actual voltage on the heater is read on the meter. So, the "full-load" voltage can be read at all times.

The control grid (G1) voltage can be varied from 0 to 100 volts, and the G2 or screen-grid voltage from 0 to 300 volts. This permits checking tubes for proper cutoff with actual operating conditions duplicated as closely as possible. The variable G2 voltage also lets you check low-G2 tubes without danger of damaging them.

A three-step rejuvenator, familiar to B&K users as the Dynamic Intensifier, is used for rejuvenation of week CRT's, including individual guns of color tubes. The voltage applied is controlled and timed to avoid unnecessary "overshooting."

A neon-lamp indicator on the panel shows shorts between heater and cathode. G1 and G2. A REMOVED SHORTS position on the selector switch,
used with the rejuvenator voltage, will burn out most of the "particle" type of shorts in CRTs. The heater voltage is not applied to the tube during this operation, lessening the danger of damage.

A three-position slide switch selects each gun of color tubes. Tests may be made for shorts, cutoff and emission. For the important gun-balance test, the reading of each gun can be compared to the rest by flipping this switch back and forth.

If a color tube's guns will read within the "best gun output not more than 1.5 times that of the worst" formula, the tube is good. In weak tubes, the low gun can often be rejuvenated to bring its emission up to that of the good ones.

Color tubes can also be checked for "warmup drift" in screen color. This is done by letting the tube cool off completely, then repeating the mission test, logging the meter reading of each gun after 2 minutes, then after 4 minutes.

The panel meter has a two-position sensitivity switch. This is used in testing certain special CRTs to get adequate meter deflection. Most tubes will read in the "normal" position.

The standard 12-pin socket is used on the cable to the tester. Adapters plug into this to match all presently used CRT bases, including round and rectangular color tubes, and even the very small bases used on some miniature CRTs.

During the bench testing of this instrument, we successfully blew a short out of an old CRT, and rejuvenated several others, including an aged color tube that had a sickly green look due to gun unbalance. All in all, a well-built and useful piece of test equipment.—Jack Darr

Live Cheaper Electronically

As the cost of living soars, electronic items provide a major exception to the trend. In its latest consumer price index, the Department of Labor found that the average prices of all cost-of-living items in June 1968 had risen 20.9% above the prices prevailing in 1957-59. However, portable and console TV set prices declined 19.8%, and portable and table radio prices dropped 22.8% in the same period.

The cost of repairs has gone up, but not nearly so much as the average of other consumer expenses.
could never get convergence until I discovered this!

Here's another thing to check. Be sure that your red adjustments have the
tilt and amplitude controls will cause the lines to
curves or straighten as they should. Com-
pare the range of the red adjustments with
that of the green adjustments, for ex-
ample. If they don't move the red as
far as they ought to, check the tilt and
amplitude controls for possible open cir-
cuits, broken wiring, etc.

One more: go back and run purity
again. Watch out for edge purity:
the yoke adjustment. Then, put your dot or
crosshatch pattern back on, and move
the deflection yoke very slightly back
and forth, watching your edge conver-
gence. At the same time, check the po-
sitioning of your convergence yoke. If
this accidentally gets knocked too far
forward, it'll cause this same symptom.

Also, move the convergence yoke very
slightly back and forth (watching your
convergence at the edges), and very
slightly around the tube neck. It takes
only a fraction of an inch of displace-
ment on this yoke to really upset things,
and the first sign is usually very poor
edge convergence.

Finally, you don't have to pay too
much attention to the absolute straight-
ness of the lines, as long as they do con-
verge. It's pretty difficult to tell when a
line is absolutely straight on the hemi-
spherical faceplate of a color tube. any-
how. (And I'd rather have a slightly
curved white line than a straight rain-
bow!)

**SERVICE CLINIC**

*continued from page 27*

**MODIFY KIT VTVM?**

I'm interested in a kit vtvem. Could
I modify it to get a 0.5-volt range?—
S. K., Union City, N.J.

Not recommended! The best way
would be to buy one that has a 0.5-volt
range! Modifying kits, especially vtvem's,
leads to trouble (calibration, mostly). If
you get a kit, build it the way the man
says in the book. That way, if it doesn't
work, you can get it fixed.

**NEW! SOLID STATE KITS**

FOR ANY TAPE RECORDER

Automatic Recording-Level Control

Low-noise distortionless compressor
preamp easily installs in line kit.
Easy-to-build kit with complete
instructions.

**MODEL ACP-1 KIT** . . . $18.50

**Voice / Sound**

Actuated Controller

Voice operate any tape recorder, ham
and CB transmitter. Ideal for intru-
sion alarms. Built-in relay switches
up to 1 amp. Easy-to-build kit with
complete instructions.

**MODEL VOX-1 KIT** . . . $18.50

**Other Kits**

Audio Amplifiers ■ Power Supplies ■
Test Equipment ■ Treasure Locators
■ many others

FREE Data sheets with circuit description,
diagram and specifications for all kits.

**CARINGELLA ELECTRONICS, INC.**

See page 173 for address.

Circle 119 on reader's service card

**QUIETROLE**

The Original Control
and Switch Lubri-Cleaner

The oldest, most
reliable and efficient
product obtainable for
positive lubrication and
cleaning of TV Tuners,
Controls and Switches.
Harmless to plastics
and metals. Zero effects
on resistance and
capacity. Non-inflam-
mable—non-conductive—
non-corrosive.

The Choice of Better
Servicemen, Everywhere.

For Color and
Black and White

Available in Aerosol or Bottle
Product of

Circle 120 on reader's service card
Spot tv x-rays

(continued from page 35)

than a few inches away, as when measuring the field external to a television set.

If improper operation is indicated by the source check or a large change in the zero setting, remove the screen on top of the instrument. If the trouble is that a high reading is obtained, the switches should be opened and closed on the GM tube boards successively until the one producing the malfunction is located. Usually the trouble will be dirt or excessive moisture on the GM tube mounting.

If the malfunction is indicated by a down scale reading or the above procedure has not corrected the condition, turn off all but one switch on the GM mounting boards. Set the range switch to zero. Set zero with the control below meter face. Turn switch off and another one on. Set zero with the 100K potentiometer (R14) on the mounting board. Turn this switch off and proceed with the next board. Setting zero with the 100K potentiometer. When all units have been set to zero, turn all 6 switches on and, if required, set meter zero with the control below the meter face.

During initial adjustments and calibration in the laboratory, the front-panel zero control is adjusted to produce a potential of between 2.6 and 2.8 volts at point C with all sensors switched off.

It is possible that the instrument will respond to light (especially ultra-violet) or strong electromagnetic fields. Light sensitivity is almost invariably caused by a defective light seal at the base of a GM tube. Re-coating the glass seal with a light-tight coat of insulating material, such as a black silicone rubber, will eliminate this type of sensitivity.

If operation without the perforated aluminum cover is required, or if an abnormally strong electromagnetic field is expected, connect integrating capacitor C4 between the base of Q4 and ground on each of the GM tube circuit boards, and add a 0.1-µF capacitor between Q7's gate and ground. This does not affect calibration or the time constant.

The instrument described in this article was developed and used by the National Center for Radiological Health to measure X-radiation from about 1200 color TV receivers surveyed in the Washington, D.C., area. Radio-Electronics would like to express its appreciation to the NCRH for making this information available so that we could pass it on to our readers. R-E
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BRAND NEW IN307 TRANSISTORS, PNP type, 10 watts Tunsied brand. $1.96 ea. for $1.60
VHF POLICE & FIRE CONVERTER MOUNT, Turn your regular AM radio into a receiver to hear Police and Fire Bands. $5.95
HIFI GAIN STEREO PRE-AMP, used in connection with a ceramic recorder. 8 transistors, works off 12 V D.C. 2 A. $16.95

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Circle 123 on reader's service card

NEW IC's

PRESSURE-SENSITIVE TRANSISTORS

Pitram PT-2 and PT-3 piezotransistors are silicon npn planar transistors that have their emitter-base junctions mechanically coupled to a diaphragm in the top of a TO-46 can. Pressure applied to the diaphragm causes a reversible change in transistor characteristics and a linear output voltage.

Applications include FM oscillators, differential pressure transducers,
accelerometers, flow gauges, blast gauges and weighing scales. A 3½" differential water pressure or 1/4" gram point force produces 1 volt output. A circuit for linear dc output is shown.

Calibration curves for sensitivity,
SEMICONDUCTORS

temperature coefficient and over-all performance are supplied with each unit. The PT-2 and PT-7 cost $75 and $125, respectively, in lots of 1 to 99. The units are made by Stow Laboratories, Stow, Mass. 01775.

VOLTAGE-REFERENCE AMPLIFIER

The DRAE 11.7B is a series of composite circuits designed as combination voltage references and error amplifiers for use in regulated power supplies. Each reference amplifier consists of an nnp silicon transistor and a silicon voltage regulator diode having equal but opposite temperature coefficients. Temperature differential between elements is held to a minimum to permit reliable operation over a wide range of temperatures.

The basic type number (DRAE 11.7B) of this 11.7-volt reference amplifier is followed by the suffix 10, 25, 50 or 100, indicating the temperature coefficient in parts per million. Case outline, base diagram and schematic of this series are shown. Further information is available from Dickson Electronics Corp., PO Box 1390, Scottsdale, Ariz. 85252.
Why is a Vectorscope essential for Color TV servicing?

1. Check and align demodulators to any angle...90°, 105°, 115°...accurately and quickly. No guesswork. New color sets no longer demodulate at 90°. Only with a Vectorscope can these odd angles be determined for those hard-to-get skin tones.

2. Check and align bandpass-amplifier circuits. Eliminate weak color and smeared color with proper alignment. No other equipment required. Only a V7 Vectorscope does this.

3. Pinpoint troubles to a specific color circuit. Each stage in a TV set contributes a definite characteristic to the vector pattern. An improper vector pattern localizes the trouble to the particular circuit affecting either vector amplitude, vector angle or vector shape. Only a V7 Vectorscope does this.

LECTROTECH V7
color vectorscope/generator

EXCLUSIVE FEATURES:
Color Vectorscope: Until now, available only in $1500 testers designed for broadcast use. Accurately measures color demodulation to check R-Y and B-Y, for color phase and amplitude. A must for total color and those hard-to-get skin tones. Self-Calibrating. Adjust timing circuit without external test equipment. Dial-A-Line. Adjust horizontal line to any width from 1-4 lines. Solid State Reliability in timer and signal circuits. Plus: All Crosshatch, Dots, Vertical only, Horizontal only and Keyed Rainbow Patterns. RF at channels 3, 4 or 5. Video Output (Pos. and Neg. adjustable) for signal injection trouble-shooting. Red-Blue-Green Gun Killer. All transistor and timer circuits are voltage-regulated to operate under wide line voltage ranges. Lightweight, compact—only 8¾ x 7½ x 12½".

ONE YEAR WARRANTY

189.50 NET

V6-B New, improved complete color bar generator with all the features of the V7 except the Vectorscope. Only 99.50

BUILD A $10 READOUT MODULE

(continued from page 69)

Fig. 13—Component placement and input connections.

Fig. 14—Test setup for the module uses battery supply for 22.5V and 3.6V. Input (temporary) uses pushbutton circuit.

Testing
You can test your unit with two D-cells and a 22 1/2 V battery, connected as in Fig. 14. Build up the bounceless pushbutton circuit shown for the input. To calibrate the unit (temporarily, of course, since you'll later be switching to a regulated meter supply), set the counter and run the count up to 9. Now adjust R9 to set the pointer precisely to 9. Your counter is complete, and you should be all set to build any of a number of digital instruments at a tiny fraction of their normal cost.

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