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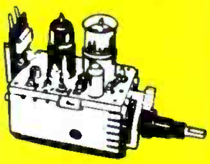

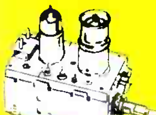

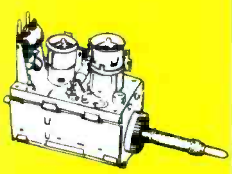

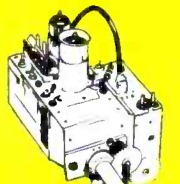

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TRANSISTOR tuner		$9.95
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Overhaul includes parts, except tubes and transistors.

Dismantle tandem UHF and VHF tuners and send in defective unit only.

Remove all accessories . . . or dismantling charge may apply. Your tuner will be expertly overhauled, aligned to original standards and warranted for 90 days.

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Circle 1 on reader service card

NEW & TIMELY

Volume 42 Number 9 RADIO-ELECTRONICS . . . FOR MEN WITH IDEAS IN ELECTRONICS September 1971

IONOSPHERIC CHANGES MAY AFFECT WEATHER

LUBBOCK, TEX.—Research conducted at Texas Tech University by electrical engineering Professor Thomas F. Trost show that radio waves entering the ionosphere, particularly the "D region", run into surprising difficulties. The ionosphere is the 40 to 600 miles up region of the earth's upper atmosphere overlaying the stratosphere and the mesosphere. Within the ionosphere are an abundance of charged atoms called "ions"—atoms which have gained or lost an electron.

Because long distance communications depend on it to bounce radio signals back to earth, changes in the ionosphere, whether abrupt or gradual, can cause distortion and interruption of radio signals. The changes are often related to the emission of radiation from the sun. There is also an effect on the weather.

In Lubbock, Dr. Trost is establishing a low frequency receiving station to monitor radiowave absorption in the "D region." He plans to correlate this information with weather data, temperatures and wind velocities obtained for the stratosphere at the Meteorological Rocket Network station at White Sands, New Mexico.

Dr. Trost is looking for the relation between the radio signal's interaction with the ionosphere and what scientists call cyclonic and planetary waves. The planetary waves are the "steering currents" for the smaller scale cyclonic waves which determine our weather. ★

TAPE DECK WITH DYNAMIC NOISE LIMITER

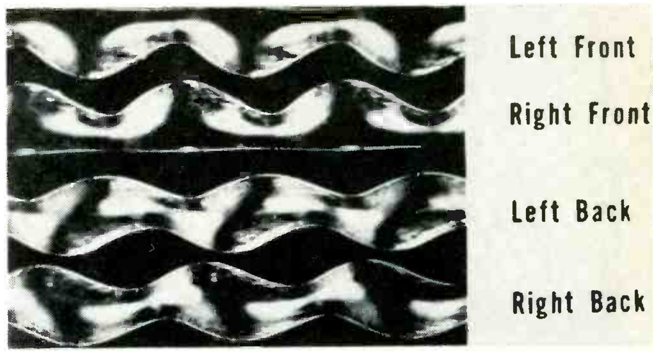
NEW YORK, N.Y.—The first cassette tape machine to incorporate the new Philips Dynamic Noise Limiter (DNL) system was announced here by Norelco. DNL circuitry virtually eliminates noise and tape hiss, according to Paul B. Nelson, Jr., division vice president.

The DNL system featured in the Model *2100* was developed by Philips of Holland and is an active noise suppression circuit that operates in quiet and silent stretches of tape where noise is especially noticeable. ★

IN THIS ISSUE

Nixie readouts are turning up in more and more new equipment. We know you'd like to learn more about how they work and how they can be used most effectively. So turn to page 50 and see what George Flynn has to say about digital readouts.

NEW QUADRAPHONIC DISC SYSTEM



HIGHLY MAGNIFIED GROOVE of quadraphonic record contains four modes of modulation.

MONTREUX, SWITZERLAND—A compatible quadraphonic disc system has been developed by Columbia Records, which now joins forces with Sony Corporation to enhance the basic invention and prepare it for worldwide marketing.

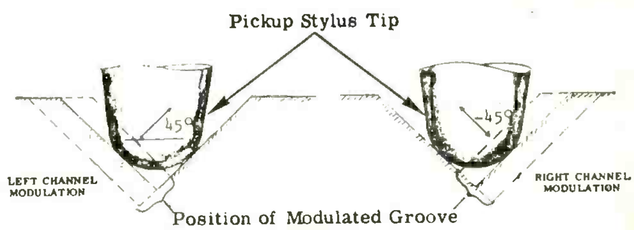
The system permits four channels of sound to be reproduced from a two-track source. Consumers will be able to obtain quadraphonic sound from their present hi-fi systems by adding a special decoder, another stereo amplifier, and two additional loudspeakers.

The basis of the innovation is a new double-helical modulation concept used to encode a quadraphonic program onto a two-channel disc. During playback a special decoder re-creates the original program of four separate channels. Without this decoder, the program is heard as conventional 2-chan-

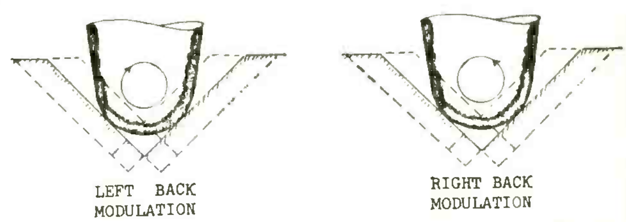
nel stereo. Therefore, the quadraphonic disc can be played on existing record players.

Quadraphonic sound is recorded in the studio on a multitrack "master tape" re-

(continued on page 6)



TWO VIEWS OF GROOVE of ordinary stereo record. To-and-fro motion of the stylus tip in response to the modulation is depicted by the arrows at 45° and -45° to the horizontal.



VIEWS OF THE TWO NEW MODES of modulation on the quadraphonic disc.

Radio-Electronics

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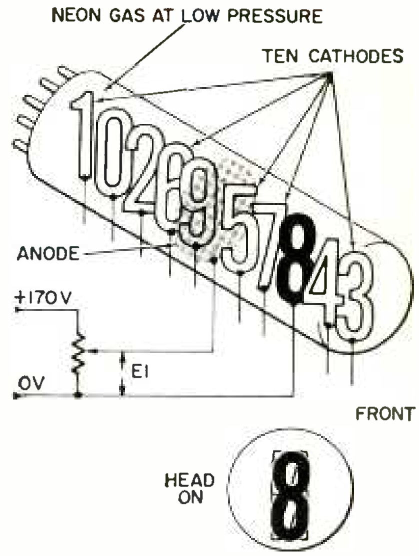
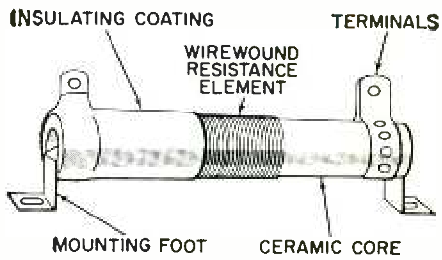


Digital readouts are popping up all over the place. Here's a look at how they work and what they do. . . . see page 50



HIGH-WATTAGE WIREWOUND

Resistors are vital to every electronic circuit. Review your knowledge and add some new facts. . . . see page 58

Dual-function generator is a modern instrument used to test and build digital circuits. It's easy to make your own. . . . see page 36

RADIO-ELECTRONICS, September 1971, Vol. 42, No. 9
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LOOKING AHEAD

Volume 42 Number 9 RADIO-ELECTRONICS . . . FOR MEN WITH IDEAS IN ELECTRONICS September 1971

by **DAVID LACHENBRUCH**
CONTRIBUTING EDITOR

A cable-TV receiver?

Some 5.3 million American families, in about nine percent of all TV-equipped homes, now get their television entertainment via cable. In Canada, the figure exceeds 20 percent. With the FCC nearing completion of its massive study of CATV, ending what has been, in fact, a freeze on cable growth in the larger cities, CATV is expected to expand rapidly. It's not uncommon to hear forecasts that 25 to 50 percent of U.S. homes will be cable-connected within the next decade or so.

Yet cable homes view their television on receivers that were designed for off-the-air reception. Increasingly, cable TV engineers are calling these receivers less than ideal for their systems, many of which already are distributing more than 12 channels of programming. Among their complaints about existing sets:

1. Many of them don't have adequate adjacent-channel interference rejection to permit use of all 12 vhf channels (cable systems currently can't use ultra-high frequencies).

2. Tuners often aren't shielded enough to prevent direct pickup of programs off the air in high-signal-strength areas, causing ghosts when a cable feeds in on the same channel. This often requires a top-of-set channel-converter.

3. AFC, when misadjusted, can cause severe adjacent-channel sound interference.

4. In some cases where a cable feeds in more than 12 vhf channels (via set-top converter), the receiver causes severe reception problems.

The CATV systems' trade association, the National Cable TV Association, has filed a petition with the FCC requesting rules and standards for special receivers designed for cable connection. There is no question that the Commission eventually will look into the entire situation, and that some day we will use a different type of receiver for CATV than we do for direct off-the-air reception. Specialized cable receivers—for multi-channel cable reception—already are being designed by major television set manufacturers. Magnavox is developing a set which can pick up 31 channels on vhf. RCA is supplying color receivers to two hotels in the new Disney World complex near Orlando, Fla., which have no tuners at all. The signal is fed directly into the i.f. and channels are selected by a switch that feeds signals from a bundle of slim cables. This distribution system, developed by Ameco, is called "Discade" and accommodates two TV channels on each cable. They are about the size of standard RG/59U coaxial antenna lead-in.

There are other methods of delivering more than 12 vhf channels. One is to use two separate standard cables, each supplying up to 12 vhf channels. By simply switching from cable A to cable B, the viewer can receive a total of 24 programs. Another system, that currently requires a set-top converter, simply carves more channels from the vhf band, by adding channels below 54 MHz (Channel 2), between 108 and 174 MHz (between the FM band and Channel 7) and above 216 MHz (Channel 13). As yet there's no standard system—and there may never be—making the development of a cable-designed receiver all the more challenging.

Competition for Dolby

The Dolby Type-B noise-reduction system has started to show up in many different brands of cassette recorders. Next year you'll see it in a great many more, including some relatively modest-priced units, when a simple monolithic IC version is made available to equipment manufacturers as the result of a cooperative effort by Dolby Laboratories of London and Signetics Corp. The Dolby system requires special processing of the signal while recording, and decoding during playback. To take advantage of the noise-reducing effects of the Dolby system, the tape you play back must have been "Dolbyized" during the recording process.

Until now, Dolby has had the cassette noise-reduction field to itself. But N. V. Philips of the Netherlands, the developer of the cassette system, has come up with its own noise-eliminator, which it calls "Dynamic Noise Limiter" (DNL). Unlike the Dolby system, DNL operates on playback only—it can be used to cut noise from any standard, unprocessed recorded cassette. Philips says it adds about $30 to the cost of a cassette deck, and Norelco will offer the first DNL deck in the U.S. at $219.95. Philips plans to make the system available to other manufacturers without cost.

The DNL circuit operates in the high-frequency area, splitting the signal into two parts. For signals above 4 kHz (where tape hiss begins) and more than 38 db below reference level, the signals in the two channels are equal but of opposite phase and cancel each other. Louder signals are permitted to pass, since noise is not noticeable during these passages, while niose suppression is complete when there is no signal.

Columbia's 4-channel system

Quadraphonic sound received a big boost with the introduction of a new four-channel disc system by big Columbia Records. At the same time, Columbia's espousal of its own proprietary system could further complicate the tangle over standards for quadraphonics. Although complete technical details weren't yet available at press time, Columbia's system is of the matrix type—other members of the matrix family are the Electro-Voice and Scheiber systems. Like the other matrix systems, Columbia's is claimed to be completely compatible with two-channel stereo and monophonic systems. That is, a Columbia "SQ" (for "stereophonic/quadraphonic")disc may be played over monophonic or conventional stereo equipment, and a conventional disc may be played on SQ equipment. For more information on SQ see story on page 2.

In a matrix system, four channels are decoded into two for recording or broadcasting, and decoded into four for listening. An accessory decoder or a decoder-equipped playback system must be used to receive the material in quadraphonic sound. The Columbia system may be broadcast on conventional stereo FM and heard in four-channel sound by listeners equipped with decoders and the required additional amplifier channels and speakers. Columbia says that left and right rear sounds are superimposed on the conventional stereo disc grooves in the form of two circular modulations, left-rear information being contained in a

(continued on page 14)

Have you tried our canned tuner?

It's not only great for color television sets, it's also great for guided missiles.

As a matter of fact, Krylon® Tuner Cleaner is made with the same solvent used in the missile industry. Plus a special lubricating oil.

Just one little spray leaves a thin, non-drying film of lubricant that conditions contact surfaces and protects them from corrosion.

And that same little spray keeps surfaces self cleaning and water repellent without ever harming any plastic surface.

Krylon Tuner Cleaner also comes with a plastic tube for controlled spraying in hard-to-reach areas.

Try it just once. You're sure to develop a taste for it.

Krylon Coatings—from the makers of Elmer's® Adhesives and Mystik® Tapes. BORDEN™

Circle 3 on reader service card

(continued from page 2)

corder and then mixed down to a 4-channel master tape, with a later encoding of these four channels onto a two-channel medium. This is done by a special encoder that produces four discrete modulation patterns on the record. These modulations are separated into four channels by the decoder for reproduction over four loudspeakers.

The quadraphonic system retains the two basic stereo modulations and provides two new additional modes of modulation for the remaining two channels. As the record rotates and the groove advances, a clockwise helix is produced for the left back channel and a counter-clockwise helix is produced for the right back channel. These two helices carry the back channel information. ★

TAPES SEIZED

NEW YORK, N.Y—Thirteen Manhattan stores were raided by detectives from the office of District Attorney Frank S. Hogan who charged that these "unauthorized mechanical reproductions of musical performances owned by another were being sold at prices far below those of legitimate record manufacturers." He accused the stores of selling pirated and counterfeit tape recordings. ★

WWV Has Laryngitis

FORT COLLINS, COLO.—WWV, the National Bureau of Standard Frequency and Time Station, began broadcasting in its new all-voice format on July 1 (see **Radio-Electronics** June 1971). The time announcements are a model of clarity.

Unfortunately, however, the same cannot be said of the voice announcements concerning radio propagation conditions and the broadcast announcements concerning geophysical alerts. The propagation forecasts are broadcast at fourteen minutes past the hour, the geo alerts are eighteen minutes past the hour.

The modulation level for these voice announcements is much too low. In addition, the announcements are made by untrained announcers whose voices are not well suited to the microphone. As a result, it is difficult, and sometimes, impossible, to hear the announcements. We can only hope that the authorities will do something quickly to improve the situation. ★

FIVE ALARM CIRCUITS
For fire or frost alarms see R. M. Marston's article that starts on page 54. They complete this series.

VIDEOVOICE—NEW INTERNATIONAL PICTURE

NEW YORK, N.Y.—Videovoice, a new video communications system permits businessmen in the U.S. and overseas to exchange virtually instantaneous views of products, charts or other subjects as they talk. It was demonstrated between Tokyo and New York City by RCA Global Communications, Inc.

Representatives of RCA Globcom and Kokusai Denshin Denwa (KKD) exchanged a series of black-and-white TV pictures over the same 3-kHz bandwidth circuits they were using for voice communications. KKD handles Japan's international communications. Videovoice is an accessory available to subscribers of leased-channel communication links.

The service can be conducted as a 2-way exchange of visual information by having transmitting and receiving units at both ends of the link (duplex) or as a one-way (simplex) service with a receiver at one end and transmitter at the other.

The system combines live camera, frame-freeze and slow-scan TV techniques. When the subject is live and in motion, it is displayed on the camera monitor. The subscriber selects the desired scene and presses the "freeze" button to stop the action. The scene viewed at the instant

(continued on page 12)

Radio-Electronics

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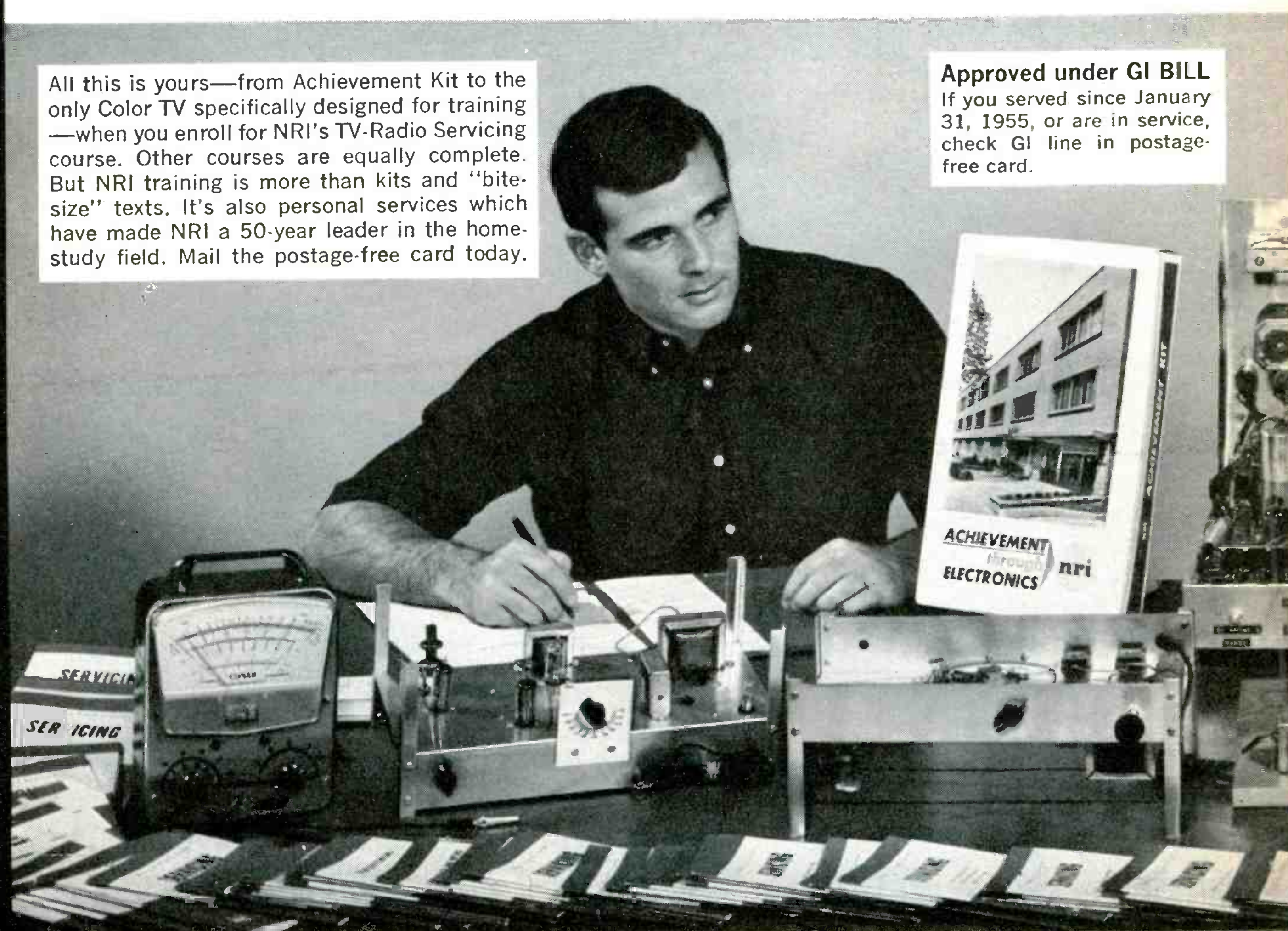

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(continued from page 6)

the "freeze" button is pressed is stored in RCA's new silicon-target storage tube and then read out at the required speed for transmission over voice-frequency links.

At the remote end, the subscriber receives the call in the video mode and can view the transmitted picture for up to 15 minutes or until a new one is transmitted. In a simplex operation the transmitting party must cease talking during the 30-second video transmission period. Full two-way conversation can be resumed after the picture has been received and is being displayed. A 2-way discussion can be carried on during picture transmission in a duplex system.

The target in the new storage tube is an array of 600,000 silicon dioxide storage elements in a 1-cm square area of a silicon wafer. Stored information, pictures or printed matter, can be read out 30 times per second for up to 15 minutes before the information on the target must be regenerated.

The information is written in normal raster fashion on the target by a high-velocity scanning electron beam. The beam places on each individual silicon dioxide storage element, in turn, an electron charge proportional to the amplitude of the incoming video signal.

To read out the data, a low-velocity scanning beam sweeps the target. At those points where the stored information is dark the scanning beam is repelled from the target by the combined charges on adjacent silicon dioxide elements. And, conversely, the beam is attracted to the silicon wafer at points where the picture is bright. The electron beam current reaching the silicon wafer is then amplified and used to modulate the electron beam in a standard CRT at the normal TV scanning rate, even though the information may have been stored at a different scanning rate.

Thus, the display CRT continually receives information from the storage tube. Since it can store information at one scanning rate and be read out at another, the storage tube can serve as an interface between narrow bandwidth systems that provide video information rather slowly and wide bandwidth display systems that require the transmission of high-speed video information. ★

ANTENNA ACCESSORIES

Getting a first-rate color TV picture on the screen doesn't stop with the antenna installation. But that is where it starts!

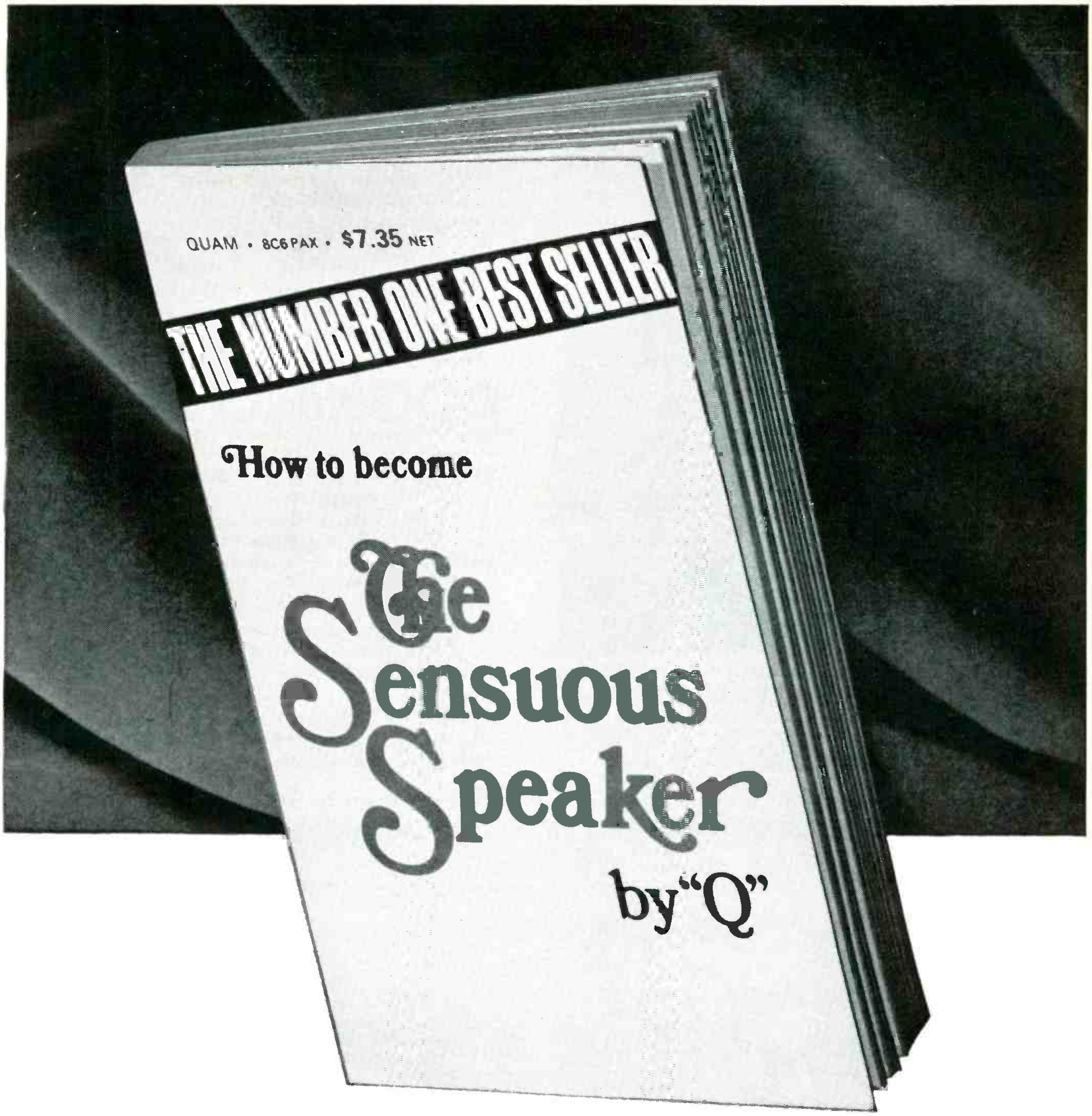
Along with the antenna there are amplifiers, boosters, lightning arrestors and a myriad of other "little" extras that make the difference between sharp clear pictures and so-so reception. For complete details read Bob Middleton's story starting on page 33.

Silent Alarm

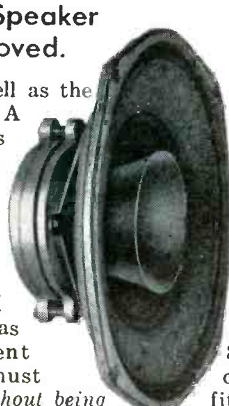
NEW YORK, N.Y.—Members of an independent taxi association in New York City will be the nation's first cab drivers to use a new RCA radio system to flash a silent alarm to their headquarters in case of a robbery or other emergency. By pressing a hidden switch a driver can signal, without the passenger's knowledge, to his radio dispatcher.

The alarm is part of an RCA two-way radio system which relays messages in number code as well as by

(continued on page 14)



Naturally Every Speaker Wants to be Loved.



But few manage it as well as the Quam Model 8C6PAX. A jillion of these speakers have already been installed in factories, offices, restaurants, and other locations. What's the secret of success? It's the Sensuous Sound!

The Quam 8C6PAX *knows* that music often has to compete with inherent situational sounds. It must manage to be *audible without being obtrusive*. It has to have what it takes.

What Does It Take?

To be the Sensuous Speaker, you have to be well-engineered and well-manufactured.

Do you have a 6 oz. ceramic magnet? Get one! And get a dual cone, too. A frequency response of 50—20,000 Hz. will also help you, the way it has the 8C6PAX.

Fitting In

Don't try to be too deep. The 8C6PAX has just the right shallow construction. At three inches, it can fit almost anywhere. Transformer mounting facilities add to its appeal.

The Easy Way

Maybe it sounds like too much trouble for you to become the Sensuous Speaker.

Especially when Quam has already done all the work . . . and made all this delectable sound available for you.

Model 8C6PAX. The Sensuous Speaker. At your distributor. *Now.*

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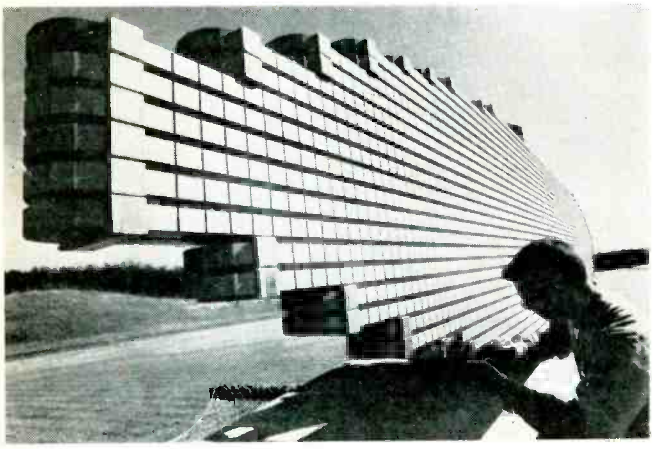
(continued from page 12)

voice. When a driver presses the switch, automatic equipment in the dispatch room prints out a log showing the taxicab's identifying number, the time of the message, and sounds a bell as an additional alert. The system's clock is engineered to log incoming calls in time increments of one-tenth second.

The RCA system, known as Voice-PLUS for its dual capability, also automatically transmits a return signal from the dispatcher that lights an "acknowledge" lamp on the cab's dashboard. ★



THIS RADAR ANTENNA TEST MODEL has been built by Westinghouse under an Air Force program to develop an improved radar screen for the U.S. Designers had to give special consideration to the problem of signals reflected from everything on the earth's surface—ground clutter—which can overwhelm radar reflections from low-flying aircraft. Reduction of sidelobe energy was used to suppress ground clutter.

CCTV AIDS POLICE

MOUNT VERNON, N.Y.—With the assistance of a closed-circuit television system installed at police headquarters, law enforcement agents were able to arrest a suspected burglar.

The monitoring system consists of two screens located at the local police station and linked with cameras in the business district. Noticing a man "acting suspiciously" at the door of Joe's Pizzeria, half a mile from his screens, the officer on duty quickly dispatched a radio car and two other policemen in time to seize the man on a charge of attempted burglary. **R-E**

LOOKING AHEAD

(continued from page 6)

clockwise helix, right-rear in a counterclockwise motion.

The first equipment for the Columbia SQ system will be built by Sony. A simple matrix decoder will retail for about $55. A more sophisticated version, called a "logic" system—which increases directionality by adding amplification to the predominant channel—will initially sell for about $165. Columbia's SQ discs will cost one dollar more than conventional stereo records.

The Electro-Voice matrix system has a headstart in the marketplace—equipment is available under several brandnames, about 50 discs are on the market, and perhaps a dozen FM stations are transmitting programs using this method. Whether the two systems can be brought into compatibility remains to be seen. **R-E**

SONY® achieves true integration

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

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

Why FET's

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

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

SONY® F.E.T. Amplifier

Power to Spare

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

Nothing Stands Between You and the Sound

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

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

An Abundance of Audiophile Conveniences

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

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

In fact, you can even get the power output section separately, as the model TA-3130 basic amp. It makes a great match for our TA-2000 preamp, too.

Your Sony dealer has both models available, and at prices—$359.50 for the TA-1130; $239.50 for the TA-3130. Sony Corporation of America, 47-47 Van Dam Street, Long Island City, New York 11101

Circle 8 on reader service card

HOME APPLIANCE ELECTRONICS

by **JACK DARR**
SERVICE EDITOR

THE "ANALYZER" IN AUTOMATIC HOME APPLIANCES

THE PRINCIPLE OF THE "ANALYZER" HAS been known and used by electronics men for a long time. This is an instrument which can be connected, plugged in, etc., to a machine, and used to make several different kinds of tests. Now, we're seeing "electric-appliance analyzers" showing up. With the numerous kinds of fully-automatic home appliances on the market today, this can be a great time saver. We'll probably see more of them in the future.

The first one I saw was a unit made by the Robinair Mfg. Co., Montpelier, Ohio, for use with various Frigidaire washers, and both gas and electric clothes dryers. Incidentally, the appliances themselves are designed for fast and easy diagnosis and repair, mostly in the home. This is a welcome trend, and one which should be adopted by a lot of other people; hopefully soon.

All of these units have removable "control consoles"; all wiring is connected by plugs and sockets. The console can be lifted off, by loosening a couple of simple clips, and the Analyzer plugged in. This allows a very rapid isolation of the trouble to one of two places; the controls themselves or the "machinery". All operations of the unit, in all parts of the cycle; can be started, stopped and controlled by the Analyzer. By running the unit through one full cycle, everything can be checked and any defective parts located.

A rotary selector switch on the Analyzer panel takes the place of the motor-driven timer in the unit. By setting this to various positions, every function of the unit can be operated normally and checked out: High, medium and low-speed agitation of the washer; high or medium-speed spinning, hot or rold water temperature—these can all be tested very quickly and easily.

Pilot lights on the Analyzer panel show which function is in operation. High, low and medium motor speed; hot or cold water; spin or agitate. There is even an "Overload" light warning that there is something jammed up in the mechanism, and putting an abnormal load on the motor. (A stray sock in the drain pump, a dry bearing, or even a motor with shorted turns in the windings will show up.) The starter relay can also be checked out, with its own pilot light.

If the machinery checks out in good working order, this clears it from suspicion. The trouble is pinned down to something in the control console which isn't working properly. The console itself can be tested with the Analyzer and the pilot lights. The Analyzer is plugged into an ac outlet, and the console plugged into it. Now, by running the timer, selector switches, etc through a full cycle, the Analyzer immediately shows up any defective switches, relays, controls or open wiring. The pilot lights indicate which functions are operating at any given time.

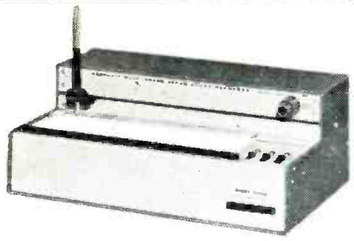
The Analyzer can be used, along with "actual operation" tests, to check out the numerous safety features provided on these machines. They have a "lid-switch", which should stop the machine instantly if the lid is lifted while it's in operation.

Another (and welcome) feature of these units is an "Out-Of-Balance" switch. Those of us who worked on the prototypes of these machines back in the late 1920's well remember what happened when a load of clothes got too far "off-center" in the first spin-dryers! The machine jumped straight up into the air, wiggled, and took off toward the lowest point!

In fact, one of these machines had such a tendency to "walk" while spinning that it was known, not affectionately, among repairmen as the "Galloping Goose"! Another one came equipped with a huge block of cement, 6 inches thick and about 4 feet square, fitted with four bolts, to which the unit was fastened. (After this, the machine didn't vibrate—the house did!) It took four husky men to carry this monolith into the house and get into place!

This, thank goodness, has been eliminated. These units have an "Out-of-balance" switch, which is designed to open, stopping the machine quickly (there is a *brake* on the drum!), if the vibration exceeds a certain number of G's. A test procedure is used; this is done by putting a deliberately unbalanced load in the machine, and running it, to make sure that the out-of-balance switch will stop it, in the right amount of time.

Electronic heat-sensors are used in both gas and electric dryers, as heat-limit controls. If they get too hot, it shuts off all power. On electrically-heated dryers, this is done by opening a relay. On gas-heated types, the main gas valve is always a solenoid type; these are always built so that if the power is cut off, the valve *closes*. This is a "fail-safe" feature; there are a lot of these in modern appliances. We will talk about them in future columns. **R-E**



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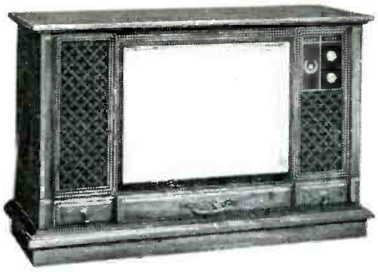

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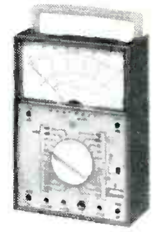

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Seven new Heathkit® improvement ideas for home or shop

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NEW! GR-371MX 25" solid-state ultra-rectangular color TV. Check out the competition for standard features like these: 25" square corner Matrix picture tube for the biggest, brightest, sharpest color picture ever... high resolution circuitry plus adjustable video peaking ... Automatic Fine Tuning... pushbutton channel advance... "Instant-On"... Automatic Chroma Control... factory assembled 3-stage solid-state IF and VHF & UHF tuners for superior reception, even under marginal conditions... adjustable noise limiting & gated AGC... adjustable tone control... hi-fi sound output to internal speaker or your hi-fi system. Plus your choice of installation in one of the three beautiful Heath cabinets or custom wall mounting capability. And the exclusive Heath self-service features let you do all normal adjustment & servicing, saving hundreds of dollars in service costs. If you want the finest, this is it... order your 371MX now. **Kit GR-371MX,** 125 lbs. **579.95***

NEW! GD-29 microwave oven... the most modern way to prepare food. Cooks up to 70% faster with better vitamin retention. Cooks on glass, ceramics, even paper plates. low profile design fits under cupboards easily, yet has one of the largest oven capacities in the industry. Operates anywhere on standard 120 VAC current. Kit includes specially prepared cookbook. **Kit GD-29,** 97 lbs. .... **379.95*** Roll-around cart gives oven easy mobility, **Model GDA-29-1, 24.95***

NEW! IB-102 Scaler and IB-101 Frequency Counter combination give you frequency measurement capability to 175 MHz at low, low cost. IB-101 counts from 1 Hz to over 15 MHz. Hz/kHz ranges & over-range indicator let you make an 8-digit measurement down to the last Hz in seconds. 5-digit cold-cathode readout... extremely low input triggering... all solid-state with 26 ICs, 8 transistors. NEW IB-102 Frequency Scaler can be used with virtually any counter on the market to extend your measurement capability well into the VHF range... at a price far below the cost of a 175 MHz counter. 10:1 and 100:1 scaling ratios give resolution down to 10 Hz... 1:1 ratio provides straight-thru counting for frequencies in range of counter. Exclusive Heath input circuit triggers at very low levels – at 100 MHz less than 30 mV is needed. A handy Test switch gives a quick, accurate check of proper operation. All solid-state; fully regulated supplies; convenient carrying handle/tilt stand. Extend your frequency measurement capability now with these two new kits. **Kit IB-101,** 7 lbs. .... **199.95*** **Kit IB-102,** 7 lbs. **99.95***

NEW! IO-102 solid-state 5" scope ideally suited for general purpose service & design work. Features wide DC-5 MHz response, 30 mV/cm sensitivity and 80 ns rise time. Switch-selected AC or DC coupling for greater versatility. Frequency-compensated 3-position attenuator. FET input provides hi-Z to minimize circuit loading. Recurrent, automatic-sync type sweep provides five ranges from 10 Hz to 500 kHz with vernier. External horizontal and sync inputs are also provided. One volt P-P output provides an accurate comparison voltage source. Additional features include a big 5" CRT with high visibility trace; 6x10 cm ruled graticule that can be replaced with a standard camera mount; solid-state zener-regulated supplies for extra display stability and 120/240 VAC operation. An excellent all-around scope that belongs on your bench now. **Kit IO-102,** 29 lbs., **119.95***

NEW! IM-105 solid-state portable VOM...an extremely rugged, highly accurate, low cost meter for hundreds of applications. High impact Lexan® case and ruggedized diode & fuse protected taut-band meter movement will suffer extreme abuse and still maintain specifications. 95° wide viewing area provides high resolution. 3% DC accuracy; 4% AC accuracy; 3% DC current accuracy. Temperature compensated. 8 DCV ranges from 0.25 to 5000 V full scale... 7 ACV ranges from 2.5 to 5000 V full scale... 6 DC current ranges from 0.05 mA to 10 A full scale... 5 ohms ranges from x1 to x10k with center scale factor of 20... 5 dB ranges from −10 to +50 dB. Other features include DC polarity reversal switch; front panel thumbwheel ohms zero; self-storing handle and fast, easy assembly. A lot of meter at a little cost... that's the new IM-105. Order yours now. **Kit IM-105,** 7 lbs., **47.95***

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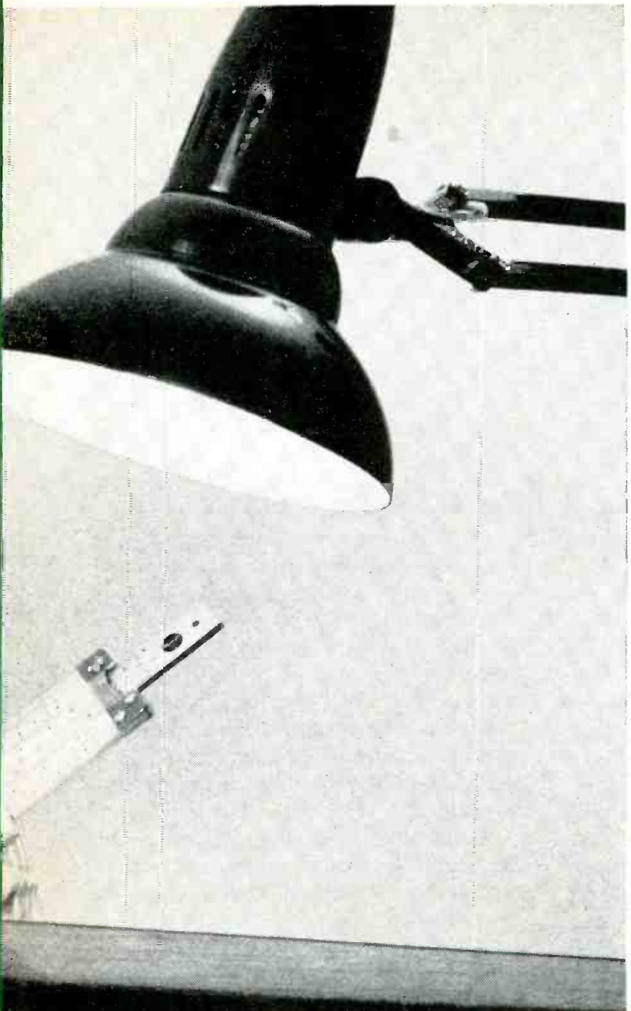
How to prepare for today's competitive job market, tomorrow's new opportunities in electronics

Competition for jobs and promotions is severe in the electronics industry today. But experts say that exciting new electronic products will create thousands of new jobs in the next few years.

One thing is certain: in good times or bad, the best opportunities come to the man with an advanced, specialized knowledge of electronics. He has a better chance of survival in a recession and will profit more in times of prosperity than the man with ordinary qualifications.

But how can you get the additional education in electronics you need to protect your future—and the future of your family? Going back to school isn't easy for a man with a job and family obligations.



College Credits for CREI Students

Recently CREI affiliated with the New York Institute of Technology for the express purpose of making it possible for CREI students to earn college credits for their studies. The New York Institute of Technology is fully accredited by the Middle States Association of Colleges and Universities and is chartered by the New York State Board of Regents.

For the many CREI students who are not interested in college credits, but simply in improving their knowledge of advanced electronics, this affiliation with NYIT will provide additional assurance of the high quality of CREI home study education.

If you want to know more about earning college credits for CREI study, check the appropriate box when you mail the postpaid card for complete information on CREI Programs.

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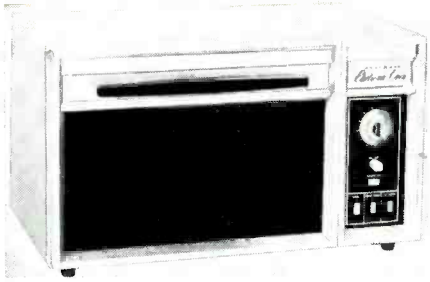
EQUIPMENT REPORT

Heathkit GD-29 Electronic Oven

For manufacturer's literature, circle No. 20 on Reader Service Card.



AN ELECTRIC OVEN IS MAGIC. IT CAN'T possibly do the things that it does do. An electronic oven that you build yourself defies belief—but it does exist and we have built one.

The Heathkit GD-29 is more an appliance kit than an electronics kit. It's easy to build: we completed our test unit in just under ten hours. And very little of that time was spent on electronic assembly—most of it went toward mechanical assembly. There seemed to be more stainless-steel self-tapping screws in the kit than we had ever seen in one place before.

Actually, we found the construction very satisfying. It's fascinating to watch the oven take shape as you work. The magnetron unit is preassembled which further simplifies construction.

But the most fascinating part of all came when we started "cooking electronically." It's a whole new world. You can boil a glass of water in one minute. You can take a Cornish game hen out of the freezer, pop it in the oven, and sit down to a piping hot dinner fifteen minutes later. A baked potato takes a mere 4 minutes, and you cook right in the dishes you serve from—no more pots and pans.

For those with economy in mind, because the electronic oven cooks so fast, it uses only a fraction of the total electric power you would use to cook the same food in a conventional electric oven. But you can read all about this in the "Cookbook" that comes with the oven.

Once you have made sure you've got all the parts and have completely unpacked the kit you'll assemble the high-voltage chassis first. Then it's on to the oven assembly and front-panel controls and indicators. There's a 35-minute, 2-speed timer, an on-off switch and four indicator lights.

When you turn the unit on, the oven door unlocks and the "power on" light goes on. When you open the door, the "door-open" lamp lights and power is disconnected from the magnetron, so even if you open the door in the middle of the cooking cycle the microwave power is off. The fourth lamp is a "hi-temp" that lights if the magnetron overheats. This is usually caused by a dirty air filter that takes only minutes to clean.

Because stray microwaves might be harmful, several safety precautions are designed into the oven and make it foolproof.

There are two safety interlocks, either one will turn off the magnetron. One operates whenever the door switch is triggered (you cannot open the door without releasing the door switch). The other is a microswitch that operates as soon as the door starts to open, it detects movement of the door guide. Also, the closed oven door is sealed against microwave leakage by a combination of a conductive vinyl seal and a Teflon-coated capacitive plate.

To sum up, the unit goes together in a matter of hours and works well—start work on a Saturday morning and you can be cooking Sunday dinner in the oven. **R-E**

SPECIFICATIONS

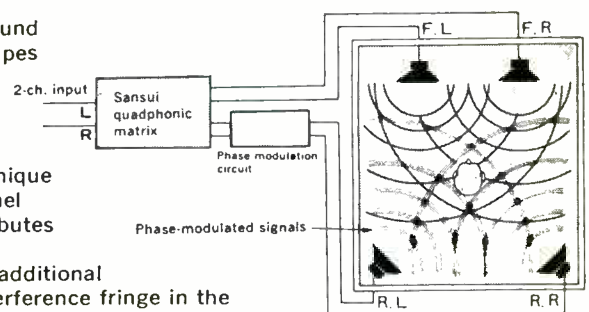
Power Output	650 watts minimum
Power Requirements	105-125 Vac, 60 Hz, 15A
Frequency	2450 MHz ±50 MHz
Microwave Leakage	1 mW/cm² or less
Magnetron Tube	Litton Industries L-5201
Stirrer	3 blades, rotates at about 65 rpm.
Interlocks	Door guide microswitch; door latch switch
Timer	0–35 minutes, split scale 0–5 minutes in 1-minute steps 5–35 minutes in 1-minute steps
Cooling	Forced air
Cooking Space	7-13/16" high; 15-½" wide; 14" deep
Outside Dimensions	15-⅛" high; 25-½" wide; 14-¾" deep
Weight	75 pounds

THE SANSUI QS-I QUADPHONIC SYNTHESIZER®

SANSUI QS-I

4-CHANNEL SOUND FROM ANY 2-CHANNEL SOURCE

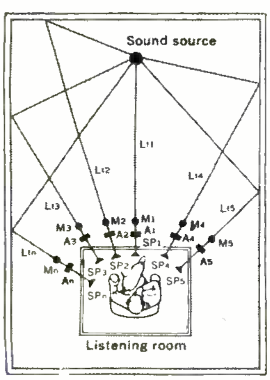
Senses and recovers the ambient information hidden in your stereo discs, tapes and broadcasts



After having discovered that the ambient components of the original total sound field are already contained in hidden form, in conventional stereo records, tapes and broadcasts, Sansui engineers developed a method for sensing and recovering them. These subtle shifts and modulations, if re-introduced, breathtakingly recreate the total of the original sound as it existed in the recording or broadcast studio.

The heart of the Sansui Quadphonic Synthesizer* is a combination of a unique reproducing matrix and a phase modulator. The matrix analyzes the 2-channel information to obtain separate direct and indirect components, then redistributes these signals into a sound field consisting of four distinct sources.

This type of phase modulation of the indirect components, applied to the additional speakers, adds another important element. It sets up a complex phase interference fringe in the listening room that duplicates the multiple indirect-wave effects of the original field. The result is parallel to what would be obtaind by using an infinite number of microphones in the studio (MI through Mn in the accompanying illustration) and reproducing them through a corresponding number of channels and speakers.



The startling, multidimensional effect goes beyond the four discrete sources used in conventional 4-channel stereo, actually enhancing the sense of spatial distribution and dramatically expanding the dynamic range. Also, the effect is evident anywhere in the listening room, not just in a limited area at the center. And that is exactly the effect obtained with live music! This phenomenon is one of the true tests of the Quadphonic system.

The Sansui Quadphonic Synthesizer QS-1 has been the talk of the recent high-fidelity shows at which it has been demonstrated throughout the country. You have to hear it yourself to believe it. And you can do that now at your Sansui dealer. Discover that you can hear four channels plus, today, with your present records and present stereo broadcasts. $199.95.

*Patents Pending

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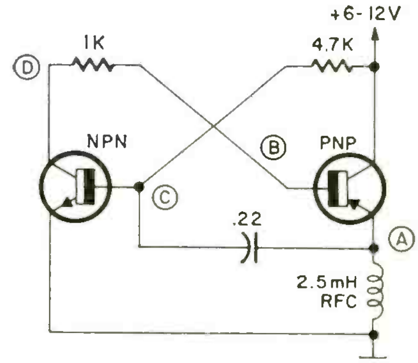
Electronic Distributors (Canada), British Columbia

Circle 12 on reader service card

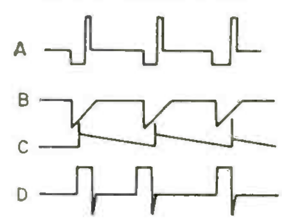
Correspondence

OSCILLATOR CIRCUIT

The circuit below is an oscillator that I found through a misconnection. I don't know if this circuit was known before, but I haven't seen it.



OUTPUT WAVEFORMS



The circuit's interest lies in its simplicity and the fact that the pnp-transistor is reversed, collector is connected to +. The frequency of the circuit is 1-2 kHz, but if you connect a $0.01\mu F$ capacitor between the pnp-transistor collector and emitter, the frequency will be about ten times as high.

I have tried it with several types of transistors, both germanium and silicon, and the circuit will oscillate with almost any type.

JAN STRAND
Skurup, Sweden

RADIO DIAGRAMS NEEDED

I recently bought two old radios and I'm trying to rework them. But I've run into a problem and need some schematics. The radios are:

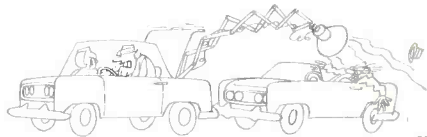
Stromberg-Carlson
Chassis PC #30317
Radio Receiver #430-11
and
Columbia Phonograph Co.
Columbia Radio Receiver
Model C4, Serial #6781

Circle 15 on reader service card

I don't know the year on these radios for sure, but I believe the Stromberg-Carlson was made in the late 1930's and the Columbia in the 1920's.

If you or perhaps a reader have a schematic or know where I might locate one I would appreciate your help. I'm willing to pay a reasonable price for them. Thanks for your cooperation.

GENE PITTMAN
Apt. 70, 632-31 Ave. N.
Columbus, Miss. 39701 **R-E**



"Stop pushing that button and go tell him to stop beeping his horn . . ."

". . . That's the spring off my sweeper, I put it there so you'd fix it . . ."

Circle 21 on reader service card

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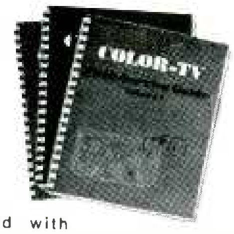

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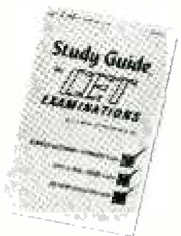

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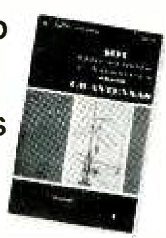
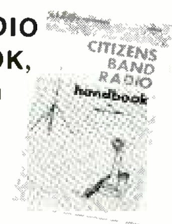
By Jim Ashe



Best overall guide to the selection and installation of the proper antenna for your Citizens band radio. An ideal guide for beginners, it also answers questions about how to improve performance and range of already operating equipment and to repair and maintain CB antennas. **No. 20749—$2.95**

CITIZENS BAND RADIO HANDBOOK, 4th Edition

By David E. Hicks



Now that two-way radio is available to any citizen, this revised edition answers the many problems and questions of all who use, or plan to use, CB equipment. Covers how to obtain a CB license, operating procedures, equipment, accessories, circuit analysis, servicing data, trouble-shooting hints, etc. **No. 20839—$4.95**

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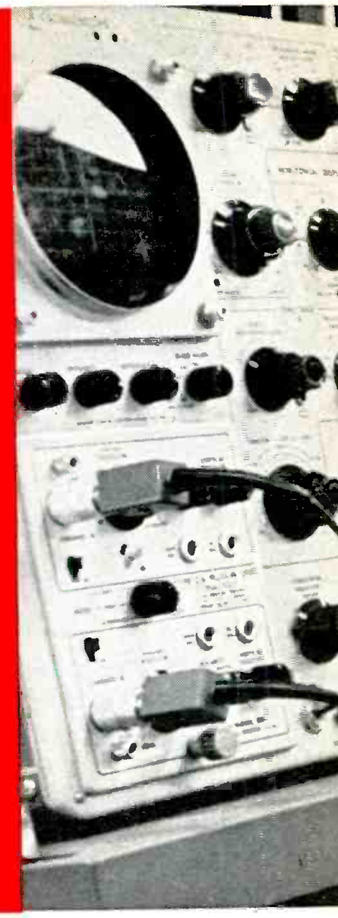
How to become a "Non-Degree Engineer"



Exciting careers in the new industries of the Seventies are waiting for men with up-to-date electronics training. Thousands of real engineering jobs are being filled by men without engineering degrees—provided they are thoroughly trained in basic electronic theory and modern application. The pay is good, the future is bright...and the training can now be acquired at home—on your own time.

ELECTRONICS, the Science of the Seventies, has created a new breed of professional man—the non-degree engineer. Depending on the branch of electronics he's in, he may "ride herd" over a sophisticated computer installation, run a powerful TV transmitter, supervise a law enforcement communications control center or work side by side with distinguished scientists fighting pollution or doctors seeking a medical break-through.

But you do need to know more than soldering connections, testing circuits and replacing components. You need to really know the fundamentals of electronics.

How can you pick up this necessary knowledge? Many of today's non-degree engineers learned their electronics at home. In fact, some authorities feel that a home-study course is the *best* way. *Popular Electronics* said:

"By its very nature, home study develops your ability to analyze and extract information as well as to strengthen your sense of responsibility and initiative."

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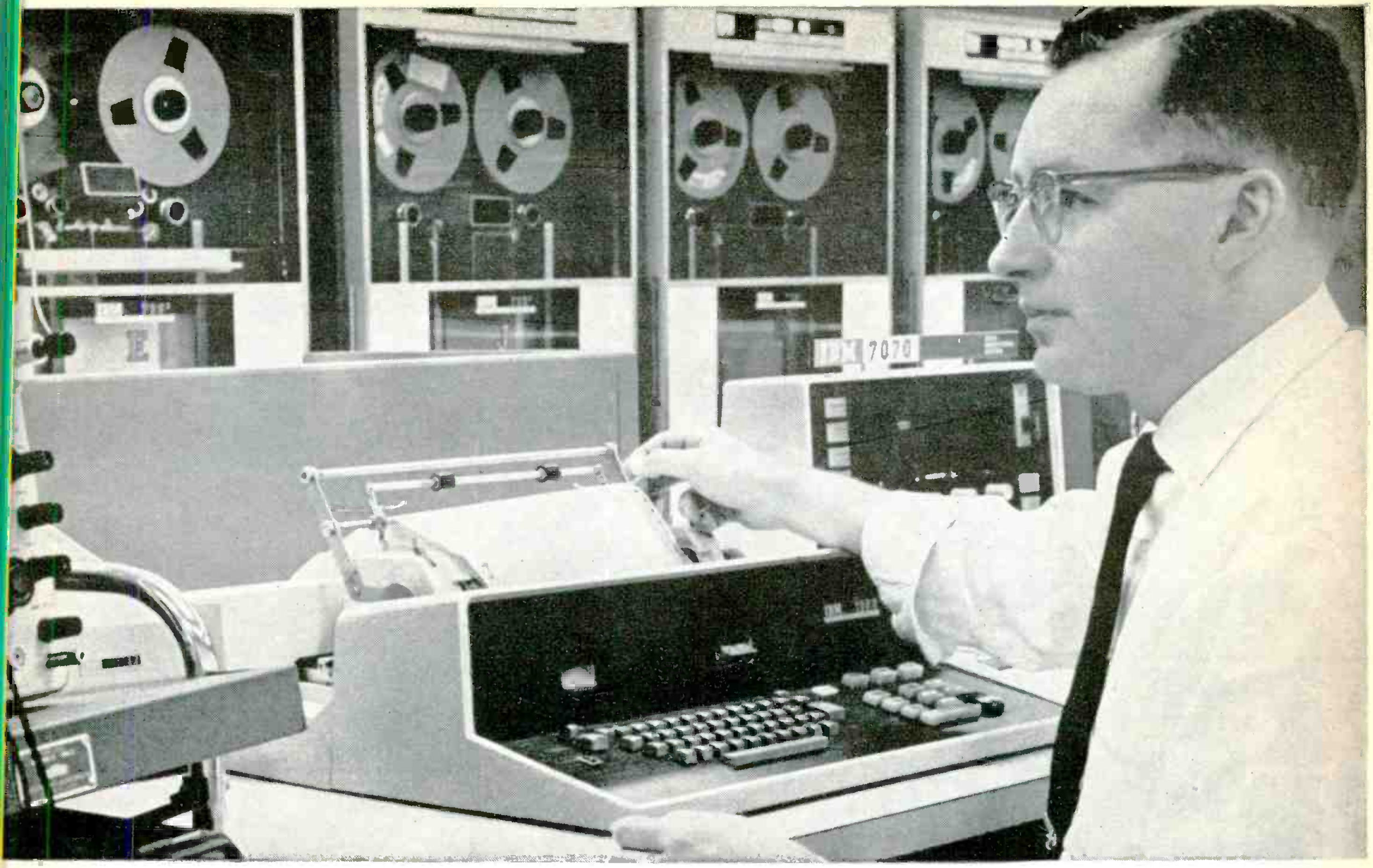
If you do decide to advance your career through home study, it's best to pick a school that *specializes* in the home-study method. Electronics is complicated enough without trying to learn it from texts and lessons that were designed for the classroom instead of the home.

Cleveland Institute of Electronics concentrates on home study exclusively. Over



the last 35 years we have developed techniques that make learning at home easy, even if you once had trouble studying. Your instructor gives the lessons and questions you send in his undivided personal attention—it's like being the only student in his "class." He not only grades your work, he analyzes it. And he mails back his corrections and comments the same day he gets your lessons, so you read his notations while everything is still fresh in your mind.

Students who have taken other courses often comment on how much more they learn from CIE. Says Mark E. Newland of Santa Maria, California:

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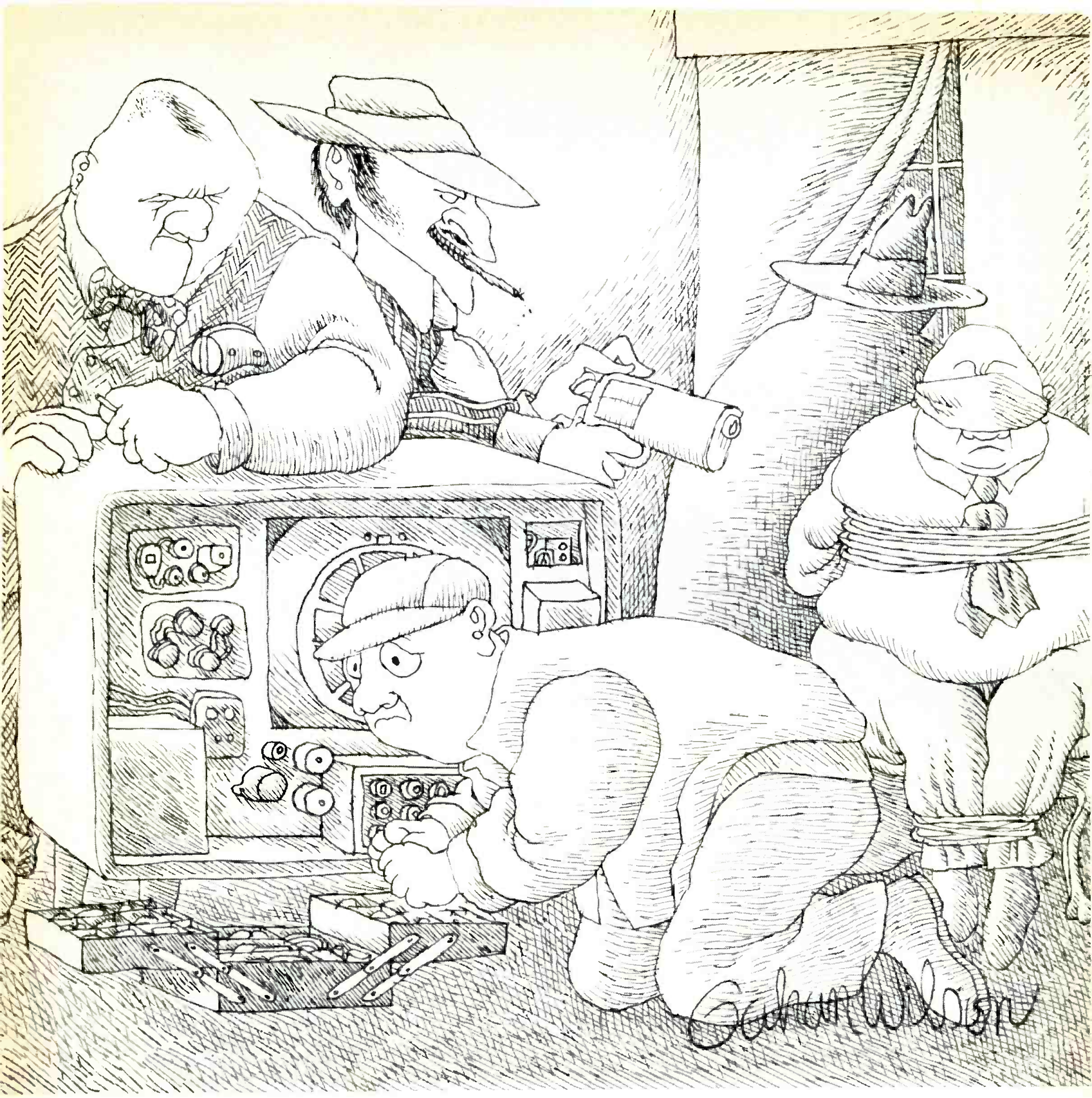


TV Antenna Accessories

For better pictures on the TV screen use the accessories that can deliver them

by **ROBERT G. MIDDLETON**

TV ANTENNA ACCESSORIES ENSURE OPTIMUM RECEPTION AND also account for a substantial portion of the technician's sales volume. Major accessories include mounts of various types, masts, standoffs, lightning arresters, ground clamps and rods, lead-in tubes, clamps of various kinds, straps, plates, brackets, clips, connectors, and incidental hardware. Other basic accessories are exemplified by multi-set couplers, band separators, matching transformers, antenna couplers, interference filters and traps, preamplifiers, distribution amplifiers, and distribution systems.

Lightning arresters

Any survey of TV antenna accessories should start with lightning protection, since this is often ignored by the beginning technician. Sometimes a mast or tower is buried in the ground, and in such instances it is usually able to "unload" electrical discharges safely. On the other hand, a mast or tower mounted on a concrete base, an insulating support or structure should have a ground wire connected directly to a cold-water pipe or equivalent low-impedance ground connection. If the mast is used as a radio antenna, for example, the ground wire can be connected to a lightning arrester, as seen in Fig. 1.

When a cold-water pipe is not available, drive a ground rod into moist soil. A copper-plated steel rod ⅝ inch in diameter and eight feet long is suitable. Article 810 of the National Electrical Code gives specifications for safe installation of antenna systems. Grounding conductors should not be smaller than 17-gage copper wire. Local electrical codes may be more stringent, and take precedence over the NEC. Also place a lightning arrester at the point where the lead-in enters the building. A typical arrester is shown in Fig. 2.

Run a ground wire from the lead-in arrester to a cold-water pipe (or ground rod). Usually a ground strap or clamp is used to connect the wire to the pipe as in Fig. 3. Electrical codes generally stipulate that where more than one ground connection is used, each of the separate grounds should be interconnected when coaxial lead-in is installed use a lightning arrester specifically made for coax.

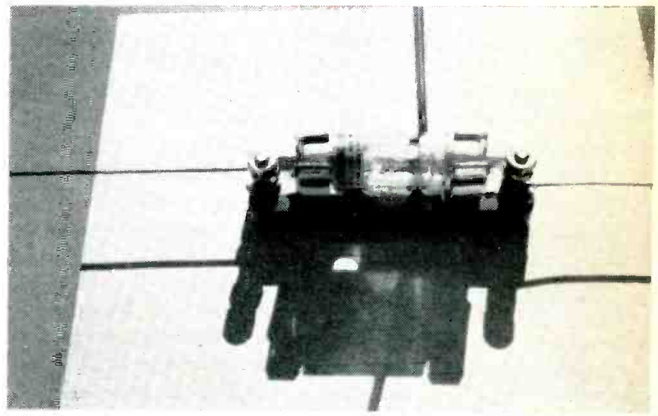


Fig. 1

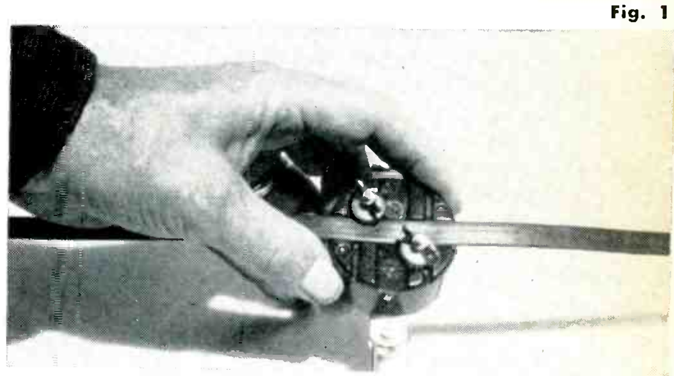
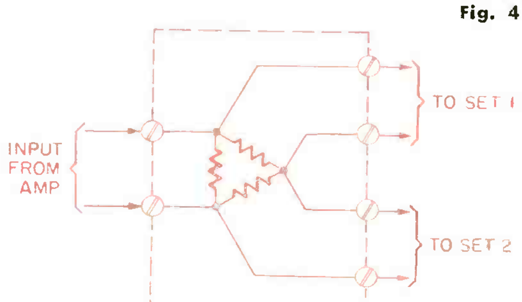
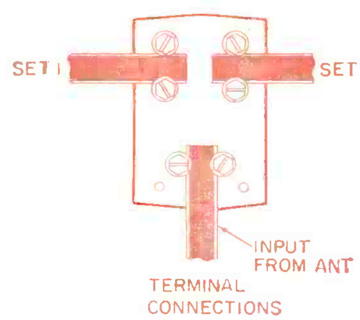


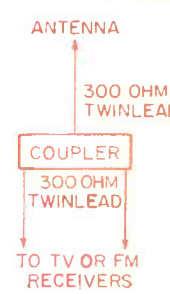
Fig. 2

▲ Fig. 3

Fig. 4







Multi-set couplers

One of the most widely used TV antenna accessories is the multi-set coupler that permits operating more than one receiver from the same antenna. The simplest couplers use a resistive network (Fig. 4) to feed a signal from a 300-ohm source to two or more 300-ohm loads. Although this design is satisfactory in strong-signal areas, its insertion loss is prohibitive in weak-signal areas. Note that the insertion loss of a multi-set resistive coupler becomes greater as the number of outlets is increased. For example, a four-set coupler (Fig. 5) has a greater insertion loss than a two-set coupler.

When a resistive coupler is usable, but not entirely satisfactory, a transformer-type coupler will often provide the needed "edge". A properly designed transformer coupler has less insertion loss than a resistive coupler, while providing impedance matching and reasonable isolation between the individual receivers. Fig. 6 shows the configuration for a typical four-set transformer-type coupler. If only three of the outlets are needed, it is good practice to connect a 300-ohm resistor as a dummy load across the terminals of the outlet not in service.

An alternate solution is to install a preamp, as in Fig. 7. The one on the left has a cartridge amplifier (Fig. 8). The advantage of the cartridge is not only its easy replacement, but also possible substitution with interference filter, trap, or matching-transformer cartridges. A cartridge amplifier can boost the signal 10 times on vhf channels, and 4 times on uhf channels. Beginners, sometimes, do not know that the same booster installed at the receiver will give a poorer signal-to-noise ratio than if it is installed on the antenna mast. The reason for the difference is that noise enters along the lead-in, reducing the signal-to-noise ratio.

A bandpass-filter type of coupler for 75-ohm cables is in Fig. 9. The markers point to inductors with adjustable cores. This feature is useful when you want to introduce a "tilt" into the frequency response of the coupler. For example, if high-band signals are weaker than low-band signals, or vice versa, this difference can be more or less compensated by appropriate tilt adjustments. Equalizating the high and low bands provides operating convenience by minimizing the need for the viewer to readjust the receiver controls.

Antenna couplers

Antenna couplers combine the signals from two or more antennas and feed the combined signals to a single lead-in. Fig. 10 shows an antenna coupler arrangement for combining the outputs of a vhf-FM antenna and a uhf antenna; feeding the combined signals to a 300-ohm lead-in. The coupler is mounted on the antenna mast, in the same manner as a preamplifier. A more elaborate type of antenna coupler is in Fig. 11. This kind of coupler com-

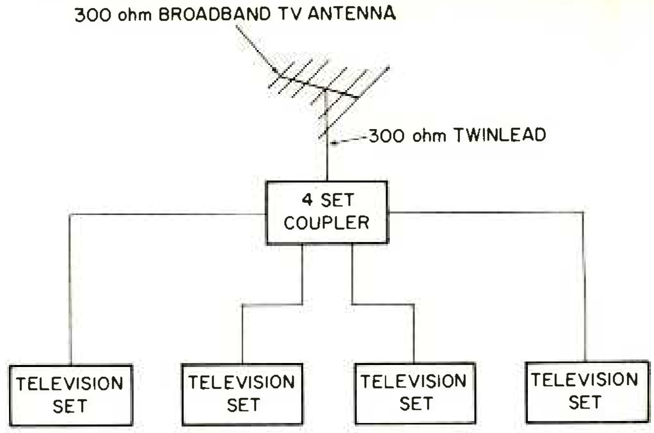


Fig. 5

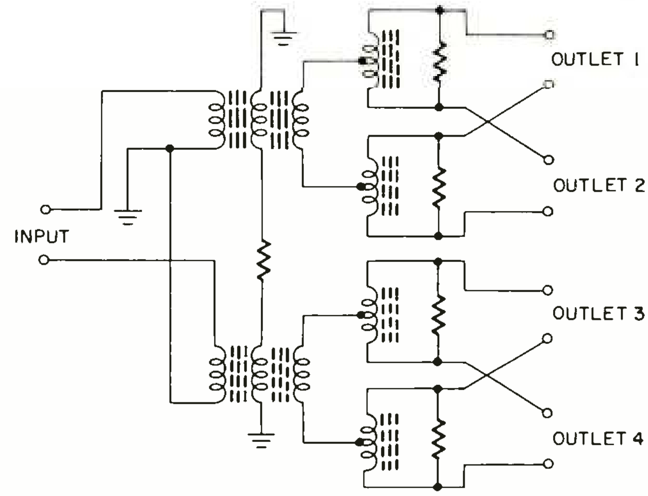


Fig. 6


Winegard Channel Master Fig. 7

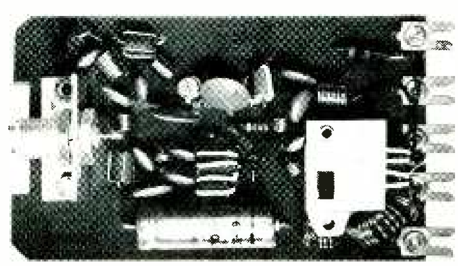

▲ Fig. 8

Fig. 9 ▼

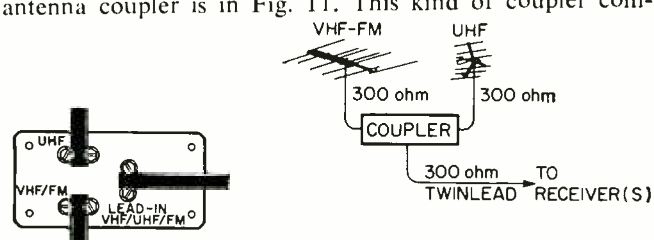
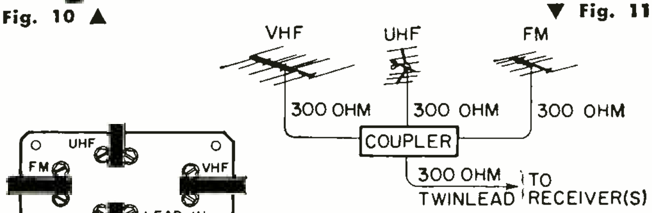


Fig. 10 ▲

▼ Fig. 11



Diagrams courtesy RCA

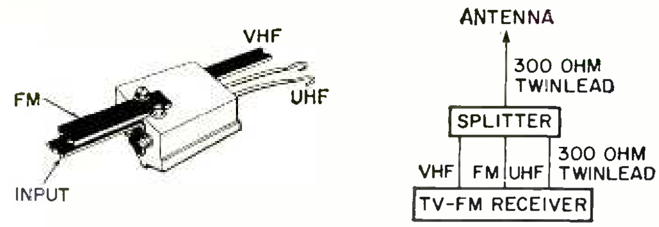
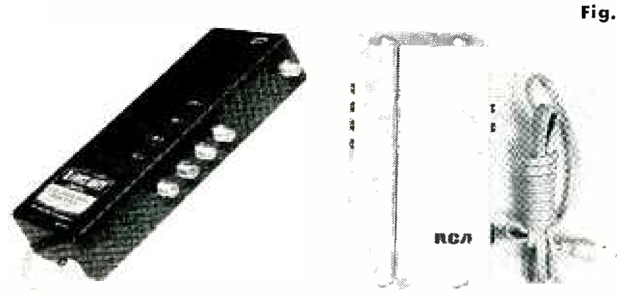


Fig. 12

RMS Finco Winegard **Fig. 13**

Fig. 14



Finco RCA **Fig. 15**

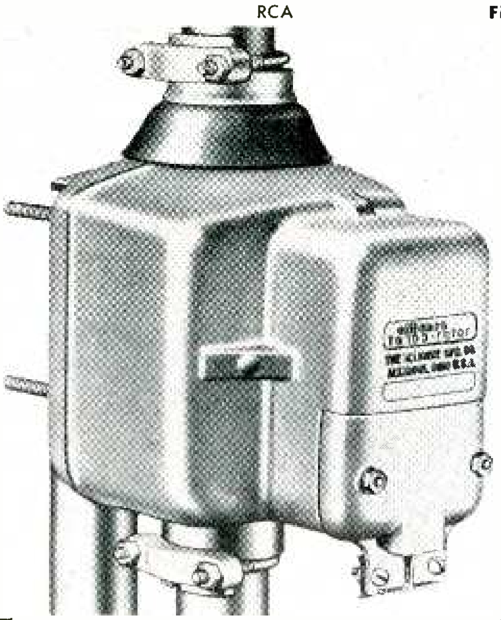
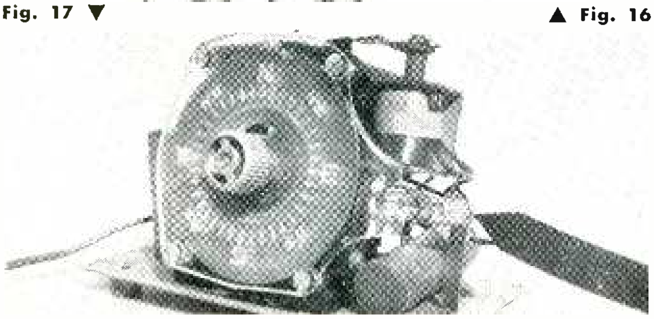


Fig. 17 ▼ **▲ Fig. 16**



bines the outputs of separate vhf, uhf, and FM antennas; feeding the combined signals to a 300-ohm lead-in.

Splitters

When an 82-channel TV antenna is connected to a receiver with separate vhf, uhf, and FM terminals, a splitter is commonly used. The splitter is connected between the lead-in and the receiver, as in Fig. 12. Bandpass coupling networks are used. They provide low insertion loss, proper impedance matches, and good isolation between the individual outputs. Splitters for the vhf and uhf bands are shown in Fig. 13. In these examples, a 75-ohm single-ended input is transformed into two 300-ohm double-ended outputs. This type of unit is mounted on the back of the receiver.

As we showed earlier, passive networks do not use active devices. In turn, they are basically bilateral, and signals fed into the outputs will appear combined at the inputs. This class of device can therefore be used either as a splitter or as a mixer. These "trunk line" units commonly have a 75-ohm coaxial input, and 75-ohm coaxial outputs. A companion device is a back-of-the-set matching transformer (Fig. 14).

Distribution amplifiers

A distribution amplifier combines the features of a preamplifier and a multi-set coupler. Fig. 15 shows two four-output solid-state distribution amplifiers which can be used in place of the four-set coupler of Fig. 5. These amplifiers provide a gain of 7 dB per ouput over the vhf and FM bands. They are active devices, and the available gain permits connecting additional receivers into the system. This type of amplifier is designed to be mounted indoors, in an attic or basement. In weak-signal areas, the signal-to-noise ratio can be improved by installing a mast-mounted preamplifier to drive the distribution amplifier.

Antenna rotators

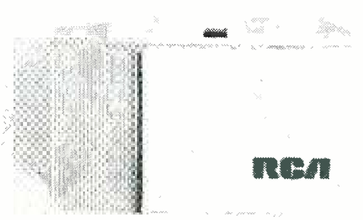
An antenna rotator is desirable in many locations, and essential in some. Rotators can be broadly categorized into light and heavy duty types. Although a rotator normally is long-lived, a small offset type of rotor loaded with a large and heavy antenna may not last very long. A rotator should be mounted as close to the antenna as practical, and never more than five feet below. This minimizes wind shear forces exerted on the rotator. Lightning protection must also be included.

A typical rotator unit is shown in Fig. 16. Beginners sometimes forget that a rotator must operate under heavy icing conditions during the winter season. Therefore, choose a unit with ample motor torque to anticipate "worst case" situations. In some installations, the control must be located at a considerable distance from the rotator. In turn, the line drop will be greater than usual, unless heavier wire is used. No. 20 wire is adequate for runs up to 75 feet. Longer runs should use No. 18 wire. Note that control units usually have pilot lights (Fig. 17) which occasionally must be replaced.

Specialized rotators that can be operated by two or more controls located in different areas of a building are

(continued on page 81)

Fig. 18



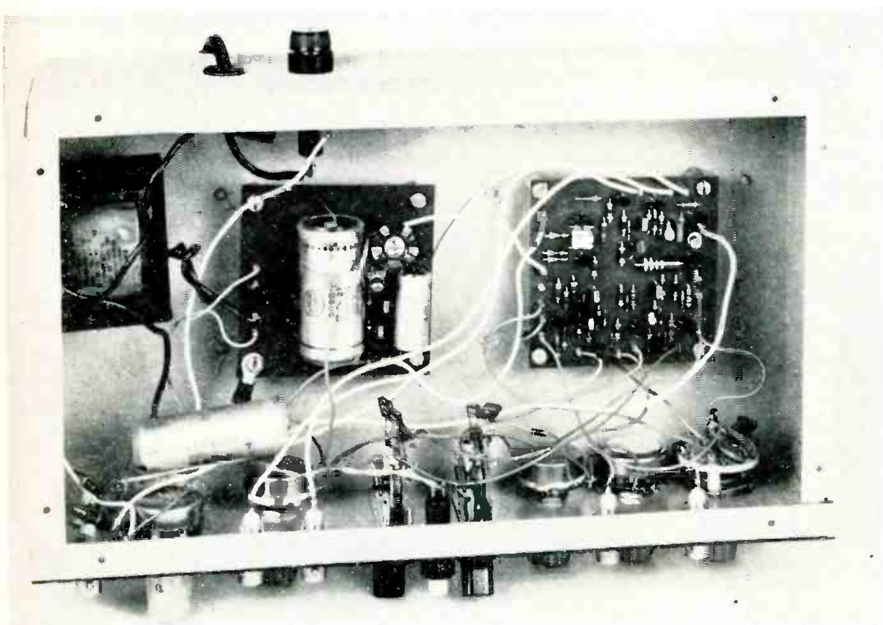
R-E's Dual-Function Generator

Use this pulse and square-wave generator with your scope to check out those digital logic circuits

by PHILIP HARMS

NEED A PIECE OF TEST GEAR TO CHECK out some of the many new digital projects you've been thinking of building? Once you get beyond the basic tool, an oscilloscope, the next best item on the test bench is a pulse-and square-wave generator to develop the digital test signals. If you decide to buy one, the price tag is rather high and it's easy to get a lot of extra frills that pinch the pocketbook but add little to the function and basic purpose of the instrument. The dual function generator (DFG) described in this article, generates both square waves and pulses, giving you more than adequate control over their parameters. In addition, the instrument includes features lacking in test gear around the $800 bracket. Total construction cost is under $50 even if you start from scratch and buy everything.

The DFG provides complete control over pulse amplitude, width, frequency and time delay from a generated sync pulse. The sync pulse can be used as a second pulse when necessary. The square-wave portion of the DFG is also amplitude and frequency controlled; both outputs have hefty drive capability with over a watt of pulse power available. As an added feature, IC compatible outputs are also provided. These two outputs are baselined at 4.5 volts and generate signals with high current-sink capability, necessary for DTL and TTL digital integrated circuits. Risetime and falltime specifications are fast enough for the choosiest ICs.



INSIDE THE GENERATOR you can see how the two small circuit boards are positioned—power supply on the left, main generator board on the right.

Construction

The DFG is self-contained in a 12" x 7" x 3" aluminum chassis with all controls and input/output jacks located on the front face for a low, slimline appearance. All circuitry is contained on two PC boards, one for the regulated power supply and the second for the generator electronics. The printed circuit boards can be made from the layouts shown or can be purchased from the supplier listed in the parts list.

If you don't want to go the PC board route, the generator can be built on perf boards using flea clips; if good solid grounds are used the specifications should not degrade.

First, build up the two PC boards. Make sure the transistors are located exactly as shown in the component layout drawing, observing either the flat portion of the plastic case or the emitter tab in case of the TO-5 metal-cased devices. Next, mark off the front panel and layout the controls, switches and jacks. Since the front panel is a tight squeeze to get everything included, be sure you have adequate clearance between the controls before drilling. The slots for the two lever switches are made by drilling a line of holes and filing. Solder the applicable capacitors to the two lever switches and the frequency decade switch before mounting on the front panel. Dry transfer letters can be used to label the front panel; use the photograph of the front panel as a guide.

Wiring of the DFG is not critical but to insure good results, heavy wire should be used to connect all ground points. A heavy ground wire should be connected to the chassis from the generator module. While it looks neat, suppress the desire to bundle wires going from the generator module to the front controls. Bundled wires have a knack of causing cross-talk. Short, point-to-point wiring is the best bet.

Capacitors C11 through C20 should all have a 10% tolerance to insure realistic results for the frequency, delay and width decades. Capacitors with this tolerance are available from any of the electronic supply houses or the builder can fabricate a set by paralleling several smaller values to arrive at the correct value. For example, I paralleled a 0.1 μF and a 0.047 μF to come up with a composite to form capacitor C11.

SPECIFICATIONS

Frequency:	**10 Hz to 100 kHz; 4 decades (pulse)**
	5 Hz to 50 kHz: 4 decades (sq wave)
Amplitude:	**0 - 12V, adj, (pulse & sq wave)**
Pulse Delay:	**0.1 to 100 μsec; 3 decades**
Pulse Width:	**0.1 to 100 μsecs; 3 decades**
Rise time:	**20 nsec (pulse)**
	35 nsec (sq wave)
Falltime:	**40 nsec (pulse)**
	50 nsec (sq wave)
Output Impedance:	**47 ohms(pulse)**
	470 ohms (sq wave)

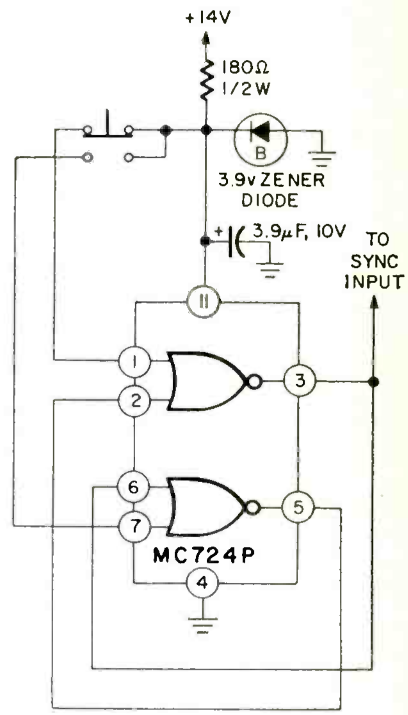
TWO OPTIONAL CIRCUITS are on the right. They can be easily added to the dual-function generator.

POWER-SUPPLY CIRCUIT is shown below. It is a fully regulated, full-wave arrangement.

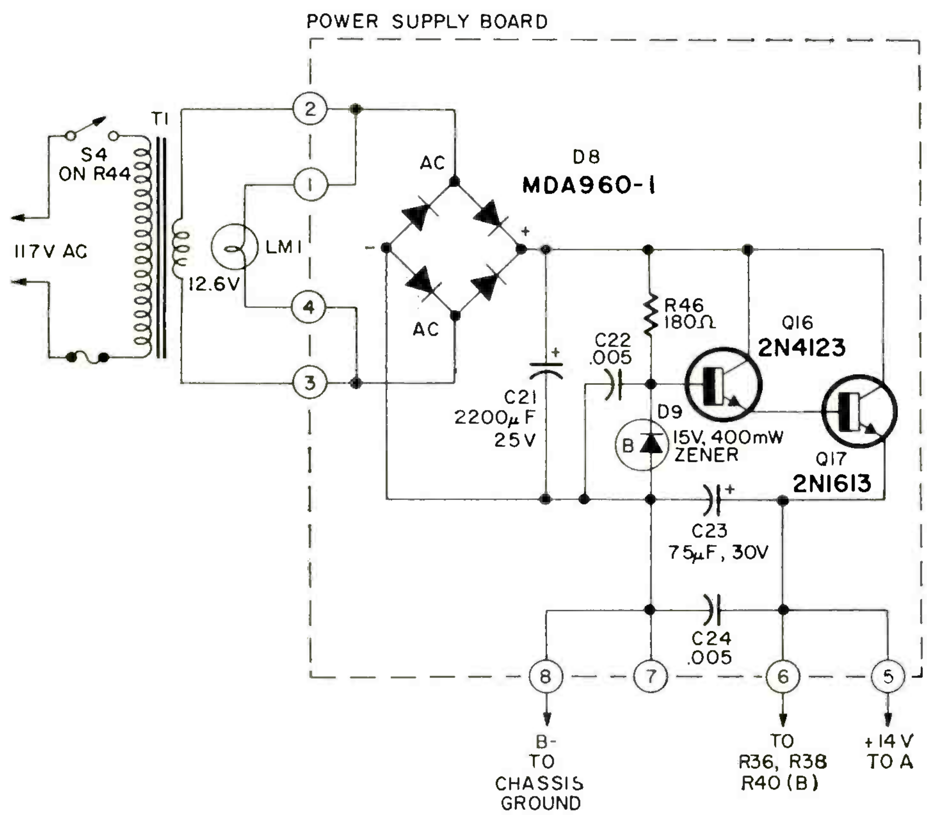
Test before using

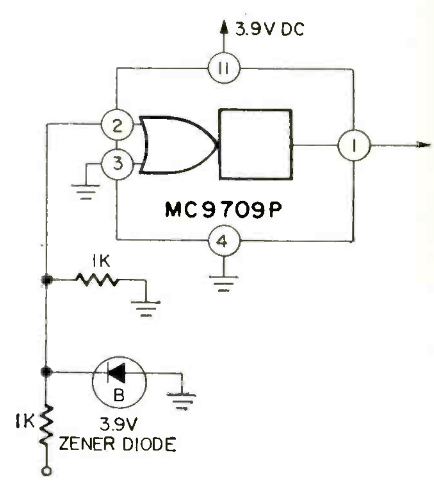
After construction is complete, test the unit with a good oscilloscope to insure all functions are operating normally. If a milliammeter is handy connect it between the power supply and generator modules. It should read about 60 mA with no loads on the outputs. Check the outputs with a scope and verify all of the controls are working correctly, full frequency range can be achieved and all pots are wired correctly. The pulse delay function can be checked by connecting the SYNC OUT signal to the sync input of a triggered scope and verifying the output pulse is delayed, as set by the delay pot and decade switch.

One important point should be kept in mind when testing and using the pulse generator controls. The

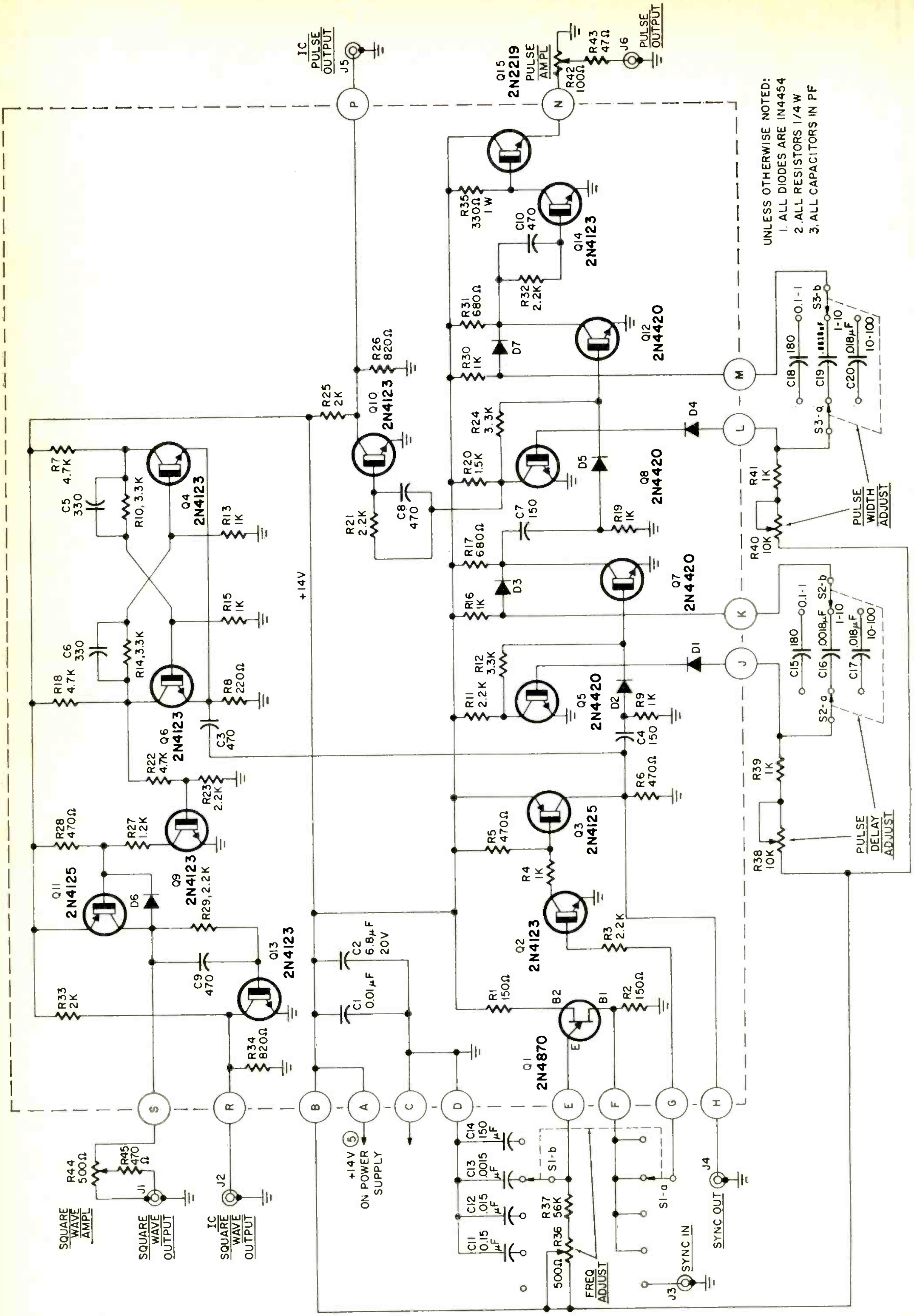


MANUAL PULSE OPTION





SCHMITT TRIGGER OPTION


UNLESS OTHERWISE NOTED:
1. ALL DIODES ARE 1N4454
2. ALL RESISTORS 1/4 W
3. ALL CAPACITORS IN PF
IC PULSE OUTPUT
J5
Q15 2N2219
PULSE AMPL
R42 100Ω
R43 47Ω
J6
PULSE OUTPUT
Q14 2N4123
R35 330Ω 1W
C10 470
R32 2.2K
R31 680Ω
Q12 2N4420
R30 1K
D7
R26 820Ω
R25 2K
Q10 2N4123
R24 3.3K
D4
D5
Q8 2N4420
R20 1.5K
C8 470
R21 2.2K
C7 150
R19 1K
R17 680Ω
Q7 2N4420
R16 1K
D3
+14V
R7 4.7K
C5 330
R10, 3.3K
Q4 2N4123
R13 1K
R15 1K
C6 330
R14, 3.3K
R18 4.7K
Q6 2N4123
R8 220Ω
C3 470
R12 3.3K
D1
R11 2.2K
Q5 2N4420
D2
R9 1K
C4 150
R22 4.7K
R23 2.2K
R6 470Ω
R28 470Ω
R27 1.2K
Q9 2N4123
R5 470Ω
Q3 2N4125
Q11 2N4125
D6
R29, 2.2K
R4 1K
Q2 2N4123
R3 2.2K
C9 470
Q13 2N4123
C2 6.8μF 20V
C1 0.01μF
R33 2K
R34 820Ω
R1 150Ω
B2
B1
R2 150Ω
Q1 2N4870
E
C18 180
C19 .0018μF
C20 .018μF
S3-a
S3-b
0.1-1
1-10
10-100
R41 1K
R40 10K
PULSE WIDTH ADJUST
C15 180
C16 .0018μF
C17 .018μF
S2-a
S2-b
R39 1K
R38 10K
PULSE DELAY ADJUST
R44 500Ω
R45 470Ω
J1
SQUARE WAVE AMPL
SQUARE WAVE OUTPUT
J2
IC SQUARE WAVE OUTPUT
+14V 5 ON POWER SUPPLY
C14 150 μF
C13 .0015 μF
C12 .015 μF
C11 0.15 μF
S1-b
S1-a
R37 56K
R36 500Ω
FREQ ADJUST
J3
SYNC IN
J4
SYNC OUT

DFG is specified as having a maximum output duty cycle of about 80%. It is necessary to understand fully the meaning of this limitation, since a misunderstanding can quickly lead to some strange signals on a scope.

The reciprocal of frequency is time (Frequency = 1/Time). For example, one period of 20-kHz is 50-μsec in time duration. If you require a pulse frequency of 20 kHz, the pulses will be spaced in 50 μsec increments. If the distance between successive risetimes of the pulses is 50 μsec, it is impossible to squeeze a 75 μsec pulse in this interval. For the example, an 80% duty cycle simply means that you can't get more than a 40-μsec pulse in a 50-μsec interval. If you try to exceed the duty cycle slightly (say 110%), the generator simply cheats on every other pulse. One pulse will be full width while the second one will be narrow. If you go overboard with the duty cycle, the generator will simply ignore every other pulse and put out a frequency half of what you have adjusted. Exceeding the duty cycle doesn't hurt the DFG in the least, although to do so can upset scope triggering and give the appearance of instability. While wringing out the DFG it's a good idea to set up this condition so you'll know what to expect, and won't be surprised later.

Applications

The dual outputs for each function provide versatile drive capability which will match with any type of circuit, either IC or discrete transistors.

The IC outputs are wired directly to transistor collectors and thus provide excellent current sinking capability, necessary for interface with DTL or TTL. These outputs are character-

PARTS LIST

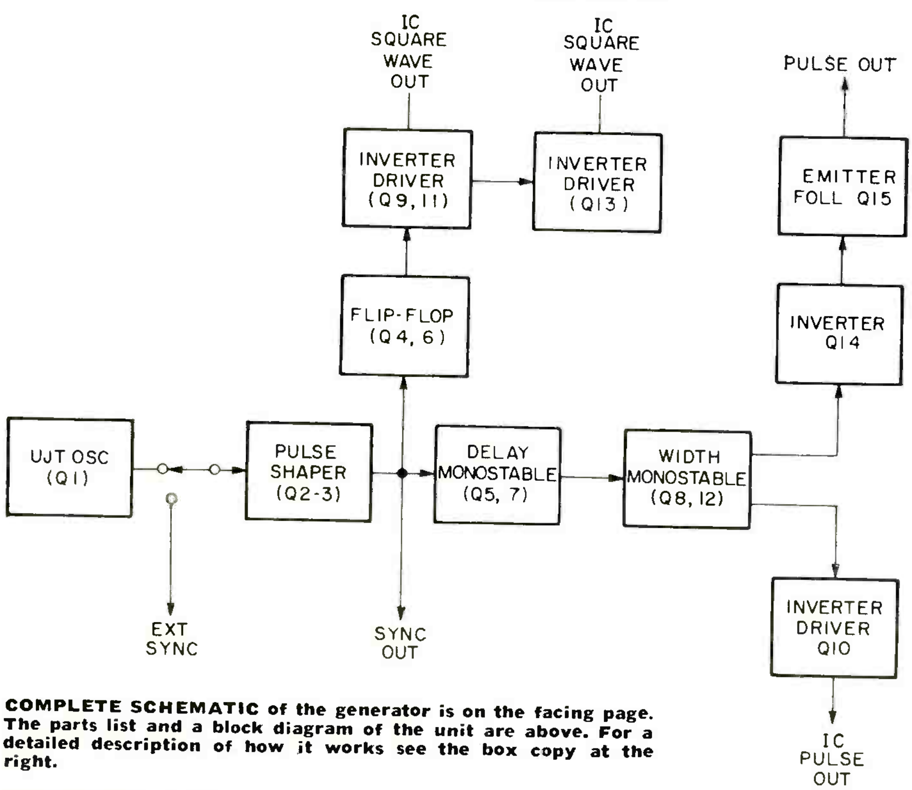
R1, R2—150 ohms, ¼ watt
R3, R11, R21, R23, R29, R32—2200 ohms, ¼ watt
R4, R9, R13, R15, R16, R19, R30, R39, R41—1000 ohms, ¼ watt
R5, R6, R28, R45—470 ohms, ¼ watt
R7, R18, R22—4700 ohms, ¼ watt
R8—220 ohms, ¼ watt
R10, R12, R14, R24—3300 ohms, ¼ watt
R17, R31—680 ohms, ¼ watt
R20—1500 ohms, ¼ watt
R25, R33—2000 ohms, ¼ watt, 5%
R26, R34—820 ohms, ¼ watt
R27—1200 ohms, ¼ watt
R35—330 ohms, 1 watt
R36—500 ohms, potentiometer, linear taper
R37—56,000 ohms, ¼ watt
R38, R40—10,000 ohms, potentiometer, linear taper
R42—100 ohms, potentiometer, 1 watt, linear taper
R43—47 ohms, 1 watt
R44—500 ohms, potentiometer, linear taper, with spst switch
R46—180 ohms, ¼ watt
C1—0.01 μF
C2—6.8 μF, 20 Vdc (Sprague 196L
C3, C8, C9, C10—330 pF ceramic
C4, C7, C14—150 pF, 10% (CDE CD15 or equal)
C5, C6—330 pF ceramic
C11—0.15 μF, 10% (CDE DMF-1P15-10 or equal
C12—0.015 μF, 10% (CDE DMF-1S15-10 or equal)
C13—.0015 μF 10% (CDE CD-19 or equal)
C15, C18—180 pF 10% (CDE CD-15 or equal)
C16, C19—.0018 μF 10% (CDE CD-19 or equal)
C17, C20—0.018 μF 10% (Sprague 192P or equal)
C21—2200 μF, 25 Vdc (Sprague 39D or equal)
C22, C24—0.005 μF
C23—75 μF, 30 Vdc (Sprague 39D or equal)
S1—2-pole, 5-position rotary switch (Mallory)
S2, S3—2-pole, 3 position lever switch (Centralab)
S4—spst switch on R36
T1—12.6 Vac filament transformer (Triad F25X)
LM1—12 V pilot lamp and assembly

Diodes

D1, D2, D3, D4, D5, D6, D7—IN4454 diode
D8—MDA960-1 diode bridge
D9—15 V Zener diode, 400 mW
Q1—2N4870 unijunction transistor (Motorola)
Q2, Q4, Q6, Q9, Q10, Q13, Q14, Q16—2N4123 transistor (Motorola)
Q3, Q11—2N4125 transistor (Motorola)
Q5, Q7, Q8, Q12—2N4420 transistor (TI)
Q15—2N2219 transistor (TI)
Q17—2N1613 transistor (Motorola)
F1—½-amp fuse and fuseholder
J1, J2, J3, J4, J5, J6—see text

Miscellaneous Other Parts

Knobs, PC boards, mounting hardware, TO-5 finned radiator



COMPLETE SCHEMATIC of the generator is on the facing page. The parts list and a block diagram of the unit are above. For a detailed description of how it works see the box copy at the right.

HOW IT WORKS

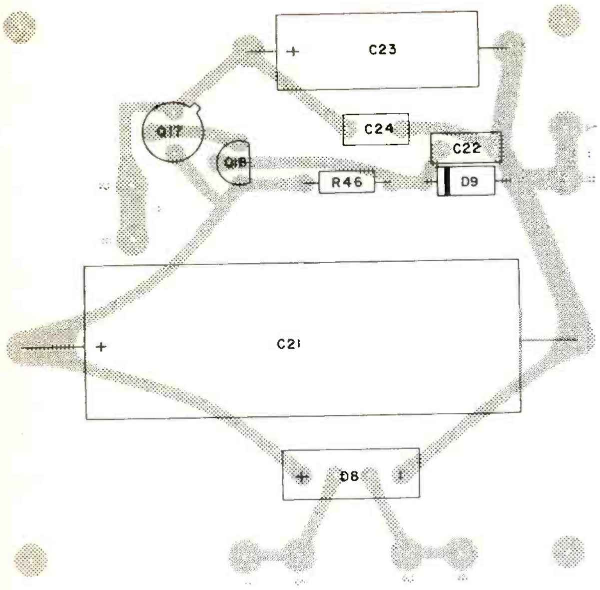
The DFG used a unijunction relaxation oscillator as the basic frequency source. Frequency is determined by the combination of the series resistance R36 and R37 and the decade switching of C11–14. The UJT output at base-1 is routed through the sync selector switch (S1-a) and to transistors Q2 and Q3, which shape the rounded UJT output. The pulse at the collector of Q3 is provided as a sync pulse for external test equipment. In addition this pulse is differentiated and routed to monostable multivibrator Q5 and Q7. The one-shot time period of this circuit is controlled by R38 (PULSE DELAY) and switching capacitors via S2. The period of Q5–Q7 determines the delay between the sync pulse and the output pulse leading edge.

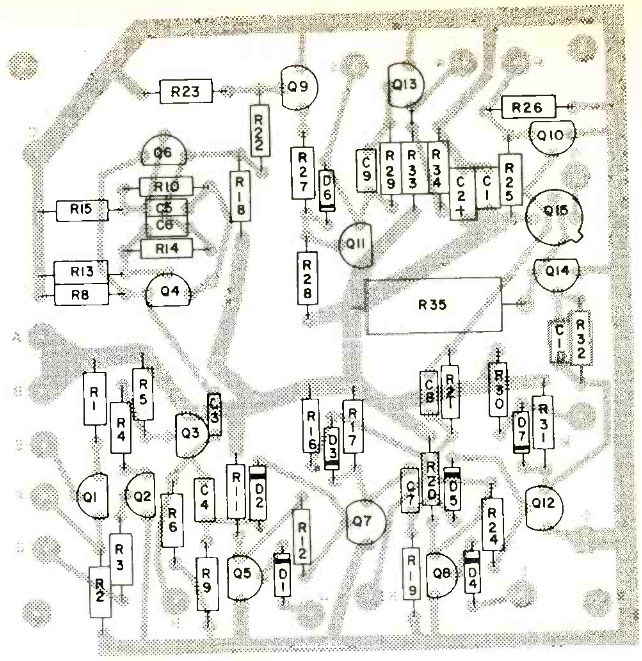
The pulse at the collector of Q7 is differentiated to trigger a second monostable multivibrator, Q8 and Q12. The one-shot period of this circuit determines the output pulse width and is controlled by PULSE WIDTH controls R40 and switch S3.

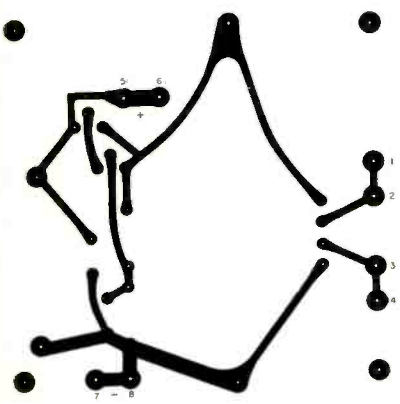
Transistor Q10 inverts the output pulse and develops a signal which is baselined at about 4.5 volts for digital IC requirements. The output, which is tied to the collector of Q10 is capable of high current sinking. The output of the Q8–12 one-shot is inverted by Q14 and provided as an output, using Q15 as an emitter follower for power boost purposes.

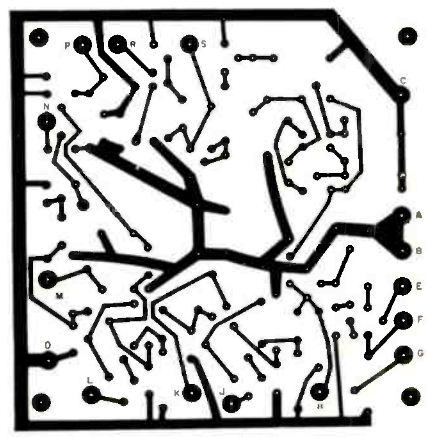
The circuitry containing Q4 and Q6 is connected as a conventional flip-flop with the output states switching each time an input pulse is present. The flip-flop is triggered by the differentiated sync output pulse. Transistor Q9 inverts and shapes the flip-flop collector signal while Q11 increases the drive capability for current-source requirements. Q13 provides an output baselined at 4.5 volts with high current sink ability.

The DFG is powered by a series regulated 14 Vdc power supply.









A set of two circuit boards is available for this generator. The glass-epoxy boards can be ordered from Photolume Corp, 118 E 28 St., N. Y., N. Y. Part number R-E 971, $6.00, postpaid.

POWER SUPPLY parts layout (above left) shows how components are positioned on the circuit board. The circuit board pattern is at the left. The actual board should measure 2½ inches between the corner mounting holes.

MAIN GENERATOR BOARD (above right) shows parts layout. The circuit board pattern (right) should be enlarged to 3 inches square.

ized by fast falltimes, which are necessary for flip-flop clocking; the risetime, while slower, is still good enough for IC use. The outputs will sink at least 50 mA of current and probably will handle more. Current drive capability in the high state is sufficient to drive RTL type IC's.

The adjustable outputs have enough power capability to drive pulse transformers, SCR's or other circuitry directly without additional buffers. The pulse output is routed through an emitter follower for optimum current drive. A watt of pulse power is available when going into a 50-ohm load. Both outputs are short-circuit protected with series resistors; the IC outputs as well can be short-circuited.

Optional modifications

While the basic DFG has all of the requirements for a complete lab-rated unit, two modifications not included in the author's original prototype will increase capabilities even further.

One option is a manual pulse mode which allows you to generate one pulse each time the button is depressed. The circuit can be mounted on a small piece of perf board inside the unit and the circuit output connected through a MANUAL position on the frequency decade switch to the input sync circuit. The circuit is a cross-coupled gate arrangement which is normally used to eliminate contact bounce in switches and relays. When using this circuit a single pulse will be generated, useful when stepping counters or registers one step at a time. When monitoring the square-wave outputs, a step function will be generated since the output will change states whenever the button is depressed.

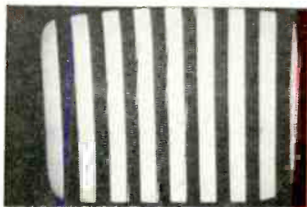
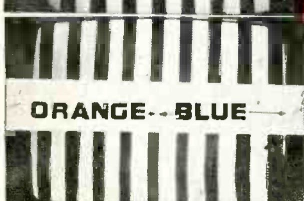
A second option expands the capability of the SYNC IN circuit, useful to lock the generator to an external signal. The SYNC IN signal can be any type of signal, periodic or random in frequency. The generator is synced whenever the input passes through about 1 volt. For signals with a dc component, the signal can be ac coupled with a 0.01-μF capacitor. The sync generator (Q2 and Q3) does a good job of shaping the incoming signal but is restricted in low-frequency response. Low-frequency signals tend to set up oscillations while going through the active region of Q2, creating unstable pulses or sometimes a chain of pulses. If you expect to be syncing to low-frequency pulses, a Schmitt trigger circuit can be added which will allow the DFG to be locked to signals down to below 1 Hz. A Schmitt trigger circuit used the technique of hysteresis to prevent active region oscillation. One way of thinking of hysteresis is to think of a transistor equivalent of an anti-bounce circuit as discussed before.

Since the ICs used for the options are powered off of a nominal 4-Vdc supply, a Zener diode is used to divide down to the correct voltage. The Zener diode in the input of the MC9709P IC is to prevent the input from exceeding 3.9 volts; anything over this value is dropped across the series resistor. **R-E**

X and Z Color Demodulators —Tube Type

Kwik-Fix™ picture and waveform charts

SCREEN SYMPTOMS AS GUIDES — WHERE TO CHECK FIRST

SYMPTOM PIC	DESCRIPTION	VOLTAGE	WAVEFORM	PART
	No color	Both screens-pin-6	WF3 WF5	R1, R2, R7, C2, L1, T1
	No blue; only red and green visible	All V2 voltages	WF5	R4, R6, R9, C1, L2, L4
	No red; only blue and green visible	All V1 voltages	WF4	R3, R5, R8, L3
	Red very weak	No help	WF5	C1
	Pink glaze over whole screen; colors very weak	V1-plate-pin-5	WF4	C3
	Left half magenta; right half light green	No help	WF5	L2
	Blue glaze over whole screen; colors very weak	No help	WF5	R9, C4
	Left half orange; right half light blue	No help	WF2 WF5	R2

Notes on following page

NOTES FOR SYMPTOM GUIDE:
Use this guide to help you find which key voltage or waveform to check first, or to guide you to the causes of symptoms that don't have voltage or waveform clues.
Study the screen and the action of TINT *and* COLOR *controls. The most helpful clues to the fault are to be found at the key test points indicated opposite whatever symptom you observe.*
Make voltage or waveform checks when indicated for screen symptoms.
Use the Voltage Guide or Waveform Guide to analyze the results of your tests.
For a quick check, test or substitute the parts listed as the most likely cause of the symptoms you observe.

DC VOLTAGES AS GUIDES

Voltage change	to zero	very low	low	slightly low	slightly high	high
V1-cathode-pin-2 Normal 1.6 V		R5 open R7 open	R3 low	C2 leaky C3 leaky		R3 open, high
V1-plate-pin-5 Normal 220 V	R8 open C3 shorted		R8 high		R5 open R7 open	R3 open
V1-screen-pin-6 Normal 165 V	R5 open R7 open C2 shorted		R7 high	C2 leaky	R7 low	
V2-cathode-pin-2 Normal 1.2 V		R6 open R7 open	R4 low	C2 leaky C4 leaky		R4 open R4 high
V2-plate-pin-5 Normal 220 V	R9 open C4 shorted		R9 high		R6 open R7 open	R4 open
V2-screen-pin-6 Normal 165 V	R6 open R7 open C2 shorted		R7 high	C2 leaky	R7 low	

NOTES:
Use this guide to help you pinpoint the faulty part.
Measure each of the six key voltages with a vtvm or fetvom.
For each, move across to the column that describes the change you find.
Notice which parts might cause that change.
Finally, notice which parts are repeated in the other voltage changes you find.
For more guides to further narrow down the faulty part, see the Waveforms Guide.

THE STAGES

This version of a color demodulator is typical of some middle-aged color sets. Each pentode gets two signals: chroma sidebands and a 3.58-MHz continuous wave.

The secret of operation is a phase shift between the CW fed to the X stage and that fed the Z stage. One stage extracts mainly red chroma or R-Y. The other, on a demodulation axis around 90 degrees away, extracts blue chroma or B-Y.

The CW signal comes from the set's color oscillator, held in phase with the station transmitter by the burst or color-sync circuitry. The chroma sidebands come from a bandpass amplifier, often supplemented by an extra stage of color amplification.

The X demodulator drives an R-Y amplifier which may be labeled red color-difference amp. The Z stage drives a B-Y or blue color-difference amplifier.

SIGNAL BEHAVIOR

Color sidebands or chroma from the bandpass amp are developed across load resistance R1, the COLOR control. (Chroma in the schematic waveforms is a keyed rainbow series.) The slider of R1 couples a certain amount of the chroma through L1 to grid-pin-1 (the control grid) of both tubes. With the tubes fed in direct parallel, the phase of input chroma is identical for both.

Meanwhile, T1 couples CW from the 3.58-MHz oscillator. This color-reference signal goes directly to third-grid-pin-7 of V1. This same CW also goes through phase-shifting network L2-C1-R2 before it is applied to third-grid-pin-7 of V2, the Z demodulator. The network imparts a phase shift of about 60 degrees to that branch of the CW signal.

The phase of CW and the operating level of V1, the X stage, demodulate whatever red is in the color sidebands at grid-pin-1. The operating level is slightly different in the Z stage; that and the shifted phase of CW in V2 demodulate whatever blue is in the sidebands. (Green is part of both signals, and is separated by a subsequent circuit and stage.)

Capacitors C3 and C4 and coils L3 and L4 filter out

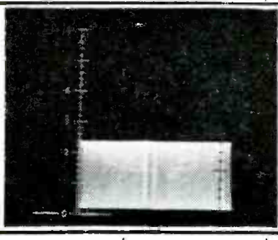
(waveforms on next 2 pages, copy continues on page 45)

WAVEFORMS AS GUIDES

WF1 Normal 25 V p-p

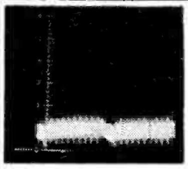
Taken at third-grid-pin-7 of X demodulator V1. Direct phase from 3.58-MHz CW output transformer T1. Viewed here at horizontal sweep rate, scope synced externally by pulse from lead clipped to insulation near output-tube plate cap. Scope shows sine waveshape if swept nearer 3.58 MHz.

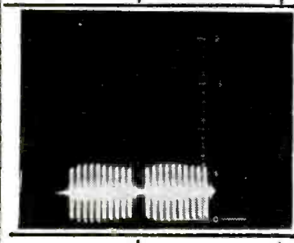
V p-p low	V p-p high	V p-p zero	Changed Shapes				
T1 mistuned R2 open		T1 open C1 shorted R2 shorted					



WF2 Normal 25 V p-p

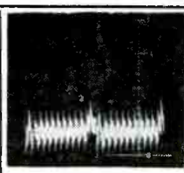
Taken at third-grid-pin-7 of Z demodulator V2. Phase has been shifted 60 degrees, but you can't see that here. This waveform or WF1 can be used as guide for adjusting 3.58-MHz output transformer T1: adjust core for maximum amplitude of the waveform. Set scope sweep about 500 kHz to view sine wave.

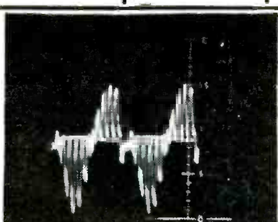
V p-p low	V p-p high	V p-p zero	Changed Shapes				
T1 mistuned	R2 open	T1 open C1 shorted R2 shorted	 0.2 V p-p L2 open				



WF3 Normal 7 V p-p

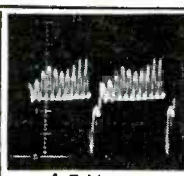
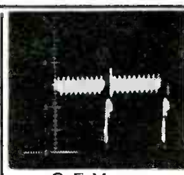
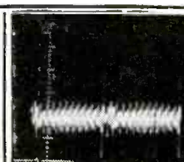
Taken at control-grid-pin-1 of either tube. This is the chroma signal from a keyed rainbow color-bar generator. Examined with a vectorscope, this signal proves to be 3.56-MHz (approximately) energy, in phase that rotates with respect to 3.58 MHz. Amplitude depends on COLOR control.

V p-p low	V p-p high	V p-p zero	Changed Shapes				
T1 faulty		C1 shorted R2 shorted R1 open	 1 V p-p L1 open				

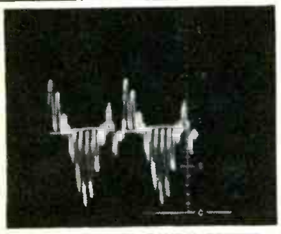


WF4 Normal 15 V p-p

Output of the X demodulator, taken following the 3.58-MHz filter. This is the R-Y content of the chroma input signal; third bar goes furthest negative. Phase of these bars can be shifted with the receiver's TINT control. Amplitude depends on COLOR setting.

V p-p low	V p-p high	V p-p zero	Changed Shapes				
C3 leaky	R3 shorted	C2 shorted C3 shorted C1 shorted R2 shorted	 4.5 V p-p R8 open R7 open R5 open R3 open R1 open	 3.5 V p-p T1 faulty L1 open	 10 V p-p L3 open	 15 V p-p L3 shorted	 4.5 V p-p R8 low

WAVEFORMS AS GUIDES



WF5 Normal 15 V p-p

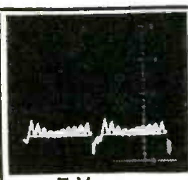
Output of the Z demodulator, taken following the 3.58-MHz filter. This is the B-Y content; the furthest negative-going bar is the sixth. Phase is movable by the receiver TINT control, and amplitude is variable by the COLOR control. This signal and WF4 later produce a G-Y signal too.

C4 leaky

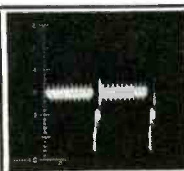
R4 shorted

C2 shorted
C4 shorted
C1 shorted
R2 shorted

3.5 V p-p
T1 faulty
L1 open

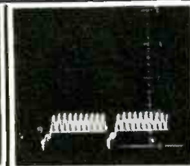


7 V p-p
R9 open
R7 open
R6 open
R4 open
R1 open

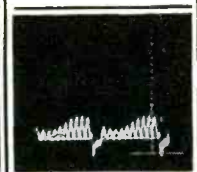


6 V p-p
L2 open

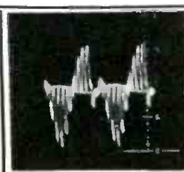
15 V p-p
C1 open



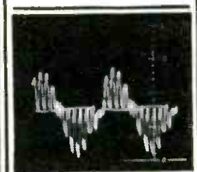
15 V p-p
L2 shorted



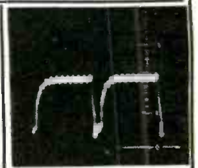
6 V p-p
C1 shorted



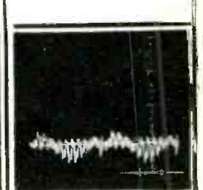
10 V p-p
L4 open



14 V p-p
R2 open

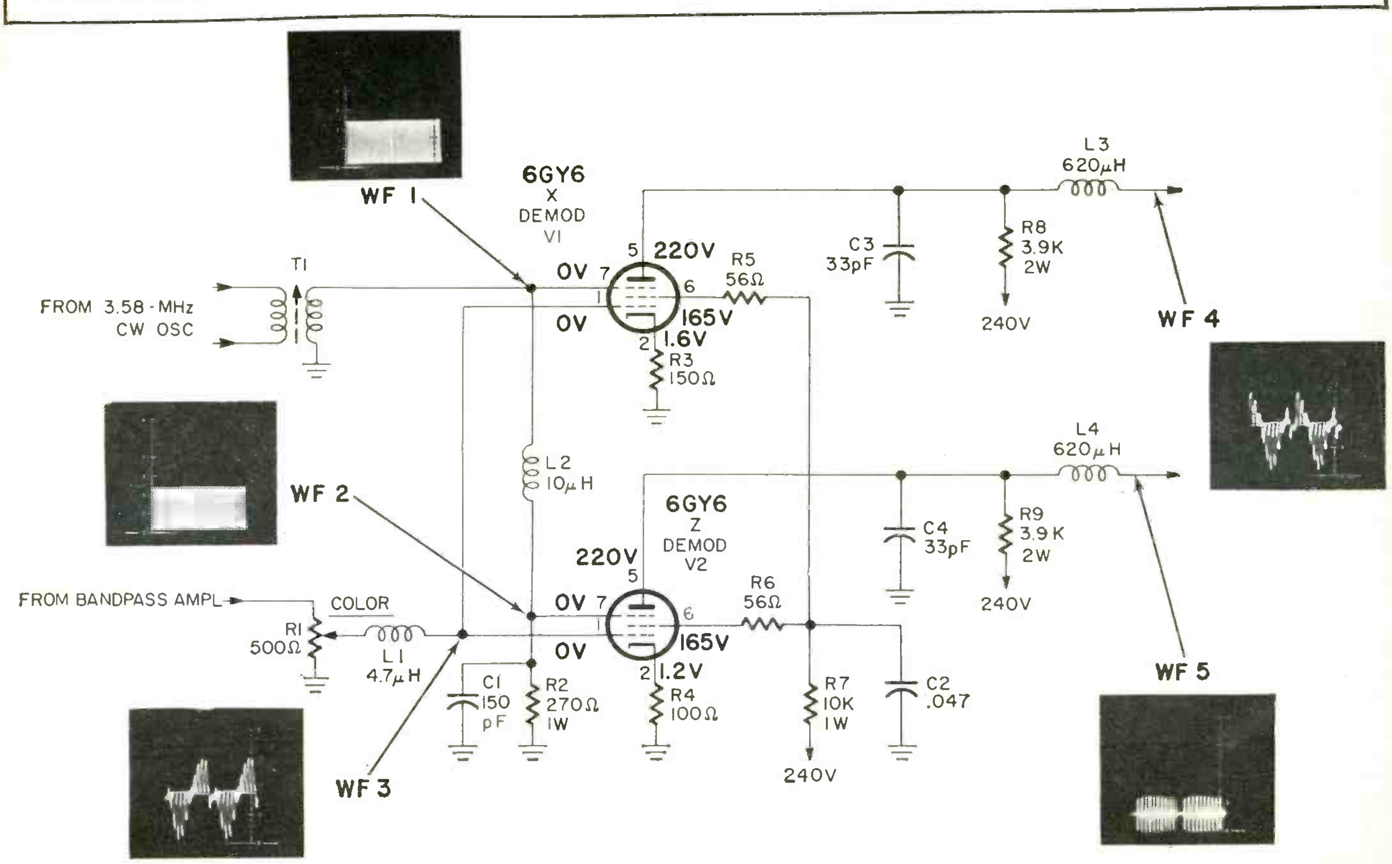


15 V p-p
L4 shorted



6 V p-p
R9 low

NOTES:
Use this guide and the Voltages Guide to help you pin down fault possibilities.
Feed a keyed rainbow signal into receiver antenna terminals, with generator COLOR *set just above 100%.*
Turn the receiver COLOR *control about two-thirds up,* TINT *control to midposition.*
Use direct probe with the scope. Set scope sweep to just under 8 kHz, to display two cycles.
Check the five waveforms at the five key test points.
Note amplitude. If it's low or high, check the parts listed under those columns.
Note waveshape. If there's a change that matches one shown, check the parts indicated.



any 3.58-MHz signal remaining after demodulation. L3 and L4 dc-couple the color-difference signals to amps. Dc coupling is generally used all the way to the CRT cathodes.

Capacitor C2 decouples both tube screen grids. Resistors R5 and R6 suppress any tendency to parasitic self-oscillation the screen circuits may exhibit.

Each tube plate has its own supply circuit. Plate voltage for V1 comes through R8; for V2, through R9. Both resistors connect to the main 240-volt dc line.

The screens get dc power from 240 volts too. But 10K resistor R7 drops the value to a mere 165 volts. R5 and R6 carry screen current, but are too small to be significant to dc operation.

Both tubes use cathode bias. A slightly larger resistance value in the cathode circuit of V1 puts somewhat more bias on that tube than on V2. The bias difference turns the demodulation angle an extra 30 degrees or so.

First and third grids in both tubes rest at zero volts dc. The control (first) grids go to dc ground through L1 and R1. The third grids reach dc ground through R2, L2, and the secondary of T1.

The plates are dc-coupled through coils L3 and L4 to the stages that follow.

STATION AND CONTROL EFFECTS

Viewed with an ordinary scope, the CW signal shows no change if station (or rainbow generator) signal is removed. Phase of the CW is no longer locked in that case, but only a special vector scope would show that.

On the other hand, chroma amplitude depends on the color signal level in the program (or generator signal) received. The COLOR control setting determines how much chorma reaches the control grids of V1 and V2. Amplitude of output waveforms, too, depends on the COLOR pot setting.

The set's TINT or HUE control affects placement (phase) of the bars—that is, whether maximum red is third as it should be or is in some other position, and whether maximum blue is sixth or somewhere else. Likewise, alignment affects phase of the normal waveforms shown.

Dc voltages are unaffected by station or controls.

QUICK TROUBLESHOOTING

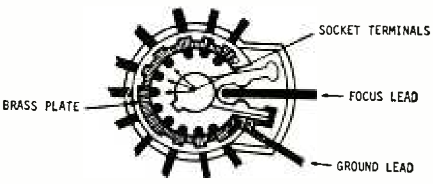
Once you're familiar with the waveforms, the scope is a revealing diagnostic tool. But don't overlook the color picture tube. With a keyed rainbow signal, you can figure out a stage in trouble from the color-bar sequence on the CRT. If red is missing, the X demodulator may be at fault; if blue is gone, check the Z demodulator.

Save dc checks for screen-circuit or bias faults. Even then, waveforms or the CRT may suggest which stage. **R-E**

G-E G1 COLOR CHASSIS

The picture tube socket in the G-1 chassis has special built-in spark gap consisting of a brass plate placed close to the socket terminals (see diagram). Unusually high voltage on a socket terminal will arc to the brass plate and not to an adjacent terminal, thus protecting the picture tube and associated components.

Arcing does not necessarily mean that the socket is defective. It usually indicates trouble in associated circuitry. For example, cases of continuous arcing in the CRT socket have been traced to an open 47-megohm resistor (R284) in the focus divider circuit.



REAR VIEW OF SOCKET (COVER REMOVED)

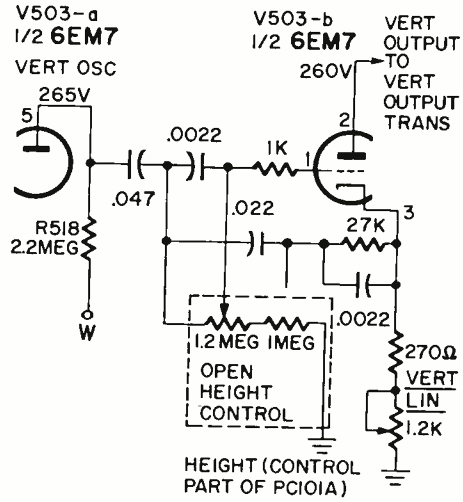
To obtain best focus, this resistor is connected through a jumper to either boosted B-plus, +280 volts or to chassis ground. A bad solder connection at the jumper or an open R284 causes the voltage on the focus anode (pin 9) to rise, causing an arc inside the socket.

If you run across a G-1 chassis with a continuously arcing CRT socket, compare the socket pin voltages against those on the schematic. The focus voltage on pin 9 should be between 3,000 and 5,000 volts, with respect to chassis ground. If it is over 5,000, there is an open circuit somewhere between the focus control (R253) and the low-voltage end of the focus voltage-divider circuit.—*G-E Portafax*

PULSING VERTICAL PICTURE

The picture in a RCA KCS136A chassis would collapse and then fill out repeatedly. A new 6EM7 vertical tube and adjustments of the vertical hold, height, and linearity controls did not help.

All voltages on the base of the 6EM7 were quite close to normal. We started to make resistance checks in the vertical circuit and luckily found the HEIGHT control open. This control is part of a printed component (PC101). The whole printed component was replaced and the pulsing picture was cleared up.—*Homer Davidson*



RCA KCS 176, -177 POWER CORD

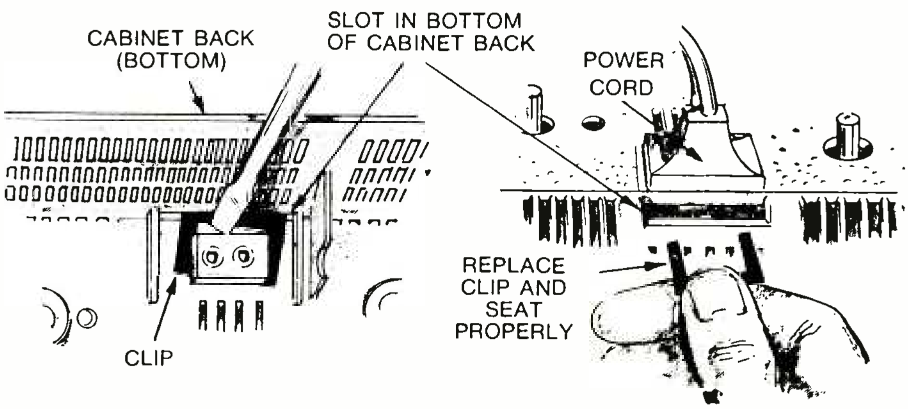
These chassis have a removable power line cord to facilitate cabinet back replacement and to insure a good ac interlock connection.

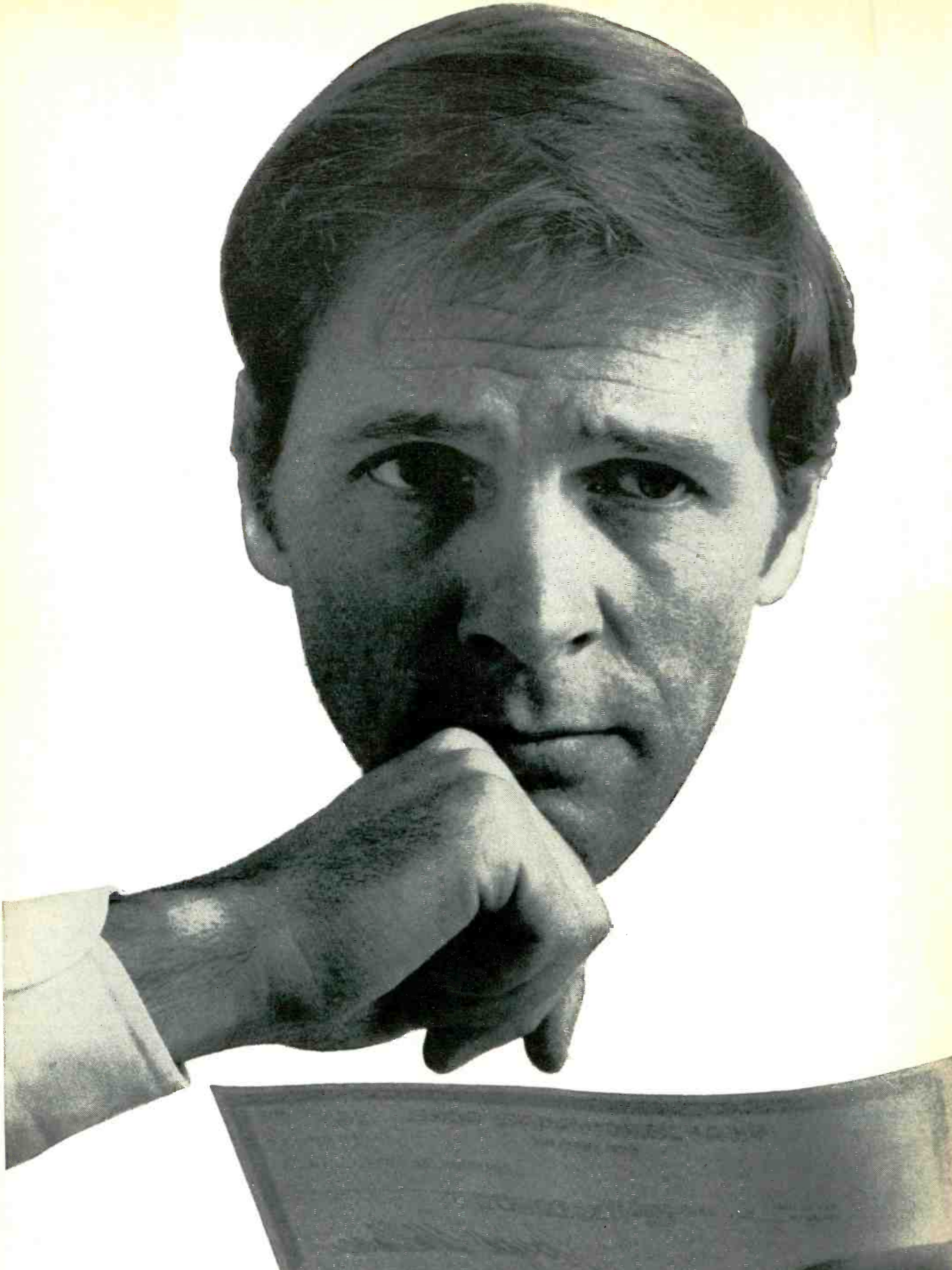
To replace the cabinet back (rear cover):

1. Release power cord by removing interlock clip through slot in cabinet back with a screwdriver as shown in the left drawing.

2. Replace and secure cabinet back.

3. Insert power cord and then replace interlock clip through slot in cabinet back as shown in the drawing on the right. Clip can be seated with a screwdriver. (**Caution:** For customer safety, this clip **must** be replaced and seated properly after servicing.)—*RCA Television Service Tips* **R-E**





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HOW DIGITAL READOUTS WORK

Nixies are easy to work with once you understand them. And they're not too complicated.*

by GEORGE FLYNN

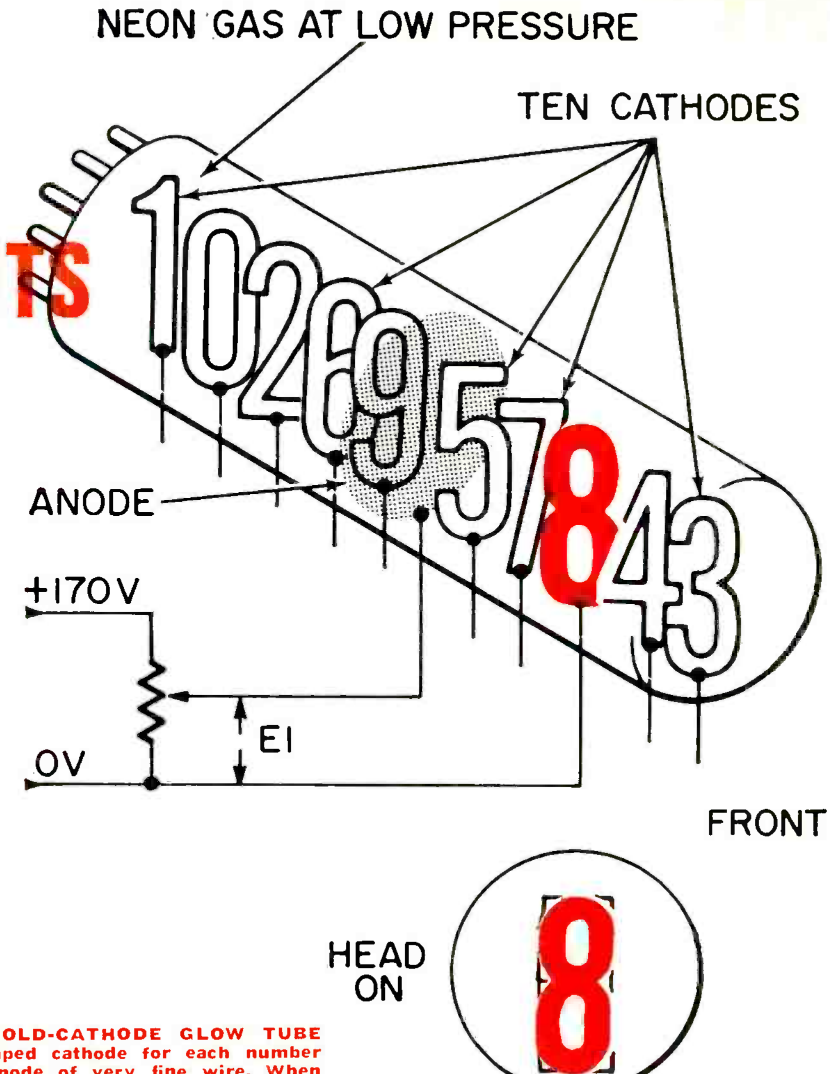


FIG. 1—COLD-CATHODE GLOW TUBE has a shaped cathode for each number and an anode of very fine wire. When viewed head on, a lighted cathode is seen clearly while unlighted cathodes and the anode are almost invisible.

***Nixie is a registered trademark of the Burroughs Corp. It is a brand name for their gas-filled readout tubes.**

If you've ever seen a digital voltmeter or a frequency counter you've probably seen Nixie tubes, because their use in digital instruments of all kinds has become widespread. Several other types of readout tubes are also used in some instruments, but more Nixies and Nixie-type devices are used than all other kinds put together and multiplied by ten. And for a very simple reason—the Nixie does a good job of displaying numbers and it does it cheaper than anything else.

Since Nixies seem certain to be around for a long time, and since anybody who associates with electronic types is bound to cross lances with this baby some time or other, it is worth taking a good hard look at what the thing really is. What does it do? How does it work? What makes it act up?

The basic job of any readout tube is to display numbers and/or letters and other symbols. The numbers, however, are more significant than letters in many applications, and thus a great deal of the art of letting machines talk to man deals primarily with numbers, plus a few symbols. Nixie-type devices, in particular, have been developed primarily to display numbers rather than letters.

The typical Nixie is a cold-cathode gas glow tube that has an anode and ten cathodes, as in Fig. 1. (Variations, including tubes with plus sign and minus sign, are also available). Each cathode has an activated surface that allows it to emit electrons readily. Connect a voltage source to the anode and to any one cathode—leave the others open—and raise the voltage slowly. At a relatively low voltage the cathode will begin to glow over a small portion of its surface. Continue raising the voltage and the glow will spread until the whole cathode is lit and a number—0 through 9 depending on which cathode you latched on to—will be clearly visible, even from many feet away.

If the voltage is raised still further, the glow will creep down from the activated cathode surface and along the connecting lead and on to the socket pin. When this happens, you'll know you've gone too far. Lower the voltage until only the cathode area glows. You are now within the correct operating region for the tube.

Careful experiments with the current and voltage characteristics of the Nixie have established the normal operating region shown by Fig. 2-a. The drawing allows for all the variables—element spacing, cathode activity, gas pressure, etc.—that cause individual tubes and individual cathodes within the same tube to differ slightly from each other. The minimum current needed to completely light a cathode of a Type B5991 Nixie (one of the most common varieties) is 1.5 mA. The maximum current for complete lighting but without creeping glow is 3 mA. When a cathode is drawing 1.5 mA, the voltage across the tube—E_1 in Fig. 1—is a function of the specific tube and specific cathodes and can be as low as 135 volts, but will not be more than 159 volts. When a cathode is drawing 3 mA, E_1 again depends on the specific tube and cathode and will range from 144 to 168 volts. Two other electrical characteristics of the tube are worth noting. Operating the device with the voltage slightly high will not cause any smoke, but you may see the creeping glow. Operating at slightly low voltage can lead to only partial lighting of the cathode. Not good but not always awful.

Now a circuit designer working with Nixie indicators likes to run the devices right in the middle of their normal operating range; the middle is 2.25 mA with the anode riding at about 155 volts. Then, if the supply voltage varies, but not too much, the tube will still operate satisfactorily.

Note in Fig. 2-a that the operating curves are striaght but that the voltage drop across the tube increases as cathode current increases. Any specific tube, such as tube X or Y, will have a curve parallel to the high and low limits. Note in Fig. 2-b that if you extend the operating curves to the left until cathode current is reduced to zero, you intersect the voltage axis at about 123 volts for the low-limit line and at about 146 volts for the high limit. Individual tubes will vary between these limits. Thus you have to buck out anywhere from 123 to 146 volts before the tube conducts significantly.

The fact that the operating curve for a given tube is a straight line tells us the device is acting like a resistor—once it starts conducting. These characteristics are duplicated by the equivalent circuit of Fig. 2-c; a resistor in series with a perfect battery and a perfect diode. The circuit applies only to the normal operating region of the tube—that is, when it is conducting 1.5 to 3.0 mA. When the tube is operated below 1.5 mA, the equivalent series resistance begins to increase and is nonlinear. The actual V-I curves also have a negative-resistance region when conduction begins.

Once the operating current and voltage have been set, the operating circuit can be designed. Fig. 3-a is a typical circuit that consists of a voltage source, a current-limiting resistor and one cathode of the indicator tube. Point A on the operating curve, Fig. 3-b, represents a low-voltage cathode being run at high current, while point B represents a high-voltage cathode running at low current. Drawing a load line through A and B and extending it to intersect the voltage axis gives minimum E_b and associated R_L: minimum E_b is 170 volts, and R_L—from the slope of the load line—is 8200 ohms. With these values, and since the operating point for any cathode is at the intersection of its operative curve and the load line, most cathodes will operate close to the optimum current of 2.25 mA, and only an occasional cathode will operate near **A** or **B**. But if E_b should sag to 160 volts, as shown, a cathode that normally operates at point **B** will now operate at point $\mathbf{B}_1$, or at a current of only about 0.75 mA. Partial glow.

If, on the other hand, E_b should

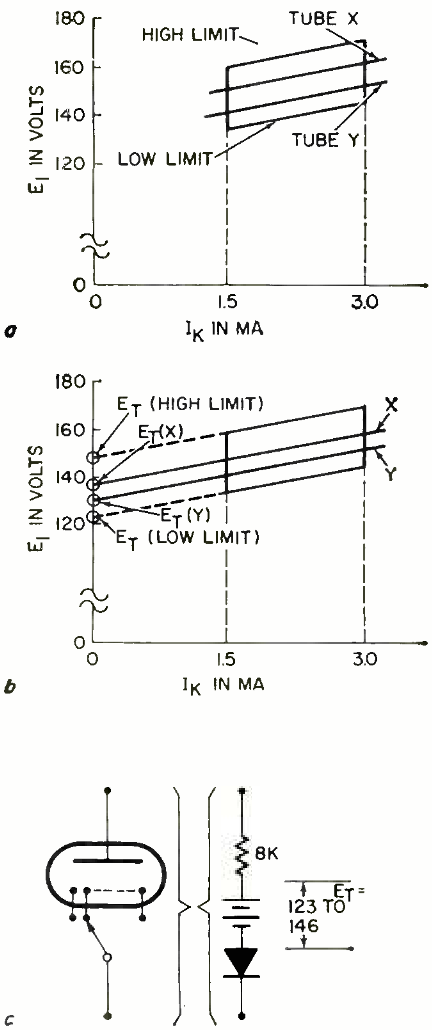


FIG. 2—The normal operating region is shown at a, tube equivalent voltage at b, equivalent circuit for one cathode at c.

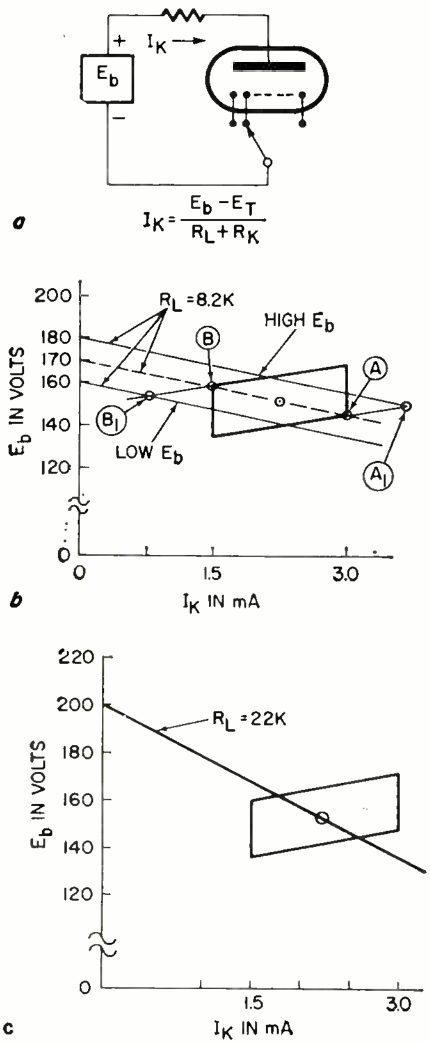
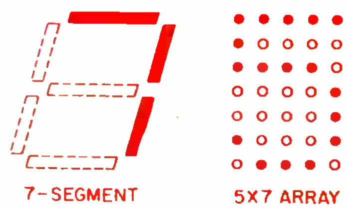


FIG. 3—ACTUAL CIRCUIT for operating a Nixie uses a load resistor to set the cathode current.

OTHER KINDS OF READOUT

While cold-cathode tubes are presently the most popular readout tubes, they have many challengers. One of the limitations of the shaped cathode approach is the limit on the number of symbols you can put into one envelope. Ideally, you would like to put the whole alphabet—capitals and lower case—plus numbers 0 through 9, plus punctuation marks. With this capability you can have real communication from machine to man. But you can cram only so many cathodes into one envelope—16 is probably the maximum for good visibility.

A second major approach to the problem is to break the shapes of the numbers and letters into small parts and then to construct a character by energizing the correct segments. The seven-segment type shown here is one way to do this. With seven segments—each of which is a small elongated neon tube or other light emitting source—you can form all the numbers plus some of the capital letters. But put three 7-segment displays side by side and try to display, say, 8B8, or



B88. You can't do it because you can't distinguish between a B and an 8 with only seven segments. Only nine letters can be formed that will not be confused with numbers (What are they? For answer,* see below.).

Going beyond 7-segments is the 35-dot array—35 light-emitting diodes formed into a matrix 7 diodes high by 5 wide. With 35 dots you can form all the 64 characters of the ASCII code. In the future you can expect to see arrays of 7 x 9 and even larger.

Another approach is to use a miniature crt and write the symbols by moving the beam to form the shape desired. An advantage of this technique is that you can stretch the tube out and then write more than one symbol side by side. Once the message being generated by the machine starts to get complicated, large crts are used, or else a teletypewriter is used to print out messages. Large, complicated displays of this type, however, are a whole different world away from simple readout tubes.

*(Answer: A+C+E+F+H+J+L+P+U)

rise to 180, a cathode that normally operates at point **A** will be shifted out to point A_1, to a current of about 3.6 mA and into creeping glow.

To avoid this high sensitivity to changes in E_b, many Nixies are operated with E_b close to 200 volts rather than at 170 volts. Draw the load line, Fig 3-c, from the actual E_b through the center (2.25 mA) of the operating curves. The slope of the line gives R_L of 22,000 ohms. With these values, the circuit will tolerate a change in E_b of about ± 5% (10 volts) without the load line drifting out of the operating region.

But R_L should be set close to its calculated value. As R_L changes, the slope of the load line changes, and this again can lead to either partial or creeping glow. Current flow for any set of conditions can be calculated from the equation given in Fig. 3-a.

Partial glow

By now you may have decided that a Nixie is nothing more than a glorified neon indicator tube. You are partly right, but only because we've been talking about energizing just one cathode at a time and leaving the other cathodes open. Since the open cathodes can't draw any current, they can't act up very much.

Put a Nixie into a circuit, however, and you usually want to drive it with a transistor, not a rotary switch. The circuit shown in Fig. 4 is recommended by

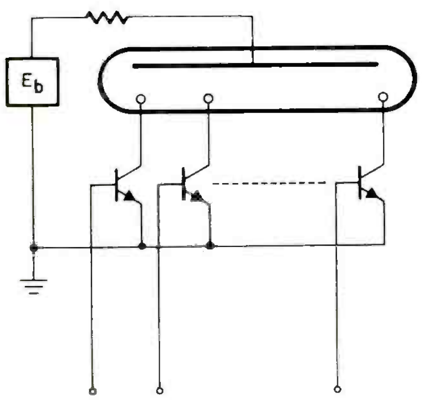


FIG. 4—TRANSISTORS are usually used to drive Nixie cathodes.

manufacturers of the indicators and uses an npn transistor for each cathode. When one of the transistors is turned on, it becomes a low resistance and grounds its associated cathode, turning it on. The other transistors are off and present a very high impedance to the flow of current from anode to cathode and thereby to ground.

Assume that the transistor for the cathode of numeral "1" is turned on, and "1" is lit. What is the voltage at the collectors of the off transistors—such as for numeral "0"?

If the transistors were perfect, they would act like infinite resistances and no cathode currents would flow unless the transistor was on. But transistors are not perfect and there is a leakage current from the off cathodes through the off transistors.

The magnitude of the off current is a function primarily of the leakage current characteristic of the transistor, while the voltage at the off cathodes is determined by the collector breakdown voltage of the transistor. What the circuit requires is a transistor with low leakage current and high collector breakdown voltage.

Extensive experiments have been carried out to determine what levels of leakage current and voltage can be tolerated before objectionable glow is generated by numerals that are supposed to completely off. Figure 5 shows typical

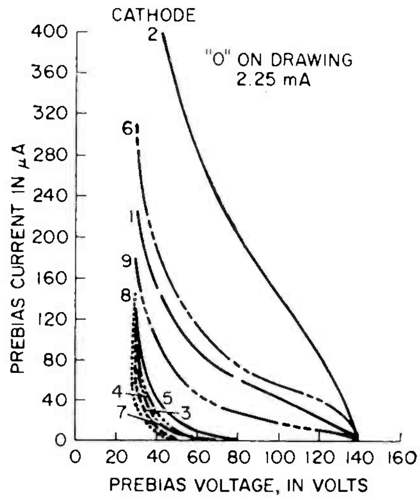


FIG. 5—INTERFERENCE between one cathode and another depends on how close the two are and how closely their shapes match.

leakage current flows through off cathodes as a function of cathode voltage, which is called the "prebias voltage". Numeral "0" is on, which means that its cathode is grounded (or has on equivalent prebias voltage of zero) and current through "0" cathode is 2.25 mA. Now look at the curve for cathode "2". When its prebias voltage is 140 volts, and if E_b is 170, then the voltage available to "2" is 170—140 or 30 volts, and the current flow is way down around zero.

Let the voltage on "2" drop to 100 and the current rises to well over 100 μA. As the prebias voltage drops further, leakage current continues to increase until eventually "2" will start to turn on.

When you perform the same tests on cathode 6 ("0" still on) you get lesss leakage current but the shape of the curve is approximately the same. Why should you get a different current flow for "6" than for "2"? Look at the actual arrangement or stacking of the cathodes as indicated in Fig. 1. Cathode "2" is physically close to cathode "0". Further, the top of cathode 2 is the same shape as the top of 0: the result of nearness plus conformance of shape results in high leakage current for "2" when "0" is on—some of the action at "0" makes "2" nervous. But look at the curve for "3" when "0" is on: practically nothing. Now look where "3" is in the stacking—it's as far away from "0" as it can be and it's on the other side of the anode as well.

If you perform the same tests with the rest of the cathodes, you get similar curves. When "8" is on, it has more effect on 4 and 7 than on 0 and 1.

All right, you say, so you get a little leakage—who cares? We now go to the second set of experiments, which try to answer the question, "How much leakage current causes an objectionable glow from cathodes that are supposed to be off?"

Fig. 6 shows how some observers judged the effects of leakage. Again, cathode "0" is on and the others are off. Based on the leakage characteristics for

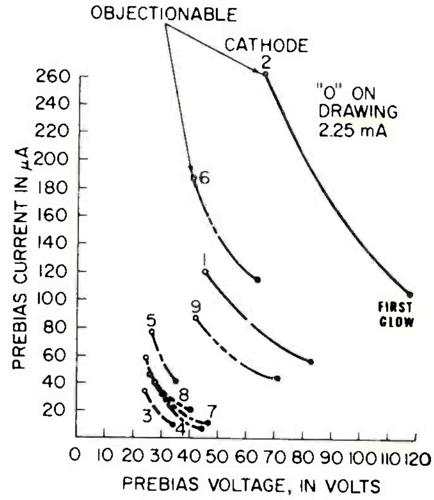


FIG. 6—BOTTOM POINTS for each cathode indicate first appearance of a glow. Top points show where glow becomes excessive.

"0" (Fig. 5), we know cathode "2" is going to bomb out first if anything does. Observers report that barely perceptible glow appears on "2" when the leakage is about 110 μA, while its associated prebias voltage is 120 V; when the prebias drops to 70 V, the leakage is about 250 μA and the glow on "2" is obvious and "probably objectionable".

But look at cathode "3". To get a glow at all you have to take the prebias down to 35 V—it's almost turned on. But as soon as "3" does start to leak, it really acts up—it only needs about 35 μA to become a clown.

Turn the 10 cathodes on one at a time and measure all other cathodes to find objectionable glow limits and you come up with 90 dots as shown in Fig. 7. According to this drawing you will never have a bad glow if you keep leakage current below 20 μA, or if you held the prebias at 70 volts and above. And if you can hold leakage below 2 μA, (at all operating temperatures), says Burroughs, you won't ever get a noticeable glow even for sensitive combinations (such as "0" on and 3 at prebias of 35). And for most tubes, 60 volts prebias—instead of 70—is good enough.

One situation which almost defies analysis is, "What happens when one cathode is on and two or more start glowing?" You can expect that two little glows (or three or four) may be worse than one little glow but probably better than one big glow. Play safe and keep the glows down.

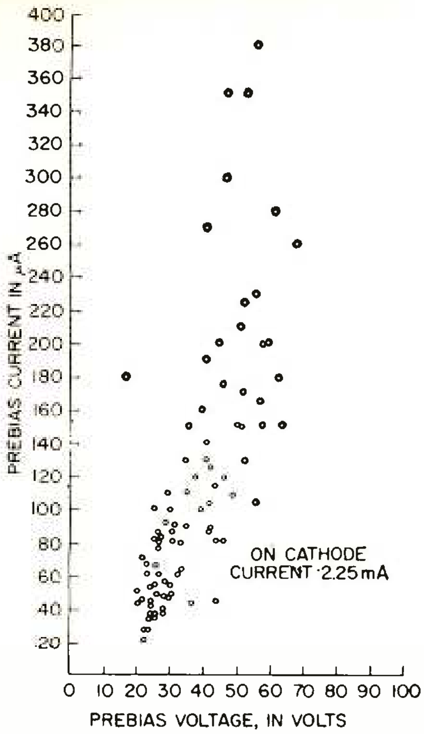


FIG. 7—OBJECTIONABLE GLOW occurs for the 90 different combinations of one cathode on and other supposedly off.

Ionizing peculiarities

Neon indicator tubes must be treated with due respect to the limitations of cold-cathode devices. Many of the limitations are not serious—that is, they are easily overcome—but they can cause a lot of tree-climbing or head-bashing-against-the-wall action if not understood.

One of the major variables of the neon indicator tube is turn-on time, which is the same as ionization time. Cold-cathode devices depend upon external radiation for initial ionization. You can apply rated voltage between anode and cathode and wait, but nothing will happen until a cosmic ray or an energetic particle from an atom undergoing radioactive decay strikes the cathode and starts the electrons flowing. Once started, the ionization is self-sustaining through the action of the electrons jumping around.

The starting incident does not need to be an energetic particle. Ordinary light—natural or man made, and bright enough to allow easy viewing—provides enough energy at the cathode surface to insure ionization under most conditions. Ionization can also be made more certain by applying increased voltage across the tube (without exceeding ratings) or by applying the voltage fast rather than slow. In addition, ionization time is affected by how long the tube has been sitting around without being turned on. The longer it's been inactive the lazier it is.

Burroughs Corp. says that ionization time will almost always be less 100 μsec in normal applications and with usual light levels. But the variations in the characteristics of cold-cathode tubes, plus the variations in local lighting and background radiation, are such that ionization time may be as short as 1 μsec or as long as several seconds.

What happens when you want to use a Nixie in a coal mine in total darkness? In this case it may be more a question of what will not happen—the indicator may never turn on. But there's really no need for this type foul-up if it is known beforehand that the tube is going to be used in absolute darkness. The manufacturers have developed a special tube that contains a small amount of radioactive Krypton 85 gas, which is relatively inactive but emits a particle sufficiently often to cause the tube to turn on within 50 msec usually, and within 1 sec pratically always.

How to dim

Cold-cathode indicator tubes are bright enough for use in fairly strong light. Sometimes, however, the tubes are too bright—as in radar rooms and aircraft cockpits—and dimming methods are needed. Reducing the voltage across the tube may produce slight dimming but runs into the problem of failing to completely light some cathodes.

The simplist way to reduce brightness is to use an optical filter in front of the tube. If continuously variable brightness control is not needed, optical filters can work well. Polaroid filters are available, in fact, that reduce brightness and reflections at the same time.

If electrical control of brightness is needed, two techniques are available. In the first method a cathode is turned on for awhile, then off, then on again, etc. at a regular rate or frequency. If the fixed frequency is 50 Hz or higher, the tube appears to be on continuously, and the apparent brightness is a function of on time to off time—the duty cycle. The maximum duty cycle is 1.000, or continuously on. The minimum duty cycle is determined essentially by the ionization time—100 μsec for reliable operation—which gives an on-to-off ratio of 1 part in 200, or a duty cycle of 0.005 (or 0.5%).

The second way to control brightness also uses the concept of duty cycle but in this case the on-time of a cathode is fixed—again, 100 μsec minimum—a the period between on-pulses is varied. If the on pulses arrive once every 100 μsec (or whatever the on time is set to) the tube is on continuously, the duty cycle is 1, and brightness in maximum. If only 50 on-pulses per second, (minimum rate for flicker-free viewing) are applied, the duty cycle is 0.005, (with 100 μsec on-time) and brightness is way down.

Both methods give the same results but the fixed frequency method causes less power dissipation—because less switching is required—in the drive circuits. Usually the on-pulses are applied via the anode. The tubes are often driven from a 200-volt supply and the anode voltage only has to be lowered to below 110 volts to turn the tube off. Anode control also eases the breakdown voltage requirements of the drive transistors in the cathode circuits.

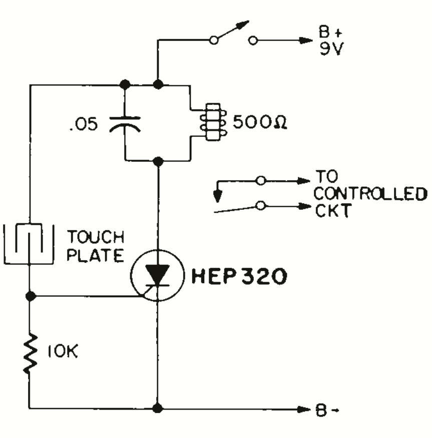
Do you remember the story about the little girl who read a book about alligators, and when her teacher asked her how she liked it, said: "This book told me more about alligators than I wanted to know."

While more could be said about the cold-cathode indicator tube—and about its competitors who are fighting for a chance to be seen—we've about run out of space.

One recent development should be mentioned. The tubes are usually driven by combination decoding/driving circuits that figure out which cathode of a given tube is to be turned on. Since the decoding/driving circuits can account for 50% or more of the cost of a numerical display, efforts have been made to use one decoder/driver for more than one tube—that is, multiplexed operation. This has led to the development of high-current tubes that operate with from 5 to 15 mA and at somewhat higher voltage. The multiplex type tubes are not interchangeable with the regular type. **R-E**

Touch Switch

This simple touch switch can turn on appliances, lamps, etc., with a finger touch. It features safe, low-voltage operation. The touch plate may be an etched circuit board as shown, or simply two copper tacks close enough that both can be touched simultaneously. The touch-plate circuit must be isolated from the ac line.



PARTS LIST

1 HEP 320 or 2N5060 silicon controlled rectifier (SCR)
1 10,000 ohms, ½ watt, 10% resistor
1 0.5-μF, 25-volt (or higher) capacitor
6 1.5-volt batteries (9 volts)
1 500-ohm relay
1 Touch plate

24 easy-to-build burglar alarms

These five burglar alarm circuits complete this series of articles. Just about every kind of alarm has been described

by R. M. MARSTON

IN THIS FINAL SECTION OF THE ALARM circuits article you will find fire or over-temperature alarms and frost or under-temperature alarms. They complete your circuit book and you should now have alarm circuits that provide almost any kind of protection you should desire.

In the alarm circuit of Fig. 10, the LDR can be any type that gives a resistance in the range 200 to 10,000 ohms when illuminated by the light beam. R1 should have a *maximum* value roughly *double* that of the LDR resistance under the above conditions and is used to set the circuit sensitivity at the required level.

Temperature-operated alarms

Temperature-operated alarm systems can be used as automatic fire or overheat alarms, or as frost-warning or underheat alarms. They can be used to sound an alarm whenever a temperature goes above or below a precisely preset value.

The four practical alarm systems that follow use inexpensive negative-temperature-coefficient thermistors as their temperature-sensing elements. These devices act as resistors that have a value dictated by temperature; they present a high resistance at low temperatures, and a low resistance at high temperatures.

The four circuits have all been designed to work with thermistors that present a resistance of roughly 5000 ohms at the desired operating temperature. All circuits are highly versatile, however, and will operate perfectly well with any negative-temperature-coefficient thermistors that present a resistance in the range 1000 to 20,000 ohms at the required temperature. Table I lists a few of the many thermistors that may be used in these circuits at different temperature levels.

Fig. 21 shows the practical circuit of a simple fire or over-temperature alarm. Here, TH_1 (the thermistor) is connected in the form of a bridge, together with R1-R2 and R3; Q1 is used as the bridge-balance detector and SCR driver. R1 is adjusted so that the bridge is slightly out of balance, with the voltage of the R1–TH_1 junction slightly lower than that of the R2–R3 junction, at temperatures just below the required operating temperature. Q1 is thus cut off under this condition, and passes negligible current into the SCR gate, so the alarm is inoperative.

When the temperature increases to the required trigger level, TH_1's resistance falls slightly and thus causes the voltage of the R1–TH_1 junction to fall as well. Under this condition Q1 turns on sufficiently to trigger the SCR, so the alarm turns on and self-latches. R1 can thus be adjusted so that the alarm turns on and self-latches when the temperature rises to any desired value within the operating range of the thermistor.

The circuit in Fig. 21 can be modified so that it acts as a frost or under-temperature alarm, which turns on when the temperature falls to a preset value, by simply transposing the TH_1 and R1 positions.

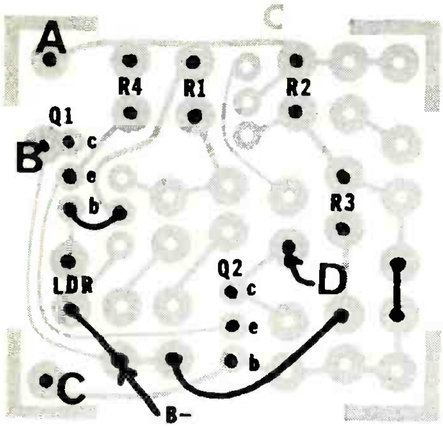
Fig. 22 shows an alternative version of the simple frost or under-temperature alarm. The circuit is very similar to that of Fig. 21, with TH_1 connected in the form of a bridge, and Q1 used as a balance detector. The circuit is set up by first adjusting R1 so that approximately half the supply voltage appears on Q1 base at the required trigger temperature; R3 is then adjusted so that the alarm turns on when the temperature falls to the required trigger level.

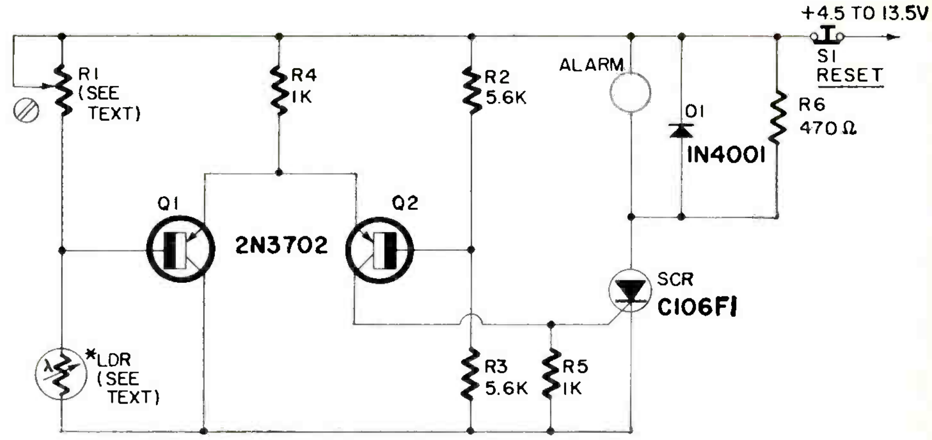
Figure 23 shows an alternative version of the fire or over-temperature alarm. The circuit is roughly similar to that of Fig. 22, since the thermistor is wired in the form of a bridge, and Q1 is used as a bridge-balance detector. In this circuit, however, Q1's output is amplified and inverted by Q2 before being applied to the SCR gate; the alarm thus turns on only when the temperature rises to the required level. The circuit is set up in a similar way to that in Fig. 22.

An interesting feature of the circuits in Figs. 22 and 23 is that they both employ identical thermistor and R1 voltage divider networks, but one circuit turns on when the temperature falls to a preset value, while the other turns on when the level rises to a preset value. These two circuits can thus be put together to form a combined over-temperature/under-temperature alarm. Figure 24 shows the practical circuit of such an alarm.

Here, Q1 and Q2 form the over-temperature sensing side of the circuit, and Q3 forms the under-temperature sensing side. In use, the circuit is set up as follows: First, set R2's slider to the positive supply line, and R3's slider to ground. Now adjust R1 to develop half the supply voltage on Q1 base at the normal or mid-temperature level. Now adjust R2 so that the alarm sounds when the temperature rises to the required high trigger level. Finally, adjust R3 so

20.

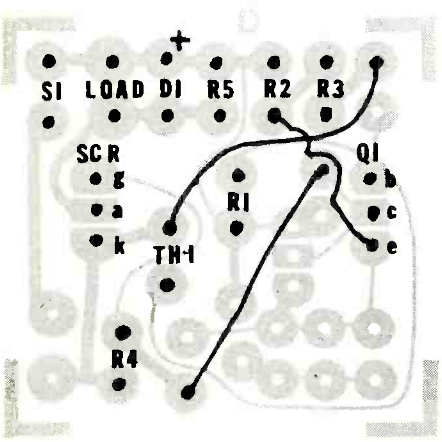


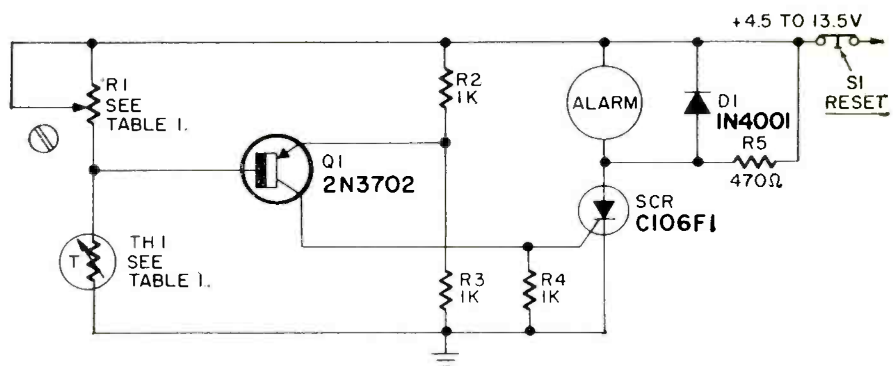


PARTS LIST

R1—see text
R2, R3—5.600 ohms, ½ watt
R4, R5—1000 ohms, ½ watt
R6—470 ohms, ½ watt
D1—1N4001
LDR—see text
Q1, Q2—2N3702
SCR—C106F1
S1—spst normally closed
Alarm Device
Circuit board C and circuit board A set up as in Fig. 5.

21.

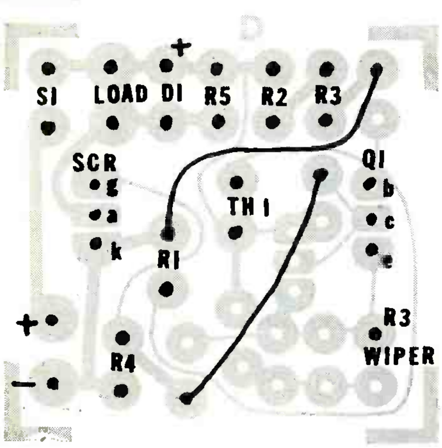


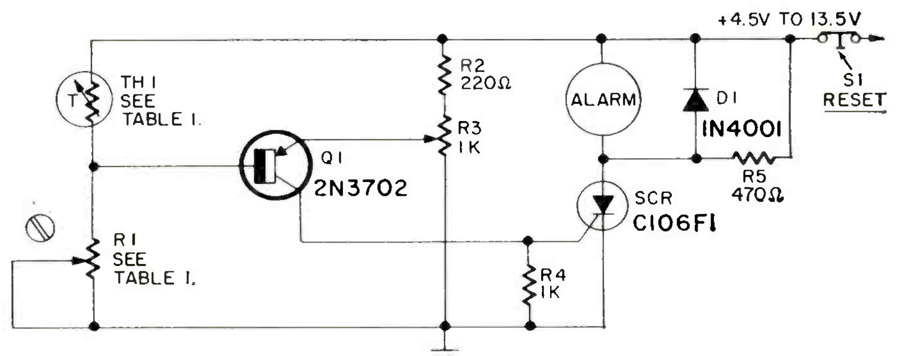


PARTS LIST

R1—see table
R2, R3, R4—1000 ohms, ½ watt
R5—470 ohms, ½ watt
D1—1N4001
Q1—2N3702
SCR—C106F1
S1—spst normally closed
TH1—see table
Alarm device
Circuit board D

22.

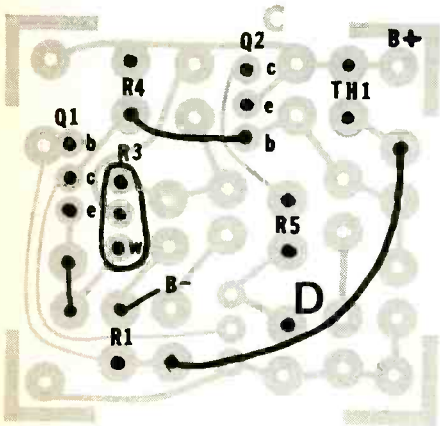


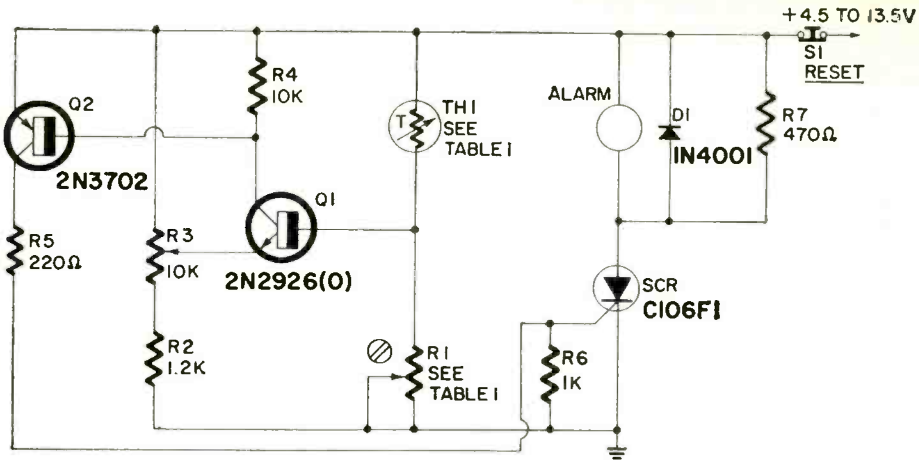


PARTS LIST

R1—see table
R2—220 ohms, ½ watt
R3—potentiometer, 1000 ohms
R4—1000 ohms, ½ watt
D1—1N4001
Q1—2N3702
SCR—C106F1
S1—spst normally closed
Alarm device
Circuit Board D

23.

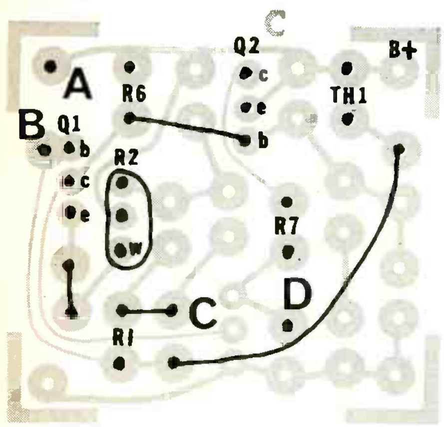


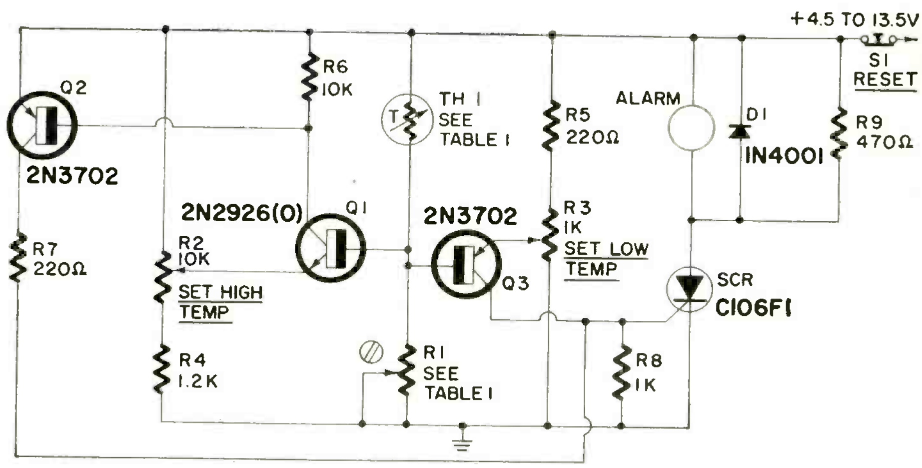


PARTS LIST

R1—see table
R2—1200 ohms
R3—potentiometer, 10,000 ohms
R4—10,000 ohms, ½ watt
R5—220 ohms, ½ watt
R6—1000 ohms, ½ watt
R7—470 ohms, ½ watt
D1—1N4001
Q1—2N2926(0)
Q2—2N3702
SCR—C106F1
S1—spst normally closed
TH1—see table
Alarm device
Circuit board C and circuit board A set up as in Fig. 5.

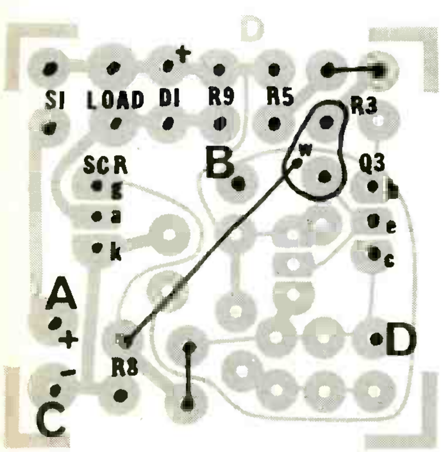
24.



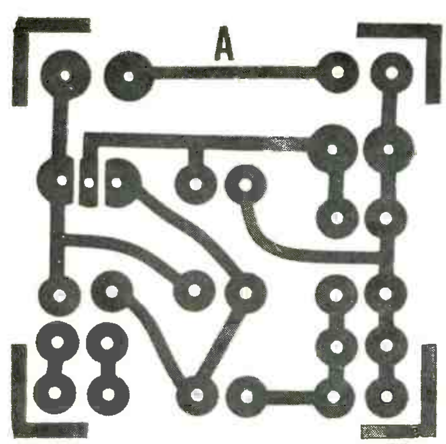


PARTS LIST

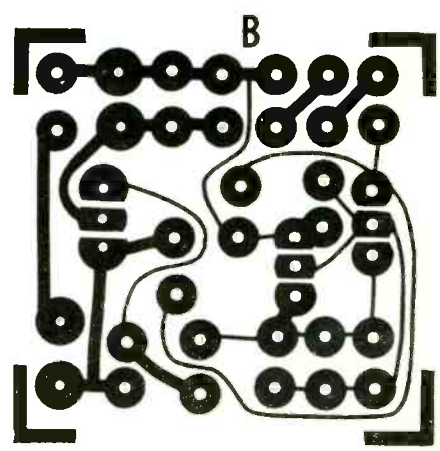
R1—see table
R2—potentiometer, 10,000 ohms
R3—potentiometer, 1000 ohms
R4—1200 ohms, ½ watt
R5—220 ohms, ½ watt
R6—10,000 ohms, ½ watt
R7—220 ohms, ½ watt
R8—1000 ohms, ½ watt
R9—470 ohms, ½ watt
D1—1N4001
Q1—2N2926(0)
Q2, Q3—2N3702
SCR—C106F1
S1—spst normally closed
TH1—see table
Alarm device
Circuit boards C and D arranged as shown



Full size pattern for circuit board A used in the 24 alarm circuits

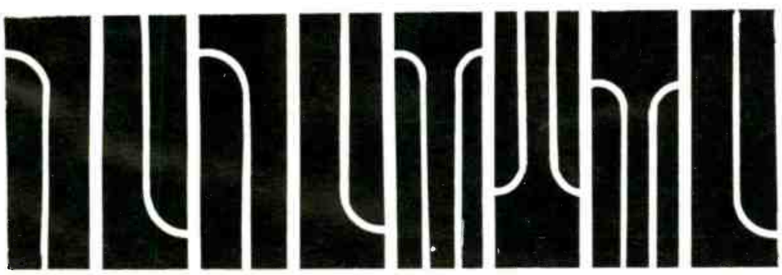


Full size pattern for circuit board B used in the 24 alarm circuits



OPERATING TEMPERATURE RANGE	SUITABLE THERMISTOR TYPES	R1 VALUE
−40°C to −12°C	KD2107 (RCA).	10,000 ohms
−15°C to +10°C	KD2108 (RCA), or VA1066S (MULLARD).	25,000 ohms
+5°C to +25°C	KD2108 (RCA), or VA1066S (MULLARD).	10,000 ohms
+20°C to +50°C	KD2108 (RCA), or VA1066S (MULLARD).	5000 ohms
+40°C to +70°C	VA1055S (MULLARD).	10,000 ohms
+60°C to +105°C	VA1055S (MULLARD).	5000 ohms
+60°C to +85°C	VA1056S (MULLARD).	25,000 ohms
+80°C to +100°C	VA1056S (MULLARD).	10,000 ohms
+95°C to +130°C	VA1056S (MULLARD).	25,000 ohms
+90°C to +110°C	VA1067S (MULLARD).	10,000 ohms
+100°C to +140°C	VA1067S (MULLARD).	25,000 ohms
+100°C to +140°C	KD2109 (RCA).	5000 ohms

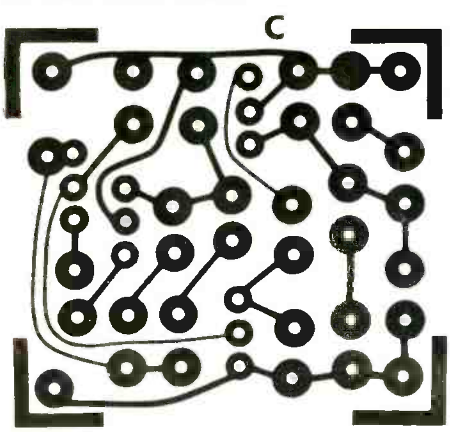
Note: The KD2107-9 thermistor types are available in the RCA experimenters kit, KD2110.



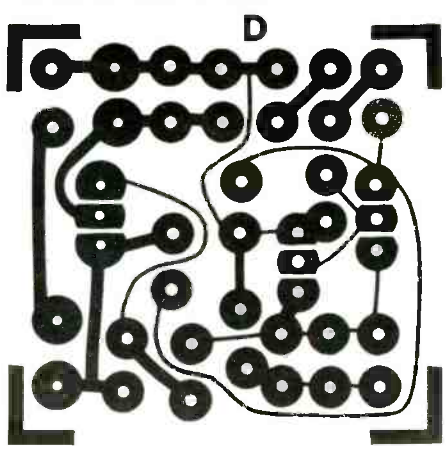
COMPONENT MOUNTING STRIP. Each strip contains 3 sections for diodes, capacitors or resistors; 1 transistor section and 1 SCR section.

The following alarm parts are available from Photolume Corp., 118 E 28 St., N.Y., N.Y.
Kit RE671-PC consisting of 1-panel of 4 alarm circuit boards; 1-panel of 3 component mounting strips; 100 plug-in-connectors . . . $6.25 postpaid.
Kit RE671-T consisting of 1 SCR; 1 diode; 4 transistors (2 npn, 2 pnp) and 1 photocell . . . $3.75 postpaid.

Full size pattern for circuit board C used in the 24 alarm circuits



Full size pattern for circuit board D used in the 24 alarm circuits



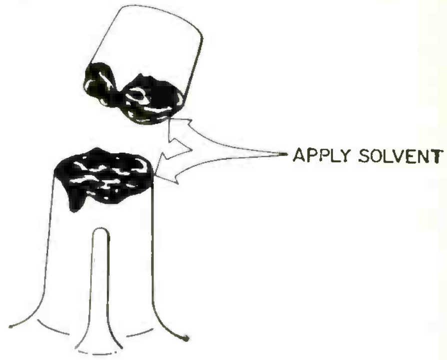
that the alarm sounds when the temperature falls to the required low level. The circuit is then ready for use.

The four temperature-operated alarms that we have looked at so far are all very useful circuits, but suffer from one slight snag. This snag is that, if the thermistor is placed remotely from the electronic circuitry (so that the thermistor and the circuitry operate at different temperature levels), the precise operating points of the circuits will be affected by variations in the operating temperature of the transistor circuitry. This is because the V_{be} characteristics of the Q1 (and Q3) bridge-balance detectors are temperature dependent. In practice, this may result in the trigger points of the circuits shifting by one or two degrees centigrade when the transistor circuitry is operated through the range 0°C to +30°C. These circuits are thus not suitable for use in precision applications, unless the circuits and thermistors are operated at the same temperatures. **R-E**

BROKEN PLASTICS

Plastic radio cabinets or knobs which are broken or cracked present a problem sometimes to a technician trying to do a first-class repair job. Of course there are glue products on the market—but who has the right glue at the right time? An amazingly simple solution I have found for making these last-minute repairs is GC Cement Solvent.

As a person might expect, one important thing to be taken into consideration before attempting to make plastic repairs is to know what kind of plastic is involved. Phenolics, such as Bakelite, are thermosetting types of plastic and will not be dissolved by ke-



tone solutions. Radio cabinets made from this material are not as popular today, however, as those of styrene, G.E. Lexan (a polycarbonate), the ethyl celluloses and the vinyls.

The drawing shows a broken portion of a printed-circuit type plastic mounting stud, popular in many cabinet styles. By merely applying a drop or two of solvent to the surface of each broken, chipped, or cracked cornice, stud, or knob, allowing a few seconds for the sections to get tacky, and, applying pressure, you've got the job done.—*George D. Philpott*

all about resistors

Resistors are essential to proper operation and control of electronic gear. Read about basic types and how they are used.

by FARL JACOB WATERS

THE FIRST COMPONENT YOU RUN INTO when studying electronics is the resistor. Learning electricity and electronics begins with Ohm's Law. It says that the ratio between the electromotive force, (voltage) and the current within a circuit is a constant value. So if voltage is increased from 100 to 200 volts the current also doubles from a possible 10 mA to 20 mA. The ratio E/I stays constant at 10,000 (100/0.010 or 200/0.020). And, since this ratio indicates the current developed within a circuit by a given voltage it is also a measure of the limiting factor—the resistance of that circuit.

In this article we are interested in components that introduce specified amounts of resistance into an electronic circuit. These components are called *resistors*. These devices do not store or hold electrons but do limit the quantity of electrons passing through a circuit. And when a current passes through a resistor the force—voltage—is diminished. Resistors make no distinction between alternating currents and direct currents and cause no phase shift between the alternating current variations and the alternating voltage variations.

Resistor uses

As transistors have become popular as the controlling device in electronic circuits, the current limiting characteristic of resistors has become important. The controlling factor in a transistor's operation is the base current and the circuit must include a device to limit that current. A basic transistor circuit has a resistor, R_b, in series with supply voltage V_{bb} and the base-emitter junction (Fig. 1). Since the forward biased base-

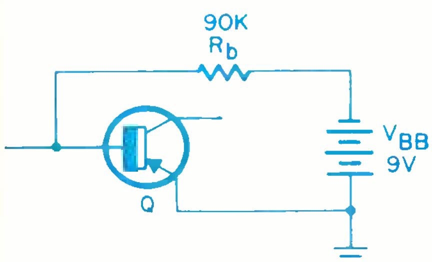


FIG. 1—TRANSISTOR BIAS RESISTOR (R_b) holds base current to safe limits.

emitter junction has a very low resistance the normal 9V supply, V_{bb}, would cause a 250-mA base current if resistor R_b were not used. Such a base current would be excessive. With resistor R_b, about 90,000 ohms, in series with the supply voltage, base current is limited to an acceptable 0.1 mA.

Vacuum-tube heaters are often connected in series, directly across the 117-volt ac source. However, a circuit, that has eight tubes, each rated at 12.6 volts, should be fed only 100.8 volts (12.6 x 8). Thus, there is an extra 16.2 volts to be consumed by some other means. Fig. 2 shows resistor R1 used as a voltage

FIG. 2—LINE-DROPPING RESISTOR (R1) prevents heater-string overvoltage.

dropping device to reduce the 117 volts to the required 100.8 volts.

A third use of resistors is in voltage dividers. In parallel with a voltage source, the battery in Fig. 3, two resis-

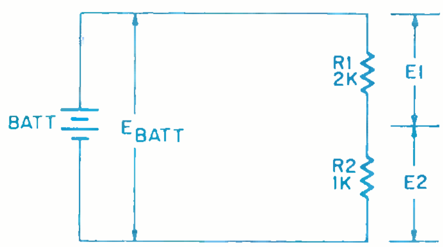


FIG. 3—VOLTAGE DROPS are in direct proportion to ratio of the resistances.

tors divide that voltage in direct proportion to the resistor values. That is; if R1 in Fig. 3 is 2000 ohms and R2 is 1000 ohms, the voltage across R1 is twice that across R2.

$$E1/E2 = R1/R2$$

where E1 is the voltage across R1
E2 is the voltage across R2

$$\text{and } E1 + E2 = E_{BATT}$$

where E_{BATT} is the total voltage of the battery.

In the early days of electronics, vacuum tube circuits were powered by three batteries—the A battery, the B battery, and the C battery. The C battery was a biasing battery that kept the tube's grid negative with respect to the filament. With progress the grid was placed at ground or zero potential and a resistor used between the cathode and ground potential (Fig. 4). Then with the normal movement of electrons from the plate through the voltage supply, cathode resistor R_k, and back to the cathode; the lower end of R_k (point B) is negative with respect to its upper end at point A. Since point B is the same as the grid; the grid is negative with respect to the cathode at point A and it is unnecessary to use the bias battery.

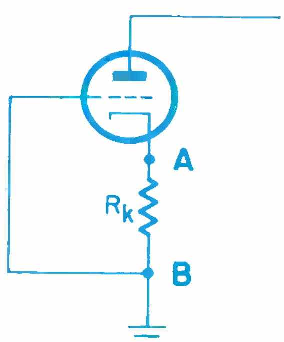


FIG. 4—CATHODE BIAS RESISTOR makes cathode more positive than grid.

Another vacuum tube circuit permits the grid to become positive for brief intervals of time and to draw electrons. Found in class-C rf amplifier circuits, the positive grid draws current through the grid-leak resistor (R_{g1} in Fig. 5) and develops a bias voltage.

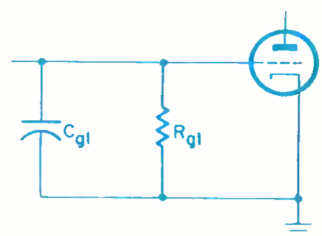


FIG. 5—GRID-LEAK BIAS. Positive drive pulses develop negative grid bias.

With gridleak capacitor C_{g1} becoming charged to a similar voltage value and then tending to discharge through resistor R_{g1}, this bias voltage remains comparatively constant.

During operation capacitors C1 and C2 of a power supply filter, Fig. 6, are

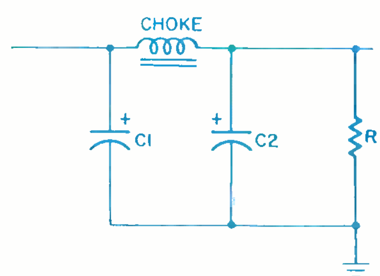


FIG. 6—BLEEDER RESISTOR (R) stabilizes voltage and discharges C1 and C2.

charged to a value that equals the output voltage. In most transistor equipment and home radio receivers that capacitor charge is not large enough to be very dangerous but similar circuits in television receivers and in transmitting equipment can produce a fatal shock, even after the equipment has been turned off. This possibility is eliminated by placing resistor R (a high valve) across filter capacitors C1 and C2.

The energy stored or accumulated within a capacitor or an inductor charging or discharging through a resistor can be used to measure time. In the circuit of Fig. 7-a any charge on capacitor C discharges through resistor R at a decreasing rate. After a time *t* equal to R x C seconds the charge remaining on capacitor C equals 37% of its original level. Therefore; if one end of Fig. 7-a is

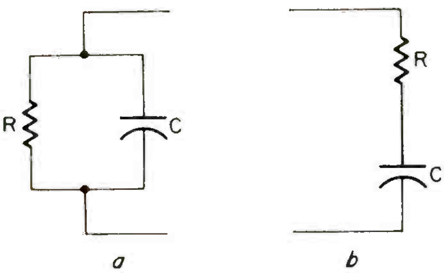


FIG. 7—R-C TIMING CIRCUITS. Parallel circuit (a) charges and series circuit (b) discharges to 63% in R x C seconds.

connected to the grid of a vacuum tube and is negative enough to cut off the plate current, after time *t* or R x C seconds the decreased charge on capacitor C can permit anode current to flow again. In this manner the R-C combination establishes the time during which the plate current is off. On the other hand, the voltage across capacitor C equals 63% of that voltage applied to the resistor and capacitor series combination (Fig. 7-b) after a period of time equal to R x C seconds.

Power dissipation

In mechanical terms power is defined as the rate at which energy or work is expended—ergs per second, joules per second, or watts.

$$\text{Power, } P = W/t$$

where W is the energy expended in *t* seconds. Work W also equals the product of force f and the distance s through which that force acts. Substituting known and absolute electrostatic values of force alters the power equation to:

$$\text{Power, } P = EI$$
$$= I^2R$$
$$= E^2R$$

where E is the voltage
I is the current
R is the resistance

Resistance is analagous to mechanical friction. And friction has the effect of adding mass to the object being moved. Overcoming friction, as in rubbing two sticks together, produces heat. Resistance is the same as friction to the movement of electrons. So the movement of electrons, a current, through a resistor also develops heat. Current through a resistor expends a major portion of its energy in overcoming the "friction." Just as rubbing of sticks can start a fire, heat produced within a resistor can burn that resistor and break the current path. Of course, if the stick rubbing occurs over a great length of the stick's surface, the heat dissipates or leaves the stick before it can get hot enough to burn. Similarly, if the resistor has enough surface to dissipate the heat rapidly enough, the resistor will not burn.

Since both the dissipating surface area of a resistor and its resistance value are related to the length and the cross-sectional area, there must be a correlation between these dimensions. A resistor that has a cross-sectional area of one unit and a length of ten units that can dissipate 1.0 watt could dissipate 2.0 watts if either the length or the cross-section area is doubled. But if we double the cross-section the resistance drops to ½ of its original value. Inversely; the resistance value doubles if the length is doubled. We can double a resistor's dissipation by increasing both the cross-sectional area and the length by a factor of 1.414. Resistance and power dissipation depend on the resistor's physical dimensions.

Although normally operating electronic circuits are seldom thought to have surges of current, nearly all circuits are subjected to some surge currents. Most surge currents exist only until the various components become fully effective. For example; before a counter voltage is developed across the load impedance and biasing voltages are produced, the plate current of a vacuum tube circuit can be quite large. In other situations, component failures or high voltages can produce surge currents. It is common to multiply the expected power dissipation of a resistor by a *safety-factor*. A 10,000-ohm resistor carrying 10.0 mA, would be expected to dissipate 1.0 watt (10,000 x 0.0001). But with a safety-factor of 2 the resistor should be rated at 2 watts or better. Commonly a safety-factor of 2 is considered adequate; however, safety-factors may be as great as 5. Naturally a safety-factor of 5 is not going to be used if it will increase the cost of an electronic gadget from $10 to $12 or if its size would be substantially changed.

Although the voltages used with vacuum tube circuits are considerably larger than those used in transistor circuits the currents are rather small in either. In tube type voltage amplifiers the largest current, the cathode current, seldom exceeds 10 mA. Therefore, a resistor of 10,000 ohms would produce a dissipation of 1.0 watt ($I^2R = 0.010^2 \times 10{,}000$). But closer to a practical value would be a cathode current of 5.0 mA and an expected dissipation of ¼ watt. Transistor voltage-amplifier circuits commonly have collector and emitter currents of about 1.0 mA so resistors as large as 250,000 ohms have expected dissipations of only ¼ watt.

Oscillators are designed as power amplifiers with outputs of 1 or 2 watts and transistor versions use resistors primarily as voltage dividers with expected dissipations of 1.0 watt. The currents found in pulse generator circuits are similar to those in voltage amplifiers while pulse amplifiers have currents much like power amplifiers. Switching circuits are not often encountered by the average person but their currents can be quite large and require resistor dissipations of 10 watts or better.

In rectifier power supplies the resistors serve primarily as 'bleeders' carrying about 1/10 of the maximum output current. Dissipations required by bleeder resistors in some larger pieces of electronic equipment may be 5, 10, or even 50 watts. Bleeder resistors in the power supply section of broadcast transmitters have dissipation ratings up to 1000 watts or better.

Resistor values

Just as clothing is made in only certain sizes, resistors are available only in specific values. Resistors are manufactured in the wide range of values shown in Table 1. In designing electronic circuits, resistor values are chosen from lists like that given in Table 1. If design calculations indicate that a resistor should be 6000 ohms the designer would choose either the 5600-ohm value or the 6200-ohm value. The choice must be based upon the effect that an increase or a decrease in resistance might have on other components or on the overall op-

TABLE 1
RESISTOR VALUES

Ohms	Ohms	Ohms	Ohms
0.24	24	2400	240k
0.27	27	2700	270k
0.30	30	3000	300k
0.33	33	3300	330k
0.36	36	3600	360k
0.39	39	3900	390k
0.43	43	4300	430k
0.47	47	4700	470k
0.51	51	5100	510k
0.56	56	5600	560k
0.62	62	6200	620k
0.68	68	6800	680k
0.75	75	7500	750k
0.82	82	8200	820k
0.91	91	9100	910k
1.00	100	10k	1meg
1.1	110	11k	1.1meg
1.2	120	12k	1.2meg
1.3	130	13k	1.3meg
1.5	150	15k	1.5meg
1.6	160	16k	1.6meg
1.8	180	18k	1.8meg
2.0	200	20k	2.0meg
2.2	220	22k	2.2meg
2.4	240	24k	2.4meg
2.7	270	27k	2.7meg
3.0	300	30k	3.0meg
3.3	330	33k	3.3meg
3.6	360	36k	3.6meg
3.9	390	39k	3.9meg
4.3	430	43k	4.3meg
4.7	470	47k	4.7meg
5.1	510	51k	5.1meg
5.6	560	56k	5.6meg
6.2	620	62k	6.2meg
6.8	680	68k	6.8meg
7.5	750	75k	7.5meg
8.2	820	82k	8.2meg
9.1	910	91k	9.1meg
10.0	1000	100k	10meg
11	1100	110k	11meg
12	1200	120k	12meg
13	1300	130k	13meg
15	1500	150k	15meg
16	1600	160k	16meg
18	1800	180k	18meg
20	2000	200k	20meg
22	2200	220k	22meg

eration of the circuit. In many instances the choice becomes a matter of experimenting to determine which value gives greater amplification or less distortion; which value gives the largest output or the poorest efficiency, etc.

Resistors are manufactured to different tolerances. The actual or true value of a resistor is within a given percentage, or *tolerance*, of the value indicated on the unit. Common composition (carbon) resistors are manufactured to a 5% or 10% tolerance. A 6200-ohm resistor with a 10% tolerance may have a true value anywhere between 6820 ohms (10% above) and 5580 ohms (10% below). There are resistors that are manufactured to very close tolerances—within 1% or less—but they cost more. Most electronic circuits function well with 10% resistors.

As a matter of quicker and simpler identification of resistors and their values a system of color coding has been devised as shown in Fig. 8.

Resistor types

There are two basic types of resistors—fixed and variable. Fixed resistors have only one value and are further classified with regard to material and construction. The most common and least expensive fixed resistor is the carbon resistor. Actually the resistance material of these so-called 'carbon' resistors is a composition of different materials that has a higher resistivity than ordinary carbon or graphite. Fig. 9 shows

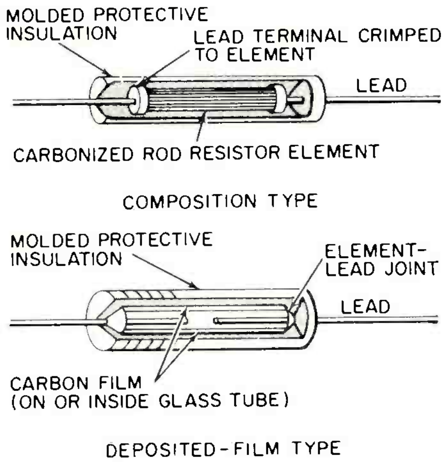


FIG. 9—CARBON RESISTORS. Composition and deposited-film types.

the construction of a modern 'carbon' resistor. The ratings of 'carbon' resistors range from ¼ to 2 watts and from a few ohms to a few megohms.

Fig. 10 shows the basic construction of two types of fixed wire-wound resistors. They are made by winding a length of

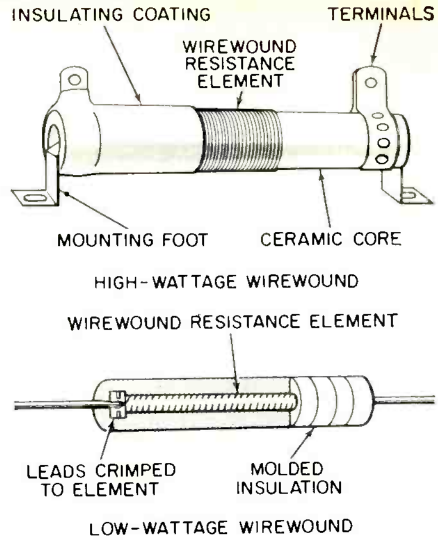


FIG. 10—WIREWOUND RESISTORS. Heat dissipation requires good air flow.

resistance wire onto a round porcelain form. Metal pieces are built into that porcelain form to serve as terminals. After winding the resistance wire onto that porcelain form an enamel containing powdered glass is baked on the unit to produce its vitreous enamel coating. Giving good mechanical protection and good heat dissipation this vitreous enamel is very smooth and usually brown in color.

Some small wattage wire-wound resistors are coated with a ceramic material (the same ceramic material being used for the core). An adjustable or fixed third terminal is sometimes provided on wire-wound resistors. With large dissipation ratings of up to 200 watts and resistance values from 1.0 to 100,000 ohms; wire-wound resistors serve as cathode resistors, voltage dividers in transistor power amplifiers, and bleeder resistors in rectifying power supplies. Ceramic wire-wound resistors, with their ratings printed on the grayish white colored body, have better insulation for high-voltage uses.

Precision resistors with tolerances within 1% of the value indicated on the unit are often *metalized* types. The resistive material is actually a film of metal or carbon deposited on a glass or other insulating core. Since this film is deposited by either electrolysis or spraying the thickness and resulting resistance can be very accurately controlled. Metalized type resistors usually look like carbon resistors and are often color coded in a similar way. However, these 'precision' metalized resistors (Fig. 9) cost 4 to 10 times more than 'carbon' resistors and are not used except where this precision is a must.

Just as it isn't practical to operate an automobile at a constant speed, it is not always practical to operate some electronic equipment at constant levels. Often it is desirable to change sound volume, television picture brightness, amplifier gain, etc. Variable resistors (potentiometers) are used to make such adjustments. Some adjustable resistors have wire-wound elements like those shown in Fig. 11. Others have com-

RESISTOR COLOR CODES

COLOR	DIGIT	MULTIPLIER	TOLERANCE
BLACK	0	1	±20%
BROWN	1	10	±1%
RED	2	100	±2%
ORANGE	3	1000	±3%*
YELLOW	4	10000	GMV*
GREEN	5	100000	±5% (EIA alternate)
BLUE	6	1000000	±6%*
VIOLET	7	10000000	±12-1/2%*
GRAY	8	.01 (EIA alternate)	±30%*
WHITE	9	.1 (EIA alternate)	±10% (EIA alternate)
GOLD		.1 (JAN and EIA preferred)	±5% (JAN and EIA preferred)
SILVER		.01 (JAN and EIA preferred)	±10% (JAN and EIA preferred)
NO COLOR			±20%

*GMV = guaranteed minimum value, or -0 + 100% tolerance.
±3, 6, 12-1/2, and 30% are ASA 40, 20, 10, and 5 step tolerances.

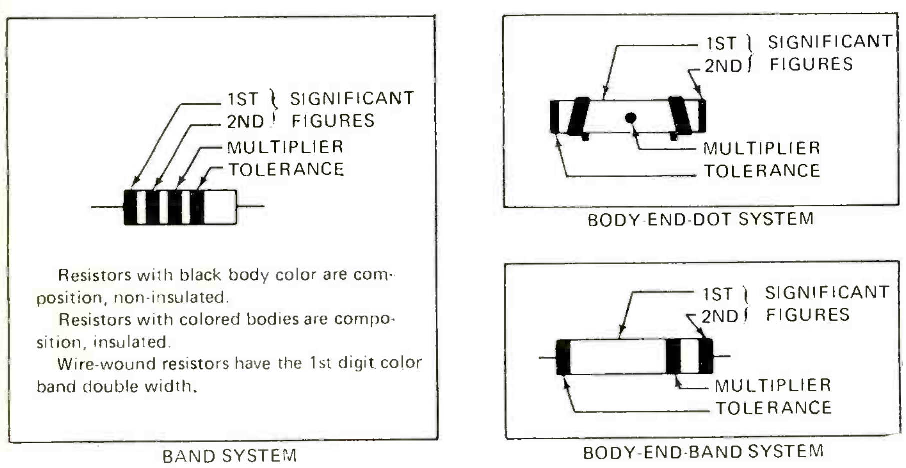


FIG. 8—RESISTOR COLOR CODING. Colored bands indicate value and tolerance.

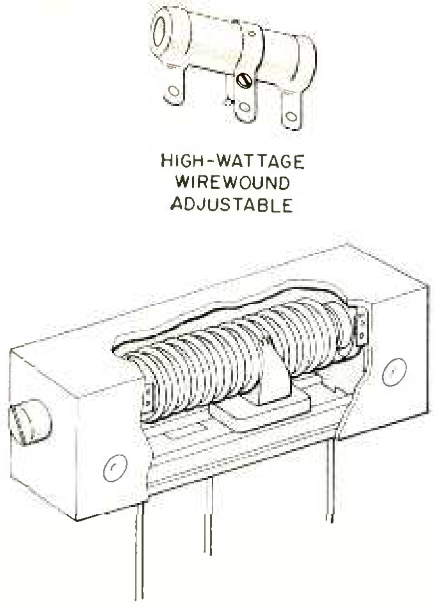


FIG. 11—ADJUSTABLE WIREWOUNDS. The trimmer is for PC board mounting.

position (carbon) elements. Doughnut shaped cores are used in wire-wound variable resistors. A circular groove in a bakelite base is used to form the composition type element. A variable contact rotates with an arm extended from a center shaft.

Most variable resistors are mounted with a nut on the threaded bushing surrounding the shaft. Variable resistors vary in size from 1.0 to 8 inches in

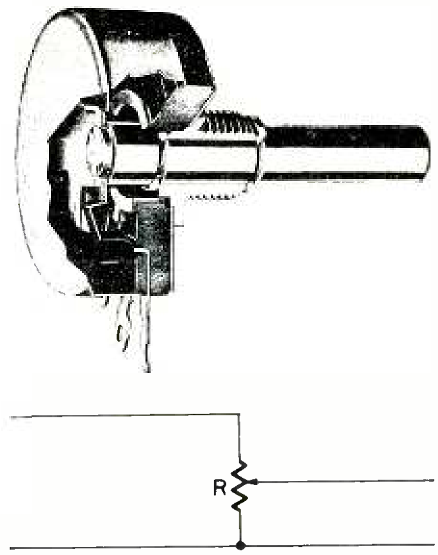


FIG. 12—CARBON POTENTIOMETER for most controls on hi-fi and TV sets.

diameter and up to 2 inches or better in thickness. With resistance values of from less than 1.0 ohm to several megohms, power dissipations extend from less than 1.0 watt to 500 watts.

In radios and sound equipment variable resistors are used primarily as voltage dividers (Fig. 12) to control volume, or as variable resistances to alter the gain or frequency response of an amplifier. In television receivers variable resistors are also used to control contrast, brightness, horizontal and vertical hold, linearity, hue, etc. (Fig. 13). Since most of these uses are in circuits with comparatively small current the composition

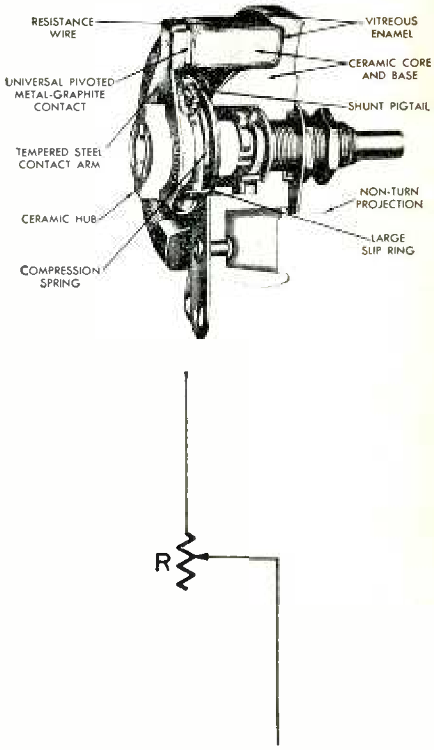


FIG. 13—WIREWOUND POT or rheostat, generally used for power control.

type is the most popular. However, to control individual loudspeakers the currents and the power dissipations exceed the limits of the composition variable resistors and wire-wound units must be used. Often these are ganged to make "L" and "T" pads. **R-E**

Grid-Dip Meter Extension

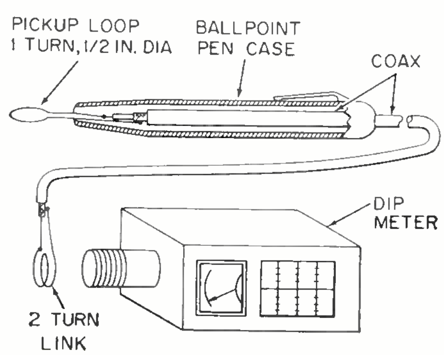
Use an old ball-point pen to make a handy accessory to your grid-dip meter

by W. P. TURNER

A grid dipper is a great piece of test equipment and should be available wherever rf equipment is to be designed, constructed, or serviced.

Probably the one most inconvenient feature of all grid-dip meters is its physical size. This holds true for the two-unit commercial models as well as the more common self-contained types. It is not so much that they are large but rather that the head will not always fit into the nooks and crannies which seem to be designed into most equipment. At lower frequencies the coil assembly is usually long enough to reach to within shouting distance of the desired circuit but as the frequency is increased the dipper coil shrinks to perhaps an inch protruding from the case. Try getting this even near a circuit buried 2 or 3 inches deep in a chassis and you will fully appreciate the magnitude of the problem.

There is a way of relieving the difficulty which requires neither a great deal of time or expense. It is only necessary to use some of the basic theory which each of us was required to know in order to get a ham license. Required are perhaps a 3-ft length of small coax (RG-174/U, 0.1" diameter), 6 inches of hookup wire and a ballpoint pen casing. The



innards of the pen are removed and the business end reamed slightly to accept the ends of a ½ inch diameter one-turn link of hookup wire. Inside the barrel of the pen the ends are soldered to the coax, insulated, and cemented in place. The remaining wire is formed into a 2 turn link which fits snugly on the coil form of your grid dipper. This link is soldered to the opposite end of the coax and secured. Shrinkable tubing is perfect to cover the joint.

The next time can't get the dipper's coil close to the circuit you want to check fear not. Merely slip the link over the coil form, place your probe so as to allow coupling into the desired circuit and proceed as usual. The only difference will be a more or less fixed load on the oscillator which doesn't effect its ability to indicate resonance. Best results are obtained with minimum coupling. **R-E**

Sweep Alignment Speeds Troubleshooting

To fix FM or AM radios fast use sweep alignment. R-E's service editor shows how to do it right

by **JACK DARR**
SERVICE EDITOR

THIS IS THE FIRST OF SEVERAL plain-language articles about all kinds of circuit alignment. In all except the most basic radio receivers, there are a number of circuits that must be tuned to precise frequencies. Since it is virtually impossible to construct tuned circuits that have exactly the desired amount of capacitance and inductance and, since tubes and transistors may add different amounts of stray inductance and capacitance, trimmer capacitors and variable inductances are used to compensate for small differences in the characteristics of each tuned circuit.

The process of adjusting the circuits to precise frequencies is called *alignment*. The results of alignment is a *response curve* that shows how the output of a circuit(s) varies with frequency.

The simplest curve is the bell-shaped response of a single tuned circuit or of a number of circuits tuned to the same frequency; as in the i.f.'s of an AM or FM receiver. The i.f. stages in a TV set often consist of a number of cascaded circuits, individually tuned to provide equal output over a band of frequencies while attenuating some adjacent frequencies by specific amounts. Not all response curves are bell-shaped. A discriminator used for FM audio detection is aligned to produce a symmetrical "S" while a discriminator in afc and aft circuits has a distorted-S response when correctly aligned. Some of the more common types of response curves are shown at the top of this page.

Alignment is simple. You don't have to know how a resonant (tuned) circuit works as long as you know how it *reacts*. (It helps to know how it works, of course.) But, if you know how these circuits react when they are working, and what they do when they're *not* working, you can test, repair and align them.

The "fault symptoms" are easy to recognize, with the proper tests. It is really as easy as ABC. So, let's begin, as usual, with

A Alignment involves *tuned circuits*. So, let's see how tuned circuits work. Each consists of inductance and capacitance. They're all resonant at *one* frequency. Even if you see only a coil, the capacitance is still there; it's the capacitance between turns of the coil. Capacitors, too, will resonate with their own lead-inductance.

Figure 1-a shows a tuned circuit with a capacitor and inductor connected *in parallel* across a signal source. This is a *parallel resonant* circuit. If we feed in a band of frequencies only the resonant frequency will be passed at full amplitude; signals above and below resonance will be attenuated or removed entirely. In Fig. 1-b we have a *series-resonant* circuit—inductance and capacitance *in series* across the signal source. When this circuit is used in this manner, *it attenuates signals at its resonant frequency* and passes all others. The characteristics of series-resonant and parallel-resonant circuits are interchanged when they are inserted in *series* with the signal path. Now, a series-resonant circuit passes a signal at its resonant frequency and rejects all others; while a parallel-resonant circuit becomes a "trap", rejecting a signal at its frequency and passing all others. Thus, resonant circuits can be used alone, or in combination, to give us what we need—*selectivity*.

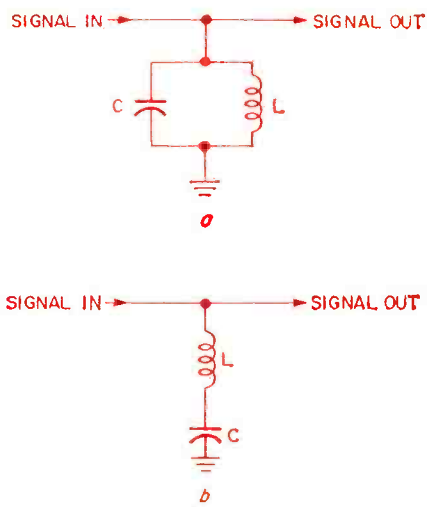


FIG. 1-a—PARALLEL-RESONANT CIRCUIT passes the resonant frequency. b-SERIES-RESONANT CIRCUIT traps the resonant frequency.

B That's how it works. Now, how can we *tell* if it's working properly? The easiest way is to feed in a signal at the resonant frequency, then vary this signal above and below resonance. If we put a detector on the output, so that we can read the output signal voltage, we will get something that could be plotted on paper, and come out looking like Fig. 2. This is a response curve. Below the right frequency, the signal is cut off; above the right frequency, it's cut off. Right at the *peak* frequency, it is amplified.

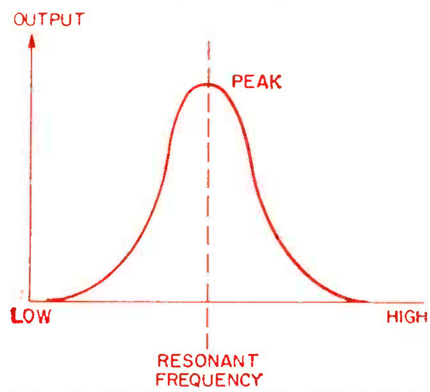


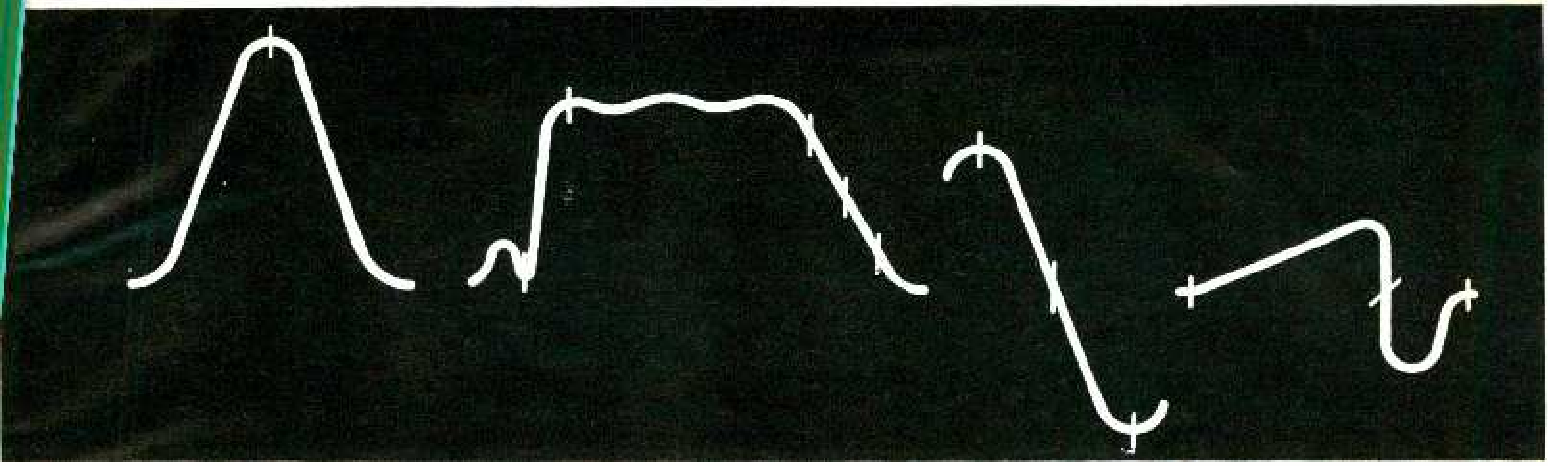
FIG. 2—WAVEFORM AT OUTPUT of resonant circuit when a sweep-frequency signal is applied to its input.

Now, here we go for the most important fact in 'B'. *All* circuits have a bell-shaped response curve like this (! If they don't, they're **not** working. This is called a *peak;* sometimes used as a noun, sometimes as a verb, but it means the bell-shaped curve is there when you sweep a resonant circuit.

Variations: If the circuit is fixed, and we vary the applied frequency, we get a bell-shaped curve. If we leave the frequency fixed, and vary the size of either the coil or capacitor, we get the same thing.

Remember this, the most important thing about it—this represents the *amplitude* of the output when the input signal frequency is varied back and forth *across* the resonant frequency. In other words, this is an "amplitude vs frequency" curve, and it shows a peak with a rounded top.

C Now, how do we get curves like this? More important, what good is it? How can we use it, in testing? This is where we get down to the real nitty-gritty!



Peaking or Sweeping

There are two ways of aligning a tuned circuit. One is by feeding in a signal, at the proper resonant frequency, and then tuning all coils or capacitors for *maximum* output. We connect an output indicator across the output of the circuit(s), and simply tune all adjustments for a peak. This is called *peaking*.

After you finish, you can draw the bell-shaped curve, if you want to. Just tune the signal generator below the resonant frequency until the output has fallen to zero. Now, start back up, moving the signal-generator dial say 1.0 kHz at a time. Log the amplitude of the output on a piece of graph paper. When you finish, you'll have something that looks like Fig. 3.

When you connect up all of the dots, you'll have the bell-shaped curve. Although you can't see it (yet) the design of the circuits will be such that simply peaking each adjustment will give you the right curve. This is actually done in radio receiver i.f. stages, and similar uses. Single-frequency alignment, like this is called peaking, because you simply adjust each stage for maximum or peak response.

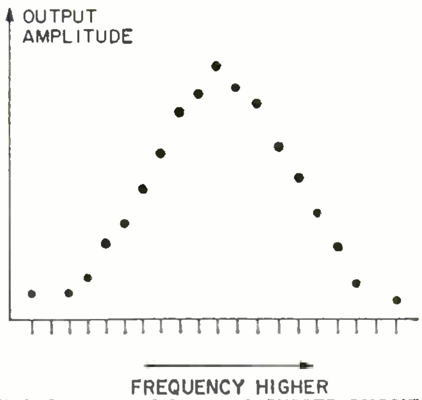


FIG. 3—HOW TO DRAW A SWEEP CURVE using the conventional, non-sweep, signal generator you have on your bench.

There's another way. If we feed in a signal which is being *varied* or swept back and forth across the resonant frequency, we can connect the output to a scope so that we can actually *see* the curve. The input to the resonant circuit is an FM signal, and the process is called sweeping the signal, because it sweeps back and forth across the the desired frequency. More (MUCH more!) on this in just a minute. Let's finish up peaking methods first.

AM radio alignment

To start with the simplest alignment of all, peaking the i.f.'s of an AM radio, all we need is a single-frequency rf signal generator, and the output indicator. If we use an AM-modulated rf signal, we can connect an ac voltmeter across the speaker voice coil and read the demodulated AM signal, or use the Well-Calibrated Ear to judge the loudness of the modulation heard from the speaker. A dc vtvm connected to the avc bus reads the avc voltage developed by the detector. This dc voltage is directly proportional to the amount of rf signal applied to the detector.

AM radios have only two sections to align; the fixed-frequency i.f. stages (Fig. 4) and the variable-tuned "front end"; meaning the rf, oscillator and mixer. The i.f. must be aligned first.

I.f. alignment

The first step is to disable the oscillator by shorting the stator of the os-

(continued on page 68)

WARNING!

At this point, let's stop to get in a very important thing. never Never NEVER *NEVER* Try to make *alignment* adjustments on a DEAD set!! You must be able to get a signal through it first. This applies to ALL types of electronic equipment.

Remember this; if a set *has* been working, and suddenly quit, you have a bad part somewhere, NOT an alignment problem! They do not suddenly "jump" out of alignment, all by themselves. Find the bad part, replace it, then make sure that you can get a signal through to the output *before* you try any alignment adjustments. You can use your alignment equipment to make signal-tracing tests; the signal generator is a handy way of finding out how far the signal is getting through the circuits.

In a lot of cases, you'll find sets which have been, quite literally, "screwed up" by previous "technicians" (???) *They* failed to find the real trouble, then got out their little screwdrivers and started turning everything in sight. Result, a set which now is so badly out of alignment that a signal can't get through!

When this happens, you begin by fixing the trouble. Then, start with the last tuned stage, for example the last i.f. transformer in a radio. Put an output indicator on it, although you can use a modulated signal and simply listen, for the time being. Get the last stage tuned up, roughly, then move the signal generator to the input of the stage ahead of it; tune this up, and keep on until you reach the antenna. After this, you can hook up an output indicator, and align all of the circuits for the proper overall response. This method applies to any type of electronic equipment using tuned circuits: radio, TV, etc.

In fact, I firmly believe that a minimum of 80% of the alignment work you will have to do will be from this cause! I have run into hundreds of them, some so badly off that they had no output at all. In these, you'd find things like trimmer capacitors screwed down so tightly that it was almost impossible to turn them. Someone had "found all of them little screws loose, and tightened 'em up!"

I have, on several occasions, checked TV sets that were ten and even fifteen years old, which *I* knew from personal experience had *not* been tampered with; checking the alignment of these sets showed that they were still practically perfect! Because of the design and construction of TV i.f.'s, etc, they seldom "get out of alignment" all by themselves. They have help! So, make sure the set is in good working order *before* realigning it.

Solid-State — the newest development

Count on NTS training to always feature the latest electronic equipment.

Now included in two exciting NTS color TV courses, this set is the largest, most advanced color television made. Guided by the NTS "Lab-Project Method" of combining professional kits and easy-to-follow lessons, you build this color TV step by step — learning TV Servicing as you go! NTS has successfully trained thousands of men at home for rewarding careers as electronics technicians. Prepare for the great opportunity fields of TV-Radio Servicing, Computers, Communications, and Automation.

This solid-state color set contains: 45 transistors, 55 diodes, 2 silicon controlled rectifiers, and 4 advanced Integrated Circuits representing an additional 46 transistors and 21 diodes. The first solid-state color TV this large — yours to keep! It features Automatic Fine Tuning; "Instant On"; an Ultra-Rectangular Screen (25 in. diagonal measurement) that lets you see the complete transmitted image for the first time — a full 315 square inches; exclusive built-in Self Servicing features which eliminate the need to buy costly test equipment; exclusive design Solid-State VHF Tuner with an MOS Field Effect Transistor; 3-stage Solid-State IF; Automatic Chroma Control; Adjustable Noise Limiting and Gate Automatic Gain Control; High Resolution Circuitry; Matrix Picture Tube; and a specially formulated Etched Face Plate that eliminates unwanted glare, and heightens contrast. Colors are more vivid, fresh tones more natural, and the picture is sharper than ever before. By training on this unique color TV, you'll gain the most up-to-date skills possible in TV Servicing!

Other valuable equipment you build and keep includes an AM SW Radio, Solid-State Radio, FET Volt-Ohmmeter, and Electronic-Tube Tester. All included in your tuition. You learn trouble-shooting, hi-fi, multiplex systems, stereo, and color TV servicing. Step right into a technician's job at top pay or open a business of your own! For complete details on *all* NTS electronics courses, mail the coupon today for the full-color NTS Catalog. No obligation. No salesman will call.

SWEEP ALIGNMENT
(continued from page 63)

cillator section of tuning gang to ground. Smaller radios usually have so little front-end selectivity that the i.f. signal can be fed directly to the antenna! It will get through to the mixer, and on through the i.f. stages. If it won't, couple the rf signal generator loosely to the mixer stage. Ordinarily, it will get through if the end of the signal-generator output cable is clipped to something close to the mixer input. You can hear the 400-Hz modulation in the speaker, and tell whether you're getting through or not.

After this, hook up the output indicator, and you're ready to go. Set the signal generator to the correct intermediate frequency. In most sets, this will probably be about 455 kHz, many car radios have the i.f. around 262 kHz. (Incidentally, car radios have excellent front-end selectivity and you'll have to feed your signal to the mixer!) To be sure, check the schematic diagram. This will usually show the i.f. used.

Adjust the rf output of the signal generator to show a *small* reading on the output indicator. Using too much signal input will cause the avc to reduce the gain, and this will actually flatten the normal peaks. If your meter-reading goes too high while tuning the i.f. stages, reduce the rf output of the signal generator; don't switch to a higher meter scale. This way, you will be sure that you're getting the sharpest peak in the tuning.

But, what if it doesn't peak?

Now, we come to the most important fault-reaction of all. As I said, this works in **all** tuned stages. Let's assume that we have three i.f. transformers, each one double-tuned (both primary and secondary are tunable). When we tune up the first and third transformers, our reading rises to a peak, and drops off on either side. These transformers are good. They will "peak" (verb).

But! when we turn the secondary adjustment of the second i.f. transformer, it shows a peak; the primary adjustment doesn't. No matter where we turn the trimmer screw, the meter reading doesn't change. **Now** we've found something! This transformer is "flat", no peak. This shows that something is *wrong*.

Right at the moment, we don't know exactly *what*, but we do know that this transformer is *defective*. The resonating capacitor may be shorted or leaking; the winding may have corroded and developed a "high-resistance joint" (puts high resistance in series with the winding). It is not *open*, for if it were, we wouldn't get any signal through the transformer. An ohmmeter check of the bad winding will often show up the type of trouble. Zero resistance indicates a shorted resonating capacitor.

Next, make sure the B+ and avc bypass capacitors are ok. Check by bridging with a good one; if this clears up the trouble, the capacitor's open and must be replaced. If the bypass capacitors are ok, replace the transformer. After this, recheck the alignment. If the primary now shows a normal peak, fine!

Oscillation when peaked

There is one other fairly common trouble which shows up during alignment, but is not necessarily due to defective transformers, etc. Quite the opposite, in fact. The symptom of this is unmistakable: all transformers will peak, but when you reach the peak reading on the meter, it suddenly jumps to a very high value; the meter often slams off-scale. *Detuning* the tuning adjustment will bring it back on-scale.

This is due to lack of bypassing at the "bottom" (B+ and avc ends) of the tuned circuits! The tuned stages are going into oscillation. They are actually *generating* a signal! This comes on through the last stages and shows up as a very high meter reading. The cause of this, as in any oscillation, is *feedback*. If the bypass or filter capacitors are open, some signal appears on to the dc supply lines, avc, etc. This signal gets into other stages, and causes oscillation.

Oscillation starts because your signal level is highest when the stages are peaked. When they are detuned, the signal is not great enough to cause the feedback. So, you can detune one stage, reducing the signal level, and get the signal on through; however, you'll find that none of them can actually be peaked as they should.

Cure: check filters and bypass capacitors by bridging. You'll find one or more that will make the oscillation stop. When you do, replace it. (In many small ac/dc tube radios, the output electrolytic filter capacitor serves as a "bypass" for all tuned stages. So, if this goes down in capacitance, the set will oscillate. Replace both filter capacitors.)

Remember, if you find a circuit that is supposed to peak, but won't, you've found the trouble. It does not matter whether this is a simple radio i.f., a TV i.f. transformer, a color bandpass transformer—any of them. Any tunable circuit which will **not** peak isn't working!

AM radio front-end alignment

After we've got the i.f.'s all tuned up, all there is left to do is align the front end. This includes the mixer, oscillator and rf stage, if any. (Scarce in small transistor portables; always used in car radios.) There are two types of adjustment made here. One is the same old peaking we've just done, and the other is similar, but for a different purpose. *Remove the oscillator shorting clip lead.*

The local oscillator of the radio must be set so the frequency of the stations tuned in matches the figures on the dial. When the pointer says "1,000 kHz", that's what you get. The converter or mixer input and the input to the rf amplifier (if any) must be tuned to the frequency of the desired station while the oscillator is (usually) tuned to a frequency equal to the desired signal *plus* the intermediate frequency. When tuning across any band, the tuned circuits must be adjusted to maintain a *constant difference* in frequency (equal to the i.f.) between the oscillator and other circuits. Since the oscillator tuning must *track* with the tuning of the mixer and antenna circuits, adjustment of these circuits is called *tracking*.

Tracking is a 3-step process. First, run the dial pointer all the way up and down the dial. At the low end, make sure that it stops exactly on the calibra-
(continued on page 82)

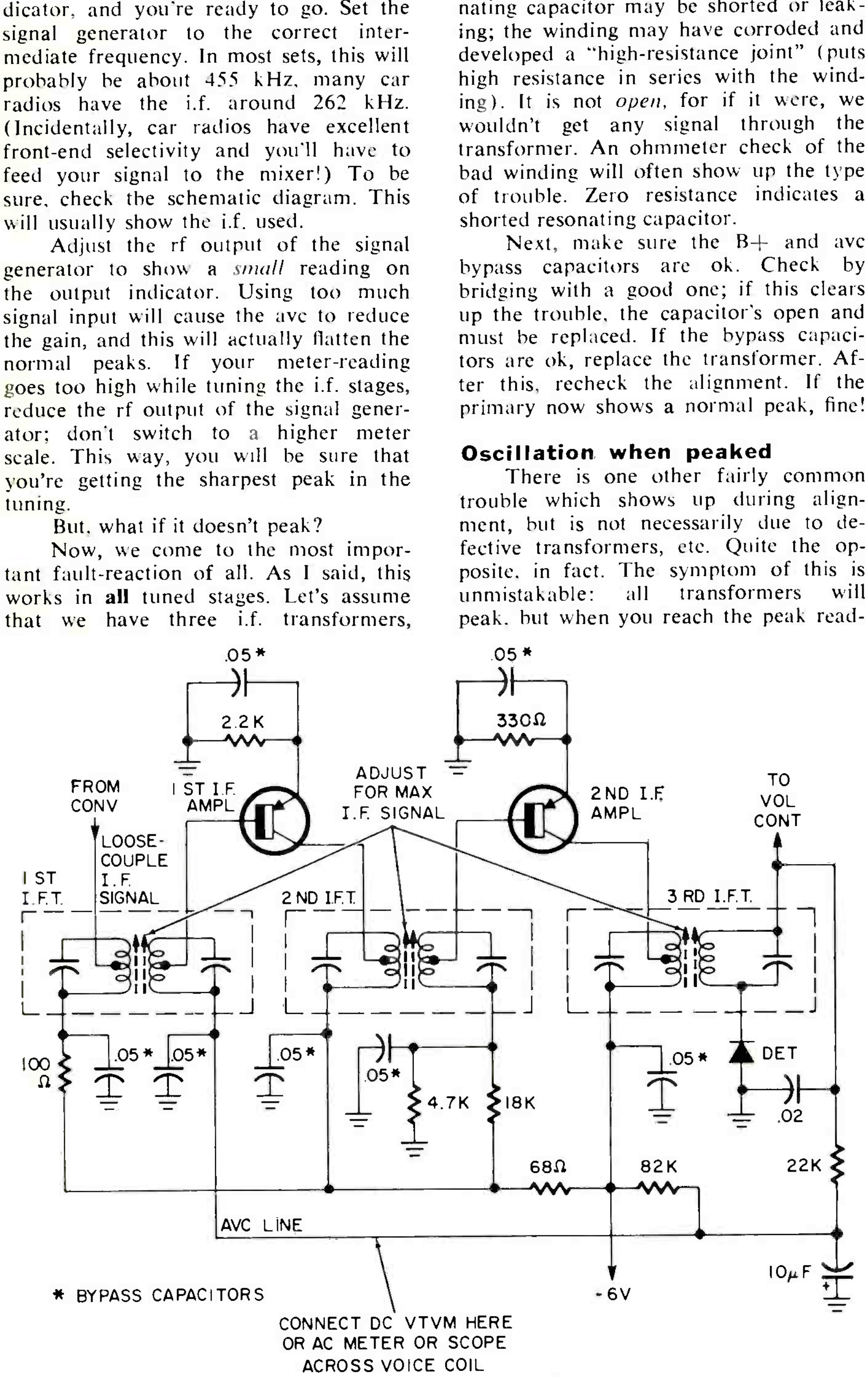


FIG. 4—TYPICAL AM RADIOS have two sections to align: fixed-frequency i.f. stages and variable-tuned front end.

IC Power Supplies

dual outputs with uA723's

Two more regulated-output supplies. These have dual outputs delivering positive and negative voltages

by WALTER G. JUNG

HERE IS THE FINAL SECTION OF OUR discussion of IC power supplies. It is completely concerned with dual-output supplies. Two circuits you can use are presented.

Now suppose we had a regulator that was the mirror image of our positive regulator. We could regulate negative leg voltages in the same manner as we've done for the positive voltage.

The big advantage to taking this approach is that it allows us to use a single transformer in a center-tapped bridge hookup, thereby saving a complete power transformer in some applications (see Fig. 1). We can make the negative regulator quite simple by slaving its output to the positive supply, forcing it to be equal and opposite. This means the negative output voltage will always be equal and *opposite* to the positive voltage. So by adjusting the positive potential we will be adjusting the negative one also, as it *tracks* the positive.

To see how this is done turn to Fig. 2, a dual (±) 12-volt supply with a 100-mA output from both sides.

In understanding this regulator, it might be well to think a moment of what is desired of this negative voltage supply. We already have a good positive 12-volt supply using the μA723. This is the upper portion, basically the same as Fig. 1, page 49 of the July issue. What we would like is a negative voltage that is the mirror image of this one, or −12 volts.

If we had a dc power amplifier which could supply a lot of current, we could feed it the +12 volts and get out −12 volts, couldn't we, the −12 volts being supplied from an unregulated minus voltage. Well, what we have boils down to just about that. The μA709 IC and pnp emitter follower Q1 form the power amplifier, and the +12-volt line is used as a signal input to the μA709. Recalling our illustration of a feedback amplifier (see **Radio-Electronics**, June, 1971, page 58), we recognize R4 as R_{in} and R5 as R_f. This is an inverting amplifier with a dc gain of −1 as $\frac{R_f}{R_{in}} = \frac{10{,}000}{10{,}000} = 1$

It regulates the −12-volt output by exactly reproducing the +12-volt output inverted. The unregulated input changes and ripple appearing across C5 (the negative supply's unregulated input) do not appear on the output because of the degeneration inherent to the IC and the extremely low output impedance provided by the 100% negative feedback.

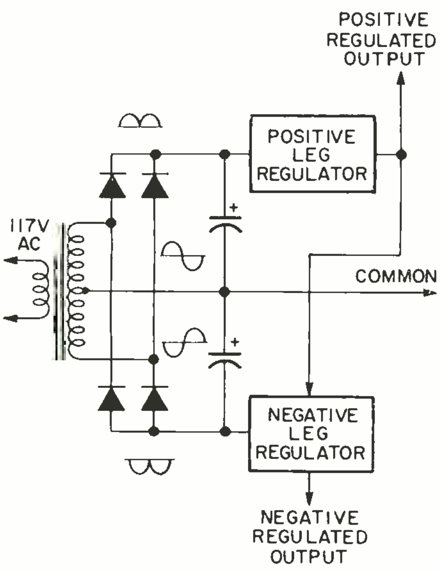
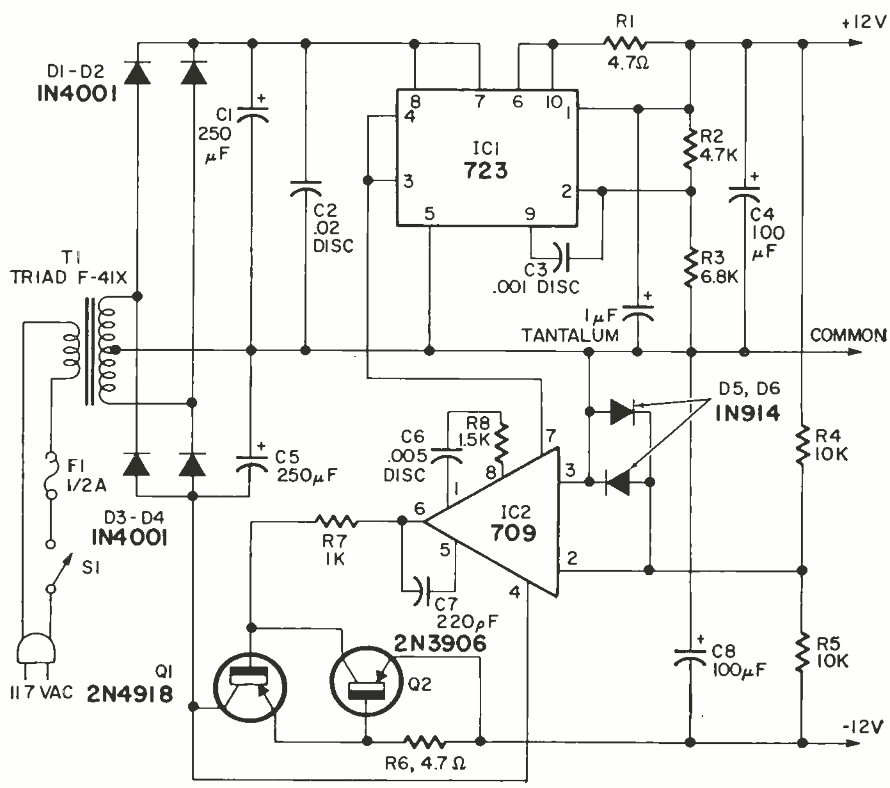
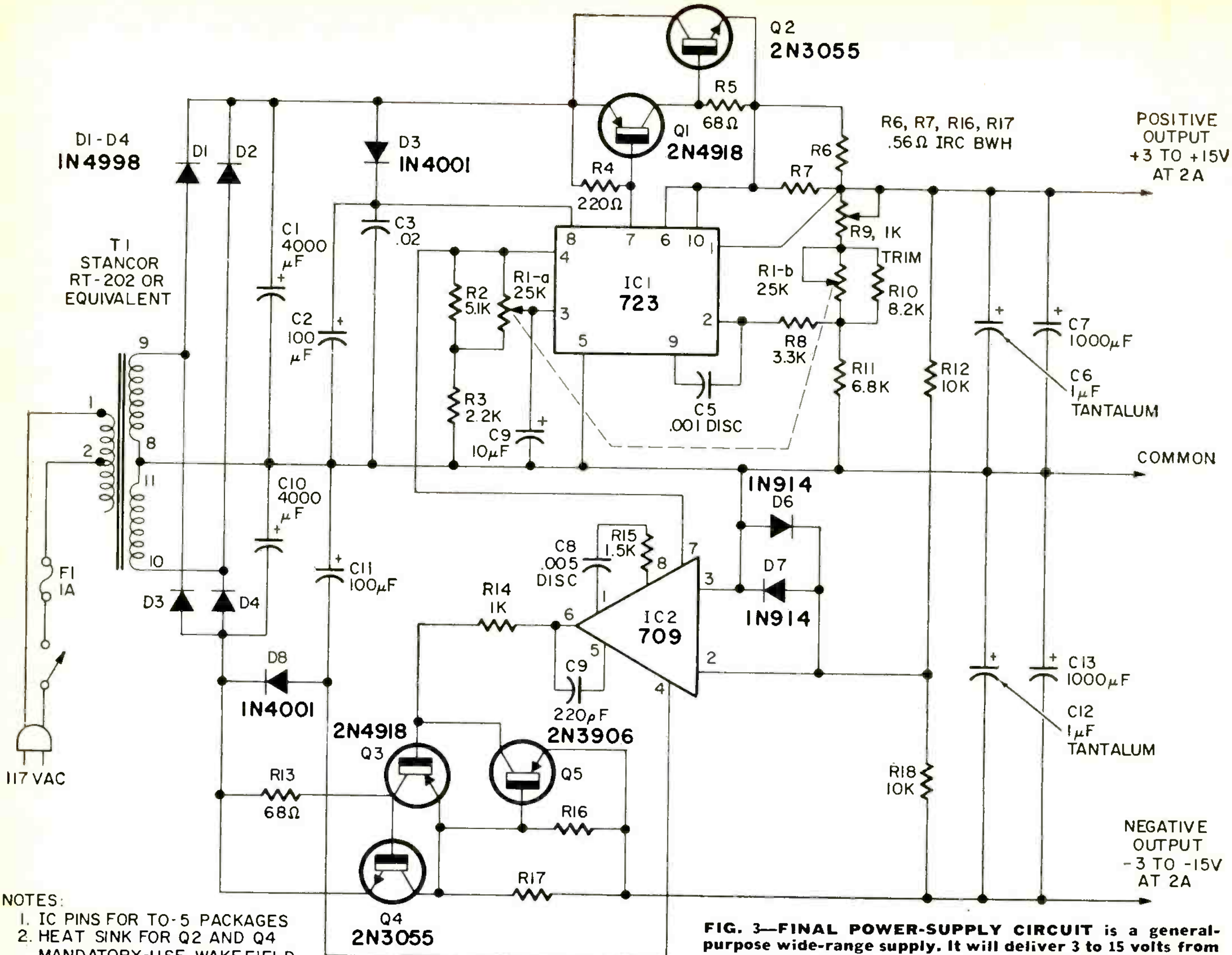


FIG. 1—DUAL-OUTPUT CIRCUITS take advantage of center-tapped power transformers. Both outputs track precisely.



NOTES:
1. PIN NOS. FOR BOTH IC's FOR TO-5 PACKAGE
2. USE CLIP-ON HEAT SINK (NF-207) ON IC1

FIG. 2—DUAL 12-VOLT SUPPLY delivers 100 mA both positive and negative legs.



NOTES:
1. IC PINS FOR TO-5 PACKAGES
2. HEAT SINK FOR Q2 AND Q4 MANDATORY-USE WAKEFIELD NC641 OR EQUIVALENT.

FIG. 3—FINAL POWER-SUPPLY CIRCUIT is a general-purpose wide-range supply. It will deliver 3 to 15 volts from each of its outputs. One output is positive, the other negative.

Since this negative voltage regulator is really an amplifier amplifying whatever it is fed from the positive input, it logically follows that changes in the positive supply will appear equal and inverted on the negative supply. If you adjust the positive output from +12 to +10, the negative will move from −12 to −10, following or "tracking" the positive supply.

Another practical detail of the circuit is current limit transistor Q2—used to bias off the regulator under overload conditions. This transistor works like the scheme used in the μA723. When the output current passing through Q1 becomes higher than a predetermined limit, Q2 turns on and removes bias from Q1, limiting the output current and preventing damage. Additional protection for the input stage of the μA709 is provided by the back to back diodes (D5-D6) across its input terminals which limit excess voltage under overload conditions. The μA709 uses the standard frequency compensation networks (R8,C6,C7).

By using this idea of a tracking complementary regulator we've eliminated many of the components of a second regulator. We've saved a second power transformer and simplified the negative regulator. This particular circuit version (±12 volts 100 mA) is ideal for powering operational amplifiers circuits (using more 709's) which we'll be talking of later on.

As a finale for our power supply discussions on the μA723 IC we'll develop that general-purpose wide-range supply we mentioned earlier. This circuit is basically the same as the dual supply of Fig. 2, but has a variable voltage feature of 3 to 15 volts. In addition the current output of both legs is raised to 2 amperes. Since the voltage variation from 3 to 15 volts is something we have not covered as yet, we'll talk about that feature first, then the supply as a whole.

The schematic of this wide-range general-purpose supply is in Fig. 3, and as before we notice many similarities to the previous circuits. The μA723 upper portion is a 2-amp regulator similar to Fig. 1 in some respects. The main difference is in the voltage determining components. From our earlier circuits we recall that dividing the reference voltage of the μA723 gave us voltages lower than 7.15 volts, and scaling the output divider gave voltages greater than 7.15. But suppose we wanted a range of voltage from below 7.15 volts to well above, could we do this in a single circuit? The answer is yes and Fig. 3 is an example of such a hookup.

This circuit uses a combination of reference voltage division (R1-a–R3) and output scaling (R1-b–R11) to both create a variable reference voltage at pin 3 and scale this voltage up. R1-a and R1-b are a ganged pair of pots connected so that as the resistance of R1-b *increases*, R1-a moves towards pin 4's potential (7.15 volts). Assume for a moment that R1-a is at maximum and pin 3 has the full reference voltage of 7.15 volts on it. Then with the full resistance of R1-b in the circuit the output voltage will be determined just as we calculated in the July issue. It will be the voltage across R1-b + R9 plus the voltage across R3 (7.15 volts). The values of R1-b and R9 are chosen to give 15 volts out with 7.15 volts on pin 3, the maximum output. In addition, the resistance of R9 serves as trim control for fine adjustment.

As the wiper of R1-a moves towards R3, two things happen to lower the output voltage. The voltage at R1-a's arm will be less than 7.15 because of the division. And R1-b will be a smaller resistance also, so these two things lower the output. At the other extreme of rotation R1-b is shorted and R1-a–R3 is at 3 volts, the lower limit of the circuit. With this range of voltage adjustment of the positive regulator, it is easy to make the

(continued on page 94)

R-E's SERVICE CLINIC

afpc troubles in color sets

Mysterious color-sync problems are often in the 3.58-MHz oscillator's control circuits

By JACK DARR
SERVICE EDITOR

MANY CASES OF "MYSTERIOUS" COLOR-sync trouble or even a loss of color, can be traced to obscure faults in the afpc. Spelled out, this is Automatic Frequency and Phase Control of the 3.58-MHz oscillator. Not really so obscure, of course, since there's no such thing as a fault which will not show you definite symptoms if you make the right tests, in the right places, with the right equipment!

Let's look at this circuit and see where these key test points are, what the normal reactions are; and most important, what the fault-reactions are. A typical afpc circuit is in the diagram. The burst is fed into a center-tapped transformer secondary winding. The signal is now 180° out of phase at each end of this winding. A diode is connected to each end, through small capacitors. The other ends of the diodes are tied together and a pair of matched resistors is connected across the diodes. The 3.58-MHz oscillator signal is fed to the junction of the diodes.

This is a simple phase-detector, and you get no long detailed explanation of how it works! You've been working with it for too many years. It's nothing but a plain old horizontal af Circuit.

If it's working, you get a balance between the voltages developed across the diodes and a zero dc voltage at the center-tap of the resistors, when the color (or picture) is locked in. If it isn't working, the dc voltage is off-zero and the control circuit pulls the oscillator *off-frequency* instead of locking it in! Notice the direct similarity between color out-of-sync and a picture out of horizontal sync. Diagonal lines just as before, but now the *picture* stays on and the *color* breaks up into diagonal lines or rainbows of red-green-blue.

What we need

What do we have to have to make this work? First, burst. In this circuit, the burst comes from the burst-amplifier plate through an isolated primary winding. In others, it may come to one end of the center-tapped winding, with the other end grounded.

We must have a good stout burst signal in this winding, 180° out of phase at the ends, and that's all. The *amplitude* of this signal is important. Check the schematic to see what is normal for the one you're working on. Average values, at least 50 volts p-p and sometimes more, up to perhaps 100 volts p-p.

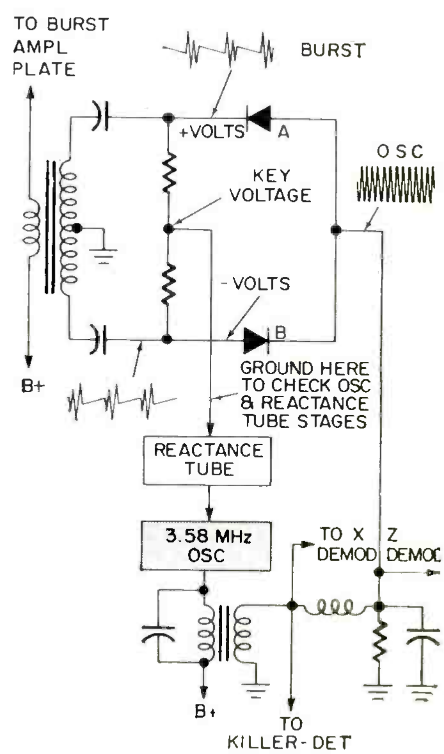
Second, we need the 3.58-MHz oscillator signal. This is taken off at the phase-shifted Z-demodulator tap of the oscillator output coil in this one. It may come from other points in other circuits, but it's gotta be there. The presence or absence of either of these signals is easy to detect with a scope.

Right now all we need to know is "Are they there?" Never mind the phase for a while. There's an awfully simple way of telling whether it's in-phase or not. Just look at the picture!

Quick-checks

The fastest way, and one of the easiest tests you can make, is to read the dc voltage developed across each diode with a color-bar signal on the set's antenna input. You can do this on a TV signal, but the bar-dot gives you a steady, controllable input signal. This must be read with a vtvm or tvm. As you can see, the voltage will be positive, on the cathode of diode A, and negative on the anode of diode B. These voltages *must be equal and opposite!*

If they're not, the circuit won't balance. Your voltage at the key test point, the cener-tap of the two resistors, will not be zero and the 3.58-MHz oscillator will be pulled off-frequency. In normal operation, this voltage is zero. If the oscillator drifts one way, the phase-detector develops a negative voltage and pulls it back. If it drifts in the other direction,



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

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

the detector develops a positive voltage and pulls it back.

Why weak color-sync?

If you have weak color sync, check these voltages. You may find that your reactance-tube grid is reading about 2.0 volts positive or negative. If so, this is wrong! The chances are that someone has run a setup adjustment on the oscillator, and pulled the oscillator back to a point where it will make color, by main strength and awkwardness. This is something like driving a car with one front tire flat. You can hold it on the road, but you have to exert a steady pull on the wheel; and if you let go for a moment, POW! The set will have a tendency to lose color sync on scene changes, station changes, etc.

Isolation tests

Since you have a servo-loop type of control system, you must break the loop and check one part at a time to check it reliably. Ground the grid of the reactance tube. This clamps it at zero voltage, or at the point where it ought to run. It also eliminates any afpc action; the oscillator is free wheeling.

With a color-bar signal on the screen, tune the reactance coil in the reactance-tube plate circuit. This varies the frequency (and phase) of the oscillator. If you can get the normal reaction on this test, the oscillator *is* capable of running on-frequency. The normal reaction, as the reactance coil is tuned through its full range, is small and numerous rainbows to start with; getting fewer and larger as you approach the correct point; then gradually straightening up and momentarily locking on the right colors. (Third bar red, in the bar pattern.)

Going on in the same direction, it should fall out of sync again, making more and more rainbows. Some reactance coils will tune far enough to kill the 3.58-MHz oscillator or throw it so far out of phase that the color will drop out entirely.

Does this sound something like adjusting a horizontal oscillator with afc? It should! It's *exactly* the same method, substituting color rainbows for slanting lines in the picture!

Diode tests

If the oscillator will set up and lock in momentarily, it's ok. If taking the ground off the reactance-tube grid makes the color fall out instead of locking tightly in, you've got diode problems. A voltage reading on the grid will probably show you a voltage quite a bit off zero.

Now, read the dc voltages on the diodes. These should be equal and opposite. This is easier to see on the grid test-point, since you can use a lower voltage scale, preferably a zero-center. (Incidentally, even if you do not have a zero-center scale on your vtvm, you can set the needle to center-scale or somewhere near center with the zero-adjust. Then you can see quite accurately whether the key voltage goes positive or negative.)

Normal reaction

This key voltage should be zero. You should also be able to make it go positive or negative by adjusting the core of the reactance coil. The deviation should be the same on each side. For instance, ±6 to 8 volts seems to be a good average range.

If you find this voltage will go from about −8 volts up to −1 volt, then turns around and goes back toward negative again, you almost certainly have unbalanced diodes. The fastest way to check this is to substitute a matched pair of replacement diodes. Use the factory replacements if possible. If both voltages now read the same *polarity*, turn it off and reverse one of the diodes!

If new diodes won't help

If the replacement diodes won't make the voltage zero, try a new crystal. This is not common, but in a few cases the resonant frequency of the crystal will be off just enough to make it impossible to balance the circuit properly. If the oscillator frequency seems steady enough after it is adjusted, but the voltage is not correct and won't "cross zero," this would be the next thing.

All of the little capacitors in this circuit should be checked, of course. One that causes some odd problems is the feedback or neutralizing capacitor from the plate to grid of the reactance tube. In the set from which this was taken, this is a 3.9 pF, NPO. Any type can be used for testing, but for replacement, an exact duplicate must be used. The temperature-coefficient is very important; this one is an NPO, meaning zero drift in capacitance with temperature change.

The killer detector

Another circuit, not shown here, is fed from the same transformer winding. This is the killer detector. It uses the same diodes, connected in the same way, with the pair of resistors, etc. However, this one is fed 3.58-MHz signal from a different point, at the X-demodulator takeoff. This is 90° (in this one) out of phase with the Z-demodulator takeoff.

This circuit is *intentionally* unbalanced, and it will develop a high negative voltage at the junction of the two resistors. It is used to signal the *presence of burst* in the incoming signal, and makes the color-killer open the color channel and let the signals through.

This is not as critical as the phase detector, of course, but it can cause trouble. If you have "no-color" problems, such as the killer cutting off the bandpass amplifier on color programs, check these diodes. If one of them should open, for example, it could upset the killer bias.

If you know what this thing does, and how it does it, it's not at all difficult to fix. Just pretend you're working on a plain old horizontal afc circuit! It'll be a lot easier.

MULTIPLE SYMPTOMS

I've got more symptoms in an old RCA KCS-113 than you can shake a stick

at! The sound is garbled, there's no picture, and half of the screen is black; the left half, vertically! It would work for a while then go into this kind of trouble. —A.S., Miami, Fla.

Try bridging some of the filter capacitors. C121, the input filter, is a good "likely suspect." Multiple symptoms like this are usually caused by an open filter in the dc power supply, which is the only thing common to every stage in the set.

SUBSTITUTE FOR 6AD7

I need a 6AD7 tube for an old radio, and I can't even find it on the lists. Do you know of another type that will replace this thing? I'll change the socket if I have to.—T.W., Cupertino, Calif.

You'll have to! There's no direct replacement for the 6AD7 triode-pentode. However, a type 6BM8 looks as if it has almost the same characteristics. You'll have to use a 9-pin miniature socket. Connect just as the original was, plate to plate, etc.

REPLACEMENT FOR 3 WINDING IFT

I need a replacement i.f. transformer for a Magnavox CR-703 radio. Can't get one anywhere. Can you help?—D.G., Los Angeles, Calif.

Yep. Your original i.f. transformer has a tertiary winding. This is switched by the "AM-BROAD: AM-SHARP" selector switch, to provide a wider bandpass. To replace the transformer, you'll have to give up this feature.

A stock J. W. Miller 455-kHz i.f. transformer, No. 14-C1, is the proper replacement. It is an exact duplicate as far as mounting is concerned. Ignore the tertiary winding, and hook it up as a straight i.f. and it will work nicely.

PLUG IN TRANSISTORS?

Do you know of anyone who is making a TV set with all plug-in transistors? —T. W., Columbus, Ohio.

No.

HORIZONTAL OSCILLATOR PROBLEM

I'm having trouble with the horizontal oscillator in a Silvertone 5177 color chassis. I've checked all parts, and replaced the oscillator coil with a Miller 6349, which I was told is the correct replacement for the original Sears 10-88-5 coil. "Everything's ok, but it still won't work!"—T.N., Redondo Beach, Calif.

Someone told you a big fib! Check the connections of a Miller 6349 coil. This is an exact replacement for an RCA 112866 coil or something like it, but not for this one. While it is a Synchroguide coil, the connections are not correct. What you need is a Miller 6359 coil. See if it won't work a little better. (Note: It did! Reader confirmed this later.)

SLOW STARTING COLOR, HEATH GR-227

The color in a Heath GR-227 color TV is "slow-starting". The picture comes on in the normal time, but there is no color for about 4 to 5 minutes, then Pow! Once it comes on, it stays.—M. C., Canada.

Lots of things. However, I'd try a new 6GH8 3.58-MHz oscillator tube *first*. I have seen a lot of tubes, back in the good old days, which checked good but wouldn't oscillate! 6A7's, etc. This has caused trouble even in modern sets. If the tube doesn't help, check plate resistors, etc.

NO PEDAL TONE

I have no pedal tones on a Hammond Model M organ. Others work fine, but no sound from the foot-pedals. What could cause this?—L. N., New Jersey.

In the early 'L' series, this was usually due to a bad 6BA96 Pedal amplifier tube. This is on the amplifier chassis, between the restifier tube and the 6V6's. In the 'M' series, it's in the same place.

There are also a couple of added controls on the M's. Check the pedal cutoff control and the pedal keying contact. Also, the flexible wire to the pedal drawbar above the upper manual. (Don't forget to check the 6BA6 tube and its voltages, too.)

COLOR SHIFT

I am getting an intermittent color shift in a Setchell-Carlson 3CL83. Blues change to green, and reds to purple, usually when the whole screen is mostly one color. I've tried exchanging the color-difference amplifier tubes, etc, without any luck. At times, it loses color entirely. Any ideas?—R. M., Washington.

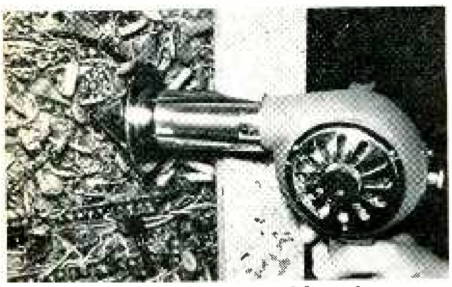
This chassis uses a 6AL5 as the color-sync phase detector, in a straight "RCA circuit". I believe this tube could be causing the phase shift trouble. (If colors *change*, you're getting a phase-shift, and it is almost certain to be in the 3.58 MHz oscillator.) I have found many of them which would show "grid emission" on a tube tester capable of reading this quantity!

This reading, of course, is actually a slight leakage in the tube—probably mount contamination or something like that. In any case, it indictates trouble. Since any unbalance or leakage in the color-sync phase detector will cause a phase shift of the 3.58-MHz oscillator, this could be it. Try a new 6AL5, checked beforehand for leakage. Also check the 3.58-MHz output transformer for any sign of leakage in the phase-shifting capacitors, drift in the resistors, poor ground connections, etc **R-E**

NEW PRODUCTS

More information on new products is available from the manufacturers of items identified by a Reader Service number. Use the Reader Service Card on page 103 and circle the numbers of the new products on which you would like further information. Detach and mail the postage-paid card.

HEAT GUN, *model HG201,* with cone attachment provides TV service technicians with a tool for quickly locating and testing bad resistors, capacitors and coils. This flameless gun can also locate hairline cracks in PC boards. The tool eliminates the long delays for components to heat up for testing. A patented directional air diffuser which elim-



inates back pressure enables the cone attachment to concentrate heat in ¼" diameter. The heat gun weighs less than six pounds and is equipped with an adjustable removable stand that supports the gun in various positions.—**Master Appliance Corp.,** 1745 Flett Ave., Racine, Wisc. 53403.

Circle 31 on reader service card

TOOL CASE, *TC100,* attache case kit for working tools. Designed for equipment of service technicians and field engineers. A 3-panel hinged tool holder is attached inside the lid, stands upright when case is opened, and can be removed. Straps and pockets hold up to 59 individual small tools, such as screw-

drivers. Compartments accommodate kits, test meters, parts boxes, and additional larger tools such as hack saws. Room for service manuals, etc. Can be purchased with a standard assortment of tools or custom-stocked to fit individual requirements.—**Xcelite Inc.,** Orchard Park, N.Y. 14127.

Circle 32 on reader service card

DESOLDERING TOOL, *DS-40,* removes soldered components from printed circuit boards or conventional circuits. Complete tool includes 40-watt power handle, desoldering head assembly with rubber vacuum bulb and tip with .063 opening, two-wire cord. May also be used to resolder new components in places where old ones have been removed. Hollow tip fits over wire leads

giving 360° contact. Replacement tips available in a variety of sizes. Also available in 3-wire models. $14.50.—**Weller, div. Cooper Industries,** 100 Wellco Road, Easton, Pa. 18042.

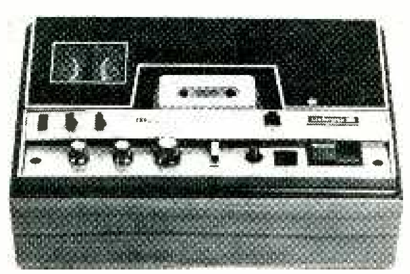
Circle 33 on reader service card

AM-FM TUNER CARTRIDGES, *models 30-3075 and 30-3076* for auto stereo tape players, slip into the cartridge loading slot of all auto 4- and 8-track tape cartridge players. The *30-3075* is powered by an internal 9-volt transistor-radio battery, connects to car's external radio antenna by an adapter which can be permanently attached. The *30-3076,* a

multiplex tuner, has a mode selector switch, an indicator light, and a switch to adjust input circuitry for nearby and distant FM stations. *Model 30-3075* is $45.00; *model 30-3076* is $54.00.—**GC Electronics,** 400 South Wyman St., Rockford, Ill. 61101.

Circle 34 on reader service card

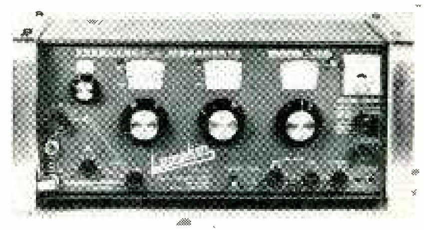
CASSETTE DECK RECORDER, *Wollensak model 4760,* incorporates Dolby noise suppression circuitry and patented



bi-peripheral drive system responsible for low wow and flutter characteristics. Frequency response 60–15 kHz. Other features are end-of-tape guard to lift the pressure roller when the end of tape is reached or a jam occurs, dual calibrated illuminated VU meters, separate input level controls with master gain, regulated dc supply voltage. A microphone preamp accessory is available for $20.00. The cassette deck is under $300.00.—**3M Company,** St. Paul, Minn. 55101.

Circle 35 on reader service card

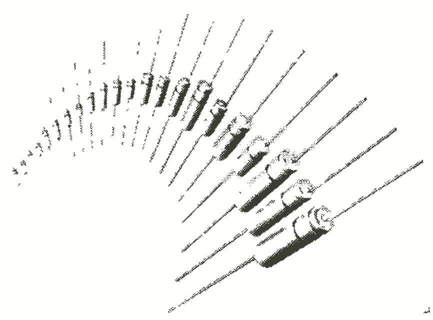
DIGITAL FREQUENCY METER/SYNTHESIZER/SIGNAL GENERATOR, *type 107A.* This solid-state unit operating from either 12 Vdc or 115 Vac weights 22 lbs. Aimed primarily at the mobile-radio maintenance field, as a heterodyne frequency meter, the *107A* will measure carrier frequencies of nearby transmitters, or signals picked up on a receiver, either AM, FM, TV, SSB, or CW. Coverage on FCC-assigned fre-



quencies is continuous from 10 kHz to above 500 mHz. Guaranteed accuracy in the field is better than 0.0001%. Readout is better than 0.00002%. As a synthesizer, any frequency from below 1,000 Hz to 9,999.9 kHz can be generated, in steps of 100 Hz, phase locked to the internal crystal standard.—**Lampkin Laboratories, Inc.,** Dept. 233, 8400 Ninth Ave. N.W., Bradenton, Fla. 33505.

Circle 36 on reader service card

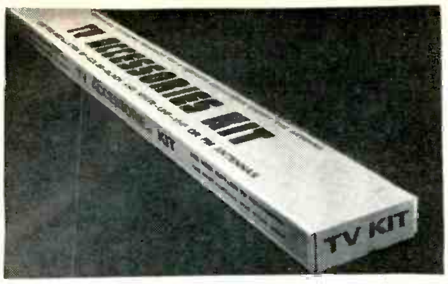
CAPACITORS. 22 new metal-encased tubular electrolytic capacitors added to the *TVA ATOM* line. Range from 11/16" in diameter x 2-5/16" in length



to 1-⅜" in diameter x 3-⅛" in length. Capacitance values from 1,000 to 10,000 μF, in a voltage range of 1 to 50 Vdc.—**Sprague Products Co.,** 81 Marshall St., North Adams, Mass. 01247.

Circle 37 on reader service card

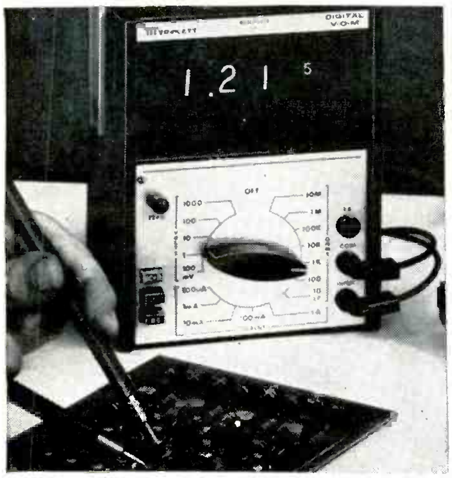
TV ANTENNA ACCESSORIES KITS, twenty-four kits in the line, complete, *except for the antennas.* Six basic mounting types, chimney mounts, wall brackets, roof mounts, tri-mounts, tripod roof towers, brace mounts. The antenna can be selected on basis of reception requirements in the area. Each kit is available with either 5- or 10-ft masts, and either 300-ohm vhf flatline wire, or uhf/vhf



foamline wire supplied. $7.69 to $20.41 price range of individual kits.—**South River Metal Products Co.**, 377-379 Turnpike, South River, N.J. 08882.

Circle 38 on reader service card

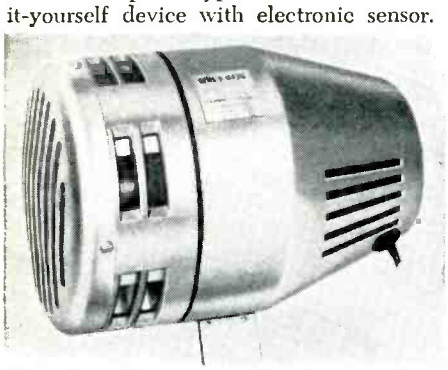
DVOM, *model 6028.* Lightweight, portable 2-¾ digit dvom operates on 105–125 Vac, 60 Hz, 4 watts or optional battery pack. Unit has 10-ohm full-scale range; gives 10-megohm input resistance on all ac and dc volt ranges; full-proof 100% overrange, out-of-range and reverse polarity indications; a zero adjust control for low ohm resistance measurements



that can "zero out" lead resistance; overload protection; and frequency compensator on ac. Readout consists of 2 cold-cathode display tubes and 3 neon lamps indicating "0" and "5" half digits and a "1" over-range digit. $275.00.—**Triplett Corp.**, Dept. PR, Bluffton, Ohio 45817.

Circle 39 on reader service card

AUTO BURGLAR ALARM, *Sens-o-matic Cyclone S12C.* This solid-state alarm with police-type siren is an install-it-yourself device with electronic sensor.



Complete kit contains 12-volt siren, key lock, hardware, spare switches and decal. No relays used. Alarm sounds if intrusion is made through any door, trunk, etc. Any action which disturbs a dormant electrical system will set off the siren. Also *S12M* sensor module only, for use with siren, relay and accessories; *S12B* marine kit with salt water protection.—**Monroe Timer Co.**, 1969 Westchester Ave., Bronx, N.Y. 10462.

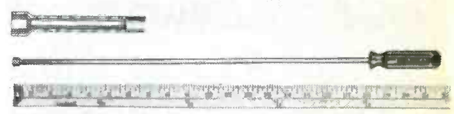
Circle 40 on reader service card

FM MONITOR RECEIVER, *Duo-Scan,* covers low- and high-band vhf channels, and features dual-conversion circuitry

and a double ceramic filter system. An IC limiting system produces a symmetrically "hard" pattern to reduce noise. Sensitivity is 0.4 μV for 12 dB SINAD. The receiver has eight channels, each with a "lock-out" push button to permit bypassing of that channel. A built-in power supply allows both 12 Vdc mobile and 117 Vac base operation. $169.95.—**E. F. Johnson Co.**, Waseca, Minn. 56093.

Circle 41 on reader service card

NUTDRIVERS, *S-818 and S-1018.* Two long-reach nutdrivers available in two sizes, ¼" and 5/16" hex. Drivers extend



18" out of handle for use in servicing deepset hex nuts and bolts. Feature all hollow shafts, tempered sockets, and large break-proof, shock-proof Comfordome handles. $4.80 each.—**Vaco Products Co.**, 510 N. Dearborn St., Chicago, Ill. 60610.

Circle 42 on reader service card

AUDIO TAPE, *Primvs Audio 2 and Audio 5*, in 1 mil and 1-½ mil tapes on 7-inch reels. Sound reproduction ranges from less than 20 to more than 20,000

Hz. The Mylar base material of the tape with magnetic coating is control wound on wrap-resistant reels. Coating is lubricated to minimize head, transport and guide wear.—**Wabash Tape Corp.**, Huntley, Ill. 60142.

Circle 43 on reader service card

MICROPHONE MOUNT, *model A55M*. This isolation mount is the smallest yet designed to control mechanically induced mike noise. Created for use with several Shure model microphones, the

noise isolation of these mikes is increased by at least 20 dB when used with the *A55M* mount. Can be used on desk stands, floor stands, lecture podiums, and for boom operation in studio applications. $25.00.—**Shure Brothers, Inc.**, 222 Hartrey Ave., Evanston, Ill. 60204.

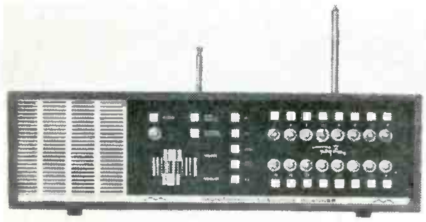
Circle 44 on reader service card

DIGITAL COUNTER TIMER, *model J-407*, has five gate interval 10 MHz frequency mode, measures frequency, period, ratio, timer and count, and has range multipliers and control inputs.

Timing frequencies from 1 kHz to 1 MHz; 1-MHz crystal oscillator. Solid-state circuitry. Display variable from 0.2 sec. to 6 sec. (approx.) with switch position for hold. Power requirements: 115 Vac, 60 Hz, 12 watts. $249.00.—**Pulsar Labs**, Box 8066 Como Station, St. Paul, Minn. 55108.

Circle 45 on reader service card

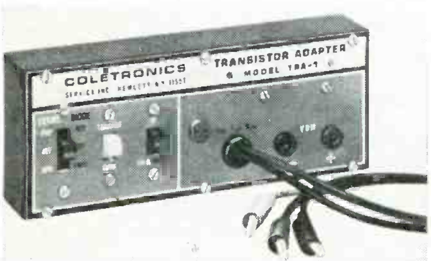
RECEIVER, *model TMR-16HLU*. Three-band FM *Monitoradio/Executive Scanner* with modular solid-state circuitry monitors up to 16 frequencies of the uhf and high and low vhf bands. Features read-out scanning lights with corresponding push-button control for any combination of frequencies in the 30–50, 148–174 and 450–470 MHz bands.



Three-speed scan process can either sample programmed channels at a 15 channels per second rate, bypass selected channels, or operate in manual mode. Sensitivity is 0.5 microvolt for low bands, 0.6 microvolt for high band, 0.7 microvolt for UHF band. $219.00—**Regency Electronics, Inc.**, 7900 Pendleton Pike, Indianapolis, Ind. 46226.

Circle 46 on reader service card

TRANSISTOR ADAPTER, *model TRA-1*, converts any vom into a transistor and diode tester. Will test pnp and npn types, high- and low-power transistors, for shorts, leakage, open and current gain. Tests diode for open, shorts, forward and reverse currents. A switching



system eliminates transferring of leads. The *TRA-1* has built-in socket, flexible alligator clip leads for transistors that do not fit the socket, self-contained two "AA" batteries included. Instructions come with unit. $15.95.—**Coletronics Service, Inc.**, 1744 Rockaway Ave., Hewlett, N.Y. 11557. **R-E**

Circle 47 on reader service card

DID YOU MISS

Bob Middleton's article on how antenna accessories can help you get the best possible reception .... *see page 33*

George Flynn's description of how readout tubes work and some experiments you can conduct .... *see page 50*

Walter Jung's IC Power Supplies. You'll find two dual-output fully regulated circuits .... *see page 69*

NEW LITERATURE

All booklets catalogs, charts, data sheets and other literature listed here with a Reader's Service number are free for the asking. Turn to the Reader Service Card on page 103 and circle the numbers of the items you want. Then detach and mail the card. No postage required!

BOOK CATALOG, *Spring 1971.* Over 170 current and forthcoming books described in the illustrated 20 page catalog. Subject areas include schematic/servicing manuals, broadcasting, basic technology, CATV, computer technology, TV, radio and electronics servicing, audio and hi-fi stereo, hobby and experiment, amateur radio, test instruments, appliance repair, and transistor technology.—**Tab Books,** Blue Ridge Summit, Pa. 17214.

Circle 48 on reader service card

DISTRIBUTION AMPLIFIER CATALOG. Solid-state TV amplifier distribution systems and couplers are illustrated, with specifications, in this brochure for TV reception needs in homes, apartments, hotels, and institutional buildings. Includes mixer-coupler-signal doubler systems, distribution amplifiers, antenna-mounted amplifiers, antenna stacking amplifiers, splitters, traps and matching transformers.—**Kay-Townes, Inc.,** P. O. Box 593, Turner Chapel Rd., Rome, Ga. 30161.

Circle 49 on reader service card

CIRCUIT-STIK BROCHURE, describes *Quik-Circuits,* sub-elements of 1 oz. copper electro-deposited on thin epoxy glass substrate with adhesive backed copper and insulative tape, sheets and donut pads. Describes all sub-elements available with illustrations and prices.—**Circuit-Stik, Inc.,** 1518 W. 132nd St., Gardena, Calif. 90249.

Circle 50 on reader service card

CAPACITOR CATALOG, gives complete listing of the line by type, with an alphabetical numerical index, of electrolytic, paper-film, fim, ceramic, mica, and ac motor capacitors, instruments, and hardware. Descriptions and ilustrations included. —**A.R.P. Div., Aerovox Corp.,** 740 N. Belleville Ave., New Bedford, Mass. 02741.

Circle 51 on reader service card

SCIENCE, OPTICS, SPACE CATALOG, *No. 715.* 148 page edition lists thousands of hard-to-find bargains in optical and scientific equipment. Features scientific tools, components, lenses, prisms, mirrors, accessories, instruments such as lasers, comparators, magnifiers, microscopes, photo attachments, lighting items. New in the catalog are industrial safety items. Also shows computer kit, fiberscope.—**Edmund Scientific Co.,** 380 Edscorp Bldg., Barrington, N.J. 08007.

Circle 52 on reader service card

MIKE CATALOG, *#AL314D,* describes mikes, mixers, and related products for public address and tape recording. Includes illustrations, specifications, and guide to types and selection. **Shure Bros., Inc.,** 222 Hartrey Ave., Evanston, Ill.

Circle 53 on reader service card

GENERAL CATALOG, *FR-71-72,* lists over 14,000 products from all operating divisions. The 312-page inventory includes chemicals, servicing tools, printed circuit materials, automotive connectors and hardware, replacement parts, knobs and antennas, electronic hardware, chassis punches, plugs and jacks, connectors, adapters, switches, hi-fi, stereo, tape and phono installation and maintenance accessories, replacement antennas.—**GC Electronics,** 400 So. Wyman St., Rockford, Ill. 61101.

Circle 54 on reader service card

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

ELECTRONIC COMPONENTS, *1971 Short Form Catalog.* Over 4000 product listings covering jacks, plugs, switches, connectors, molded cable assemblies, audio accessories. Illustrated 36-page catalog with descriptions and a numerical-alphabetical index.—**Switchcraft, Inc.** 5555 E. Elston Ave., Chicago, Ill. 60630. **RE**

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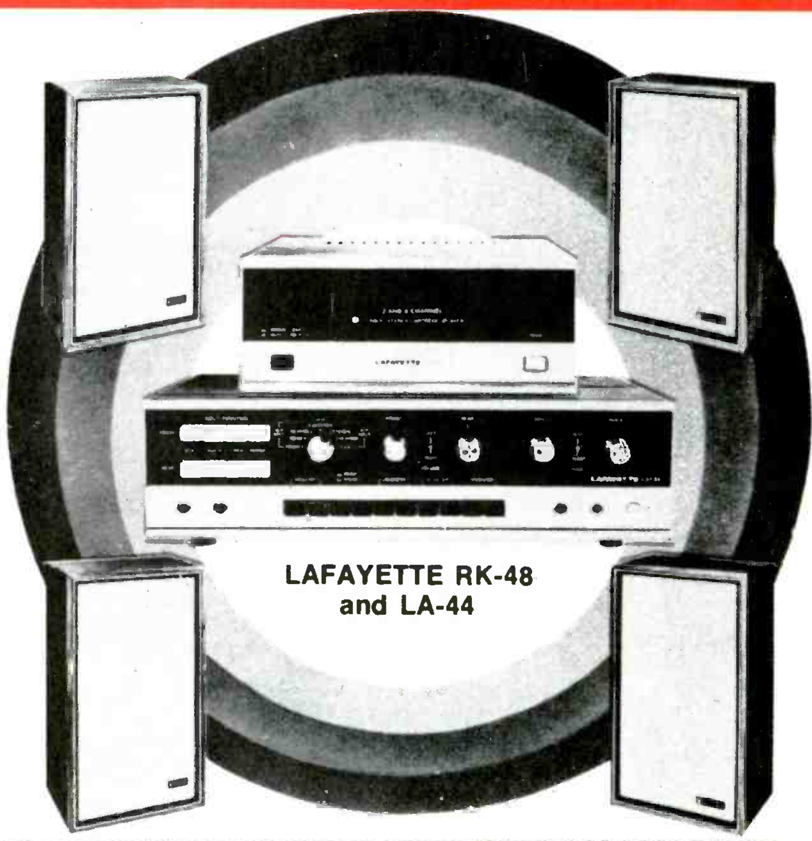

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(continued from page 35)

also available. They show the direction of the antenna on all controls simultaneously. This type of rotator is a convenience where two or more TV receivers are to be used.

Interference filters and traps

When TV interference is a problem, it is often possible to reduce or eliminate the trouble with suitable interference filters or traps. A typical back-of-the-set filter is in Fig. 18. A filter that cuts off below 50 MHz, and also rejects from 110 to 170 MHz will often reduce interference from neon lights, ham radio, diathermy machines, and some other sources. Another type of trap, designed as a band-reject filter can reduce interference from strong local FM stations. Both fix-tuned and adjustable units are available. A typical tunable interference trap can be peaked up at desired point in the FM band, or can be adjusted to attenuate one, two, or three low-band TV channels. This feature is helpful when a powerful FM or TV transmitter is nearby. High-band TV channel traps are also available.

Although there is no sharp distinction between a filter and a trap, the filter generally has a comparatively broad frequency characteristic. A trap is basically designed as a series or parallel LC resonant circuit. On the other hand, a filter uses both series and parallel reactances, as in Fig. 19. From a practical viewpoint, the essential consideration is to load a filter correctly. For example, R_L could be specified at 300 ohms, or at 75 ohms. When a filter works into an incorrect value of load resistance, its frequency characteristic becomes distorted, and it operates improperly.

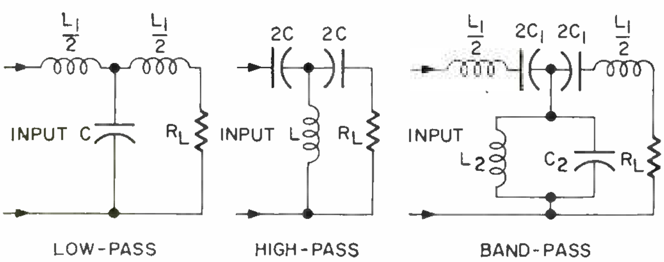


Fig. 19

Note in passing that there is also no sharp distinction between a filter and a booster, or preamplifier (Fig. 20). That is, if a bandpass filter configuration is supplemented by a transistor, the combination is termed a booster or a preamplifier. However, it is basically a filter with an insertion gain instead of a filter with insertion loss. A TV preamplifier operates as an interference filter inasmuch as signal frequencies below the vhf range are usually rejected. Similarly, a preamplifier designed for vhf application usually rejects uhf signals. *(continued on page 88)*

Fig. 20

SWEEP ALIGNMENT
(continued from page 68)

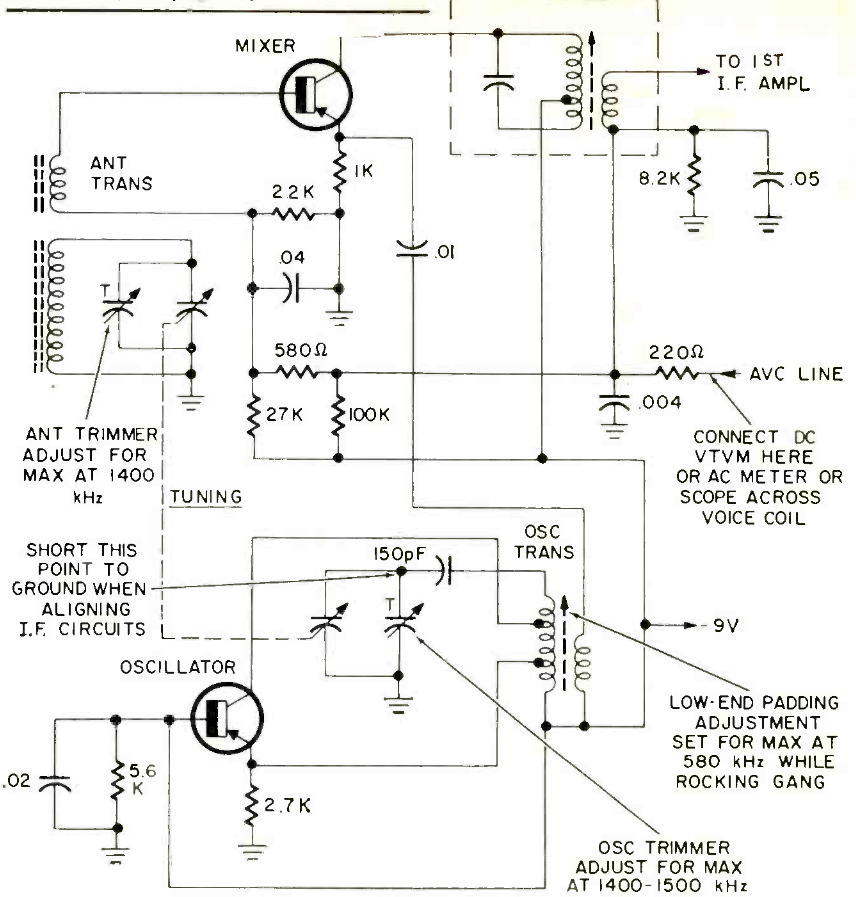


FIG. 5—TUNING UP THE FRONT END isn't hard when you know what to do. Basic adjustments are shown here.

tion mark, which is a little extra mark just past the lowest figure. The ganged capacitor should be completely closed. If this set uses variable-inductance tuning, the cores will be all the way inside the coils. If the pointer isn't exactly on the calibration mark, slide it along the dial cable until it is.

Now, we're ready to go. Tune the radio dial to a point near the high end. This is usually somewhere around 1,400 kHz, although the actual frequency isn't too important. 1,500 kHz is ok, too. Set the signal generator to the same frequency. If you do not hear the signal in the output, retune the radio until you do. If it comes in anywhere else, say at 1,300 kHz, the dial is out of calibration.

Leave the signal generator at 1400 kHz. Tune the radio dial to 1400 kHz. Now, locate the oscillator trimmer capacitor (Fig. 5). In sets with ganged capacitors, this will be a small variable capacitor on the *smallest* section of the gang. This is always the oscillator section; the other is the mixer, or rf. If this is a small radio, with a sealed-up tuning capacitor, as in some of the transistor types, look it up in the service data. (Not a bad idea in all cases.)

Check to see which way you need to turn this. If the pointer indicated 1300 kHz on the 1400 kHz signal, you have too *little* capacitance in the oscillator circuit. Turn the oscillator trim-

(continued on page 85)

NEW BOOKS

HOW TO REPAIR SOLID-STATE IMPORTS, by Paul Lawrence. Tab Books, Blue Ridge Summit, Pa. 17214. 160 pages, 8½ x 11 in. Leatherette, $7.95, Paperbound, $4.95.

This guidebook is a large, diversified collection of schematics and service data representing the most popular foreign-made home entertainment equipment, including radios. TV's, phonos, and tape recorders. The author begins with a general look at imports, and how they differ from domestic brands. as well as how to obtain parts and service data. The second chapter goes into basic circuit descriptions, audio. RF. IF, converters, detectors, TV, tape recorders. etc. Chapter three describes servicing tips that will help unbend the kinks which often get in the way. The author reveals many shortcuts—what to look for. where to find it, and how to fix it. There's also a chapter which offers help when a schematic isn't available. It contains numerous tips to help the service technician get a clear picture of what the circuit should and should not be doing.

T.V. TECH AID, COLOR TELEVISION AND B&W TELEVISION, TIPS FOR TECHNICANS. Edward G. Gorman, Publisher, T.V. Tech Aid, P.O. Box 603, Kinks Park, N.Y. 11754. 150 pp., color manual; 115 pp., b&w manual; 8-½" x 11". Soft cover, $5.95 each.

The color manual recaps the troubles printed in the 1970 mailings of T.V. Tech Aid, and the black-and-white manual compiles troubles of a recurring nature. Outlines manufacturer. model, symptoms, possible causes, cure, with diagram of each individual problem. Index of symptoms makes these manuals handy reference works for all service technicians.

ADVANCED ELECTRONIC INSTRUMENTS AND THEIR USE, by Sol D. Prensky. Hayden Book Co., 116 W. 14th St., New York, N.Y. 10011. 208 pages, 6 x 9 in. Hardcover, $9.50, softcover, $6.95.

Background in sophisticated, general purpose laboratory instruments currently used in industry and research. Covers major instrument groups used for sensing, measurement, or control monitoring. Basic electronic principles, practical applications, and specific examples of typical, representative instruments are discussed. Over 140 photos and diagrams for devices such as femtometers, frequency synthesizers, solid-state multimeters, including FET types, digital voltmeters, sampling and storage oscilloscopes, analog and digital computation elements, radiation survey meters. Text emphasizes standardization and calibration procedures.—*MCL*

HANDBOOK OF ELECTRONIC TEST EQUIPMENT by John D. Lenk. Prentice-Hall Inc., Englewood Cliffs, N. J. 07632. 6¼ x 9¼ in. 460 pages. Hardcover. $15.00.

A detailed coverage of all types of electronic test equipment. Includes digital, microwave and laboratory test equipment. Presents basic principles and operating procedures and describes what test instruments are available, what they do and general calibration techniques—

DICTIONARY OF TELECOMMUNICATIONS, by R. A. Bones. Philosophical Library, Inc., 15 E. 40th St., New York, N.Y., 10016. 5 x 7½", 200 pp. Hardcover, $15.00.

Wide range of definitions. including many based on British Standards recommendations, supplemented by appendices including units and abbreviations, wavelengths and frequency bands, and signal reporting codes. Includes concise explanation of terms, diagrams and graphs. Basic text for students as well as engineers and technicians.—*ML*

BASIC ELECTRON DEVICES by E. George Griffith. Rinehart Press, Holt, Rinehart and Winston, Inc., 383 Madison Ave., New York, N. Y. 10017. 6 x 9 in. 212 pages. Softcover. $3.95.

A basic course on basic electronic devices. Provides a source of ready reference for electrical engineers, technicians and engineering assistants. Includes a presentation of the underlying physics of solid-state devices and transistor action. The majority of basic devices in use today are described, including several that are obsolete but still in common use.—*LS*

ELEMENTARY COBOL PROGRAMMING, A STEP BY STEP APPROACH by Gordon B. Davis and Charles R. Litecky. McGraw-Hill Book Co., 330 W. 42nd St., New York, N. Y. 10036. 8½ x 11 in. 164 pages plus worksheet section. Softcover $5.95.

Written to allow the student to actively learn COBAL, this manual presents a series of examples in writing and executing a modular set of problems. The student is encouraged to learn on his own by self-testing quizzes and through the structuring of the problems. All major COBAL features are covered. **R-E**

DREAM

White space, layout complete the

by JACK DARR

There's a saying about newspaper ads, with large areas of white space attracting more attention than crowding the whole thing with fine print. We can use the same principle, in avoiding *crowding*. How many shops have you seen where every inch of the *bench* (the *working* area) was covered with radios, TV sets and assorted electronic gradoo in various stages of disrepair? (You wouldn't happen to be *standing* in one right now, would you?) When a new job comes in, the technician has to push something aside to get room to set it down.

This is the Cardinal Sin in our business! I've seen it happen in a great many shops, including the one with my name over it, too many times. There's only one cure for this, and it is SELF DISCIPLINE! Figure out how many sets you can have on your bench at once; then DON'T bring another one in until you get one finished and moved out! My own bench, 20 feet long, proved by actual experiment to hold not more than *two* TV sets at the same time, for most efficient working.

With the bench jammed up like this, you're always reaching over something; you can't get to the test equipment; and, worst of all, you actually don't have the needed "elbow-room" to work most efficiently. So, up with the willpower; keep the bench as clear as possible, and you'll be amazed at the difference, not only in ease of working, but of total output of work for the day!

You'll notice that I did not indicate any place for parts-storage. You can make this up to suit yourself. However, here's one very useful hint: do NOT use any of the space on the *bench itself* for parts storage! Store parts on end walls, or on the wall opposite the bench; you can simply turn around and reach the part you need. On the bench, the chances are they will be covered up by the set you're working on, by some of the test equipment itself, etc. The extra room available will let you put up shelves, bins, cabinets, etc. to keep each class of parts instantly available, without them getting in the way of the actual diagnosis/repair operation.

Small but very helpful item: when you tear a set down for repair, put all of the small parts; knobs, bolts, etc., into a little box, and stick this inside the empty cabinet. They'll be there when you're ready to put it back together. If the set must be held for parts, slide the chassis back in the cabinet, and put the whole thing out in the Storage-In area. Put a scratch-paper tag on it "Waiting Flyback", etc. The customer's name will also help in finding the thing faster.

Mobility

Most of the things we handle are big; TV sets, stereos, etc. So, use a sys-

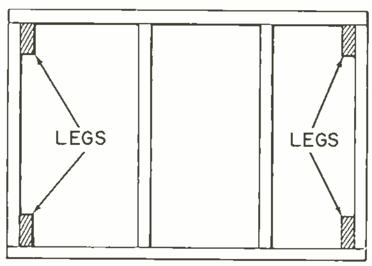
WORKBENCH

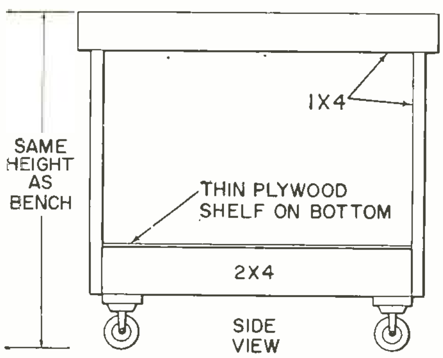
mobility and equipment
second part of this article

SERVICE EDITOR

tem that will make them easier to *move*. The best way I've found for this is carts, mounted on good-sized caster wheels. Make the overall height (don't forget to include the casters!) the same as your bench-top.

The tops are made with vertical "slats" of 1 x 4; this is for bracing, and also to give you access to the underside of a big chassis, to get the mounting bolts out without having to take it off the cart. Table-model TV sets can be "driven up" to the bench and slid off onto it, with very little effort. Big consoles can be set on the cart, balanced, and left there while the chassis is moved to the bench, connected with those extension cables.





The sets can be loaded directly from the truck onto the cart, which is then pushed into the Storage-In area. From there it's wheeled up to the bench, fixed, then wheeled back out into the Storage-Out area for reloading on the truck and delivery.

The total number of carts will depend on the amount of business you are doing! In my own one-man shop, I had six of them, and this came out pretty well. I could have used two more, in the rush seasons. If you find yourself having to move sets off the carts onto the floor, make up a couple more carts!

For that very important area where you have all the fun (the place where you get the money!) set aside a space for the book-keeping department; records, job-tickets, files, and so on. This can be outside of the shop-area proper, in an adjoining room. This depends on your floor layout.

Test equipment layout

Now, we get to the most important area of all; the workbench, and the test equipment. The object of this is the same as all the rest; to get the equipment set up so that you can work in the most efficient way, with the least wasted time, and so on.

The basic principle of this is to get the test equipment divided into FUNCTIONAL GROUPS. The instruments that are used together should be together. For instance, one group could be TVM, parts testers, tube tester, transistor tester. Another could be sweep generator, bar-dot and scope, and so on. There will be a little "Overlap" of use, of course; you'll use the scope for both diagnosis and alignment. So, these really shouldn't be "fixed", but easily movable.

Probably the oldest layout in the world is a workbench, with a shelf above it for the best equipment. The unit under repair is below the test instruments. This *is* a good method, and is probably in use by more shops than any other. It is efficient, as long as the unit being repaired isn't too big! It's fine for small radios and TV's. However, for color TV and other big chassis, you may find that the thing covers up the test equipment!

So, we worked out a variation of this. Some of the equipment is placed on the shelf, and other units mounted on wheeled carts. These can be rolled to any position needed. Here again, we must group the cart equipment into functional groups. For instance, all parts-testers could be on one cart, and all sweep equipment on another, and so on. These carts, too can be hand-made out of 1x4's, of any dimensions needed.

Every technician works just a little bit differently. So, it's very likely that none of these ideas will exactly suit *your* preferences. So change 'em! Use a *combination* of the different methods, and experiment until you find the one that is the best for *you*. Right now, I have some instruments on the shelf, and some on a cart. I'm planning some changes, too just as soon as I get through with this article. (All sweep-alignment equipment is going on a cart, with an "old but good" second-hand scope permanently connected up.) Try out different ways, and use the one that lets you get out the most work in the least time, with the least effort. Keep notes.

Bench width

One small, but important factor, when you're building a workbench, is the depth (front-to-back measurement) of the "free space" that is the actual working area. My own bench is now too shallow, although it was fine 15 years ago when it was built! I made it 4 feet deep, but my shelf is 2 feet deep, and now I don't have enough depth to put color-TV chassis, etc., on it with perfect safety! I run a cart up to the edge to support the "overhang". (I have a feeling that the shelf is going to get cut back about a foot!) Most test equipment, with the exception of a scope, will

(continued on page 95)

SWEEP ALIGNMENT
(continued from page 82)

mer down, or in; add more capacitance until you hear the signal with the dial-pointer at the right place. *Actually, you usually don't have to even look; just move the trimmer a little either way, until you hear the signal then stop.*

This is, in a way, a peaking process. However, what the oscillator trimmer does is "walk" the peak back and forth along the radio dial. You won't lose any of the signal amplitude until you walk this peak far off frequency.

Rf and mixer peaking

Now, you've got the dial showing the right frequency. Next, align the rf and mixer stages for maximum gain or a peak, and you're done. The oscillator trimmer should not be moved any more. Find the rf or mixer trimmers, and adjust these for maximum meter reading. A good way of getting the test signal, for this part, is to put the signal-generator output cable on the bench, a couple of inches away from the loop antenna.

Once again, use the smallest test signal you can. To reduce the signal input, just push the signal generator cable a little farther away from the loop. The low signal lets you tune the rf/antenna trimmers for the sharpest peak.

Low-end tracking

In many of the older radios, and in the better grade receivers of today, especially short-wave and communications types, you will find a low-frequency adjustment for the oscillator. The really good ones will have low-end adjustments for the antenna, rf and mixer coils, too. In a lot of these, you'll find that the high end of the dial is tuned with "trimmers"; small adjustable capacitors—and the low end is tuned by varying the inductance of the coil with an adjustable iron core. (Side note: a "variable" capacitor or coil is one that is tuned by a *knob*, or by hand. An "adjustable" trimmer or coil-core requires an alignment tool.)

When working with these more complex radios, be sure that you have the alignment instructions. These are absolutely necessary; you must know the location of each adjustment, and what frequency it is to be tuned to. In some of the more elaborate SW receivers, you may have 15 or 20 adjustments!

With these dual tuning adjustments, we can now get much better "tracking" over the entire dial. "Tracking" means that the dial-pointer indicates the correct frequency over the whole dial. In the smaller and cheaper radios, calibration is set at one point, and the dial is slightly off over all of the rest.

To make this adjustment, set the dial calibration, and tune up the rf/mixer/antenna at the high end first. Then, tune the radio and signal-generator to a frequency near the low end of the dial, and adjust the low-end tuning. Then, go back to the high end and recheck the calibration; since these adjustments interact to some extent, the high-end will be slightly off. You'll generally have to repeat these at least three times to get the best results.

In many radios, only the oscillator has a low-end adjustment; an adjustable iron core in the oscillator coil, for example. When you find one of these, you use a method known as "rocking" the dial, to get maximum results. Align the high end as before. Then, tune to the low end of the dial, and set the signal generator at a point about 50-100 kHz from the last figure (550 kHz, set at 600 kHz, for example).

Note the reading on the output meter. Now, turn the receiver dial in either direction, and watch the meter. If the reading goes *up*, adjust the core of the oscillator coil for maximum, then "rock" the dial again. Your rf/mixer coils are tuned to a slightly different frequency from the oscillator, *at this end* of the dial! So, you're actually moving the oscillator over to match them, since you can't tune them. Keep rocking the dial and watching the meter, until you note the meter reading starting to go down. When you see this, back up, and find the absolute maximum output meter reading you had; leave it set at that point. Now, go back up and recheck the calibration at the high end. You'll usually have to move the oscillator trimmer just a little bit, but the rf/mixer trimmers will probably be OK.

In a later article, we will do sweep alignment—a quicker and more exact method of aligning circuits in all types of radio and TV sets. **R-E**

COMING NEXT MONTH

OCTOBER 1971

HI-FI STEREO 4-CHANNEL

There are important things happening in the October issue—all of them related to the latest in solid sound.

- **Build R-E's 4-Channel Stereo System**
  You'll see them on the cover and read how to build them inside. First there's a 4-channel power amplifier. It delivers 35 watts per channel . . . .rms watts! And you build it with four new hybrid POWER IC'S (one per channel). Almost a one-evening project. Then there's a matching 4-channel preamp. It's also built with IC's—one IC for each pair of channels. The hardest part of building it is punching the holes in the chassis.
  Put them together and you're all set for exciting 4-channel sound.

- **4-Channel Adapters**
  A report on what's available now; what they do and how you will be using them tomorrow. Block diagrams show how to set up the equipment and illustrate effects you can expect to hear.

- **Which Way 4-Channel**
  What's new; what's happening; what's next in the exciting new arena of solid sound. Take a guided tour around the next corner and get a sneak preview of future sound, now.

PLUS . . .

Instant Circuits
Jack Darr's Service Clinic
IC Popourri
Kwik-Fix Troubleshooting Charts

ANTENNA ACCESSORIES
(continued from page 81)

Flush-mounting outlets

TV/FM outlets like those in Fig. 21 provide convenient, permanent arrangements for connecting receivers to antenna downleads, multi-set couplers, booster couplers, or drop taps. In turn, portable receivers can be moved from one room to another and quickly connected to the antenna system. Flush-mount models mate standard electrical boxes, or they may be mounted on plaster straps. If an antenna rotator is used, a five-pin rotor socket can be inserted below the three-pin TV/FM socket.

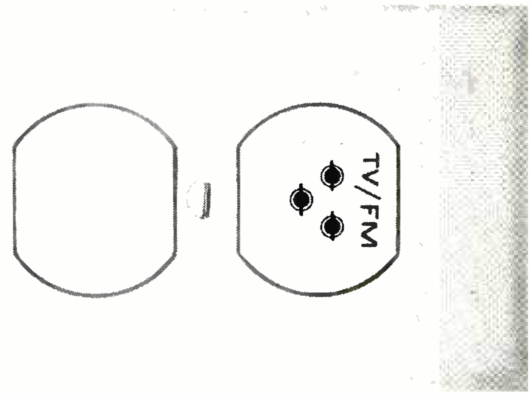


Fig. 21

Conclusion

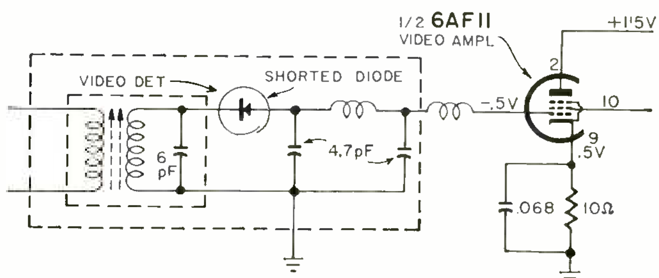
TV antenna accessories represent a significant source of income for the technician, as well as ensuring optimum reception and providing a professional type of installation. This article provides a helpful introduction to the subject. Manufacturers can supply detailed data on their products, and are generally very cooperative when consulted on unusual installation problems. **R-E**

SERVICE NOTE

REPEATING PICTURE PROBLEM

A General Electric b/w model M782YMD came in with good sound and no picture. With the scope we found a video detector was shorted. Replacement of the video detector cured the no-picture problem.

Within ten days the same receiver came in with the same condition. Again we found a shorted video diode. A new one was installed. It lasted two days during a bench test. In this particular circuit very little voltage was applied to the video diode. What was burning out the video diode?



The 6AF11 amplifier was checked in the tube tester. When rapped real hard, a short would momentarily occur between screen grid and grid terminals. This placed the screen voltage across the diode (see diagram). Replacement of the video amplifier and a new video diode finally cured the repeating no-picture problem.—*Homer L. Davidson* **R-E**

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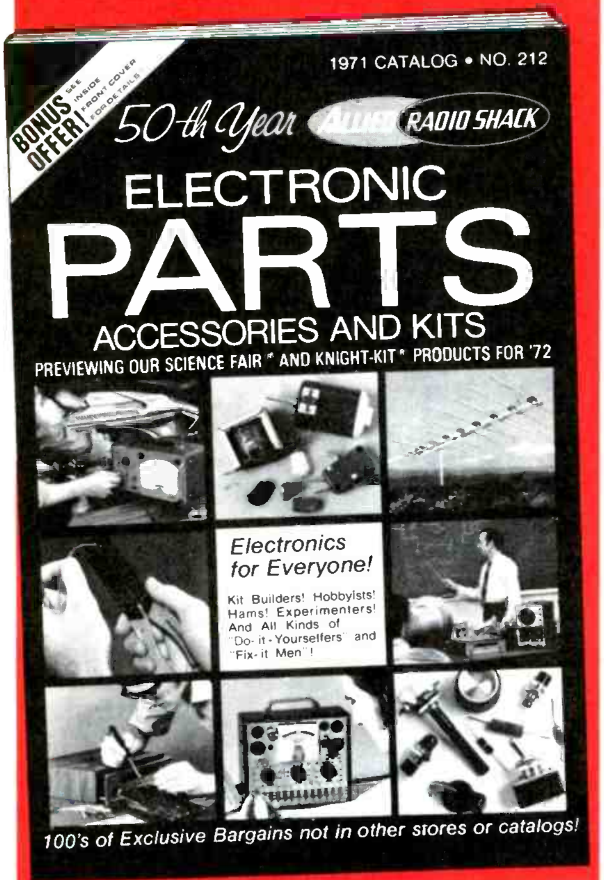

A valuable money-saving, time-saving Buying Guide for kit builders, hobbyists, experimenters, Hams, "fix-it men," every student and teacher of electronics. 1000's of bargains in everything from "AA" batteries to Zener diodes and all the "pieces and parts" in between. Like hard-to-find phono needles and accessories, recording cassettes, cartridges and accessories, replacement speakers, microphones, headphones, cables and connectors and—you name it! Plus—our exclusive Science Fair® and Knight-Kit® products for '72. Allied Radio Shack is the one chain of stores that *really cares* about selling the "little things," too. We've proved it by publishing this special catalog—and by stocking its items in our over 950 stores coast-to-coast!

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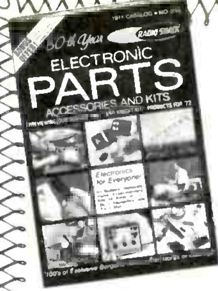

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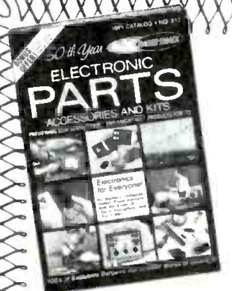

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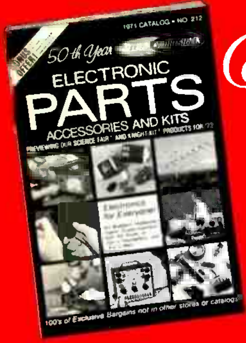

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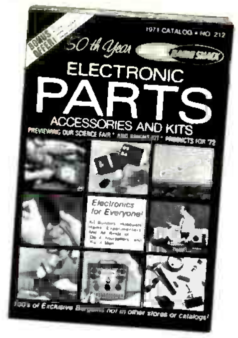

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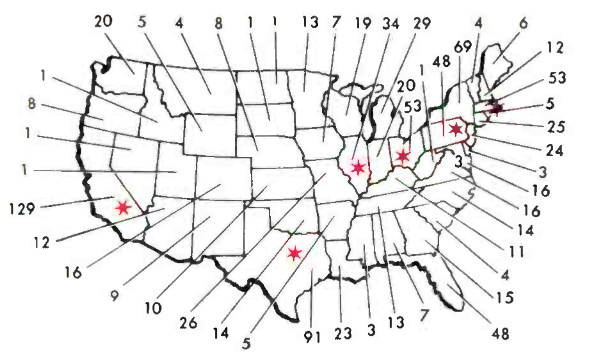

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EQUIPMENT REPORT

TRIPLETT 990 INDUSTRIAL MAINTENANCE ANALYZER

For manufacturer's literature, circle No. 22 on Reader Service Card

THE TRIPLETT 990 INDUSTRIAL MAINTENANCE Analyzer is one of those outfits that can do almost anything. I had a lot of cornball similes for this, but decided against using them. Suffice it to say that I didn't find any standard test, and several unusual ones, that it **would not** make!

When I got it, I found a beautiful shiny "attaché case"; the inside is lined with very thick foam padding. Each part has its own slot, even the test leads. It should withstand a pretty high-G shock.

Right in the middle of it is the heart of the set; a special model of one of Triplett's vom's, a Model 900. This is a new version of the 630, with special scales for the new tests which can be made with this instrument. It has an automatic overload protector device; a very fast-acting relay, which trips a pop-up reset button on the panel. This latches open; you must push the RESET button to get it back in operation (being more careful next time!) Besides this, meter-protection diodes are shunted across the movement for bypassing possible transient spikes which could slam the needle before the relay can open. By the way, if you try to reset the protector, with the overload still connected, it won't go on. The overload must be removed first. So, this is pretty well foolproof.

The basic vom has dc volts ranges of 0-2.5, 10, 50, 250, 1,000 and 5,000 volts; at 20,000 ohms per vol.t Dc millivolts can be read on an 0-250 mV scale; for checking small thermocouples, etc. Ac volts ranges of 0-3, 10, 50, 250, 1,000 and 5,000 volts; at 5,000 ohms per volt are used.

For current tests, the Model 900 has a terrific range; from 100 microamperes to 100 amperes. Starting with an 0-100-μA range, it goes to 0-10, 100, 1,000 dc mA, then to 0-10 amperes direct, and to 100 amperes using a special heavy-duty shunt furnished with the kit. If you need other ranges, shunts for 0-25 and 0-50 amperes dc can be used.

In all kinds of electrical and electronics maintenance work, **ac current** readings are very important. This tells you how much power the unit is drawing, and tells you whether it is overloaded, underloaded or normal. The 990, with the Model 10 Clamp-on Ammeter Adapter, will read ac current over a wide range; from 0-6, 12, 30, 60, 120 and 300 amperes on the stock scales.

The Model 10 Clamp-On is attached to the vom by a long lead. This makes it much easier to use, since the clamp-on unit is no bigger than the palm of your hand. This must be clamped over only *one* wire in a circuit to read currents. For reading lower currents, like those drawn by small appliances, motors, etc., another adapter is used. This is the Model 101 "Line Separator". A plastic case has line-plug prongs, and three receptacles on the other end. The wires are separated, and a "hole" provided in the case for clamping on the Model 10. This is plugged into an outlet and the appliance under test plugged into the other end.

The center receptacle on the Model 101 is DIRECT, and you read on the 0-6 ampere scale of the vom. The other two outlets are DIVIDE BY 10 and DIVIDE BY 20; the original 0-6 ampere scale now reads 0-0.6 amperes or 0-0.12 amperes. Your "lowest readable deflection" on the meter is *0.04 amps* which ought to be far enough down for anything!

The ohmmeter ranges of the 900 start with R x1 0-1,000 ohms, 4.4 ohm center-scale, and then to R x10, R x1k and R x100k, and "megohm scales" of 0-1 and 0-100 megohms; 2% accuracy.

Now for the fun; the accessories! With the Model 901 Tachometer Generator, you can read rotational speed in ranges of 0-500 and 0-5,000 rpm, on specially calibrated scales. The tach generator is a compact device looking like a tiny drill, with interchangeable soft rubber tips, cone and inverted-cone.

A dual-range thermometer is also provided. A temperature probe no larger than a standard test-prod is used. The end is held against the object whose temperature is to be checked. The temperature ranges from −50 to +100°F, and +40 to +300°F can be read, from solid surfaces, liquids, or in air. (I used this to check the case-temperature of a suspected power transistor!)

The "sound-man" and audio work was not forgotten, either. The 900 vom has an OUTPUT jack, with blocking capacitor, as well as a full set of dB scales, four of them from −20 to +11 dB, and up to +49 dB, across a 600-ohm line. The standard ac/dc voltage and current scales of the vom will handle anything found in receiver or transmitter test work, tube or solid-state.

A small but comprehensive instruction booklet gives full details (and many safety precautions!) for making all of these tests. The Ingenious Engineer will undoubtedly find many other uses for this kit of instruments. **R-E**

TRY THIS ONE

OHMS TRANSISTOR CHECKER

"Transistor Testing: What With?" by Jack Darr in the November 1969 issue was a fine article. However, reversing probes and holding the transistor can be a little awkward. Why not get the idea off the ground? Build an *OHMS TRANSISTOR CHECKER* that will make ohms checking a snap. The diagram in Fig. 1 indicates the simplicity of the checker, Fig. 2 shows the panel. Your ohmmeter connects to the plus and minus leads by a short lead with alligator clips. Connections are made quickly. The transistor is similarly connected to the checker's collector, base and emitter terminals.

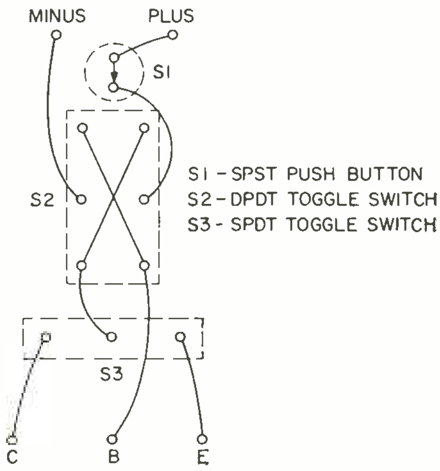


Fig. 1

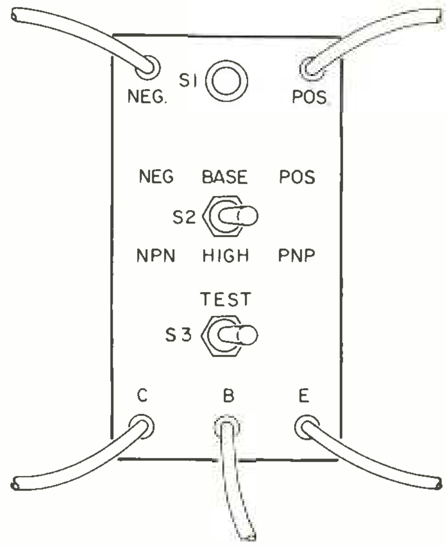


Fig. 2

Set the ohmmeter to the proper range and push switch S1. Move switch S2 either to left or right to obtain a high ohms reading. Now move

S3 to the left to test the base–collector junction. Move the switch to the right and test between the base and the emitter.

The transistor leakage factor is quickly obtained by moving S2 to the opposite side. Again S3 makes the test between the collector and emitter. A wide variation in readings between the test at the collector and emitter indicates a defective transistor.

The polarity of the voltage on the ohmmeter leads should be so that with S2 at the right (POS–PNP), a voltmeter with its plus lead to the base terminal and the negative to the emitter with switch 3 to the right you have a positive reading on the meter. The setting of S2 now lets you determine the sex of the transistor automatically.

Pnp or npn? Connect the transistor to the collector, base and emitter leads. If the HIGH reading comes with S2 set to NPN, the transistor is an npn. It is a pnp when the HIGH reading occurs with S2 set in the PNP position.—*H. Lindon Robinson*

AIRGUN CLEANS CHASSIS

After 15 years of full-time television repair, I have found that one of the most unpleasant jobs is working in a blanket of dirt and dust inside the cabinet and chassis. This is an especially acute problem when you're trying to trace every potentially burned resistor that is buried in dust, to say nothing of the shortened life of the equipment and the potential fire hazard.

The photo shows the air gun that I have used very successfully to clean all incoming television bench jobs. The unit can also be used in the home by taking the set outside to be cleaned. Often my customers have tried to use their vacuum cleaners to do this—sometimes damaging their sets in the process. (The air gun I use was purchased from the Carl Co. of Lisbon, Ohio, for $49.)

I also use the air gun to wipe out high-voltage corona caused by moisture in color televisions.—*Thomas H. Davenport* **R-E**

(continued from page 45)

negative side track. This done by making R12 and R18 equal.

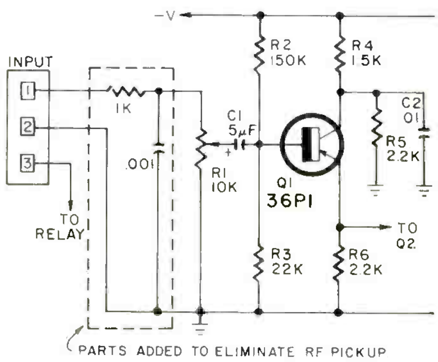
The negative portion of the circuit is made up of IC2, Q3, Q4 and Q5. The 2-amp output rating is supplied by Q2 and Q4, a pair of 2N3055's. These two transistors need to be well heat-sinked so follow the recommendations. Other portions of the circuit are beefed up accordingly; a pair of large computer grade input filters (C1-C10). husky rectifiers (D1-D4) and 0.27-ohm current limit resistors in each leg. Extra filtering is on the output too, C7 and C13.

This concludes the 723 "family" of power supplies. **R-E**

TECHNOTES

MAGNAVOX S-61 TONE CABINET

After over a year of normal operation, this church organ extension speaker system began playing the music (?) from a new AM radio station located nearby. Apparently the station's rf carrier was being picked up



in the long, unshielded cable which runs between the organ and the tone cabinet. It was then detected by the amplifier's input transistor. A simple rf filter was added as shown and it completely eliminated the problem. *—Donald R. Hicke*

CURE TUBE SOCKET TROUBLES

Before you change that tube socket try "Cool-Amp". Todays heater cuits carry a lot of current, especially those in color TV. This high current causes the pins and socket contacts to heat up, open up and corrode.

To save time and work replacing the socket, get some Cool Amp silver powder and a damp cloth and rub the powder into the tube pins and socket.

The silver helps cool the contact points and the trouble is cured, nerves are soothed.

Cool-Amp is the trade name and is produced by, The Cool-Amp Co., 8603 S. W. 17th Avenue, Portland, Oregon 97219.*—John J. Pirch*

ADMIRAL 4H12—NO SOUND OR PIX

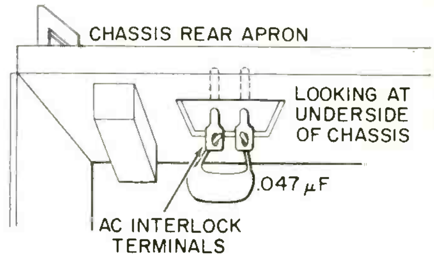
No sound or picture on channels 7 through 13—or, in some cases, the station comes in on the next higher channel—may be due to a leaky C454. This capacitor 0.01-uF is located under the shield of the sound take-off coil (L403).*—Admiral Service News Letter*

AC LINE CAPACITOR

The RCA "G" series color TV receivers have a .047-μF filter capacitor connected across the ac line (wired directly across the ac interlock terminals). This capacitor can be checked or replaced in the home—using the following procedures:

1. Remove the rear cover and chassis retaining bolts. Slide the chassis slightly rearward to inspect the capacitor. See diagram.

2. If the capacitor is an approved type—identified by its *white* color and stamped with the numbers



90097-221 or 1442487-221—no further action is necessary. Restore the chassis to normal operation.

3. If the capacitor is brown or reddish brown in color, it should be replaced with an approved type.

The RCA stock number of the approved capacitor is 111286. It is recommended that all service technicians carry this approved type capacitor when making housecalls on "G" series receivers.*—RCA Television Service Bulletin*

EMERSON 31T53 AND 31T54

Some of these sets develop noisy tuning on FM. This is caused by a poor ground wiper contact in the tuning capacitor. This condition can be corrected by installing a separate wiper washer (part No. 985314) on the tuning capacitor shaft as follows:

1. Remove the chassis.
2. Remove tuning capacitor from the PC board and label all wires removed for easy replacement.
3. Remove two small screws on front of tuning capacitor and place the washer (part 985314) on shaft and secure with the two screws.
4. Reassemble tuner and replace chassis in cabinet.*—Emerson Field Service Bulletin*

ZENITH 14Y33 CHASSIS

Complaint: Contrast, normal when set is first turned on, drops to a low level after 20–30 minutes of operation.

Remedy: Replace the 17JN6 horizontal output tube.

Cause: Tube develops gas or grid leakage, causing decrease in negative grid voltage which is used as a source of bias for the agc circuit. It will be noted that the agc control will not operate normally when this condition exists.*—R.J. Turner*

INSTANT-ON, WON'T TURN OFF

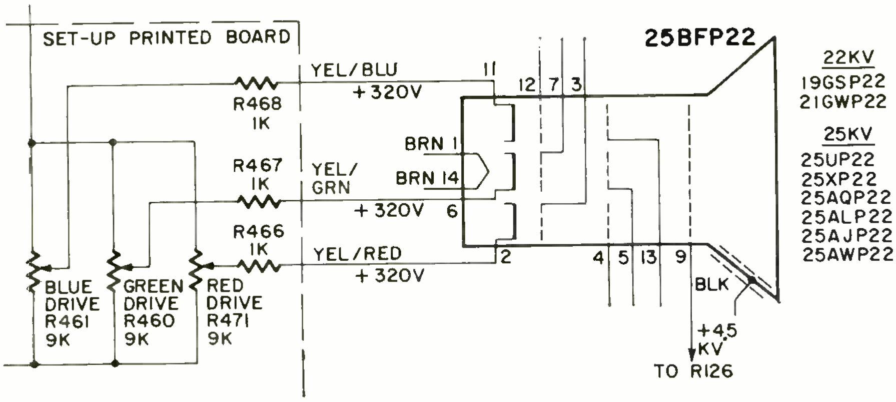
When the switch cannot be used to turn off sets with instant-on circuits, check the diode associated with this circuit. It may be shorted.*—B. J. Brown* **R-E**

Red Drive Control Update

Simple modification adds red gun drive control; also changes gray-scale adjustment in G-E color TV

Beginning with the KE chassis serial number OT1G, a 9000-ohm RED DRIVE control (R471) was added to the set-up board. At the same time the GREEN DRIVE (R460) and BLUE DRIVE (R461) controls were changed to 9000 ohms each as shown in the diagram.

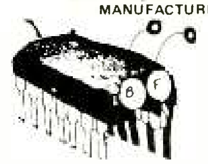
Control R471 was added to provide a drive control for the red gun in the new type 25BFP22 picture tube.

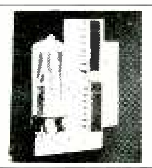


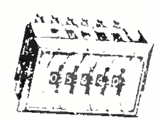
The three 9000-ohm controls in parallel present a 3000-ohm load to the video output tube; the same as was presented by the previous two 6000-ohm controls in parallel.

To make gray-scale drive control adjustments on KE chassis using picture tube types *other than* the 25BFP22, rotate the RED DRIVE control *fully clockwise and leave in this position*. Now make the usual gray-scale adjustments using the GREEN and BLUE DRIVE controls just as if the RED DRIVE control were not present.

To make gray-scale drive adjustments on KE chassis using the 25BFP22, rotate the GREEN DRIVE control *fully clockwise*. Advance the RED DRIVE control to produce a yellow background. If yellow cannot be attained with the RED DRIVE control at its maximum clockwise position, then leave the red control at maximum clockwise and retard the GREEN DRIVE counterclockwise to produce yellow. **At the end of the gray-scale adjustment procedure, either the GREEN DRIVE or RED DRIVE control must be in its maximum clockwise position.** **R-E**



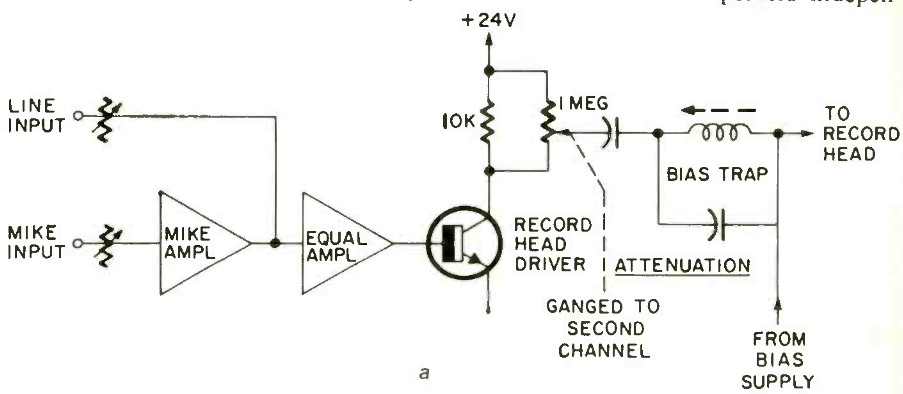




NOTEWORTHY

ATTENUATOR FOR SMOOTHER RECORDINGS

Very often, when making a tape recording from a tuner or a turntable, it is desirable to employ the level controls of the tape recorder to fade smoothly on and off the tape between selections, between records, or between announcements in the case of the tuner. A problem that arises when the recorder gain controls are so used is the fact that it is quite difficult to re-establish exactly the same record level as before the gain control was moved. This change of level on the tape, if audible, is a source of annoyance and detracts considerably from the smoothness of the recording. This situation can also mar the finished recording by requiring an excessive amount of gain riding when the recorder is re-started if there is much difference between the peak amplitude of the previous selection and the current selection, as is often the case when recording from a tuner. Since it is not always convenient to place markings on the recorder level controls, especially when recordings are made from more than one source as in even mildly complex music systems, it becomes convenient to add an attenuation control that operates independently of the existing recorder level controls.



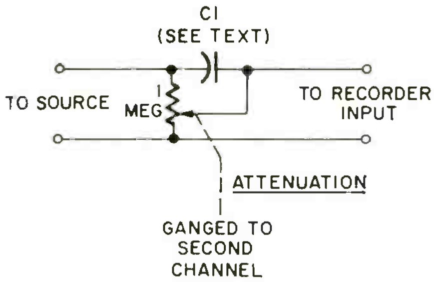
a

Such an auxiliary control should vary the gain of the recorder from zero to whatever levels have been set by the regular recorder controls while introducing a minimum of insertion loss and other undesirable effects. Figure 1-a illustrates an arrangement that has been successfully used for some time on a custom-built preamp that drives a modified tape deck for special-purpose recordings. The attenuation control is inserted between the record head and its driver, be it tube or transistor. Neither the taper nor the value of the pot is important so long as it is several times the resistance of the amplifier load resistor. Of course, in a stereo system, the two sections of the pot should be identical.

Figure 1-b shows how to insert an auxiliary level control externally if no room is available on the record preamp itself. Take care in choosing R1. It will introduce too much loss if it is of a lower resistance than the input impedence of the recorder, while it may tend to exhibit nonlinear frequency characteristics if it is made too large. The latter consideration will not normally present a problem as this control will usually be either fully on or fully off, but in the event that this situation becomes objectionable a small capacitor, C1 may be added as shown to im-

prove the frequency linearity of the circuit. The exact value of C1 will vary with the impedance and cable lengths involved and is best found by experimentation. It will usually be on the order of a few hundred picofarads for most high-impedance circuits.

In operation, the ATTENUATION control is set to its minimum loss position (normally fully clockwise) and the record levels are set using the normal source and recorder gain controls. Thereafter, if the recording must be interrupted, smooth transitions are made using the ATTENUATON control only. The recorder gain controls are

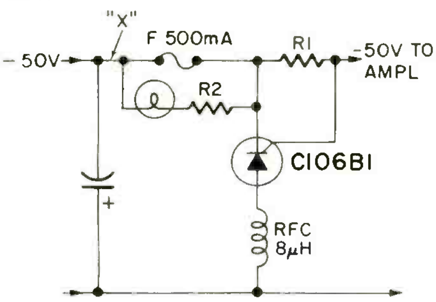


b

not disturbed unless the level of the program material changes. This arrangement has proven to be invaluable when making recordings off-the-air that include undesired commentary or commercials. This simple circuit, used with slow bias buildup to eliminate clicks when the tape is started, makes it almost impossible to tell when the tape has stopped to preclude recording unwanted material.—*J. Chamkis*

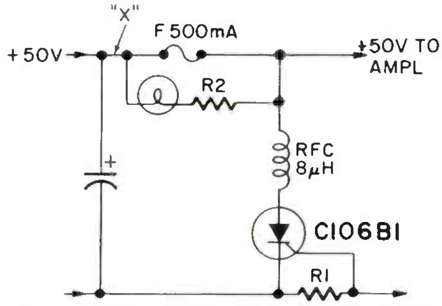
AMPLIFIER PROTECTOR CIRCUIT

Some of the earlier solid-state power amplifiers lack circuitry to protect the power transistors against damage if the amplifier is overdriven or if its output terminals are shorted. This circuit, described by Mr. L. Paal in *Electronics Australia*, is placed between the power supply and the amplifier.



Resistor R1, in series with the supply, is selected so the voltage drop across it turns on the SCR when the current through it reaches an unsafe level. When conducting, the SCR appears as a partial short-circuit across the power supply and removes about 60% of the voltage from the amplifier in about 4 μsec. The fuse blows in a few μsec and the lamp lights, indicating a short or overload.

The rf choke, made by winding 16 turns of No. 20 wire over a ¼-inch form, limits the in-rush of current to a safe value. In a 50-volt supply, the resistance of a 500-mA fuse (around 1.5 to 2 ohms) limits the



short-circuit current through the SCR to around 35 amps, well within the maximum-surge-current rating of the C106B1. Insert a resistor of about 2 ohms at "X" for higher current supplies. Select a value for R2 to supply the correct voltage to the overload indicator lamp. **R-E**

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DREAM WORKBENCH
(continued from page 85)

sit safely on a 12-inch shelf. Mine works on the bench-top at present, under the shelf, but is going on a cart soon.

That about takes care of the serious business of designing a workshop for maximum efficiency; the Ideal Shop, or as close as we can get to it. There's one more thing we really need, though, (and I'm only about half-joking). This is a good big *junk-room!* If we have say 5,000 feet of floor space, we'll need 10,000 feet for the inevitable junk. Those good old sets that we won't throw away because "there are a lot of good parts in there that I might need some day!" Hi!

Offhand, I'd say that my own setup is about Ideal. I have an old building, 125 feet long and 25 feet wide. Shop and storage space account for about 50 feet of the overall length, and the rest is one monster junk-room! I wouldn't go so far as to say that I *never* throw anything away (That's my *wife* who says that!). I will admit that while looking for something the other day, I found a Grebe Synchrophase radio (Circa 1925), a Majestic Model 20 radio (1928) and an RCA 630 TV set! Y'know, I'm gonna fix them one of these days, just as soon as I can get around to it! **R-E**

"Gee, Dad . . . vivid red . . . vivid orange . . . vivid purple . . ."

R-E ON FILM

Two sources of filmed back issues of RADIO-ELECTRONICS are now available. Please write the companies for further information. Microfilm editions are available from University Microfilms, A Xerox Company, Ann Arbor, Mich. 48106. Beginning with the January, 1969, issue, Microfiche editions are available from NCR Microcard Editions, Industrial Products Division, 901 26th St., N.W., Washington, D.C. 20037.

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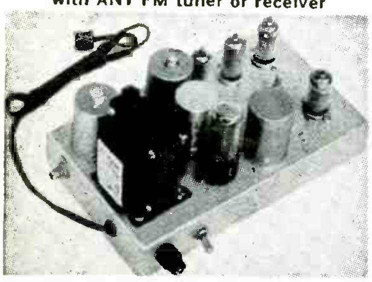

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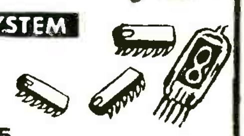

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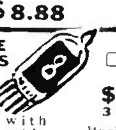

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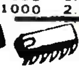

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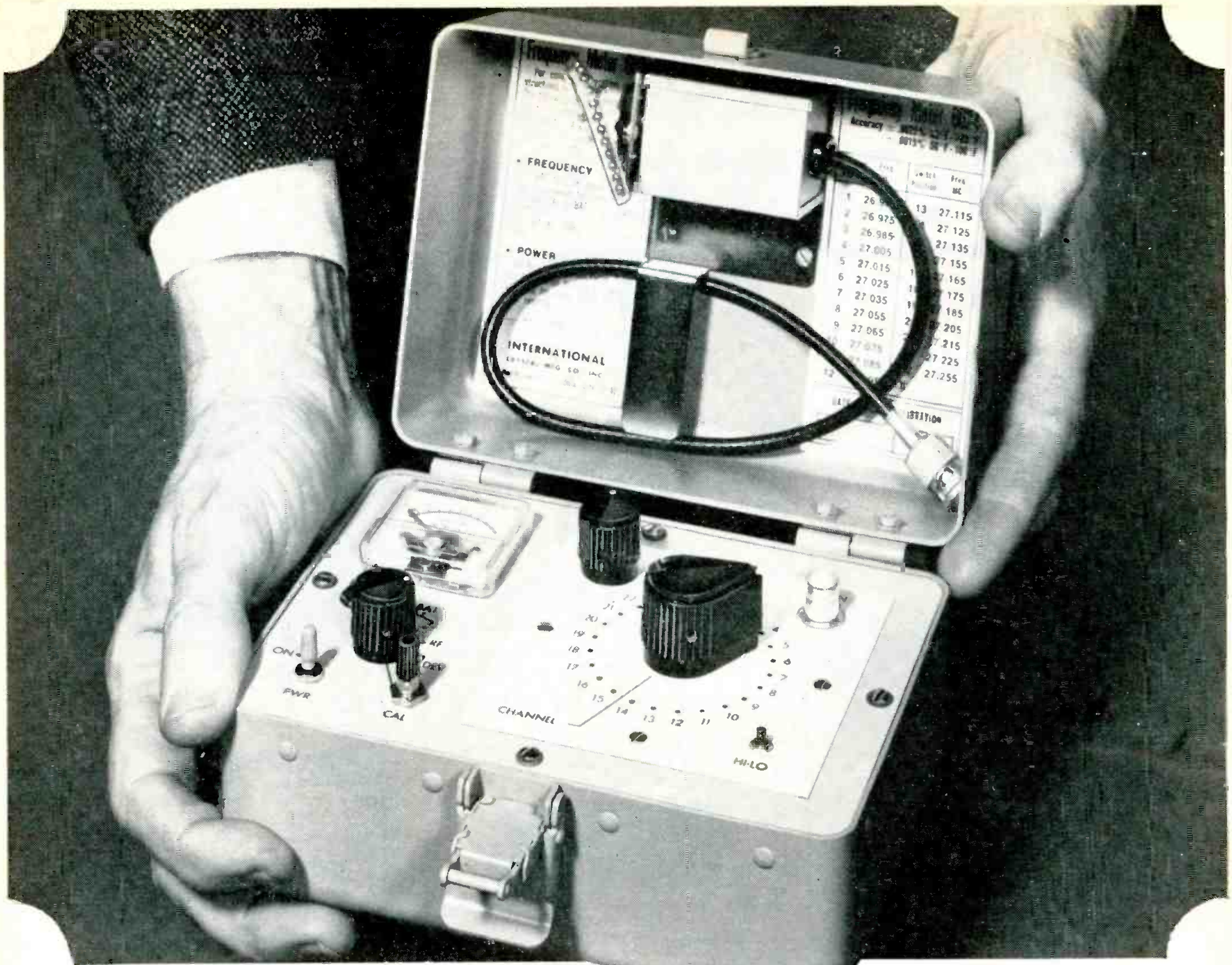

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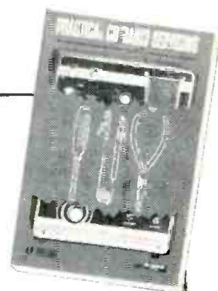

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