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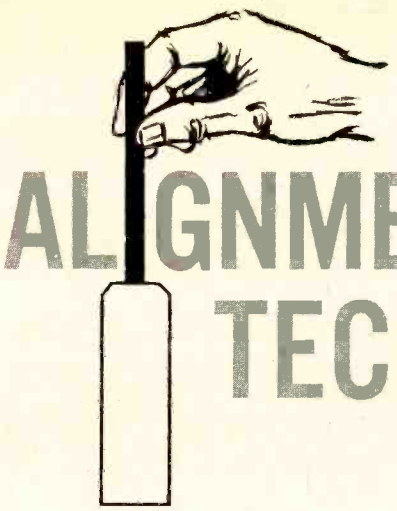

ALIGNMENT TECHNIQUES For Two-Way

Bench servicing transmitters and receivers.

by Patrick M. Craney

Since indirect FM (phase modulated) transmitters and receivers are basically alike, there are very few differences in alignment procedures among the different makes. Fig. 1 shows tuned circuits in both the transmitter and receiver of a typical VHF two-way radio. In the transmitter, alignment is performed on all stages but the speech amplifiers and the modulator. In the receiver, all circuits but audio and squelch require alignment.

Some transmitters and receivers incorporate series-resonant circuits, while other tanks are parallel-resonant. No matter whether the inductor or the capacitor is adjustable, the circuits are always aligned for a peak.

Since power levels in a transmitter are much higher than in a receiver, interaction between the primary and secondary of a transmitter coupling transformer is more noticeable. It is thus desirable, and often necessary, to align first the primary and then the secondary; then repeak the primary and again touch up the secondary. In tuned stages which do not use transformer coupling, the adjustments usually consist of a slug-tuned coil in parallel with a capacitor; this type of tank circuit serves as grid or plate load.

Test Equipment

For service and maintenance of commercial two-way radio, several pieces of special test equipment are necessary. Since the FCC governs the use of radio transmitters, and thus regulates frequency and modulation, it is necessary that transmitter test equipment be precise.

If a unit is *not* checked with accurate equipment, you can't be sure it isn't in violation of FCC regulations; also, communications may suffer. With such a narrow bandwidth (±5 kc, narrowband; ±15 kc, wideband), even a very small frequency error can impair communications.

Frequency Meter

A frequency meter is required to insure that the transmitter is on its assigned center frequency, within the tolerance allowed by the FCC. For dependable communications, the transmitter and receiver must both be on precisely the same frequency (netted), and a heterodyne-type frequency meter is a most accurate way of checking both.

Some frequency meters can be used as a communications receiver as well as for measuring frequency; this type generally has a phone jack or speaker for monitoring modulation. Such instruments use a receiver whose discriminator output is measured on a calibrated meter.

Modulation Meter

Without a modulation or deviation meter there is no way of determining if the frequency modulation is within legal limits, or if it is high enough to produce optimum communications.

Bandwidth of FM communications in the commercial services is limited by FCC Rule to a maximum of 20 or 40 kc, depending on the exact use. The 20-kc bandwidths do not permit the fidelity of the 40-kc units, but fidelity is not the prime consideration in these sets. For best clarity, some technicians like to maintain modulation deviation of narrowband equipment at the full 10 kc. When the modulation is set at maximum, there is little room for error or for subsequent aging of circuit components. It is thus advisable that modulation be set with the aid of an accurate deviation meter.

Should modulation exceed that allowed by the FCC, it will spill over into the guard bands on either side of the channel—see Fig. 2; if overmodulation is great enough, it can even cause interference on adjacent channels. In the wideband channels (±15 kc), there is actually 40 kc between one center frequency and another. However, when both channels are modulated 100% to the full ±15 kc, there is only a 10-kc guard band between. If either should overmodulate slightly, interference might result.

Normally, wideband two-way radio transmitters are not modulated 100%. Most technicians keep them set for about 85% (approximately ±13 kc) maximum. This provides good fidelity, and yet allows a "safety

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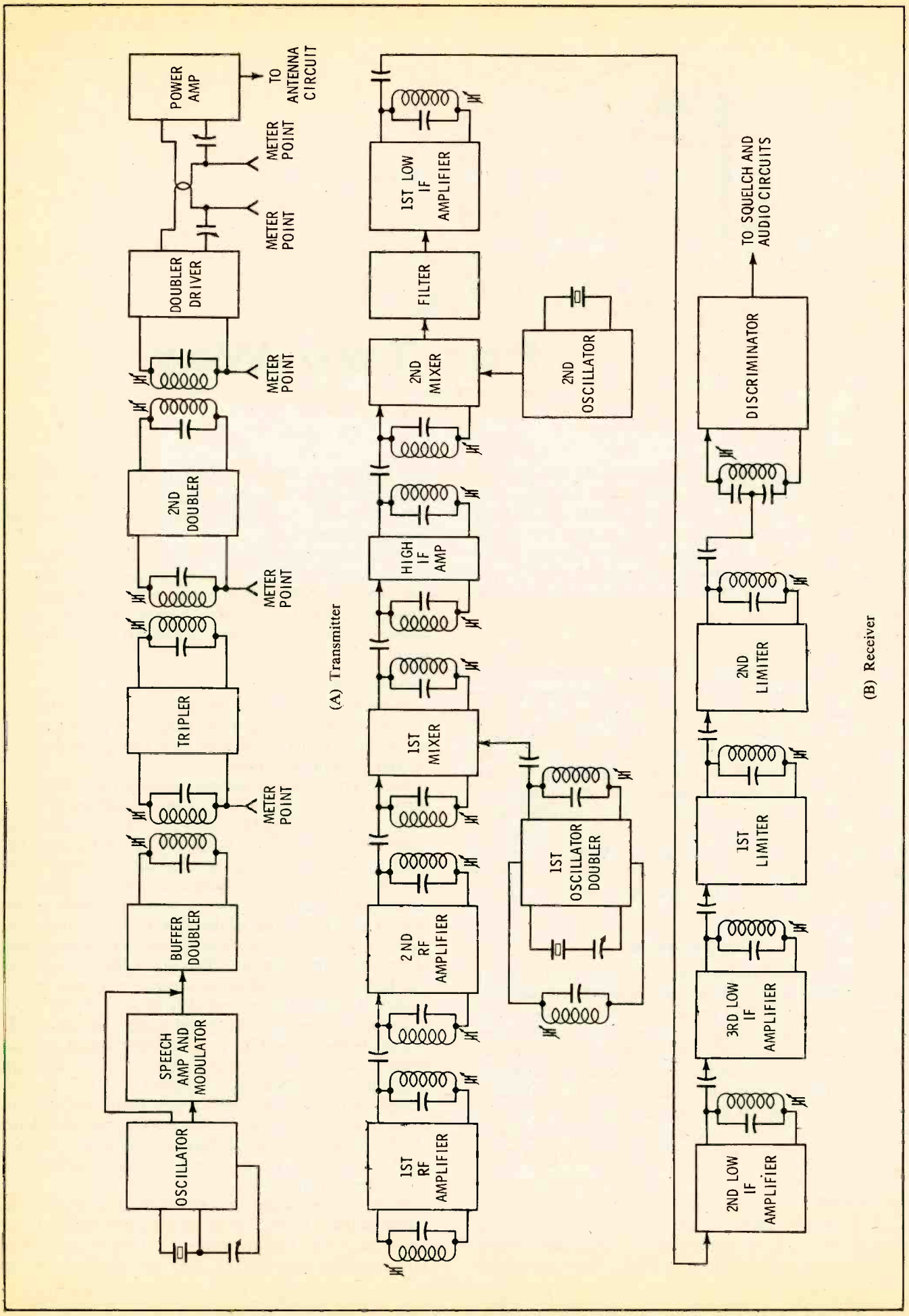

Fig. 1. Block diagram of two-way radio transmitter and receiver showing alignment points in each.

margin" for circuit changes that might increase modulation percentage.

On narrowband channels (±5 kc), achieving good fidelity is largely a matter of keeping the modulation level high enough that most of the voice signal is transmitted, and yet not so high as to cause overmodulation; ±4.7 kc is a good, safe deviation figure. Besides creating interference, overmodulation can cause distortion of the recovered audio at the receiver.

RF Power Meter

For the measurement of transmitter RF power output, an in-line wattmeter like that shown in Fig. 3 is very valuable. This type of power meter not only allows you to align the final power amplifier(s) and antenna circuit for maximum efficiency and power output, but it also permits you to check the antenna and transmission line.

Some technicians use a field-strength meter in place of a wattmeter. While this method of aligning the transmitter is okay in a pinch, it is better to align with an in-line wattmeter. An FSM is broadly tuned and won't always indicate very sharply the peak power point. Most generally you will have to tune from one side of the peak to the other and then determine *approximately* where the peak is. A transmitter will probably work satisfactorily after being peaked with an FSM, but you will *know* you have correct output and tuning if you use the proper instruments.

Another method of measuring the RF power output is by use of a dummy load outfitted with some type of indicator. This can take the form of either a light bulb, which burns brightest at peak power, or a meter. Neither device, however, will show the condition of the antenna circuit, but will indicate only the power output.

The schematic of a low- and high-power dummy load is shown in Fig. 4. The input is through a coax connector to series-connected 25-ohm noninductive resistors. Since the output impedance of most two-way radio transmitters is 50 ohms, the load must also be 50 ohms for maximum transfer of power. Although the dummy load itself consists of nothing more than 50 ohms of resistance at a suitable power rating, a few additional components will enable measurement of the applied RF power.

All you need do is insert a DC voltmeter from the meter jack to ground, connect the transmitter output to the coax connector, and key the transmitter on. The RF power is sampled and rectified through M1, R3, and R1. M1 should be fairly husky—able to take repeated surges as the transmitter is keyed on and off. R1 can range from approximately 30K to 200K, depending on the meter scale you wish to use; the larger the resistance, the greater the meter readings will be. R1 through R4 need be only 2-watt resistors, as very little power is dissipated in them.

The 25-ohm resistances, however, must dissipate the total transmitter power output. If the transmitter is a 1- to 5-watt unit, it is termed "low-power." Anything above 5 watts is termed "high-power." The load-resistance wattage can be chosen to suit the highest-powered transmitter you expect to test. Allow sufficient safety margin so the load won't burn up if a surge of power higher than that normally expected should occur. Also, be sure to use hookup wire heavy enough to carry the current, with insulation sufficient to withstand the voltage peaks.

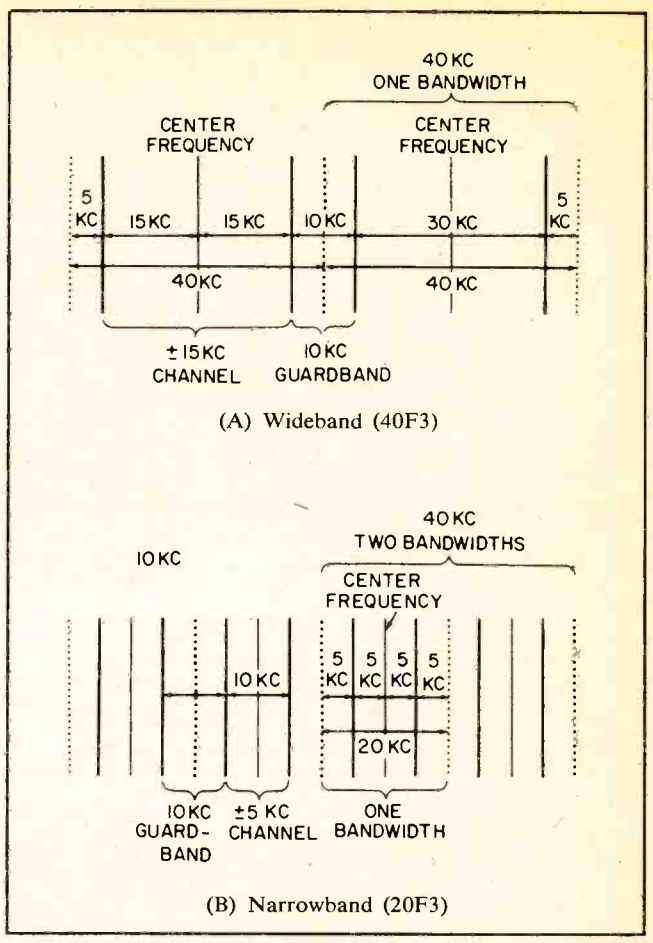

Fig. 2. Narrowband channel uses one-half the space of wideband.

Signal Generator

For maintaining and troubleshooting receivers, you will need a signal generator with at least three frequency ranges: one for alignment of the low frequency IF's, one for high IF's, and another for the front end or RF sections. The first is usually around 455 kc or less; the second ranges from 2 mc to 15 or 20 mc; the last is VHF—from 30 to 175 mc. If you encounter UHF receivers, signals up to 500 mc will be required. Frequently, two generators are required to cover the entire range—three, if UHF is needed.

The VHF or UHF generators should be equipped with an attenuator calibrated accurately in microvolts,

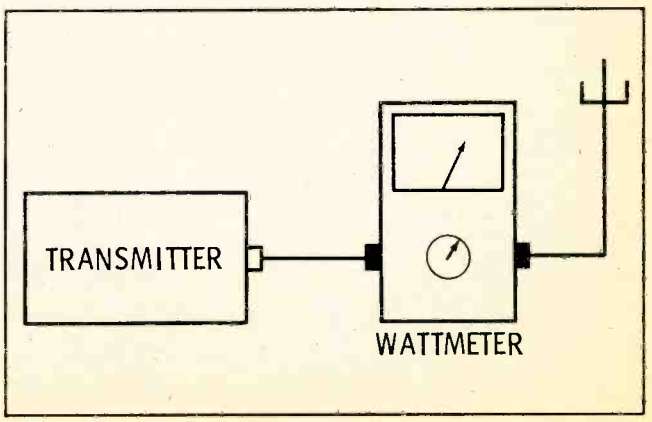

Fig. 3. An in-line wattmeter can be used to check antenna SWR.

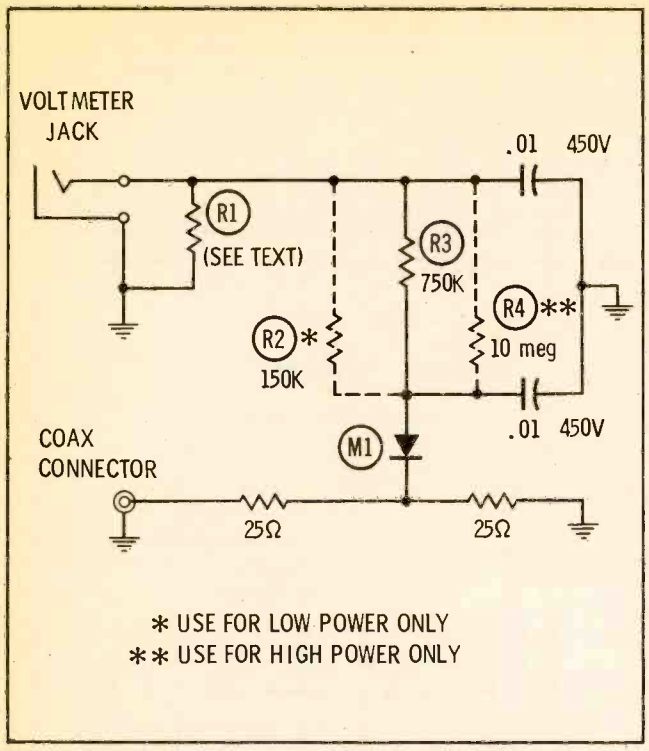

Fig. 4. Circuit dissipates and samples transmitter RF power.

for measurement of sensitivity. The attenuator shown in Fig. 5 works with a bolometer circuit and a meter to accurately control the generator output in microvolts. Signal generators ordinarily used in radio and TV shops have unmarked attenuators. Of course, you can use your servicing generator to align the FM communications receiver, but sensitivity measurements would be very inaccurate.

Transmitter Alignment

Before aligning a transmitter, measure its power output, carrier frequency, and modulation deviation. Just throwing a transmitter on the bench and beginning alignment is not the best habit to develop. First you should determine what needs improvement. These measurements will quite often give you clues to existing trouble before you even pick up your alignment tool.

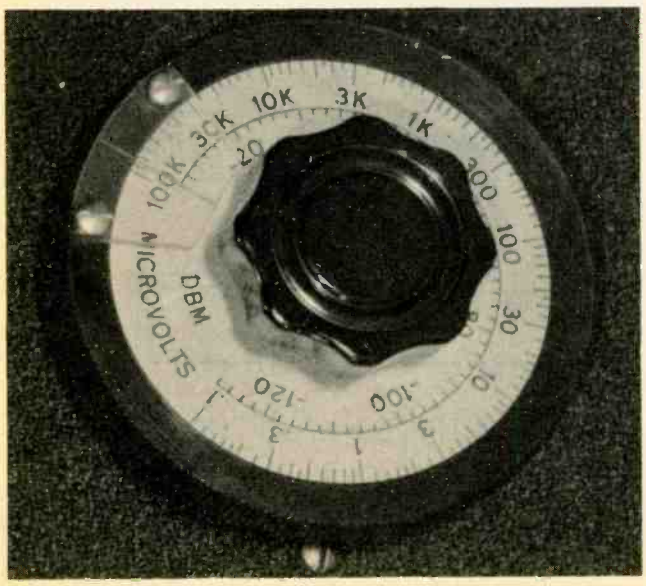

Fig. 5. Signal generator attenuator calibrated in microvolts.

Power Check

To check the power output, you can use either an in-line wattmeter, as shown in Fig. 3, or an indicating dummy load. If the output power is present, even though weak, it is an indication that all stages are working. If output is nonexistent, the fault must be found and fixed before alignment can be completed.

Make a note of the power level so you will have a reference to determine improvement, if any. If output power is less than it should be, after alignment you will have to troubleshoot the transmitter. For now, however, just measure the output power.

Frequency Check

Once you are satisfied the transmitter is okay, and have measured output power, check the center frequency with a frequency meter. While measuring the frequency have the transmitting antenna disconnected—provided you can get enough signal to the frequency meter. With the antenna connected, every time you key the transmitter you are preventing someone else from using the channel. A dummy load is best for all tests, except the final station check.

If the frequency is even slightly wrong (even though still within legal limits), carefully adjust the oscillator frequency adjustment. In some transmitters this adjustment is a trimmer, as shown in Fig. 6. In others, a coil slug is the adjustment. In either case, be sure to use a nonmetallic tuning tool. The tool in Fig. 6 consists of a metal blade set in a nylon handle.

A screwdriver used for such adjustments (even trimmers) will change the capacitance and detune the circuit, making accurate adjustment difficult. When nothing else is available, a screwdriver will have to be used. All you can do in such a case is observe how far off frequency the signal is, make a small correction with the adjustment, take the screwdriver away, and note what change was made. This adjust-and-check procedure must be repeated until the frequency-meter indicates the carrier is exactly on frequency with the screwdriver withdrawn from the adjustment.

Modulation Check

Once the carrier has been adjusted to the proper frequency, monitor the modulation deviation while injecting a 1000-cps tone into the speech-amplifier input. A shrill whistle into the mike will serve the purpose. If modulation deviation exceeds 100%, adjust the modulation limiting control (Fig. 7) for the proper level. Having set the modulation control, speak into the microphone with a normal-to-loud voice and observe deviation. If voice peaks drive the modulation over 100%, back off the control just a little. If no trouble exists in the speech or modulator circuits, this will correct any overmodulation or undermodulation.

Oscillator Peaking

Besides a frequency adjustment, some transmitter crystal oscillators have a slug-tuned coil for peaking the oscillator output. Be sure it doesn't alter frequency. If it does, you may have to reset the trimmer. Peak the oscillator output for enough power to feed the modulator and first multiplier sufficient signal for normal transmitter operation.

To know when the oscillator is producing maximum output, connect a VTVM or test set from the grid

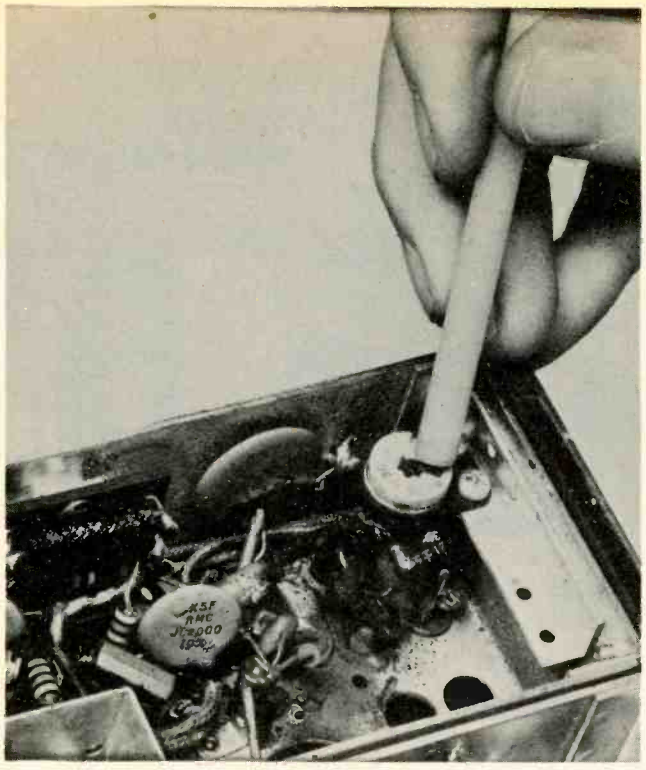

Fig. 6. A nonmetallic tool should be used to make adjustments.

Fig. 7. The modulation control is usually beneath the chassis.

circuit of the second multiplier to ground. As shown in Fig. 8, some transmitters have special connections for metering. The VTVM in Fig. 8 is connected to measure the IR drop across R1, thus indicating tripler drive. The higher the driving voltage, the larger the grid current, and the greater the meter reading.

Adjust oscillator coil L1 for a maximum meter reading. A point of interest in this circuit is that the oscillator output contains no adjustment, but is fed directly to the modulator. M1 is a low-Q phase-shift circuit that works in conjunction with the modulator.

Multiplier Alignment

The number of multipliers in a two-way radio transmitter varies from one band to another. In the low-VHF band (25-54 mc), there are usually only two doublers and one tripler. In the high band (144-174 mc), there are usually three doublers and one tripler. In the UHF band (450-470 mc), there are usually two doublers and two triplers.

No matter what the frequency range of the transmitter, tuning is the same for all multipliers (Fig. 9): tune for maximum meter reading. As shown in Fig. 10, metering of the input circuit for the doubler-driver in a low-band transmitter consists of measuring the voltage drop across the grid resistor. Both the primary and secondary of L1 are adjusted for a peak meter reading. Upon completion of the multiplier adjustments, if any one of the coils was very much out of alignment, you should go back and perform the whole procedure once again to assure optimum signal transfer.

PA Alignment

When aligning the power amplifier, you should watch both the power output indicator and the voltmeter that indicates plate current in the final stage—see Figs. 10 and 11. For these measurements, the antenna should be connected.

With the antenna coupling at minimum, adjust the PA tuning capacitor for a minimum (dip) on the voltmeter. Once a definite dip has been achieved, adjust the antenna trimmer for a maximum and then increase antenna coupling for an increased maximum output reading. Continue to alternate adjustments as follows: increase coupling for slightly greater output; dip the current reading with the PA tuning adjustment; set antenna trimmer again for maximum output; redip PA

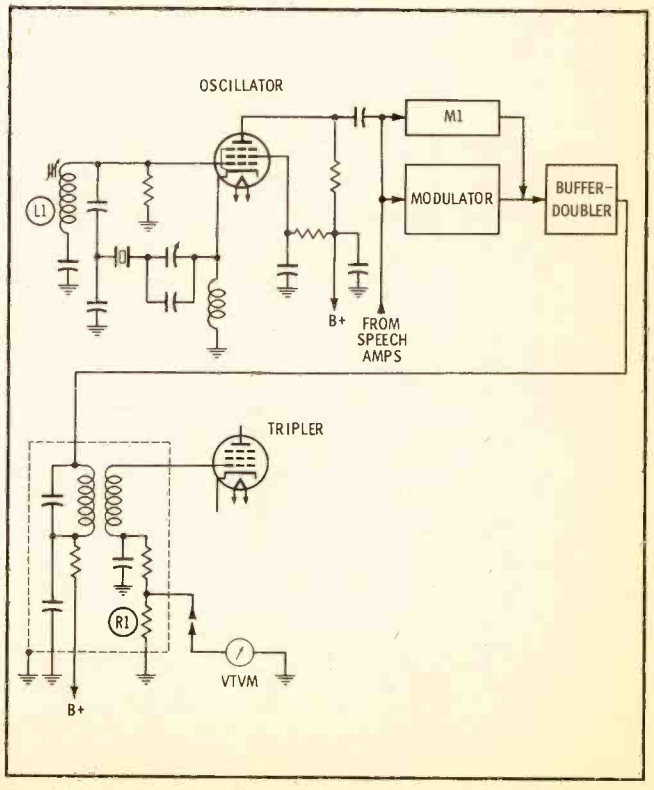

Fig. 8. Oscillator adjustment indicated on tripler circuit meter.

Fig. 9. Multiplier coils are aligned for a peak VTVM reading.

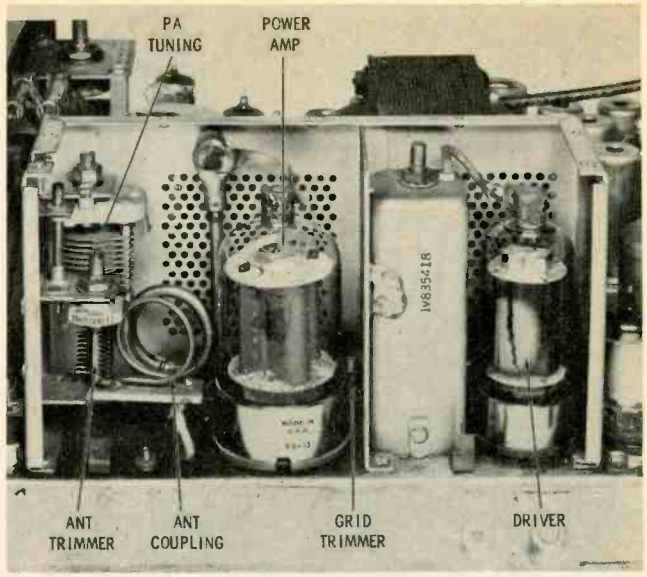

Fig. 11. Location of the driver and final and their adjustments.

tuning adjustment. When rated output of the transmitter is reached, don't increase coupling any further. As a final adjustment, retouch PA tuning *for maximum output reading,* but be sure plate current rises only slightly above minimum.

If you should be caught out in the field with no output wattmeter, and you have to tune the final amplifier, leave the antenna connected, decrease the antenna coupling 50% or more, and adjust the PA tuning capacitor for minimum PA current. You can then adjust the antenna trimmer for maximum PA current. Next, in alternate steps, increase the antenna coupling slightly and then redip the PA tuning. Repeat these steps until the current reading ceases to increase with increased coupling, and the PA-current dip is very indefinite (not sharp). At this point, back off the coupling just a little. You can then be sure the transmitter is pretty near optimum power output, and the final tube isn't overloaded.

Although not a part of transmitter alignment, the physical length of the antenna has a great deal to do with whether or not maximum power is radiated. If your in-line wattmeter indicates an SWR greater than 1.5:1, it is quite possible the antenna is not the correct length for the transmitter frequency. If the antenna whip is too long, careful pruning will bring it to the correct length. If too short, a longer one will have to be installed.

When pruning an antenna, take ¼" off the top at a time, and then take a wattmeter reading. If the

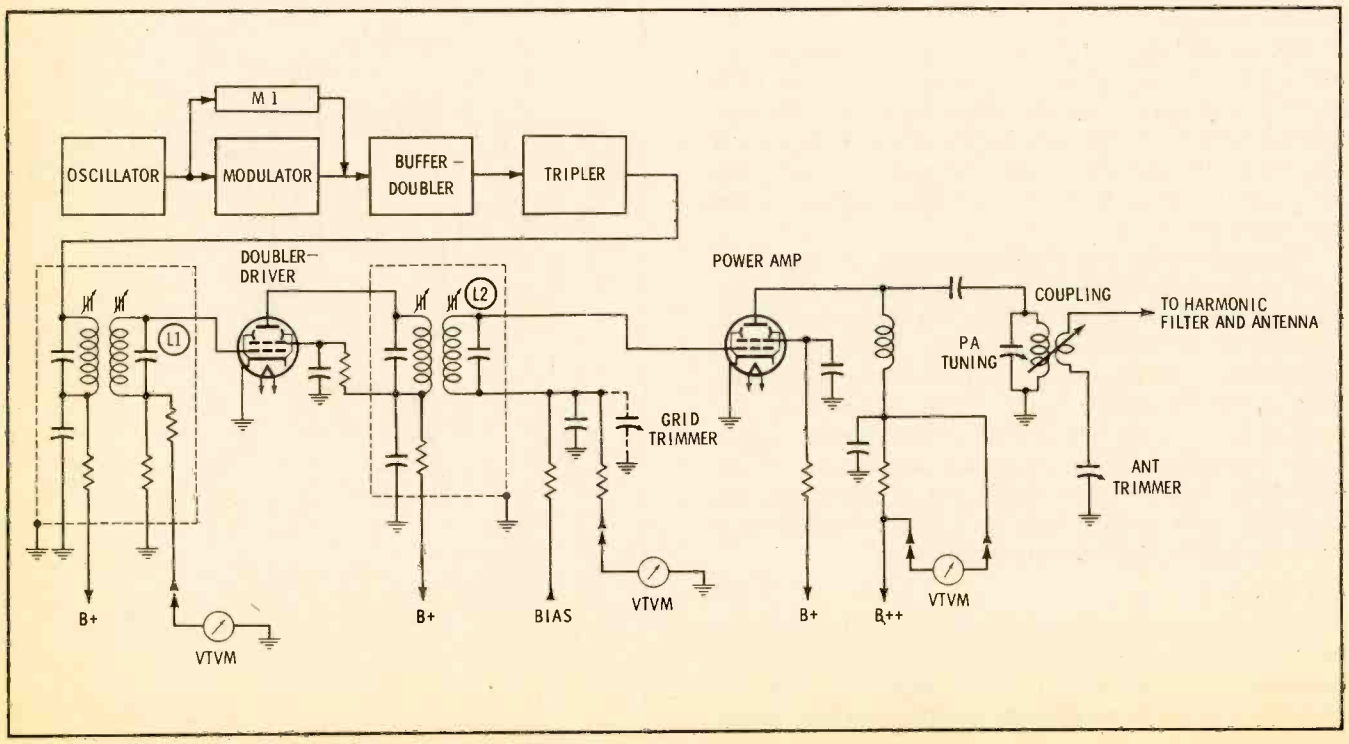

Fig. 10. Power-amp plate current measured across B++ resistor.

amount of reflected power (SWR) is reduced, but not yet acceptable, continue to prune and take readings until the SWR is acceptable. (Don't try pruning with the transmitter on, or you'll get an RF burn.) An SWR of 1.2:1 is not too bad.

Receiver Alignment

Before performing receiver alignment, it is best to determine the receiver's actual condition. Listen to the audio as messages are being received. Connect a signal generator and measure the sensitivity. Also, check the receiver's frequency; does the discriminator zero when a signal is being received?

Mushy audio indicates overmodulation at the transmitter, squelch-circuit trouble, an audio fault, poor alignment, or even an off-frequency oscillator. Sensitivity should be 1 uv or better; if not, a faulty RF or high-IF stage is indicated. Make sure all tubes are okay before starting alignment; by doing so, you partly eliminate the possibility of finding a bad tube later and having to align all over again.

Frequency Adjustment

If the receiver isn't on frequency with the transmitter, first be sure the transmitter frequency is correct. To do this, you'll have to first be sure the discriminator is set precisely for the low IF.

The discriminator can be checked by coupling a signal of the exact discriminator frequency into the grid circuit of the first low-IF amplifier, as shown in Fig. 12. If the discriminator output reading (Fig. 13) is precisely zero, and can be tuned sharply above and below zero, the discriminator transformer is correctly tuned. If not, carefully adjust the secondary (be sure you're not adjusting the primary) for a zero reading.

To set the receiver frequency accurately, couple an *accurate* signal (of the station frequency) into the antenna input circuit. Then, while metering the discriminator output as shown in Fig. 13, set the local-oscillator crystal adjustment to obtain a precise zero reading.

Low IF Alignment

With a loosely coupled low-IF signal injected into the grid circuit of the first low-IF amplifier, as shown in Fig. 12, meter the grid circuit of the third IF amplifier (Fig. 14). Reduce signal level until the meter reads in the lower one-third of the scale, and adjust L1 for maximum. If the reading has increased so the meter needle is in the upper portion of the scale, again reduce signal input level. Now adjust coil L2 for a peak meter reading.

For adjustment of coil L3, you will have to move the VTVM to the discriminator input meter point (Fig. 13). At this point, you will measure the drive voltage from the second limiter. Adjust L3 for a peak meter reading. Some receivers will have a limiter metering point, as well as limiter tuning adjustments. In these sets, it is best to use that metering point for all low-IF and limiter tuning.

The limiters in some sets have no adjustments; however, there is an adjustment for the discriminator input. As shown in Fig. 13, both the primary and secondary of the discriminator transformer are tunable. The secondary, of course, determines the crossover

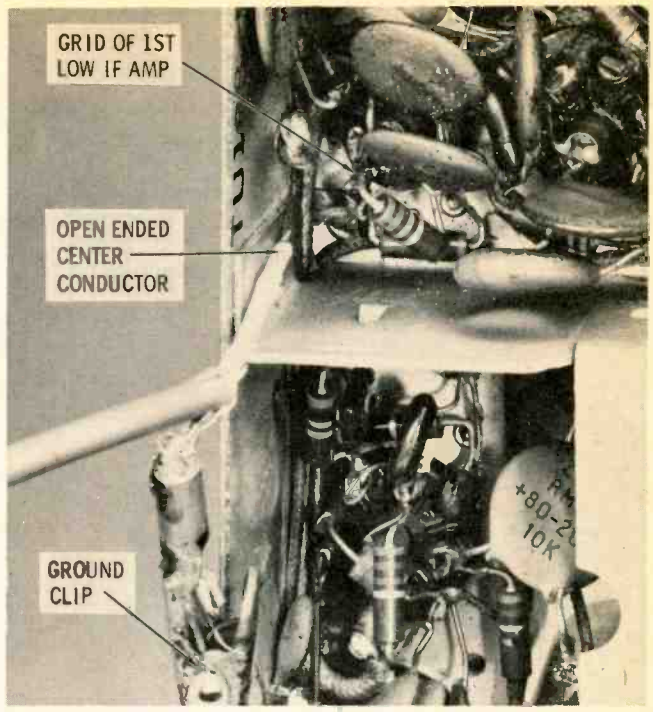

Fig. 12. Generator signal is *radiated* into IF amplifier circuit.

or zero point of the discriminator S-curve. The primary is tuned for maximum signal transfer. In many commercial two-way receivers, the discriminator primary has been preset at the factory and should not require adjustment. However, should you find it absolutely necessary to align the primary, it is best to short out the secondary while you align the primary.

Once you complete low-IF alignment, go back and touch up each coil to insure peak performance. You can then remove the signal source and proceed to front-end and high-IF alignment.

Front-End Alignment

Having determined that the receiver is on frequency and having properly aligned the low IF's, inject a signal of the station frequency into the antenna terminal and connect a VTVM to the meter jack of the third low-IF amplifier. Adjust the generator attenuator so the meter needle reads in the lower third of the scale.

With a nonmetallic tuning tool, as shown in Fig. 15,

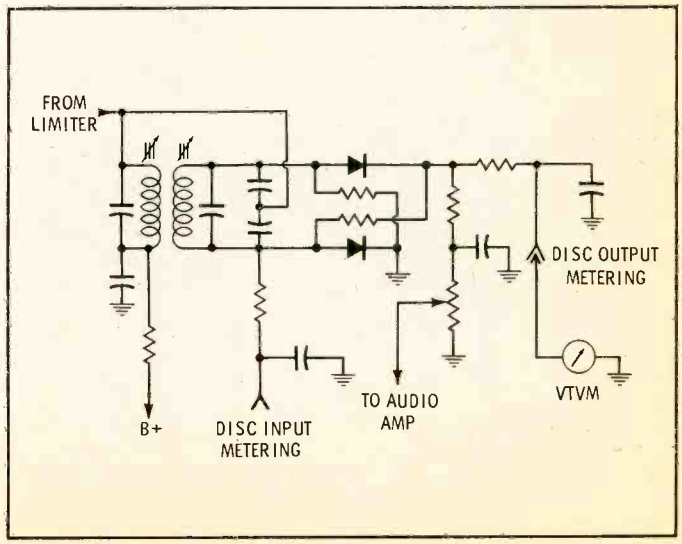

Fig. 13. Discriminator has meter jack at both input and output.

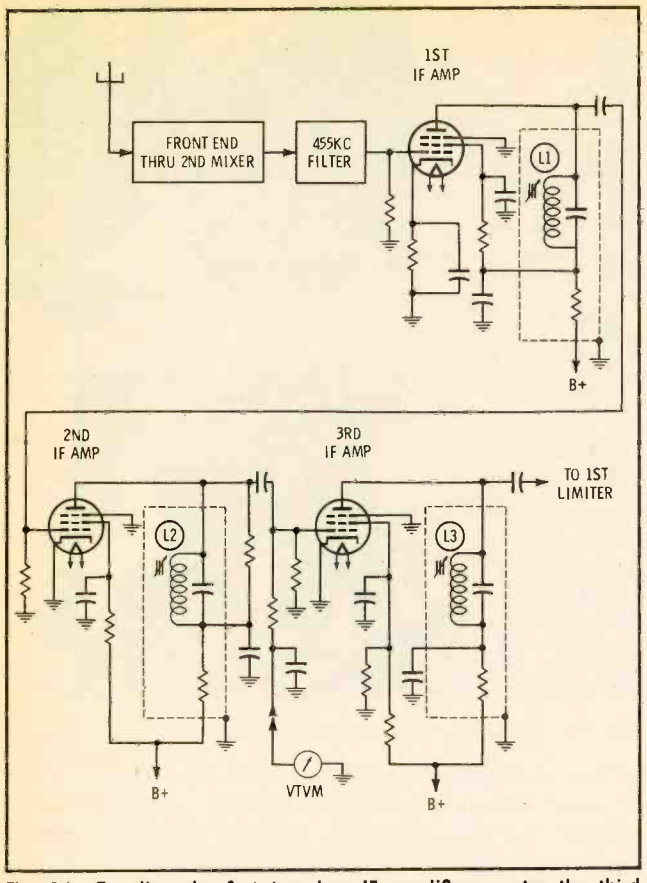

Fig. 14. To align the first two low IF amplifiers, meter the third amplifier and adjust coils L1 and L2 for a peak reading.

begin at the antenna coil (if there is one) and work towards the second mixer, peaking every coil but that of the first oscillator. If at any point the meter reading increases considerably, reduce the generator output to bring the needle back to the lower portion of the scale. If you don't have a nonmetallic tuning tool, and if the slug screws protrude from the bottom of the cans, turn the radio over and tune from the bottom.

If the first local oscillator has a multiplier stage following it, there will be provisions for alignment.

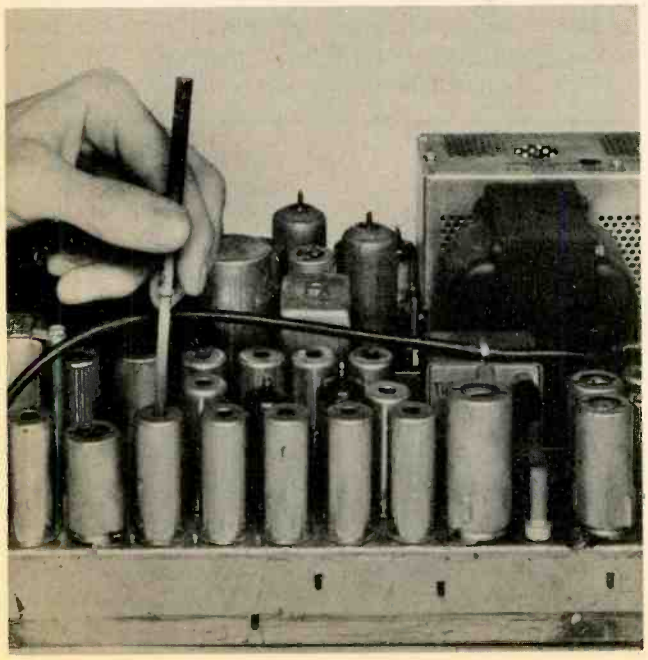

Fig. 15. Alignment of the RF and IF coils is with a plastic tool.

Adjust the multiplier or oscillator coil for a peak meter reading. Be sure to recheck the discriminator zero reading to be sure the oscillator frequency hasn't been affected.

In cases of extreme misalignment, the meter indication may be too low for easy reading. One method to achieve a larger meter reading is to bypass the selective bandpass filter located between the second mixer and first low-IF amplifier. This can be done by temporarily disconnecting the filter input and connecting a .01 mfd capacitor from the output of the second mixer to the input of the first low-IF amplifier. More signal will thus reach the IF amplifier than would be delivered through the filter.

This filter must not be left out of the circuit except during preliminary alignment. When the set is brought into some semblance of proper alignment the filter should be reinserted in the circuit, and alignment completely reperformed to insure accurate peak meter readings.

With the receiver completely aligned and on frequency, it should have a sensitivity of something less than 1 uv. Open the squelch control and slowly increase the generator signal level from zero to the point where 20 db quieting occurs. If it does not occur with 1 uv or less of signal, the receiver is still not sensitive enough. If realignment doesn't improve the overall sensitivity, try new tubes one at a time, peaking the associated coils (input and output) as you do.

To check squelch operation, turn the control just to the point where the receiver noise is squelched, and no further. Begin with no signal and increase the level to the point where you can hear the audio amplifier start conducting. Read the signal level in microvolts on the generator atteuator; this is the squelch-opening sensitivity of the receiver. Any transmitted signal whose strength at the receiver is less than this sensitivity figure will not open the squelch circuit.

When you are satisfied the receiver is aligned properly and is working satisfactorily, remove the signal generator and voltmeter, and connect the antenna. Try an on-the-air test with another two-way radio. If you can, communicate with a distant station, one that you would consider on the fringe area of communications for that particular system. If communications can be established and maintained between two sets at the fringe of their coverage, you have performed a good servicing job.

After putting the radio back in service, make another on-the-air check. Too many times, the shop bench voltage exceeds that of the auto or office where a unit will be used. If such is the case, communications may suffer; transmitter output power and receiving sensitivity may be reduced.

Customer Satisfaction

Since the commercial two-way radio customer counts on his radio to earn money, he is usually far more discriminating than the TV owner. If his radio isn't operating at maximum efficiency, he is unhappy not only over the loss of communications but also over losing money. If you as a serviceman give him the very best in service, and keep his equipment doing the job it was designed for, you will seldom lose any business. A satisfied customer is all the advertisement you'll need. ▲

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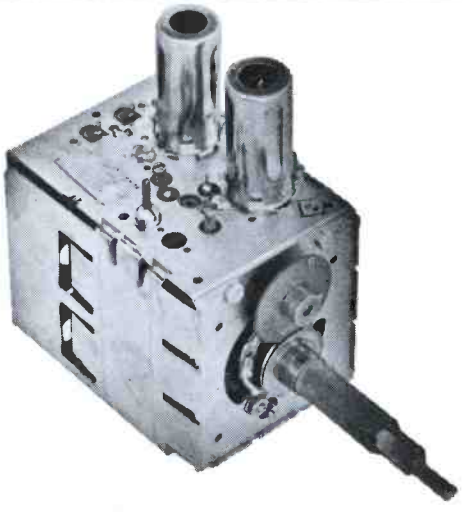

ALL PARTS (except tubes) and LABOR

24-HOUR SERVICE 1-YEAR WARRANTY

It just makes sense that a manufacturer of tuners should be better-qualified, better-equipped to offer the most dependable tuner repair and overhaul service.

Sarkes Tarzian, Inc. pioneer in the tuner business, maintains two complete, well-equipped Factory Service Centers—assisted by Engineering personnel—and staffed by specialized technicians who handle ONLY tuner repairs on ALL makes and models.

Tarzian-made tuners received one day will be repaired and shipped out the next. Allow a little more time for service on other than Tarzian-made tuners.

Tarzian offers a 12-month guarantee against defective workmanship and parts failure due to normal usage. And, compare our cost of $9.50 and $15 for UV combinations. There is absolutely no additional, hidden charge, for ANY parts except tubes. You pay shipping costs. Replacements on tuners beyond practical repair are available at low cost.

Ⓣ Tarzian-made tuners are identified by this stamping. When inquiring about service on other tuners, always give TV make, chassis and Model number. All tuners repaired on approved, open accounts. Check with your local distributor for Sarkes Tarzian replacement tuners, replacement parts, or repair service.

TWO SERVICE CENTERS TO SERVE YOU BETTER

See your distributor, or use the address nearest you for fast factory repair service

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SARKES TARZIAN, INC.

Bloomington, Indiana

MANUFACTURERS OF TUNERS . . . SEMICONDUCTORS . . . AIR TRIMMERS . . . FM RADIOS . . . AM/FM RADIOS . . . AUDIO TAPE . . . BROADCAST EQUIPMENT

Circle 2 on literature card

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PF REPORTER
including Electronic Servicing

VOLUME 14, No. 4 APRIL, 1964

CONTENTS

SPECIAL COMMUNICATIONS SUPPLEMENT

Popular demand by our readers, and the vast expansion in the field of two-way communications within the past two years, have prompted the specialized servicing articles included in this month's supplement. You'll find it starting on page 73.

ABOUT THE COVER

Two-way radio communications antennas, blossoming from atop buildings, automobiles, trucks, and other vehicles, bear evidence of the rising popularity of two-way systems. If you're servicing equipment of this type, or planning to start, don't miss the special Communications Supplement bound inside the rear cover.

WHY bother with makeshift twist-prong capacitor replacements?

When you substitute capacitor sizes and ratings, you leave yourself wide open for criticism of your work . . . you risk your reputation . . . you stand to lose customers. It just doesn't pay to use makeshifts when it's so easy to get the *exact* replacement from your Sprague distributor!

Get the right SIZE, right RATING every time with improved

SPRAGUE TWIST-LOK® CAPACITORS!

Over 1,690 different capacitors to choose from!

The industry's most complete selection of twist-prong capacitors, bar none. Greater reliability, too. Exclusive Sprague cover design provides a leak-proof seal which permits capacitors to withstand higher ripple currents.

GET YOUR COPY of Sprague's comprehensive Electrolytic Capacitor Replacement Manual K-106 from your Sprague Distributor, or write Sprague Products Co., 105 Marshall St., North Adams, Massachusetts.

SPRAGUE®
THE MARK OF RELIABILITY

WORLD'S LARGEST MANUFACTURER OF CAPACITORS

65-122-63

Circle 3 on literature card

For window-size blow-ups of this message, send 10¢ to Sprague Products Co., 105 Marshall St., North Adams, Mass., to cover handling and mailing costs.

You'll never see your doctor advertise a special sale on appendectomies . . .

You'll never see your lawyer announce cut-rates for divorce cases . . .

You'll never see your dentist hold a "2-for-1" sale on extractions . . .

AND You'll never see the day when you can take your TV set in for a service "bargain" and be sure you're getting a square deal!

"Bargains" in home electronic service are as scarce as the proverbial hen's teeth! Here's why—

The expert service technician, just like other professional people, must undergo years of study and apprenticeship to learn the fundamentals of his skill. And a minimum investment of from $3000 to $6000 per shop technician is required for the necessary equipment to test today's highly complex sets. Finally, through manufacturer's training courses and his own technical journals, he must keep up with changes that are developing as fast as they ever did in medicine, law, or dentistry. Those best equipped to apply modern scientific methods are almost certain to be most economical for you and definitely more satisfactory in the long run.

Unfortunately, as in any business, there will always be a few fly-by-night operators. But patients, clients, and TV set owners who recognize that you get only what you pay for, will never get gypped. "There just ARE no service bargains" . . . but there is GOOD SERVICE awaiting you at FAIR PRICES!

THIS MESSAGE WAS PREPARED BY SPRAGUE PRODUCTS COMPANY,
DISTRIBUTORS' SUPPLY SUBSIDIARY OF SPRAGUE ELECTRIC COMPANY, NORTH ADAMS, MASSACHUSETTS, FOR . . .

YOUR INDEPENDENT TV-RADIO SERVICE DEALER

65-124-63

Circle 4 on literature card

In your store, these compact counter merchandisers **continue that pre-selling** right at the point-of-purchase.

In their homes, your customers are being pre-sold on **RCA Radio Batteries** over network TV ...on Walt Disney's **"Wonderful World of Color."**

NETWORK-TV ADVERTISING

During the key summer months, network-TV commercials will be carrying RCA Battery Advertising into over NINE MILLION homes...to over 21 MILLION viewers*. Get the most out of the radio battery business with the name your customers associate with radio...RCA.

COMPACT COUNTER MERCHANDISERS

Here's the way to take a single foot of counter space and really put it to work. Any one of these attractive merchandisers effectively displays RCA Batteries while creating strong RCA brand recognition. Such a merchandiser, with pilfer-proof plastic front face, creates a real battery showcase.

For self-service operation, there's RCA's award-winning blister-packaging. New to the battery business? Then pick an RCA pre-packed battery assortment as a start.

See your Authorized RCA Battery Distributor or write: Battery Department, RCA Electronic Components and Devices, Harrison, N. J.

*Estimate of average viewing audience per show during June, July and August based on Nielsen National Television Index.

The Most Trusted Name in Electronics

Letters to the Editor

Dear Editor:

A member of our association brought your October issue to a recent meeting, and we discussed the article, "Profits From PA Systems."

In the State of California, a license (C-61 classified specialist) is required for the installation of PA systems. Also, in our area, new construction installations must be done by union contractors (International Brotherhood of Electrical Workers). Thus, we feel that service shops wishing to enter the PA field should be advised of the possible need for both union agreements and contractors' licenses prior to submitting any bids.

There are other items to be considered prior to bidding work in this field:

1. Additional insurance costs.
2. Specialized tools for installation.
3. Familiarity with the contractor and lien laws.
4. Necessity for checking credit (because of larger sums involved).
5. Financial backing for larger operations.
6. Status of the competitive bid market in the area.
7. Associations that represent those specializing in this type of work.

These reminders are not intended to scare people away, but to make servicemen aware there is more to electronic specialty contracting than one might think at first.

RICHARD E. LINEBARGER
Secretary
Associated Electronics Systems Contractors
San Carlos, Calif.

Since these conditions vary a great deal from one state or city to another, it's up to each prospective PA installer to check into the situation in his own area. A prudent businessman in any line will investigate all possible pitfalls before embarking on any new venture into a specialized field.—Ed.

Dear Editor:

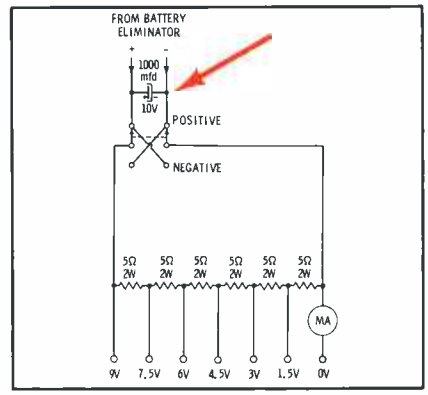
Would it be possible for you to print an up-to-date listing of the EIA source code numbers for various manufacturers?

CLAYTON VOLZ
Peoria, Ill.

A revised list is issued each year as a regular feature of the PHOTOFACT *Servicer; the next one is scheduled to appear in the first* PHOTOFACT *Set of the July, 1964 group. Look under "Additional* PHOTOFACT *Benefits" in the* Master Index *to determine which Set contains the current EIA list (presently Set 642).—Ed.*

Dear Editor:

In your June, 1963 issue, Fig. 3 on page 50 showed a diagram of a tapped bleeder circuit to supply several different



output voltages from a battery eliminator. In this hookup, what happens to the 1000 mfd electrolytic capacitor when the double-pole, double-throw switch is thrown to the position that applies negative voltage to the positive side of the capacitor?

THOMAS D. SCHNADER
Irwin, Pa.

Whatever might happen, it's not good! The capacitor should have been shown connected directly across the output of the battery eliminator—see revised schematic. In this position, it supplements the internal filter circuit of the battery eliminator, to make sure the filtering will be adequate for transistor work.—Ed.

Dear Editor:

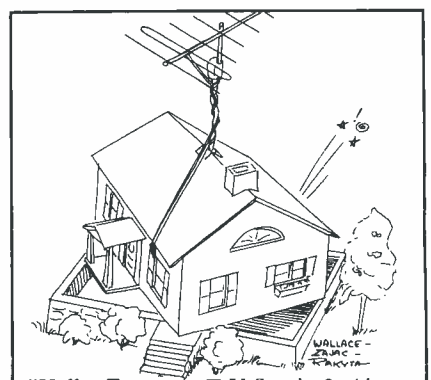
To obtain the full benefit from your *Troubleshooting* column without having to cut each item out of the magazine, we make a note of each individual trouble and attach this note to the PHOTOFACT Folder for the set in question. Then, whenever we're faced with a similar trouble on that set, we can easily refer to the pertinent issue of PF REPORTER. Here's a sample note:

MOTOROLA
SAMS 579-2
SYNC TROUBLE
PER OCT '63 P. 24

Needless to say, we keep every issue stacked right on top of the Sams file cabinet for handy reference.

JOHN B. HUCKABY
Eunice, La.

Aha! This is what we had in mind when we began mentioning the appropriate PHOTOFACT *Folder number for for every receiver discussed. Glad to hear you're enjoying the benefits of this cross reference.—Ed.*



"Hello, Economy T-V Service? About that rotor you just installed . . . !"

STOP! LOOK! SAVE!

All crystal controlled

A STANDARD COLOR BAR GENERATOR at 1/2 THE COST OF OTHERS

only $124.50

the all new SENCORE CG126 STANDARD COLOR BAR GENERATOR

A standard color bar, white dot, crosshatch generator especially made for field service on color TV . . . and at a great savings to you.

Check these outstanding features and you will see why this generator belongs on the top of your list for color TV servicing.

All patterns crystal controlled offering "rock like" stability. You'll think the patterns are painted on the TV screen.

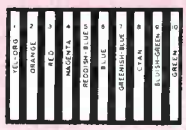
Simplified operation speeds up every servicing job. Just dial the standard keyed bars, white dots, crosshatch, vertical bars or horizontal bars and watch them "pop" on the screen. That's all there is to it.

Exclusive adjustable dot size. The white dots can be adjusted to the size that satisfies your needs by a screwdriver adjustment on the rear. No need to argue about dot size anymore. Just select the size that you like to work with best.

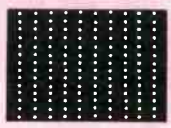
Pretuned RF output to Channel 4. Other low channels can be selected if Channel 4 is being used in your area by simple slug adjustment. Patterns are injected directly into antenna terminals, simplifying operation and saving servicing time.

Reserved output on color bars for forcing signal through defective color circuits. The color output control is calibrated at 100 percent at the center of rotation, representing normal output. A reserve up to 200 percent is available on the remainder of rotation.

Smaller and more portable. With color receivers weighing much more than black and white TV, portable equipment becomes essential for home servicing. The CG126 weighs less than 10 pounds and measures only 11" x 8" x 6".

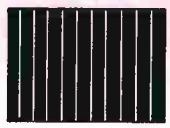


Ten standard keyed color bars (RCA type) that automatically provide all colors at specified NTSC phases . . . but without need of interpretation when servicing.



Stable white dots with new exclusive dot size adjustment in rear.

Stabilized crosshatch pattern for simplifying convergence adjustments.



10 thin white vertical lines for horizontal dynamic convergence adjustments . . . often missing on other generators.

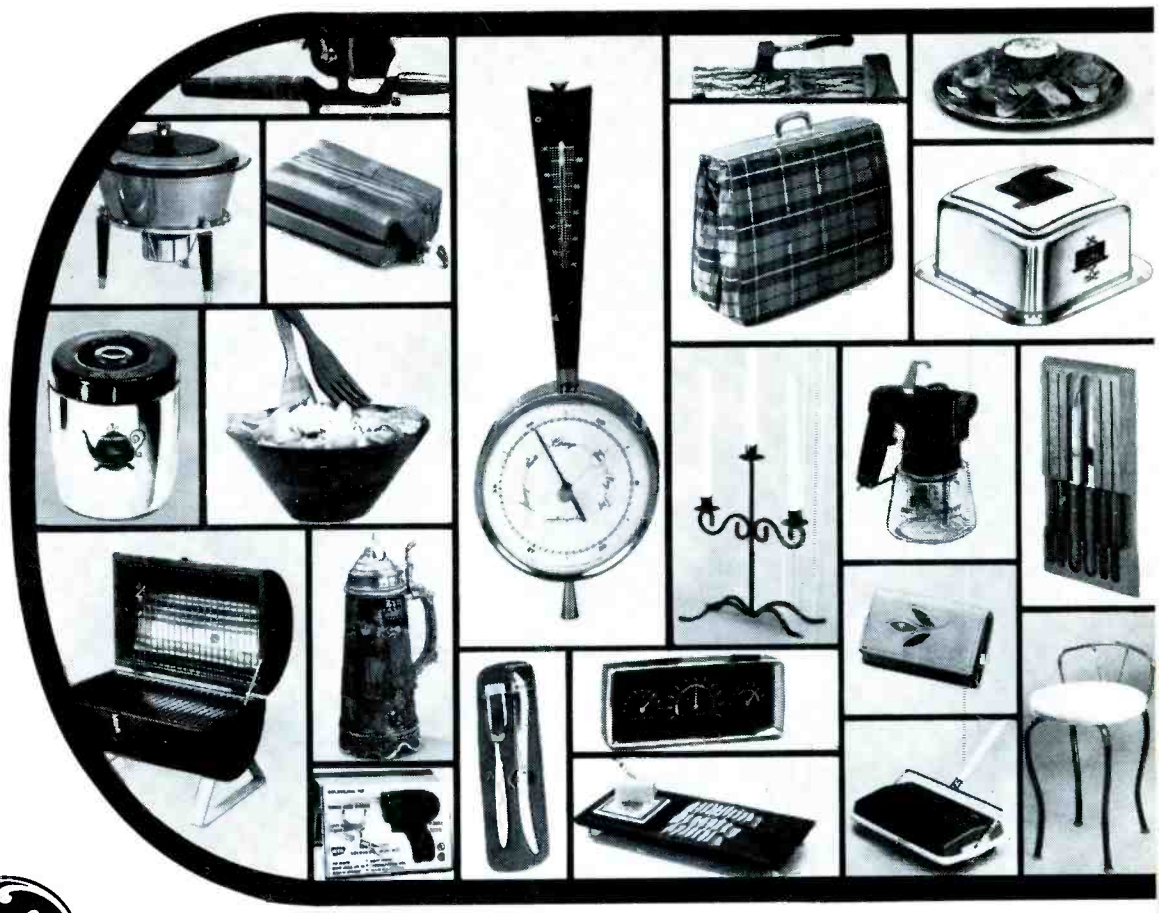
14 thin horizontal lines for vertical dynamic convergence. Also missing on many high priced generators.

March into your local parts distributor and demand the CG126 Sencore color generator that sells at ½ the price of others. Don't let him switch you.

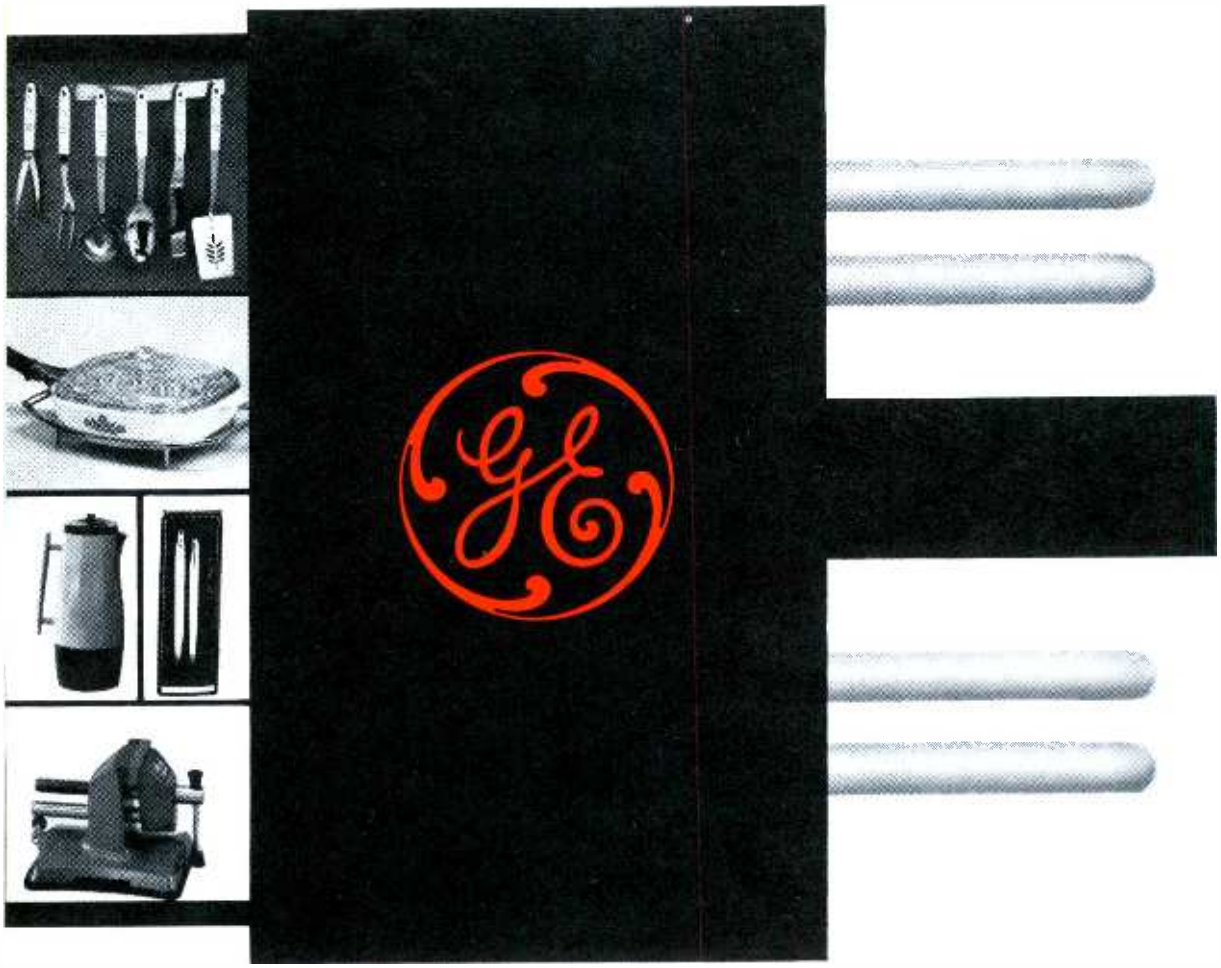
SENCORE

426 SO. WESTGATE DRIVE • ADDISON, ILL.

Circle 12 on literature card



pleasure pak

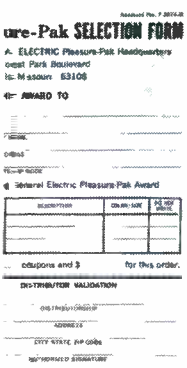


Get in on General Electric's Pleasure Pak program

The purchase of General Electric tubes makes you eligible to receive valuable merchandise during G-E's Pleasure Pak program. Imported musical steins, luggage, barbeque grills, tools, sporting equipment, carving sets and tableware and many other things can be yours at a tremendous discount or *even free*. All of these are well-known brand name products or special items that are not normally for sale.

Make your own selections from G-E Pleasure Pak books

You're not limited to just one or two items. General Electric Pleasure Pak books contain 48 handsome "prizes," accurately illustrated and described. When you buy G-E tubes, you earn one of these books. Then it's *your choice* of the merchandise inside.


ure-Pak SELECTION FORM

Ask your G-E distributor how to earn Pleasure Pak books

Your General Electric receiving tube distributor has a supply of Pleasure Pak books. The back cover of each book is a certificate redeemable for the merchandise shown in the book. Ask your distributor how to get them. The Pleasure Pak program is limited to April and May, 1964. Better stock up on G-E tubes NOW!

Progress Is Our Most Important Product

GENERAL ELECTRIC

Circle 10 on literature card

The Electronic Scanner

news of the servicing industry

Service Award Presented

Howard Sams, president and chairman of the board of **Howard W. Sams & Co., Inc.,** accepts the NATESA "Friends of Service Management Award" from Larry Dorst, president of NATESA. NATESA annually presents this award to three companies chosen for their outstanding contributions to the service industry. The Sams Co. has been so honored for each of the eleven years the award has been made.

Pay TV Unscrambled

A new patent has been granted to **Teleglobe Pay-TV System, Inc.** for a pay-TV device for use with centralized metering and billing. The new system connects the home pay-TV decoder between the TV antenna and receiver, obviating removal of the back cover of the TV set, thereby reducing service costs and installation complications. The intensity of the scrambled picture received at the TV set when using Teleglobe encoding methods is shown in the left hand photograph. Teleglobe has approximately 30 patent applications for pay-TV systems granted and pending in the U.S. and foreign countries.

Reception Detection

Nine heavy-duty station wagons have been equipped by **Finco** with laboratory equipment for detecting and solving TV and FM reception problems in the field. The equipment includes an improved 60' extension tower, adjustable engineering antennas, special field meters, scopes, a VHF-UHF TV set, an FM tuner, an amplifier, and measuring instruments. Each unit of the research fleet will be under the supervision of a Finco regional manager and an engineering assistant. The mobile units will also be available for distributor open houses, service-dealer clinics, and other similar meetings.

Pioneer Cited

In recognition of his fifty years in electronics and his 64th birthday, William J. Halligan, W9AC, chairman of the board of **Hallicrafters,** was presented a wrist watch and scroll at a surprise party sponsored by amateur radio hams. Tim Coakley, W1KKP, Boston, is shown making the presentation while Garry Cole, W9MKY, Chicago, looks on.

Mr. Halligan founded The Hallicrafters Co. in 1933 when he recognized several basic needs within the then infant electronics industry.

BEST PROFESSIONAL VTVM VALUE

EICO 232 peak-to-peak VTVM featuring exclusive Uni-probe® (U.S. Pat.)

Deluxe VTVM for color & B & W

- Calibration without removing from cabinet
- Measure directly p-p voltage of complex & sine waves: 0-4, 14, 42, 140, 420, 1400, 4200
- DC/RMS sine volts; 0-1.5, 5, 15, 50, 150, 500, 1500 (up to 30,000 volts with HVP probe, & 250 mc with PRF probe)
- Resistance ranges: 0.2 ohms to 1000 megs in 7 ranges
- 7 non-skip ranges on every function
- 4 functions: + DC Volts, — DC Volts, AC Volts, Ohms.
- Uniform 3 to 1 scale ratio for extreme wide-range accuracy
- Large 4½" meter in can't-burn-out circuit
- Zero center for TV-FM discriminator alignment
- Smart professional styling—new satin finish etched panel with contrasting knobs and meter and grey wrinkle steel case.

Kit **$29.95**; wired **$49.95**.

Exclusive UNI-PROBE: (pat. pending) Terrific timesaver, performs all functions: A half turn of probe-tip selects DC or AC-Ohms

EICO KITS FOR 1964

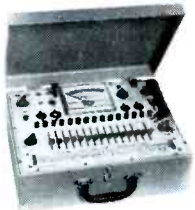
BEST BUY SCOPES

EICO 460 WIDEBAND 5" SCOPE For color & black-and-white TV servicing. Easily reproduces 3.58 mc color TV synchronizing burst. Vert. amp. flat from DC to 4.5 mc, usable to 10 mc; 25 mv rms/inch sensitivity. Horiz. amp. flat from 1 cps to 400 kc; 0.6 v rms/inch sensitivity. Automatic sync. Sweeps from below 10 cps to 100 kc. Kit **$89.95**; Wired **$129.50.**

EICO 427 ADVANCED GENERAL PURPOSE 5" SCOPE High sensitivity scope has all the facilities and quality demanded for servicing audio, communications and industrial equipment. Vert. amp. flat from DC to 500 kc, —6 db at 1 mc; 3.5 mv rms/cm sensitivity. Horiz. amp. flat from 2 cps to 450 kc; 0.18 v rms/cm sensitivity. Automatic sync. Sweeps from 10 cps to 100 kc. Kit **$69.95**; Wired **$109.95.**

EICO 430 PORTABLE GENERAL PURPOSE 3" SCOPE Remarkably fine compact scope. Excellent for servicing audio, communications, and industrial equipment. Ideal as a ham shack monitor. Flat-face 3" CRT with mu metal shield eliminates affects of external fields. Vert. amp. flat from 2 cps to 500 kc, —6 db at 1 mc; 25 mv rms/cm sensitivity. Horiz. amp. from 2 cps to 350 kc, 0.25 v rms/cm sensitivity. Sweeps from 10 cps to 100 kc. Kit **$69.95**; Wired **$99.95.**

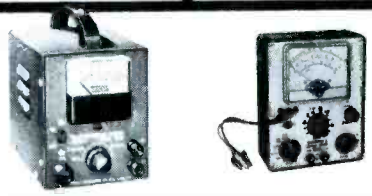
EICO 955 IN-CIRCUIT BRIDGE-TYPE CAPACITOR TESTER Unique shunt-resistance balancing* provision, permits in-circuit short checks even in the presence of as little as 1 ohm shunt resistance. Sensitive open check down to 15 $\mu\mu$f normally, adjustable to as little as 5 $\mu\mu$f. Wien Bridge capacity measurements from 0.1 to 50 μf. Kit **$19.95**; wired **$39.95** *Pat. applied for.



EICO 667 DYNAMIC CONDUCTANCE TUBE & TRANSISTOR TESTER Combines mutual conductance test with a peak emission test—gives a single reading of tube quality. Also spots bad NPN and PNP transistors by gain and leakage tests. New 1964 design has sockets and settings for the latest receiving types, including 5 and 7-pin nuvistors. Also tests novars, 10-pin miniatures, and compactrons, many low-power transmitting and special-purpose tubes, voltage regulators, electron-ray indicators, etc. Multi-circuit lever switch; 13 tube-element pushbutton switches. 4½" meter; roll-chart in snap-in window. Kit **$79.95**; wired **$129.95.**
EICO CRU CRT ADAPTER—Adapts 667 to test all color and B & W CRT's. Wired **$9.95.**

FOR COLOR AND B & W

EICO 369 TV/FM SWEEP GENERATOR WITH BUILT-IN POST INJECTION MARKER Feeds only the sweep signal to the circuit under test or alignment. A demodulator picks off the response signal and feeds it to a mixer stage where the markers are added before scope display. Thus, troublesome interaction effects are eliminated. Sweep generator has controllable inductor sweep circuit (all electronic) with no mechanical parts to wear and give trouble, and 5 fundamental ranges from 3.5 to 316 mc. Variable frequency marker provides output on 3 fundamental ranges from 2 to 60 mc., and 60 to 225 mc range on harmonics. 4.5 mc crystal supplied for rapid check of marker generator alignment. Kit **$89.95**; wired **$139.95.**



TOP-NOTCH TRANSISTOR TESTING TEAM

EICO 1020 POWER & BIAS SUPPLY with 0.005% ripple. Continuously variable metered output voltage, 0-30 VDC at 150 to 300mA. Kit **$23.95**; wired **$29.95.**

EICO 680 TRANSISTOR & CIRCUIT TESTER Measures basic characteristics of signal and power transistors. Provides DC current, DC voltage (20K ohm/volt), and resistance ranges normally needed for transistor work. Kit **$25.95**; wired **$39.95.**

EICO Electronic Instrument Co., Inc. PF-4
131-01 39th Avenue, Flushing, N.Y. 11352

Send new 1964 catalog featuring more than 230 EICO Products.

NAME_____

ADDRESS_____

CITY_____ ZONE____ STATE_____

Add 5% in West

WINEGARD COLORTRON.

FIRST IN PERFORMANCE! FIRST IN CONSTRUCTION QUALITY! FIRST IN APPEARANCE!

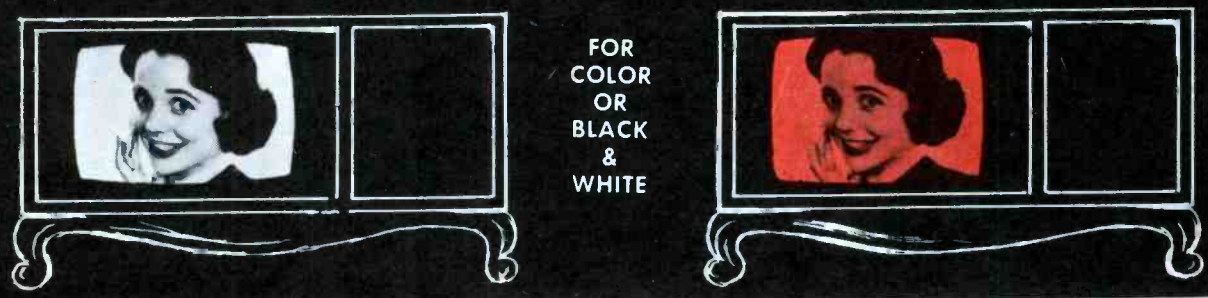
Antennas come. Antennas go. But Winegard's *patented* Electro-Lens all channel yagi continues to be the standard of excellence. You can see its influence in the design of every high gain antenna made today.

Because Winegard COLORTRONS *are* recognized as the standard of excellence in TV antennas, you'll find them in every state of the union and 42 foreign countries. Four models satisfy every reception requirement.

WINEGARD COLORTRONS deliver today's finest color reception, give a new picture quality to black & white. And COLORTRONS are rugged. High tensile aluminum tubing for rigidity and stability . . . insulators with triple moisture barrier . . . GOLD ANODIZED for complete corrosion-proofing. Winegard GOLD ANODIZING is the finest in the industry —not an inexpensive stain that fades out in a few weeks, but a bright GOLD that lasts for the life of the antenna.

Try a COLORTRON. Test it against any competitive make for performance, construction, appearance. If you're not 100% convinced, we'll take it back. Your satisfaction is guaranteed.

. . standard of excellence in the industry



COLORTRON TWIN NUVISTOR AMPLIFIER

Has highest input — up to 400,000 microvolts
Has highest output — up to 1,200,000 microvolts
Perfect partner to the COLORTRON ANTENNA!

Winegard's revolutionary new circuit, employing 2 nuvistors, enables the Colortron to overcome the service problems and limitations of other antenna amplifiers. Colortron will not oscillate, overload or cross modulate because it takes up to 400,000 microvolts of signal input. This is 10 times better than any transistor antenna amplifier made. Has highest output, too—up to 1,200,000 microvolts.

Nothing on the amplifier is exposed to the elements —even the terminals are protected. Colortron comes complete with an all AC power supply with built-in 2 set coupler. Colortron model AP-220N 300 ohm input and output $39.95 list. Model AP-275 300 ohm input 75 ohm output $44.95 list.

WINEGARD RESEARCH, ENGINEERING AND MANUFACTURING ARE DEVOTED EXCLUSIVELY TO PRODUCTS FOR BETTER TV-FM RECEPTION

Colortron Antenna Model C-43
Gold Anodized — $51.90

Colortron Antenna Model C-42
Gold Anodized — $34.95

Colortron Antenna Model C-41
Gold Anodized — $24.95

Stereotron Antenna Model SF-8
For long distance FM reception
$23.65

2-Set Color Coupler
Model EC-230 —
transistorized 2-set coupler
boosts signals, couples
2 sets — $17.95

Red Head Antenna amplifier
Model RD-300—most reliable
transistor TV-FM
antenna amplifier — $29.95

Nationally advertised month after month

ADVERTISED IN LIFE

PLUS 3 NEW TV-FM DISTRIBUTION AMPLIFIERS

Model A-215—15 DB gain
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Circle 8 on literature card

Exhaustive checks throughout the receiver failed to reveal any faulty components. After repeated searching, however, we found the following defect: The filament voltage on the horizontal oscillator tube (a 6CG7) would drop from 6.3 volts to approximately 2.5 volts, killing the oscillator. Loss of drive voltage to the horizontal-output stage caused the 6DQ5 to draw excessive current, popping the circuit breaker.

The trouble was remedied by replacing the 6CG7 socket.

MORRIS GLIKLICH

Hillside, N.J.

This was indeed an unusual fault, and I'll bet you had quite a time locating it. Evidently, the socket had developed a resistance in series with the filaments, dropping the voltage applied to this particular tube.

Touchy Radio Volume

I have a Silvertone radio, Chassis 132.40100 (PHOTOFACT Folder 347-16) that has an intermittent volume condition. The volume drops just low enough to require readjustment of the control; the sound never disappears completely.

All voltages throughout the receiver are okay. The AVC voltage drops approximately 1 volt when the volume decreases. I have monitored this set with a signal tracer and found I'm losing the signal all the way back to the antenna. I've replaced the RF transformer without curing the problem. Sometimes, just touching the antenna with my finger or connecting my meter to the chassis will return the volume to normal. Can you help?

WILLIS LONTERAT

Ville Platte, La.

The most likely causes of this trouble are a coupling capacitor, a bypass capacitor, or the volume control itself. Since the set doesn't go completely dead, I would strongly suspect a bad coupling or bypass capacitor. These capacitors may develop a faulty connection between a lead and its associated foil. When the capacitor heats up, the connection opens, due to expansion. A good way to locate one of these offenders is to tap each

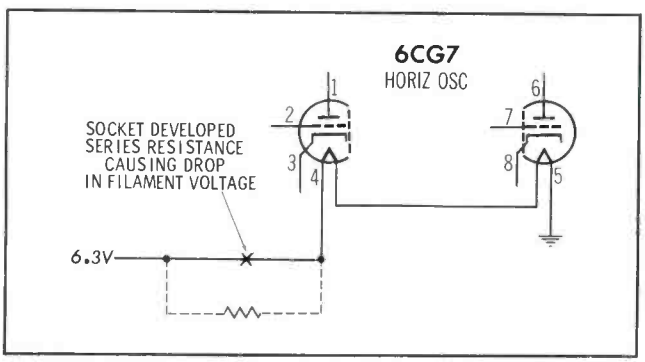
The Troubleshooter

answers your servicing problems

Lowered Filament Voltage

I would like to share a recent experience with your readers, in the hope it will prove as helpful to them, as their experiences have to me.

This problem concerned an RCA CTC11 color chassis (PHOTOFACT Folder 550-2), and the symptoms were: the circuit breaker would pop open after the set had operated for approximately two hours. After the receiver was permitted to cool, the circuit breaker could be reset, but would open again in a short time.



inside the control, making smooth or stable operation impossible. These spots usually appear at the most-used positions on the control; to check for this you might try operating the radio at a much higher volume than usual and seeing what happens. Don't overlook the possibility of a bad tube socket, loose component, or faulty connection. A corroded IF transformer could also cause this type of trouble.

Tape Saturation

I would like to know how to adjust the VU or level meters on tape recorders so they will read 100% when the tape is saturated. Most of us can easily change the gain of the meter amplifier, but how can we tell when the recorder is beginning to saturate a tape—so we can make the adjustment properly?

ROBERT KINNISON
Granada Hills, Calif.

Your interest in the correlation between VU meter (relative sound volume level indicator) settings and 100% tape saturation is shared by many other technicians and recording enthusiasts.

The first step in solving your problem is to be sure that all voltage, current, and impedance settings—and mechanical adjustments relating to recording and erasing—are made according to the recommendations of the recorder manufacturer. When you are sure the unit is operating properly, put on a standard alignment tape, and adjust the meter circuit according to the instructions with the tape.

The key to success in this operation is in having and properly using a standard tape; if this is done you will have the accuracy you need for most purposes. Since tape varies from type to type, from manufacturer to manufacturer, and from reel to reel, a measure of 100% saturation is never exact—reasonably exact measurement can be made only with very specially designed equipment.

Although the method just given for establishing tape saturation is more reliable, here is another method that can be used:

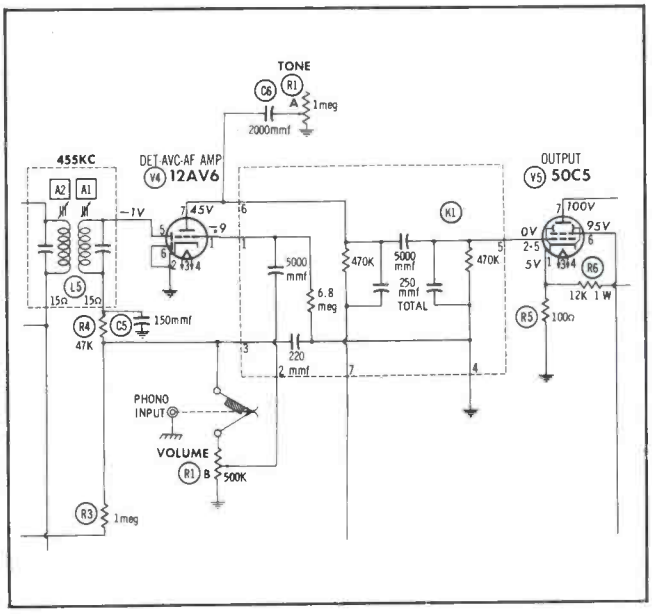
• *Please turn to page 68*

....New Developments in Electrical Protection

capacitor with a pencil; this method works better than bending or twisting the leads.

If the tapping does no good, try applying heat to the capacitors by holding a hot soldering iron near each capacitor while listening for a change in the sound level. If this doesn't flush out the culprit, you may have to try substitution. Merely paralleling a suspected capacitor will not always work, because this may cause a surge through the bridged unit, which might effect a temporary cure.

The volume control itself may be causing the sound to fade. The carbon element may become dirty at one or more spots



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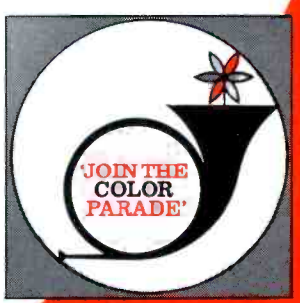

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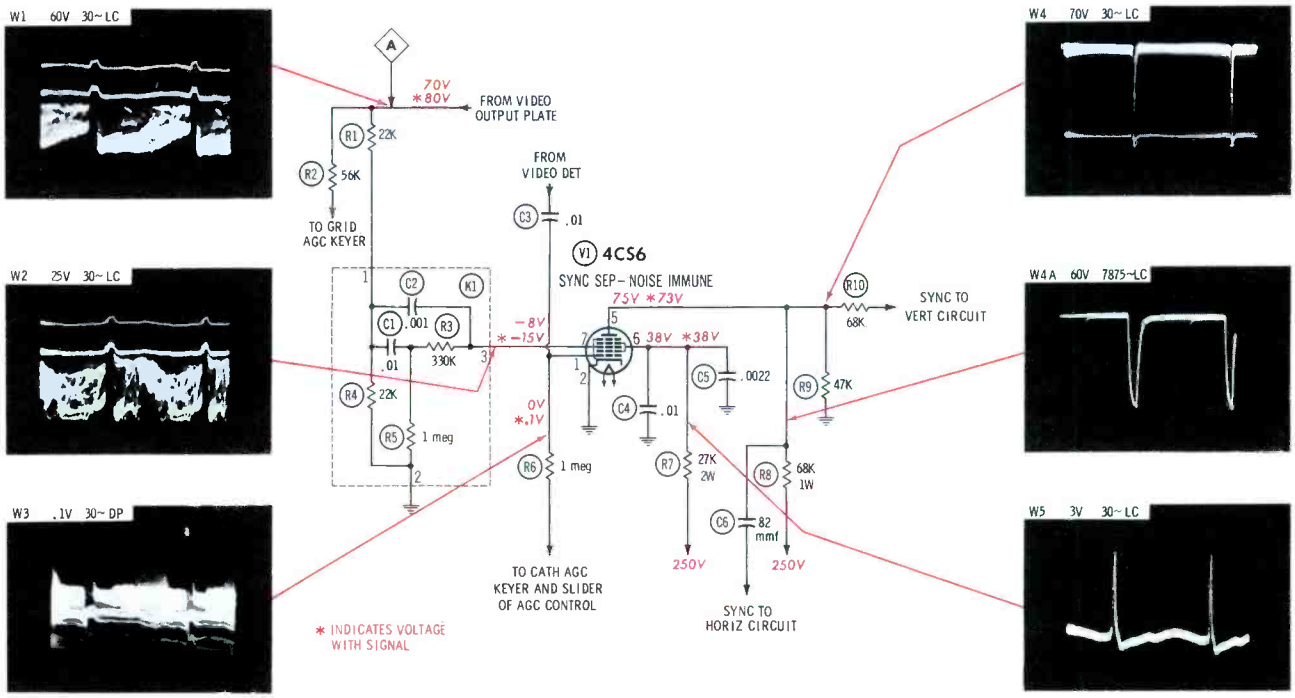
Circle 11 on literature card

PF REPORTER Symfact™

'CS6 Sync Separator

Noise Immune



DC VOLTAGES taken with VTVM, on inactive channel; antenna terminals shorted. *Means voltage varies with signal conditions—See "Operating Variations."

WAVEFORMS taken with wideband scope; controls set for normal contrast (50 volts p-p video to CRT). Low-cap probe (LC) used where direct probe distorts.

Normal Operation

Pentagrid 4CS6 functions as combination sync separator-noise limiter in this circuit from Sylvania Chassis 571-1. High-level composite video signal (positive-going) is obtained from plate circuit of video-output tube, and coupled via R1-K1 network to grid 2 (pin 7) of V1. (Same signal is coupled to grid of AGC keyer by R2, affecting amount of AGC developed in set.) Contrast control is located in video stage after sync takeoff point, so its setting should have no effect on amplitude of W1 at Point A. W1 (60 volts) is divided by input resistor-capacitor network R1-K1, leaving 25-volt signal for input to grid of separator. Incoming signal develops grid-leak bias on V1, and tube conducts only during uppermost region of sync pulses—above blanking level. V1 is easily saturated because of low screen and plate voltages, so extreme tips of sync pulses—and any noise spikes appearing above sync tips—are clipped. Low-level negative-going video signal from detector circuit is coupled via C3 to grid 1 (pin 1) to make circuit immune to noise. If spikes of noise are present in W3, grid is driven negative for their duration, stopping conduction. Effective operating point at grid 1 of V1 is varied by small positive voltage obtained from cathode of AGC keyer; this voltage is proportional to AGC, and stabilizes noise-cancelling action. Horizontal sync pulses are fed to AFC circuit by C6; vertical sync goes via R10. Ten-volt additional amplitude of W4 (over W4A) is result of scope—at 7875 cps—not "seeing" signal being coupled back from vertical oscillator via R10.

Operating Variations

PIN 1 No important changes in DC voltage as set is switched among local channels. However, amplitude of W3 varies widely with adjustment of AGC control; also, from minimum to maximum settings of control, DC voltage changes from 0 to 1.5 volts.

PIN 7 Changing channels causes only 1 or 2 volt change in amplitude of W2. Rotation of AGC control, however, produces large amplitude change—maximum before *overload* is 60 volts p-p; minimum before *whiteout* is 5 volts. DC voltage stays around –15 volts with stations in local area. With fringe-area reception, voltage at this pin can drop as low as 12 volts.

PIN 5 DC voltage is within a couple of volts with or without signal. Likewise, DC voltage is stable at all *normal* settings of AGC; however, at *whiteout* voltage drops to 25 volts, and at *overload* rises to 50 volts. Output signals undergo no significant change from one station to another.

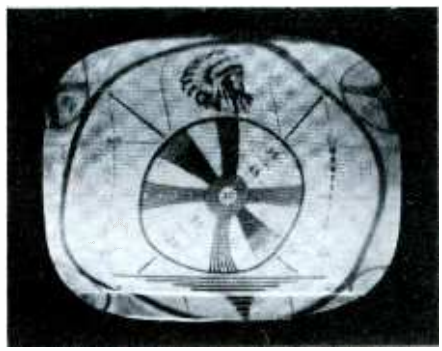
PIN 6 Voltage at this pin doesn't change, with or without signal. Screen is well decoupled, and W5 contains only small ripple signal and spike picked up by radiation from vertical circuit.

Horizontal Pulling

SYMPTOM 1

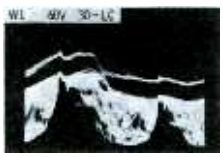
Vertical Jitter

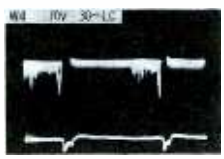
C2 Open



Symptom Analysis

Severe pulling and intermittent vertical jitter on strong local stations; symptoms not so pronounced on fringe-area station. Looks similar to slight AGC overload, but AGC control is operative, suggesting trouble in sync stage. Vertical and horizontal controls operate normally.

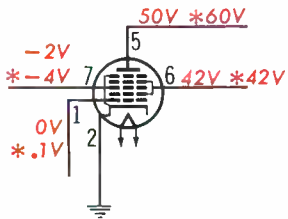




Waveform Analysis

Amplitude of W1 is okay, but bent waveform suggests AGC trouble. Clamping AGC line eliminates some bending, but picture symptom is still present, pointing further to defect in sync circuit. Lack of horizontal pulses in W2 offers evidence that trouble is between Point A and grid of V1. Video contamination in W4 isn't great, indicating that DC operating conditions of V1 are not too bad—fault is definitely caused by wrong *signal* at grid.

Voltage and Component Analysis



Grid bias on pin 7 has decreased somewhat—with or without signal—and may cause some concern; it has decreased 6 volts below normal. Normal –8 volts is caused by noise from high-gain front-end and video stages in absence of signal; with C2 open, noise is seriously attenuated (same as horizontal pulses), and fails to develop much grid-leak bias at pin 7. Plate voltage drops as negative grid bias is reduced. Open C2 drastically changes characteristics of network C1-R3-C2 hence higher frequencies (noise or horizontal pulses) fail to reach grid.

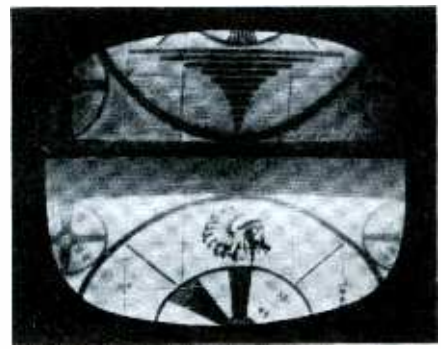
Best Bet: Scope will isolate this trouble quickly.

Vertical Hold Critical

SYMPTOM 2

Horizontal Affected Slightly

R8 Increased in Value

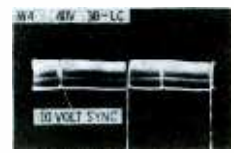


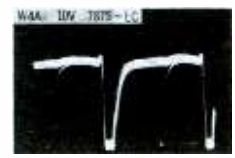
Symptom Analysis

Picture rolls intermittently. Hold control is operative, but fails to give positive lock-in action. Roll can be stopped momentarily by careful adjustment. Symptom is more severe on distant stations—rolling constantly. Indications point to trouble in sync path to vertical stage.

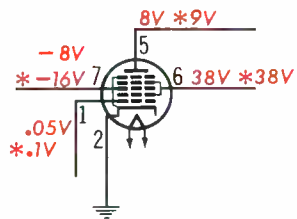
Waveform Analysis

Normal W2 indicates everything up to this point is working normally, ruling out possibility of defects in RF-IF, video, or AGC circuits. W4, taken with vertical hold set to permit viewing sync pulse, indicates pulse at this point is low. Ten-volt *sync* signal here is greatly attenuated from that of normal operation. 40-volt spike is coupled back from vertical oscillator. Viewing sync signal at 7875 cps (W4A) will confirm low 10-volt sync pulse from V1.





Voltage and Component Analysis



Best voltage clue is extremely low plate voltage. Voltages on both grids of V1 are within limits—with or without signal—dismissing possibility of overconduction through tube. B+ source is normal, so trouble is isolated to one or more components in plate circuit of V1, best suspects being R8 and R9. In this instance, R8 had increased to nearly 1 meg; further increase in value would cause loss of both vertical and horizontal sync. Separating ability of '6CS6 is not altered greatly, since grid-leak bias is maintained by good input signal to grid.

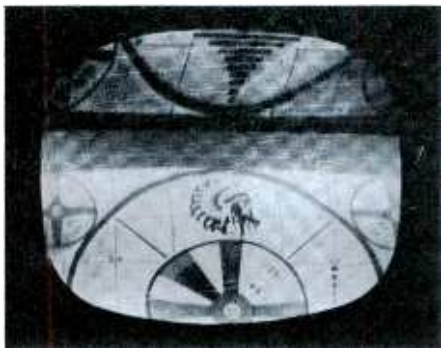
Best Bet: Isolate with scope; pinpoint with VTVM.

Vertical Roll

SYMPTOM 3

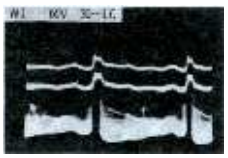
Horizontal Stable

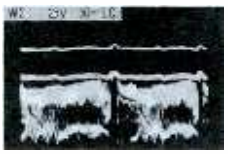
R7 Increased in Value



Symptom Analysis

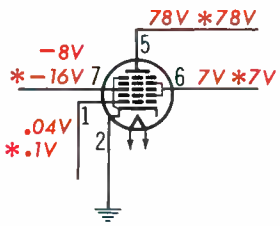
Vertical rolls slowly; may lock in at times, but jitters or bounces under most conditions. Symptoms are same on local and fringe stations. Height and linearity are good, and vertical hold control is operative. Trouble likely caused by weak or distorted sync to vertical oscillator.





Waveform Analysis

Scoping W1 shows good composite signal, removing all suspicion that poor vertical sync is caused by front-end or video stages. W2 has normal amplitude of 25 volts, and vertical sync pulse is clearly defined. W4 offers conclusive indication that trouble is in sync stage: vertical sync pulse at this point is only 10 volts. As in Symptom 2, horizontal is fairly stable, although overall sync amplitude is reduced; AFC discriminator still controls horizontal.



Voltage and Component Analysis

All voltages on V1, with exception of screen voltage, are within normal range—with or without signal. Screen voltage, however, is only 7 volts; trouble is probably faulty tube, shorted C4 or C5, or defective R7. Here, value of R7 has increased to around 250K, considerably lowering gain of V1 (note plate voltage is slightly higher from reduced conduction). Attenuated sync pulse in output of separator is not sufficient to lock in vertical oscillator. It's a good idea to check C4 and C5 for possible leakage when R7 is found damaged.

Best Bet: Scope to isolate; VTVM to pinpoint.

Horizontal Bending and Pulling

SYMPTOM 4

Intermittent Vertical Roll

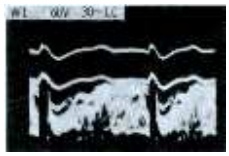
K1 Ground Return Open

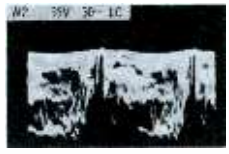
Symptom Analysis

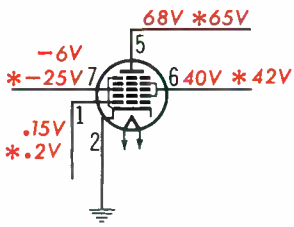
Entire CRT screen is affected and pulling is most pronounced at top of raster. Trouble remains on all stations—local and fringe—and AGC control is operative; almost rules out fault in AGC circuit. Vertical holds fairly well, rolling only a few frames occasionally.

Waveform Analysis

W1 is good, disregarding slight distortion caused by feedback loop of keyed AGC action. Clamping AGC does little to improve picture condition, and thus definitely eliminates AGC trouble. Distorted W2 is good evidence that defect follows Point A, probably in some component associated with printed couplate K1. Sync pulses actually appear in waveform, but they're swamped by video information—much like overload from AGC.







Voltage and Component Analysis

Voltages on V1 without signal are normal. However, with signal, bias on pin 7 goes rather high, averaging –25 volts and fluctuating from –5 to –45 volts with video content of incoming picture. Wild variations such as these give hint that grid circuit is "floating" and check on grid-to-ground path of V1 is in order Ohmmeter connected from pin 7 to chassis gives infinite resistance reading. Open connection could be inside K1, making replacement necessary. Open connection external to couplate (poor solder joint) can be corrected easily.

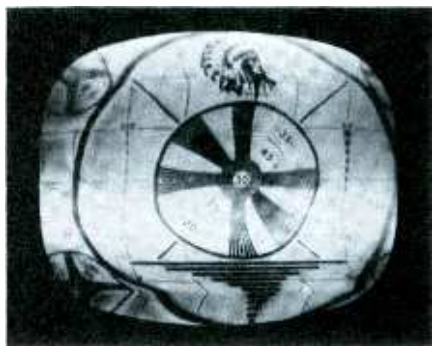
Best Bet: Scope isolates; VTVM pinpoints.

Horizontal Pulling

SYMPTOM 5

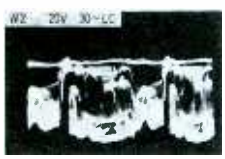
Slight Vertical Jitter

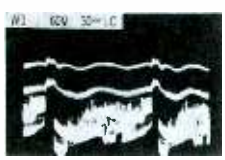
C1 Leaky



Symptom Analysis

Pulling at top of raster on all channels, and degree of pulling varies with picture content. Jitter is also noticeable—not pronounced, but still unpleasing to the eye. Both horizontal and vertical remain in sync; adjusting either hold control gives good lock-in action.

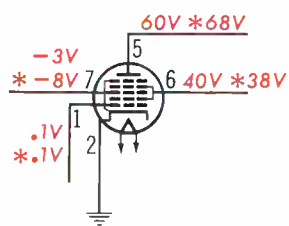




Waveform Analysis

Clamping AGC first rules out trouble in AGC circuit—symptoms remain. 70-volt amplitude of W4 at output of separator is okay, but contamination is evident. Checking input to V1 (W2) is next logical step; 20-volt amplitude is acceptable, but sync pulses are highly compressed. Theory of possible trouble in video stage is disproved by normal W1. Only three waveform checks are necessary to pinpoint troubled area: Fault must be in K1.

Voltage and Component Analysis



Voltages on plate, screen, and noise grid are within normal limits. Vague voltage clue is reduced bias on pin 7, with or without signal. Leaky C1 provides path for positive voltage to reach grid of V1; grid bias is lowered, and normal operating mode of separator is changed. Time constant of K1 is also affected, and sync pulses at pin 7 are compressed. When grid bias is lowered in this and similar circuits, coupling capacitor(s) in grid circuit should become prime suspects. Dynamic leakage check at terminal 3 of K1 can be made by slicing of PC board.

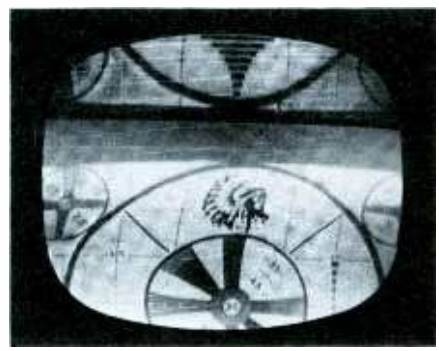
***Best Bet:** Scope and VTVM will pinpoint this defect.*

Vertical Hold Critical

SYMPTOM 6

Horizontal Not Affected

R8 Decreased in Value

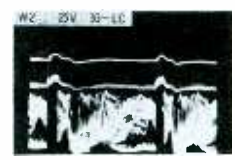


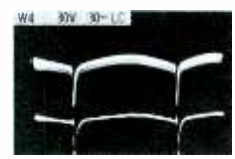
Symptom Analysis

Picture has tendency to roll a few frames, then lock in. Condition is aggravated on fringe-area station, and rolling occurs more often. Vertical hold control does not give positive snap-in action, probably indicating distorted or weak sync reaching oscillator stage.

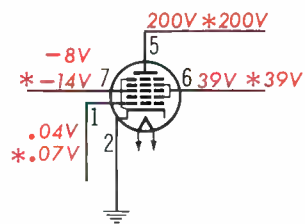
Waveform Analysis

When vertical seems to "float-by" as hold control is adjusted, best procedure to isolate trouble is by taking waveform samples at input and output of separator. Normal W2 at grid of V1 holds no clue to fault, but does eliminate K1 and front-end stages. Abnormal W4 clears oscillator of suspicion and suggests trouble in plate or screen circuit of V1—normal 70-volt W4 is down to 30 volts. W4A (7875 cps) is likewise attenuated, but still controls horizontal.





Voltage and Component Analysis



Big voltage clue—200 volts on plate accompanied by *normal* screen voltage—is conclusive proof that defect in plate circuit is causing this trouble. Voltages on other elements of V1 are normal, with or without a signal; tube obviously isn't cut off, and this further narrows fault to shorted R8 or open R9. In this instance, R8 decreased to 6800 ohms, increasing plate voltage close to B+ source value. Under these conditions, little gain is developed by V1, and weak sync pulses appear in output. Resistor usually shows signs of overheating.

***Best Bet:** VTVM for voltage and resistance measurements.*

WIN

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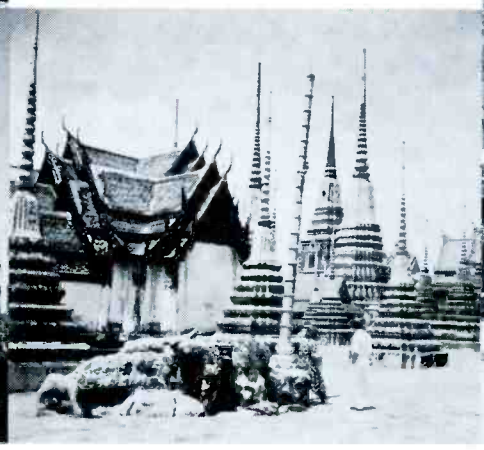

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Shop Talk

TOUGH DOGS in SYNCHROGUIDES

by Allan F. Kinckiner

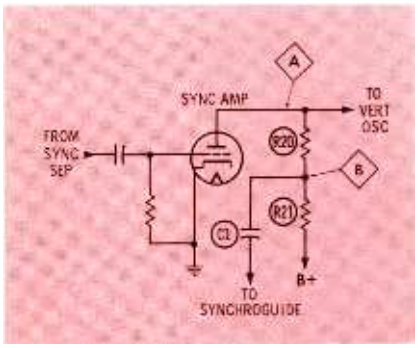
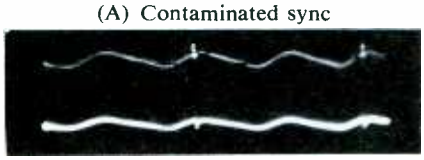


Fig. 1. Point B is waveform-divider point for checking sync amplitude for Synchroguide.

There are a number of *Synchroguide* troubles that can be classified as "tough dogs." They affect reception in various ways. In some cases, horizontal sync is intermittently lost; in between these periods, operation is just about perfect. Every serviceman has house-checked a poor-sync complaint only to find the receiver operating properly. The receiver may continue to work normally for days and sometimes weeks before the customer calls again with the same complaint. Checking these sets when they are working right will often produce no clues even though sync operation is subjected to the closest scrutiny.

In other cases horizontal sync is poor only on one of several stations. Here again, a house-check procedure, including changing of suspect tubes, will fail to reveal the cause of the trouble. In addition to sets that act up only on widely separated days, or only on certain stations, there are those sets with horizontal sync so sensitive that poor sync occurs only on certain programs.

(A) Contaminated sync



(B) Ripple didn't affect sync

Fig. 2. Scope displays of abnormal sync at output of sync separator circuit in Fig. 1.

While these conditions cannot be corrected during home service calls, the cause of the trouble can often be readily determined by scope checks. So a shop troubleshooting session using scope traces is frequently the best way to handle "tough-dog" *Synchroguide* troubles.

Sync-Signal Defects

Because many of these troubles result from defective sync signals rather than *Synchroguide*-circuit defects, the best place to start is often at the output of the sync section. In addition, it is easier to identify sync-signal distortions than it is to recognize abnormalities in the combined signal applied to the AFC-stage grid, inasmuch as this combined signal is subject to normal variations in different receivers.

For efficient operation, the *Synchroguide* requires that sync signals have the following characteristics: (1) Amplitude—ranging between 15 and 25 volts, (2) Shape—narrow pulse with steep leading edge, (3) Polarity—pulse must be positive-going. All of these requirements are easily obtained from a two-stage sync section, and the majority of receivers using *Synchroguide* contain at least two stages of sync. Since two-stage sync sections usually supply 30 or more volts of sync amplitude, a voltage divider is generally incorporated at the output to reduce the sync to 15 volts or so. The circuit in Fig. 1 is typical of final sync stages in *Synchroguide* receivers. The voltage divider consists of R20 and R21, and C1 couples sync pulses to the *Synchroguide*.

For examining the sync signal, it is recommended that the first scope observation be made at the plate of the sync output (point A of Fig. 1), since any distortion is more obvious here than at the takeoff point (point B of Fig. 1). It is also recommended that the scope sweep be set at one-half the vertical frequency rather than the horizontal frequency. There are two reasons for these recommendations: First, the amplitude at point A is often supplied on schematics, while that at point B is not. Second, any video contamination of the sync signal (as shown in Fig. 2A), becomes obvious when such a signal is displayed at a vertical-frequency sweep. Not only is the same distortion harder to see if the signal is displayed at a horizontal rate, but video contamination in the sync brings about another problem. If a defect is present that is capable of producing video signals in the sync, the front pedestal preceding the horizontal sync pulse will ride up in the sync. This front pedestal distorts the leading edge of the horizontal sync pulse. Since scope sweep locks on leading edges of viewed signals, the distorted sync pulses cause jitter in the scope trace.

Unlike some other horizontal AFC circuits, the *Synchroguide* is not critically affected by amplitude

(A) Symptom appearance

(B) Vertical sync signal

(C) Horizontal sync signal

(D) Waveform B after servicing

(E) Waveform C after servicing

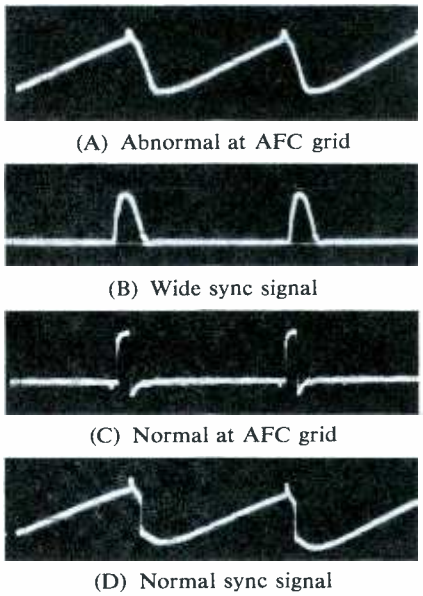
Fig. 3. Picture instability resulting from modification when changing to a larger CRT.

variations between adjacent horizontal sync pulses. In one Philco using *Synchroguide* AFC, a defective filter resulted in the ripple on the sync output shown in Fig. 2B. Strangely enough, this large ripple did not affect horizontal deflection or synchronization in any way. If, however, the low-amplitude points in the ripple had dipped below a critical value, jitter and poor sync would have resulted. The distortion so apparent in Fig. 2B could not be detected when the same signal was displayed at a horizontal viewing rate.

The Third Signal

The picture presented in Fig. 3A was taken from one of the first Muntz receivers using a rectangular picture tube. The set had a peculiar horizontal jitter and irregular twists to vertical lines (the picture is shown deliberately out of phase so you can see the raggedness of the raster edges). Because the condition looked like a contaminated-sync defect, I checked the sync at point A in Fig. 1 and was surprised to find the signal there was perfectly normal. Next, I checked at point B of Fig. 1 and got the trace shown in Fig. 3B. The amplitude was slightly less than it should have been, but the hash in the horizontal portions between the vertical sync pulses was the most disconcerting factor. Viewing this same signal at a sweep rate of 7875 cps revealed the badly distorted horizontal sync pulses shown in Fig. 3C.

Checking the schematic revealed that the *Synchroguide* in this set used three signals instead of two on the AFC grid. Disconnecting the third signal (a sawtooth obtained by integrating a negative pulse from the flyback-yoke circuit) removed the raster defects and also resulted in more normal traces. The trace in Fig. 3B became the one shown in Fig. 3D, and the trace in Fig. 3C became the one in Fig. 3E.



(A) Abnormal at AFC grid

(B) Wide sync signal

(C) Normal at AFC grid

(D) Normal sync signal

Fig. 5. Waveforms in circuit with defective resistor in the horizontal separator.

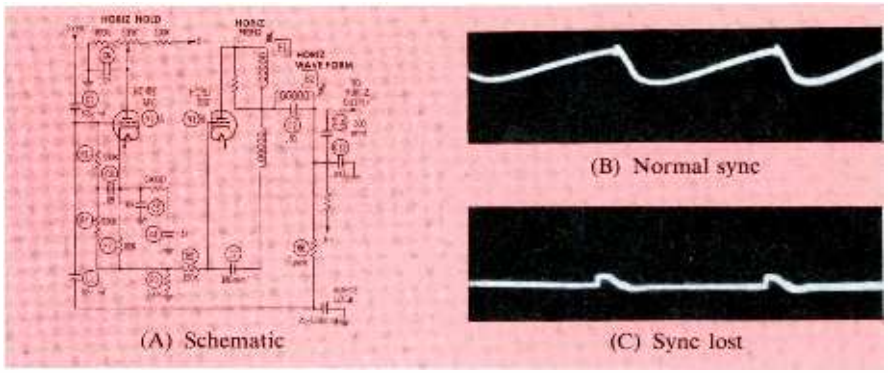


Fig. 4. Combined sync-sample signal in receiver with very erratic horizontal sync.

The conditions shown in Fig. 3 have been encountered numerous times in receivers converted for the use of larger picture tubes, but not very often in sets conforming to the manufacturer's original design. Any time a serviceman is confronted with horizontal jitter that defies correction, he should check to see if the design uses a third AFC signal. When it does, temporarily remove this third signal. Quite often in such cases better horizontal stability will result.

Checking the Combined Signal

Troubleshooting by observing the combined sync and sample signal at the AFC grid with an oscilloscope is frequently the quickest way to pinpoint specific defects. In one Teletone receiver—Fig. 4A—horizontal sync was erratic and intermittent. With the scope lead attached to the AFC grid, it was noted that every time trouble occurred, the waveform in Fig. 4B changed to the one shown in Fig. 4C. The loss of sample signal in Fig. 4C could only result from two possible causes: opening of the sample-signal resistor or capacitor or shorting of the locking-range trimmer. The latter was proved to be the case, and replacement of the locking trimmer restored normal operation.

In sets where a locking-range trimmer is used, the scope can be used to set the trimmer for best operation. First, observe the sync at the input end of the coupling capacitor (C1 in Fig. 4A), and note the amplitude. Next, attach the scope to the AFC grid and adjust the locking-range trimmer so that the combined waveform has twice the amplitude of the trace previously observed. This should result in *Synchroguide* operation compatible with standards prescribed in service literature.

Less apparent defects can also be picked out easily by checking the combined signal with a scope, but only if the technician is familiar with normal waveform departures among different receivers. For example, the sync pulse retains its shape in the combined signal in many sets. In other receivers, the shape of the sync pulse is lost, and the only indication of its presence in the waveform is the slight pip seen atop the sawtooth in Fig. 4B.

In an RCA KCS81 with extremely critical horizontal hold, the combined sync and sample signal appeared as in Fig. 5A. Note the long fall time or slope of the retrace. The scope probe was next applied at the takeoff point in the horizontal sync-amplifier circuit, resulting in the trace of Fig. 5B; this trace shows an excessively wide horizontal sync

• *Please turn to page 66*

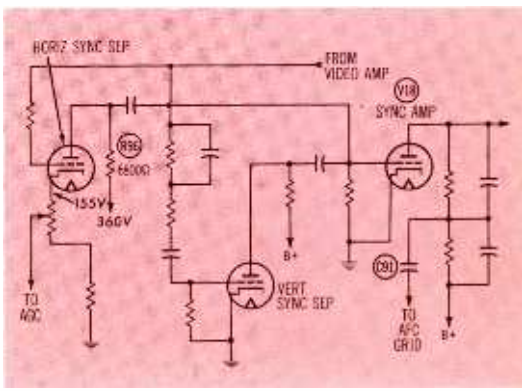
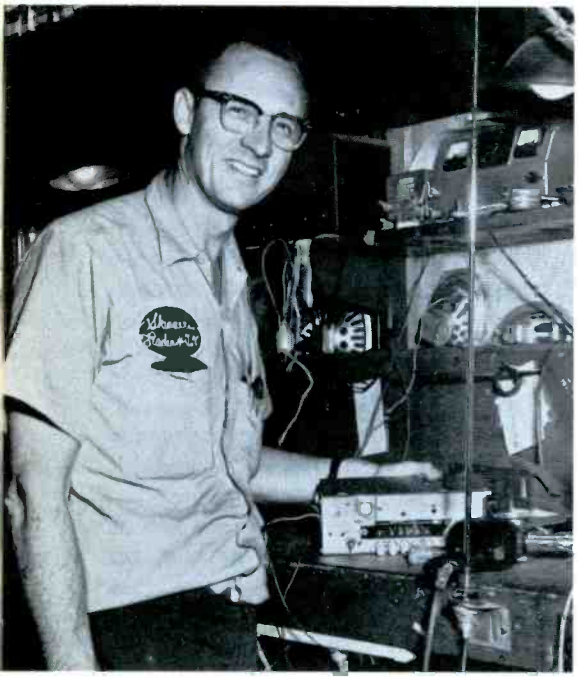


Fig. 6. Portion of sync circuits in receiver from which waveforms in Fig. 5 were taken.

The large garage area depicted in this photo facilitates the booming volume of drive-in repairs. This garage area will hold as many as six cars, and a rear lot accommodates six others. Gene mentioned that quite often all twelve spots are full.



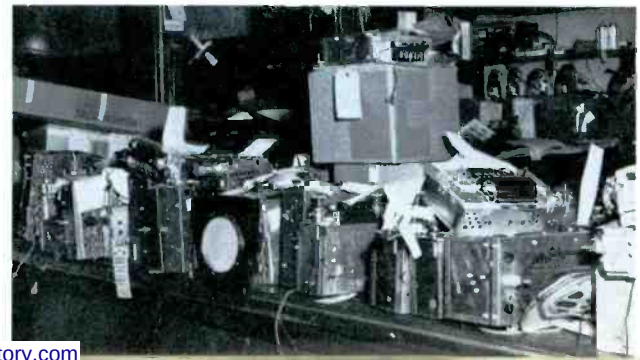
Meet Gene Fortune, working owner of Skinner Radio and Television Inc. in Indianapolis, Indiana. Gene has been in the auto-radio repair business since his discharge from the Navy in 1945. Skinner Radio first opened its doors in 1934; and Gene purchased and incorporated the business in 1956. From the onset, auto radio has been the company's prime target.

meet an

Being an auto radio specialist involves more than generally meets the eye! We found this to be very true when we visited the owner of a thriving auto-

Here's the other end of the equipment Bob was using in the trunk. Similar power-extension setups are located at convenient points throughout the garage. The handle of the trouble light also has AC receptacles for quick power-tool connections. Equipment such as this must be right at hand for this type of service operation. Speed is important!

Talk about warranty work—take a look at this stack of radios in for repair! Gene does repair work for at least 43 new-car dealerships. We wondered where he found time to repair so many of these carried-in sets, when he averages 35 to 40 drive-in jobs every day. The answer: two nights a week they work till nine, and they make good use of any other time when drive-in business slacks.



Shown at this special auto-radio repair bench is Bob Shepherd, one of three full-time technicians in addition to the owner (who also does servicing on a full-time basis). The bench has all of the test equipment needed to troubleshoot auto radios.

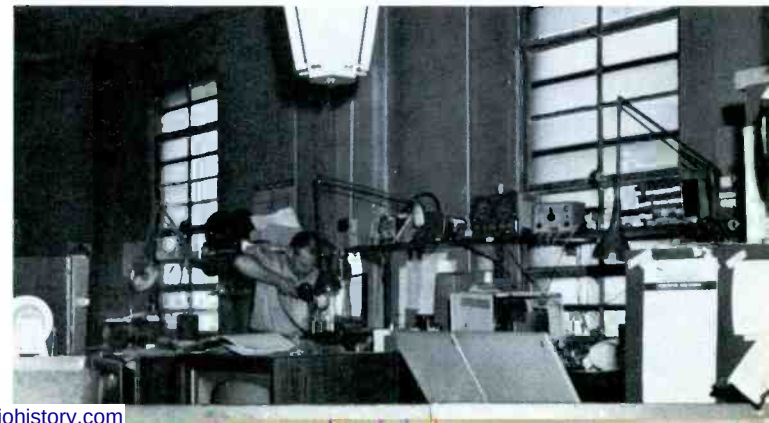
The technician in this photo is preparing to mount a reverberation unit in the trunk compartment of a new car. Notice the drill and trouble light; they are always within easy reach, as you'll see presently. Asked how reverberation-unit sales were going, Gene informed us requests came in groups—several in one day, then maybe a week until the next one.

Auto-Radio Specialist

radio repair business and asked him several questions: How many auto radios does an expert repair in a day? What about warranty work? We found answers to these and other questions as we talked with this specialist, and saw how he handles his fast-growing service business.

This is one of the two stock rooms, where new radios are waiting for installation. Skinner's is the central warehouse in this area for auto radios manufactured by Automatic. In addition, Gene is an authorized dealer for Motorola and several other auto-radio manufacturers. Gene also repairs other auto accessories, such as alternators, electronic light dimmers, etc.

A special area is set aside for television, radio, and phonograph servicing. Two additional technicians are employed in this activity, and one of them specializes in the installation and repair of garage-door openers. The office personnel consist of Gene's wife—Jean Fortune—and one other employee.



SIZES, FUNCTIONS, AND FACTS

ABOUT SMALL-VALUE CAPACITORS

Fixed capacitors are used in large numbers in modern electronic equipment, and often outlast the equipment unless something goes wrong in the circuit. They play an essential role in spite of their basic simplicity.

Much has been written about high-capacitance units, both large- and small-sized, used principally in power supply filters. But relatively little attention is paid to the more numerous capacitors of the so-called "micromike" variety, having capacitance between .5 mmf and .01 mfd.

You may occasionally see the term picofarad (pf) in electronic literature and schematics; it is equivalent to micromicrofarad (mmf). This expression is gradually being adopted as the preferred term for most military and industrial electronics, and will soon be commonly used in TV schematic notation.

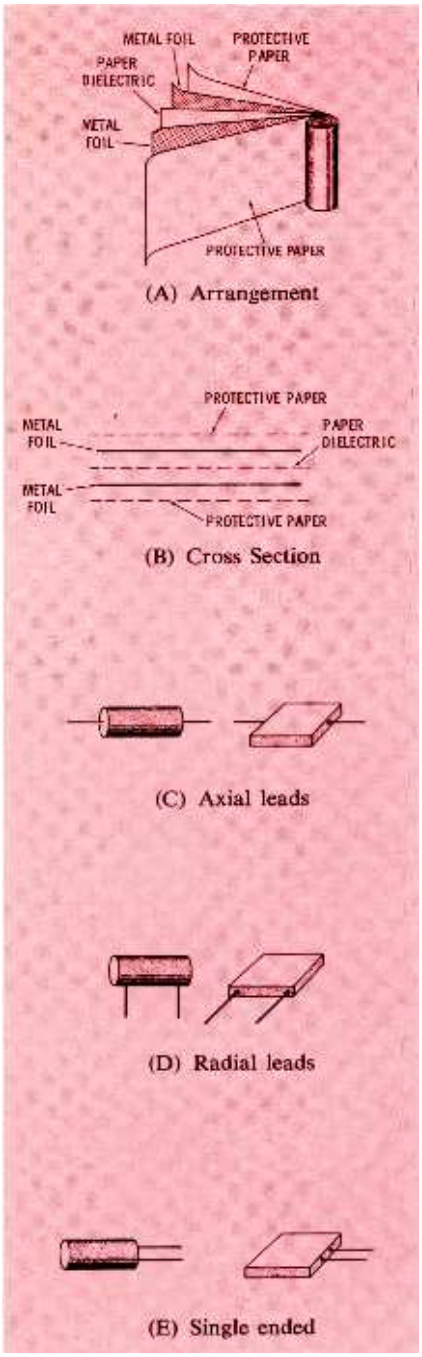


Fig. 1. Paper capacitors are made in tubular shape but can be potted in rectangular case.

These capacitors are used for AF and RF bypass and coupling, tank circuit tuning, oscillator padding, audio tone control, industrial timing, flip-flop speedup, high-frequency filtering, vibrator buffering, and in countless other applications. Common capacitor types are paper, metallized paper, plastic film, foil-type mica, silvered mica, glass, and ceramic.

Paper Tubular

Tubular configuration is one of the oldest arrangements employed in capacitor construction. Fig. 1 shows the essential details. The capacitor is made from two strips of aluminum foil separated by a strip of paper (Figs. 1A and 1B). For protection, an additional strip of paper is placed over the outside of each foil. This sandwich is rolled up and a pigtail attached to each foil. The completed capacitor assembly is enclosed in a cylinder or tube of paper, plastic, or metal, or is pressed flat and enclosed in a rectangular case and impregnated with wax or oil (Figs. 1C, 1D, 1E).

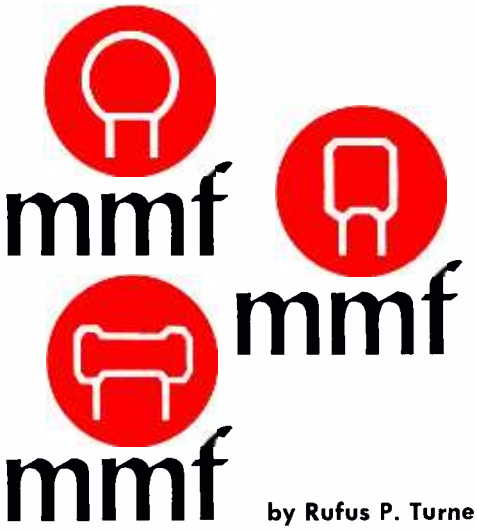
A few low-capacitance units of this type are obtainable, but typically their values are close to .1 mfd. Capacitance tolerance is usually ±10% or ±20%. Temperature characteristics are poor, compared to those of other capacitors, since heating can cause a shift in the separation between foils. (Paper tubulars in TV sets often leak their wax coating.) Common DC voltage ratings are obtainable (with still lower values). Power factor is comparatively high; Q is low. Because this capacitor is rolled, it has higher inductance than other types; therefore it has a lower self-resonant frequency, but special noninductive types are available in some values.

The foil-type paper tubular is used only for noncritical coupling and bypassing, where temperature variations and size is inconsequential and low cost is important. Because of its low Q and erratic temperature characteristics, the foil-paper type is not used in tuned circuits where selectivity and frequency stability are major factors.

Metallized Paper

The metallized paper capacitor is similar to the paper tubular just described, except that its plates are made by depositing a metal film in a special pattern on each side of the thin paper strip used as a dielectric. In this way, the plates are tightly bonded to the dielectric to a degree not possible with foil plates. The resulting metal-paper-metal sandwich is provided with pigtails, insulated, rolled up, and encased like the tubular in Fig. 1.

This type of capacitor is supplied over a wide capacitance range. Microminiature units in the low-capacitance range (500 mmf to .01 mfd at ±25%) are available, rated at DC working voltages of 200, 400, and 600 volts. Power factor is less than 1% at 1000 cps, and the oper-



by Rufus P. Turner

ating temperature range is –55°C to +100°C.

The metallized paper tubular is smaller in size than a foil-type unit of the same capacitance and voltage rating. It is used in coupling and bypassing where important considerations are reduced size, improved temperature characteristics, long-term capacitance stability, and ability to heal itself after momentary breakdowns. This type is useful also in wavefilters (high-pass, low-pass, bandpass, and band rejection). Its Q is not high enough, however, to recommend its use in highly selective tank circuits.

Plastic Film

If a metal film is deposited on each side of a plastic film dielectric and this combination is finished and packaged like one of the metallized paper types, the result is called a plastic film capacitor. Various plastic materials are used for the dielectric, some of them being polystyrene, *Mylar, Teflon,* and *Cellophane.*

Mylar, Cellophane, and *Teflon* types are found almost totally in the high-capacitance range, hence will be ignored here. However, there is at least one example of a low-capacitance series of polystyrene capacitor; the range is 20 mmf to .01 mfd at ±5% tolerance (special tolerances of ±2%, ±1%, ±½%, and ±¼% are obtainable). Rated DC operating voltage is 500 volts; minimum Q is 2000 at 1 mc; power factor is .02% at 1000 cps; and negative temperature coefficient approaches 200 parts per million per °C.

The polystyrene capacitor is used in critical applications, where size is unimportant, but wide operating temperature range, good temperature coefficient, high leakage resistance, and high Q are essential. Such applications include computer circuit coupling, commutation, and bypassing; RF tank circuit tuning; wavefilter frequency setting; industrial timing; and laboratory capacitance standards.

Foil-type Mica

The mica capacitor is the oldest of the high-performance types. In its simplest form, it consists of two aluminum foil plates separated by a thin wafer of mica (see Fig. 2A), but this simple arrangement is used only in very-low-capacitance units. In order to obtain higher capacitance, most of these capacitors contain several alternate layers of foil and mica (with the foil connected to pigtails), stacked as shown in Fig. 2B. This is equivalent to connecting several simple two-plate units in parallel. Pigtails are attached to the capacitor assembly and the latter is molded in plastic or enclosed in a container (Fig. 2C, 2D). In some commonly used styles, the capacitor element is simply dipped in a protective plastic. In most cases, the mica capacitor is smaller-sized than an equivalent paper or plastic type (the dielectric constant of mica is more than three times that of paper).

Mica capacitors are supplied in the capacitance range of 1 mmf to .01 mfd at ±5% tolerance for 10 mmf and higher and ±10% below 10 mmf. Special units are available with closer tolerances. Receiver-type units are rated at 500 volts DC; transmitter types are rated up to several kilovolts. Minimum Q varies from 150 at 5 mmf to more than 1500 at 500 mmf.

The electrical, temperature, and size characteristics of the mica capacitor suit it to many applications. Because it is not rolled, the mica capacitor has low internal inductance and therefore a very high self-resonant frequency. It has the disadvantage that, in its higher values, it costs more than other capacitors of similar ratings.

Silvered Mica

Just as the paper capacitor may be improved by metallizing a paper film instead of using foil plates, the mica capacitor may be improved by metallizing the mica wafer and discarding the foil plates. In this way, variations in plate spacing from temperature or aging are minimized, because the plate is tightly bonded to the mica. The metallizing process consists of painting and firing a silver paste on the mica face, or electrodepositing the silver. A single silvered-mica wafer provides a simple two-plate capacitor similar to Fig. 2A, but for higher capacitance several silvered wafers may be stacked and alternately connected to pigtails, as in Fig. 2B. For very low internal inductance (to use in UHF circuits), some silvered-mica capacitors employ round discs of mica and are assembled in small metal

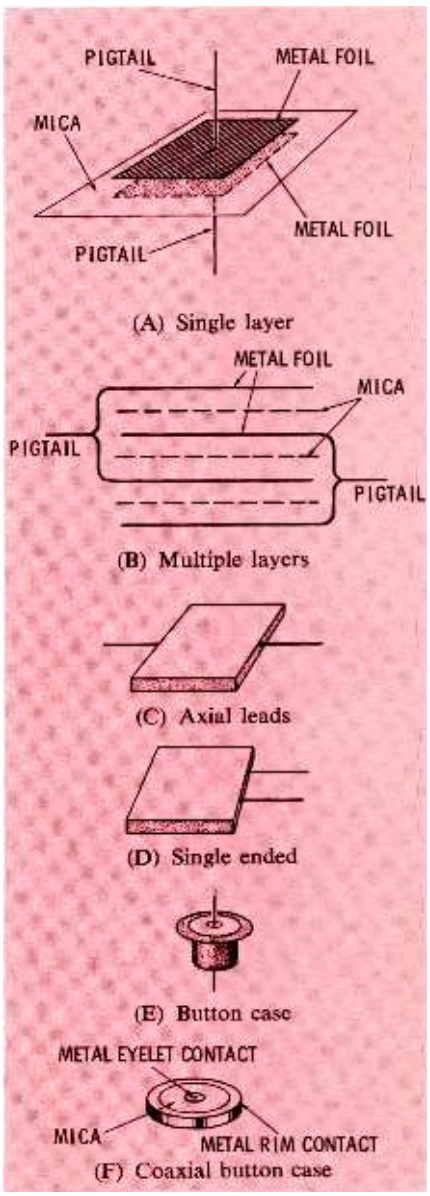


Fig. 2. The high-performance mica capacitor is available in a variety of configurations.

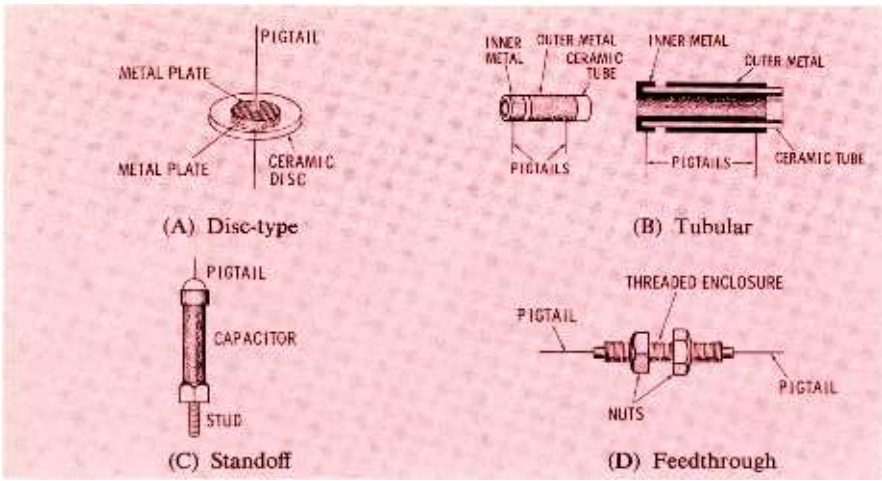


Fig. 3. Its high dielectric constant makes the ceramic capacitor a good space saver.

cases (Fig. 2E) or as "coaxial" buttons (Fig. 2F).

The major ratings of silvered-mica capacitors are similar to those of foil-type micas. However, temperature coefficient is greatly improved, ranging from –20 to +100 parts per million per °C, depending upon type and capacitance. Receiver types are commonly rated at DC operating voltages of 300 or 500 volts, but they are available up to several thousand volts. The Q may be several thousand.

Silvered-mica capacitors are used in very critical circuits, especially at high radio frequencies, where important considerations are low inductance, high leakage resistance, high Q, capacitance stability with temperature and aging, and small size. In receivers, transmitters, and test instruments, special close-tolerance silvered-mica capacitors are employed in stable oscillators. Close-tolerance units are used also as laboratory standards and are found in capacitance, inductance, and impedance bridges.

Glass

The glass capacitor is similar in construction to the silvered-mica capacitor, the difference being that the dielectric is a thin glass wafer, each face of which is metallized to form the electrode plates, and the capacitor assembly is molded in glass to provide a fused, completely sealed structure.

Capacitances are supplied in the range .5 mmf to .01 mfd at ±5% tolerances. DC working voltage is 300 or 500 volts, and power factor is .1% at 1000 cps.

The glass capacitor is the only type made entirely of inorganic materials. Because of its high Q, extremely high leakage resistance, and good temperature characteristics, it may be used in all critical applications where its capacitance and voltage ratings are adequate. Possible disadvantages are the high cost of this capacitor and its susceptibility to breakage.

Ceramic

Ceramic provides the highest capacitor values—size-for-size—of the low-capacitance types. This capacitance-to-size ratio results from the high dielectric constant (K) of the ceramic material (commonly titanium dioxide or barium titanate). It is not unusual to find a 1000-mmf ceramic capacitor no larger than a 2-mmf unit of some other type.

The principal configurations of the ceramic capacitor are shown in Fig. 3. In the disc type (Fig. 3A), a metal plate is deposited on each face of a thin ceramic disc by painting and firing or by electrodeposition, and a pigtail is attached to each plate. In a similar construction (flat-plate type), a thin rectangular ceramic wafer is used. In the tubular type (Fig. 3B), the inside and outside of a thin ceramic cylinder or tube is metallized to form an inner and outer plate, and a pigtail is attached to each. The capacitor structure is completed by protective painting, dipping, molding, or encapsulating.

Sometimes, to insure low inductance and to provide a straight conduction path, the capacitor is enclosed in a special housing, such as the standoff type (Fig. 3C) or feedthrough type (Fig. 3D). Dual assemblies are available containing two capacitor elements.

Depending upon type and voltage rating, capacitances are supplied from .5 mmf to .05 mfd. Common DC working voltages are: 500, 600, and 1000 volts for general-purpose ceramics; 3000 volts or more for high-voltage units; and 3, 10, 20, 30, 50, 75, 100, and 150 volts for low-voltage types, such as those intended for transistor circuits.

One special ceramic capacitor is the temperature-compensating type. This type may be obtained with either positive or negative temperature coefficient. The drift of a conventional capacitor may be reduced to zero by operating it in a circuit with a temperature-compensating unit having the same drift in the opposite direction. Or, the drift may be set at any desired specific amount by proper selection of a compensating capacitor. Zero-temperature-coefficient ceramics also are available and are replacing silvered micas in critical applications.

Because of their small size for a given capacitance, ceramic capacitors often replace all other low-capacitance types in miniature equipment. An important disadvantage is the readiness with which the brittle ceramic material may be chipped or broken if the capacitor is of the uncased type.

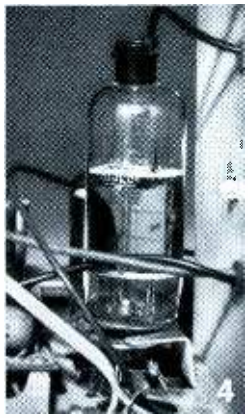
Selecting the Correct Unit

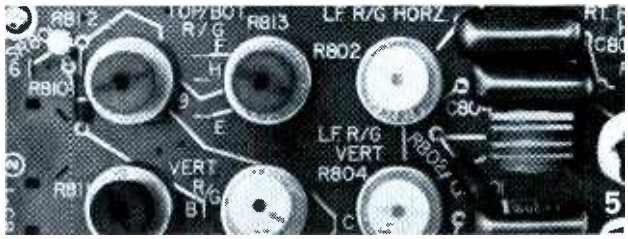
It is often said that a defective capacitor should be replaced with one of the same type or better. Often, however, the cost and size of a better replacement must govern whether or not it is chosen. With this in mind, it is interesting to note the difference in price of capacitors of various types.

It is difficult to compare prices meaningfully "across the board," since price differences between types vary in different capacitance groups and between various capacitor styles. Nevertheless, some notion may be gained from the following comparison of prices of a .005-mfd, 500-volt capacitor in various types:

TYPE	COST ($)
Paper	.15
Metallized Paper	.27
Polystyrene	.21
Mylar	.15
Mica	.42
Silvered Mica	.99
Glass	2.89
Ceramic Disc	.15

CTC 15 Color TV Chassis gives brighter, sharper picture; has greater reliability; is easier to service... than any previous RCA Victor Color TV Chassis!





RCA Victor's new CTC 15 chassis keeps all the performance-proved virtues of the CTC 12 . . . but adds these engineering improvements that should please both you and your customers:

The picture is brighter, better. It's brighter because a new design in the high voltage section (1) gives 30% more current output at the same voltage. The picture tube circuits are designed for effective use of this higher power.

It's sharper because the picture tube screen voltages have been boosted . . . giving a smaller, sharper dot pattern with less blooming. The video amplifier has better phase response.

It's steadier because of substantially improved vertical hold circuits.

A new picture "tone control" . . . it's a video peaking switch (3) . . . offers three choices of picture quality: soft, normal and sharp. When snow and ghosts are your problem, use the soft setting for a smoother, more pleasing picture. When the signal is better, make the most of it with the normal or sharp setting.

Less color fringing results from a new clamp diode in the convergence circuit and rearranged controls are easier to use. And UHF reception is improved by new circuitry that reduces snivets . . . those black vertical lines near the center of the picture.

Greater reliability . . . longer component life. Heat build-up has been reduced by housing the flyback transformer and the regulator tube in separate compartments.

The horizontal output tube (4) is placed on a raised "cooling shelf" outside the H.V. compartment. Its position allows free flow of air around its base. Three conventional tubes have been replaced by novars (6). They run cooler and last longer. One of them is the hardest working tube in the set—the horizontal output tube.

And dark heater tubes are used in all high-performance circuits.

To further increase life, the focus rectifier is now specially designed for additional life expectancy.

Easier servicing. Circuit tracing is easier and faster . . . the new schematic solid-line roadmaps (2) go point-to-point, and component labels are larger.

It's easier to service the high voltage compartment . . . it has a hinged cover and better arrangement.

Color setup has been simplified by the addition of a conveniently placed 3-position bias switch (3) which accommodates wide variations of picture-tube characteristics.

RG controls (5) on the convergence board have also been rearranged for your convenience. Now you use the entire top row to make adjustments according to the horizontal lines in a crosshatch pattern; the entire second row is for the vertical lines.

Color TV is the technician's big bread and butter business . . . for years to come. We stand ready to help in every possible way to make this fast-growing business a profitable one for technicians —and for dealers as well.

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

"HIS MASTER'S VOICE"

RCA The Most Trusted Name in Television

Tmk(s)®

Cheerful Charlie foils the DIY'S

Service-Shop humor . . . with a wise moral

by Charles F. Lieder

I've noticed that many servicemen have a cynical attitude toward the ambitious "do-it-yourselfers" (DIY's) who attempt to repair their own television sets. For my part, I rather like them; particularly the ones who manage to damage a few parts and put a little more cash in my register.

I suppose, too, I can understand their motives as I happen to be a DIY from 'way back, myself. When a board comes off the house I built, I nail it back on. If the faucet leaks, I repair it. When it still leaks, then I call a plumber. The only thing I'm reluctant to work on is my own TV, but my wife insists.

I usually encourage people to tell me their TV troubles and ask my advice. I inform them about such things as being sure the set is plugged in, power cord is not broken, antenna lead is not pulled loose, how to adjust controls, etc.

Some people know very little about these things. One of them phoned my home late the other evening. It seemed the switch on his set had jammed and he couldn't shut it off. He got excited and phoned for me. Since I wasn't home, my wife had taken the call.

"Tell Charlie to come as soon as he gets home!" the man implored her. "I can't leave it run and I want to go to bed!"

"Can't you pull the plug from the wall outlet and stop it?" my wife asked.

"No, no! I tried that and it still runs!" he answered.

"It has to stop," my wife insisted.

"It just doesn't!" he exclaimed.

My wife was very puzzled. She knew that television sets had to be connected to the line in order to operate. But she'd begun to wonder if I'd been keeping something from her.

A little later, another phone call erased her doubts. The man explained balefully that he had pulled the antenna lead loose instead of the power cord. After talking with her, he'd looked again and seen his mistake. He had the set stopped.

Leave the Back On?

I do warn the DIY's against tampering with the "innards" of their TV's. But if I warn a DIY not to poke his fingers around the high voltage section while the set is running, and he does it anyhow—well, after all, it's his TV!

Many DIY's have learned to read the tube charts on their TV sets. They can take the tubes out and put them back in the right sockets most of the time; but that's all they know about it. They're all eager to get advice and this is where I beat the self-service tester in the drug store. I give advice besides selling tubes—something the tester can't do. As a result, I even sell tubes to the druggist.

Generally my pet DIY's will come in time and again, with a couple of tubes for me to test. This is always their first step. The tubes will have been pulled at random from the set with no regard of trouble symptoms. Only a few tubes will be brought in at a time. I'm told this is done to avoid getting them mixed up. If the tubes they've pulled test good (as they usually do) the DIY will bring a couple more. After a few trips he gives up, and does what I suggest; he brings the set in.

Dean was a hard man to convince on this score. He had a good general ability to do things for himself and a great belief that he could fix anything.

He came into the shop one morning, held out a dark-looking 6BN6 and announced, "I need a new tube like this. I've got good sound, but the picture is blacked out. The little light comes on in the back of the picture tube so that's okay, but this tube is burned out."

"Perhaps I'd better test it," I suggested.

"No, just give me a new one. I know this one is shot."

I sold him a new tube and he left. He lived some distance from town, so I turned my attention to another job while I waited for him to come back.

This time he brought in several tubes. I could see they were from the tuner and IF stages.

"Better test these," he said. "that one didn't make any difference."

I don't know how, but I kept quiet and just tested the tubes. The 6BK7 was quite weak, so he bought a new one and departed. A short time later he was back again.

"I need a 6U8 and 12AX7," he said.

"Didn't you bring the old ones?" I asked.

"Well, when I was putting the tubes back, one of them popped out of my fingers, hit another one, and they both broke," he confessed.

I got him two more tubes, but I was getting writer's cramp from making out sales slips.

"This time you may be able to zero in on the neck of the picture tube," I told him, "and it's fairly fragile. When you break it, jump back quickly because that glass can really fly!"

Dean looked startled, but left without a word. In a little longer than his average time, he was back again. His TV was in the car.

We carried it in. When I found the burned out fuse and replaced it, the set was back in action. No other trouble showed up. Dean was quite

SENCORE
SIMPLIFIES COLOR SERVICING

NEW! CA122
COLOR CIRCUIT ANALYZER

A simple approach to a complex problem

Here is an instrument that is designed to eliminate the guesswork in color TV servicing. A complete analyzer that provides all required test patterns and signals for testing from the tuner to the tri-color tube. Additional analyzing signals for injection at each stage including audio, video and sync, brings to life a truly portable and practical TV analyzer for on the spot service; virtually obsoleting other analyzers with the advent of color. Sencore's simplified approach requires no knowledge of I, Q, R-Y, B-Y, G-Y or other hard to remember formulas. The CA122 generates every signal normally received from the TV station plus convergence and color test patterns.

The CA122 offers more for less money:

TEN STANDARD COLOR BARS: The type and phase that is fast becoming the standard of the industry. Crystal controlled keyed bars, (RCA type) as explained in most service literature, offer a complete gamut of colors for every color circuit test.

WHITE DOTS: New stabilized dots, a must for convergence, are created by new Sencore counting circuits.

CROSS HATCH PATTERN: A basic requirement for fast CRT convergence.

VERTICAL AND HORIZONTAL BARS: An added feature to speed up convergence, not found on many other color generators.

SHADING BARS: Determines the ability of the video amplifier to produce shades (Y Signal) and to make color temperature adjustments. An important feature missing on other generators.

COLOR GUN INTERRUPTOR: For fast purity and convergence checks without upsetting color controls. Insures proper operation of tri-color guns, preventing wasted time in trouble shooting circuits when CRT is at fault.

A must for color . . .

a money maker for black and white TV servicing

ANALYZING SIGNALS: RF and IF signals modulated with any of the above patterns for injection into grid circuits from antenna to detector. IF attenuator is pre-set for minimum signal for each IF stage to produce pattern on CRT thus providing a check on individual stage gain. Sync and video, plus or minus from 0 to 30 volts peak to peak, have separate peak to peak calibrated controls for quick checks on all video and sync circuits. Crystal controlled 4.5 mc and 900 cycles audio simplify trouble shooting of audio circuits.

NEW ILLUMINATED PATTERN INDICATOR: A Sencore first, offering a rotating color film that exhibits the actual color patterns as they appear on color TV receivers. Locks in with pattern selector control.

You'll pay more for other color generators only.

Dealer Net 187.50

NEW! PS120 PROFESSIONAL WIDE BAND OSCILLOSCOPE

A portable wide band 3 inch oscilloscope for fast, on-the-spot testing. An all new simplified design brings new meaning to the word portability . . . it's as easy to operate and carry as a VTVM. Though compact in size, the PS120 is powerful in performance: Vertical amplifier frequency response of 4 MC flat, only 3 DB down at 7.5 MC and usable to 12 MC, equips the technician for every color servicing job and the engineer with a scope for field and production line testing. AC coupled, with a low frequency response of 20 cycles insure accurate low frequency measurements without vertical bounce. Sensitive single band vertical amplifier; sensitivity of .035 volts RMS for one inch deflection saves band switching and guessing. Horizontal sweep frequency range of 15 cycles to 150 KC and sync range from 15 cycles to 8 MC (usable to 12 MC) results in positive "locking" on all signals. New exclusive Sencore features are direct reading peak-to-peak volts —no interpretation; dual controls to simplify tuning; lead compartment to conceal test leads, jacks and seldom used switches. Rear tilt adjustment angles scope "just right" for easy viewing on bench or production line.

Size: 7"w x 9"h x 11¼"d. Weight: 12 lbs.

Dealer Net 124.50
(with low cap. probe)

Kit 74.50

A must for servicing color TV in the home . . . lowest priced broad band scope. All hand wired — all American made

Circle 12 on literature card

disgusted, but he was finally convinced that TV repair was out of his line.

DIY Symptoms

There are also times when DIY's can do things to a TV to create symptoms that no self-respecting TV would have of its own accord. These are probably very rare symptoms, taking almost sheer genius to accomplish, but to a genuine DIY nothing is impossible.

For an ordinary technician to undo what the successful DIY has managed to do can cause plenty of headaches. The bald spot on *my* head was not caused by dandruff.

In one particular case I found a set on the bench when I came back from a round of service calls. No complaint was listed and my wife informed me that the gent who left it just said it didn't work as it should. He was so right!

When I turned it on, it had lovely symptoms. One was a loud buzz that changed in pitch when I rotated the vertical hold. The picture had good contrast, and was stable and well defined, but bright vertical retrace lines were superimposed on it. Adjusting the contrast control changed the lines very little, but did affect the contrast normally. I could black the lines out only by turning the brightness down.

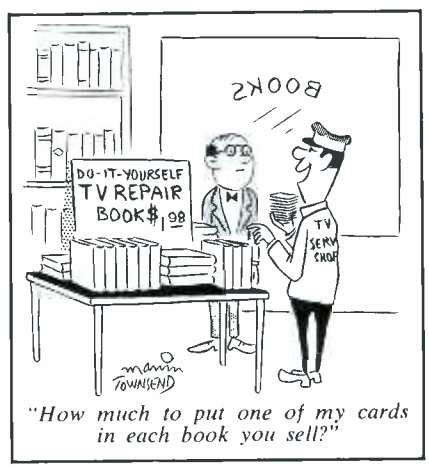
At first, I suspected the CRT. This checked good. The next culprit could possibly be a filter capacitor. The vertical buzz in the sound seemed to indicate this. I checked the tubes in the vertical circuit first though, just in case; they tested all right.

The next thing I did was get into the set with my scope. I found no unusual waveforms at the terminals of the electrolytic capacitors. I checked the blanking signal at the grid of the CRT; it was there and in good shape.

I had noticed that several of the molded capacitors and several resistors were new. Many of the solder joints were new and shiny. It was evident that this set had been worked over already. The work seemed to be done well, so I suspected it had been in a shop very recently. I began to think perhaps this was one of those sets with fleas.

The vertical circuit was checked out next. The waveforms at key points looked normal. I checked further. At the plate of the video amplifier the vertical pulses showed up. Tracing backward, I found them also at the grid and at the detector output. Evidently they were getting into some IF stage. Checking through these to the AGC circuit disclosed a prominent vertical pulse which didn't belong there. Still, a voltage check of the AGC showed normal action. Whew!

The signs indicating that the set had just been worked on led me to start a terminal-to-terminal check



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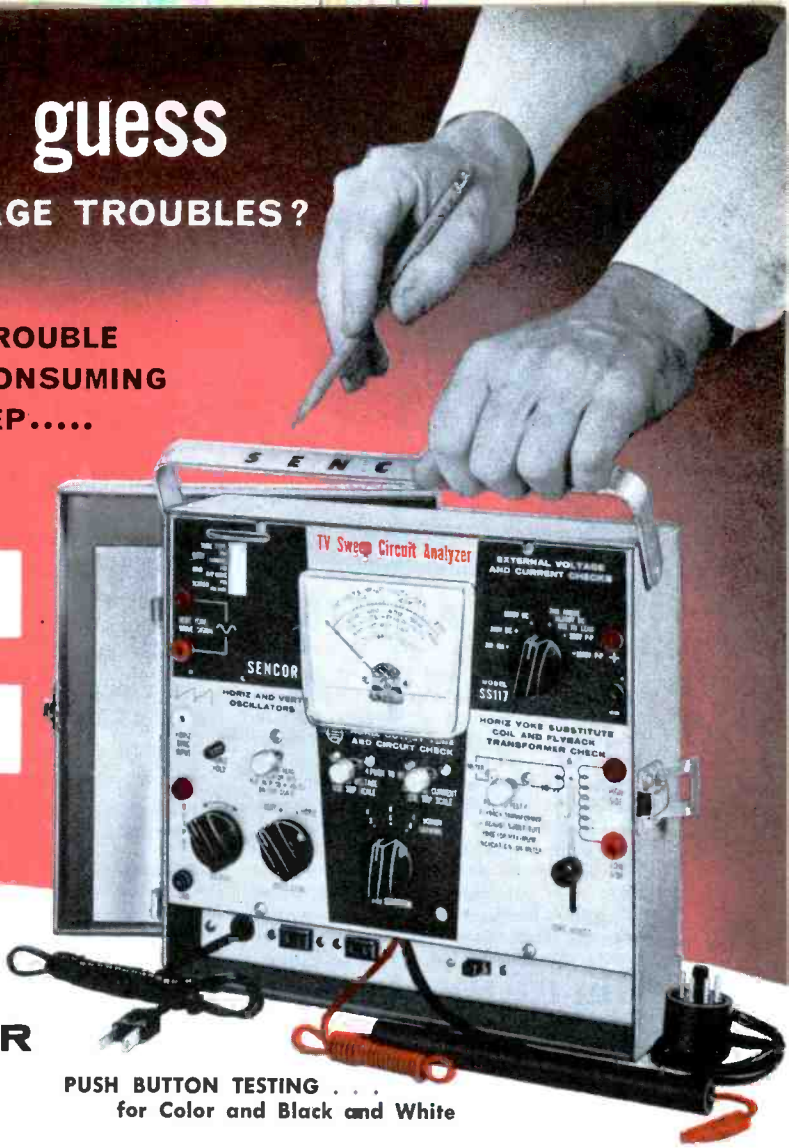
Can you afford to guess

AT SWEEP, SYNC OR HIGH VOLTAGE TROUBLES?

WHEN IT'S SO EASY TO WALK THE TROUBLE RIGHT OUT OF CIRCUITS..... THESE TIME CONSUMING STEP BY STEP.....

SYNC. CIR. & H. SYNC. DISCRIM.	VERT. OSC.	VERT. OUTPUT	VERT. OUTPUT XFORMER	VERT. DEFLEC. YOKE
HORIZ. OSC.	HORIZ. OUTPUT	HORIZ. FLYBACK XFORMER	2nd ANODE VOLTAGE CIRCUIT	HORIZ. DEFLEC. YOKE



NEW, IMPROVED SENCORE
SWEEP CIRCUIT ANALYZER
MODEL SS117

PUSH BUTTON TESTING . . . for Color and Black and White

How many times do you ask, "Why do I take so long finding that sweep trouble?" How often have you wondered whether weak horizontal sync was caused by defective sync circuit, horizontal oscillator, or sync discriminator? Can you quickly isolate inadequate width or low 2nd anode voltage to the oscillator, output, flyback transformer, or yoke? How many times have you changed a good yoke by mistake?

The SS117 will pinpoint troubles like these in minutes with tried and proven signal injection, plus yoke substitution for dynamic in-circuit tests. Error proof push button testing enables you to make all tests from the top of the chassis without removal from cabinet for maximum speed and profit on every job.

Here are the checks the SS117 makes . . .

- Horizontal Oscillator: Checked by substituting 15,750 variable output universal oscillator from SS117. Signal can be injected at any spot from horizontal output grid to horizontal oscillator to determine defective component.
- Horizontal Output Stage: Checked by reliable cathode current and screen voltage checks made with adapter socket and two push buttons,
- Horizontal Output Transformer: Checked for power transfer in circuit and read as good or bad on meter.
- Horizontal Deflection Yoke: Checked by direct substitution with adjustable universal yoke on SS117.
- Vertical Oscillator: Checked by substituting 60 cycle synchronized oscillator.
- Vertical Output Transformer: By simple signal injection for full height on picture tube.
- Vertical Deflection Yoke: By signal substitution for full height on picture tube.
- Sync Stages: Checked by synchronizing triggered horizontal SS117 oscillator from any stage. If oscillator synchronizes, sync is O.K.
- 2nd Anode Voltage: A new dynamic check using simulated picture tube load. C.R.T. does not need to be operating for current tests. No interpretations—read direct from 0 to 30 KV.
- External Circuit Measurements: By applying from 0 to 1000 volts AC or DC to external meter jacks. Meter will read DC or peak-to-peak volts. 0 to 300 milliamp scale also provided for measuring horizontal fuse current.
- New features include: Large 0 to 300 microamp meter for minimum circuit loading; all-steel carrying case with full mirror in adjustable cover; two 115 volt AC outlets in cable compartment.

Size: 10¼" x 9¼" x 3½". Wt. 10 lbs.

Model SS117 Dealer Net **$89.50**

Sencore Sam says . . . How can you miss . . .

EACH PACKAGED UNIT CONTAINS:
- An Easy to Follow Instruction Book Especially Prepared and Edited by H. W. Sams.
- A complete 33 RPM, 10 inch Permanent Record on "How to Simplify Sweep Circuit Trouble Shooting."

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Circle 13 on literature card

SENCORE

ADDISON, ILLINOIS

of each component in the AGC circuit. I looked for unsoldered or incorrect connections and touching leads. I compared each connection with the schematic and the location of each component with the pictorial section of the PHOTOFACT folder.

Finally, I found that one of the two AGC filter capacitors in this set had been connected to the junction of two series-connected capacitors in the vertical waveshaping network instead of ground.

When the owner came for his television, I showed him that it was working good. Then I asked, point blank, who had worked on it before.

"Oh, my nephew did," he told me. "The boy is smart. He even built himself a radio with one of those kits." The man admired the picture on his TV. "My nephew knows how to fix TV's, too," he added.

"He sure does!" I agreed, and handed him my bill.

I try to coax people to admit if they have attempted to fix a set themselves. Some are proud of their efforts. If I also point out that knowing what they have done will help me fix the receiver more quickly, they will explain just what happened. Others will not admit that they touched the set, although the evidence is apparent.

DIY Fingerprints

Signs of tampering are usually easy to see. I generally examine a set for misadjusted controls. I've also found that the DIY will often leave the back off or will just put it on loosely, not bothering to tighten the screws. As a coating of dust soon accumulates on a TV chassis, a quick look will tell if it has been disturbed recently.

One general habit of the DIY is to misplace tubes. Suspecting that this may have happened to a receiver I'm about to work on can save me a lot of needless trouble-shooting.

I received a call from a farmer's wife. I knew that Mrs. Joe was one of those few women who will try to fix anything themselves, so I wasn't surprised to find the back off of her TV. She readily told me that a friend had informed her that merely changing the tubes around in a receiver will often cure some trouble it might have.

(Incidentally, I don't start rumors like this. Business has been good enough without using such tactics.)

Mrs. Joe's set wouldn't stay in sync anymore and she had tried the tube changing scheme. She had broken a tube in the process so I was called.

I decided to test the tubes as I rearranged them into their proper sockets. I noticed that the high voltage cage had been opened and the damper tube was missing. I assumed it was the broken tube.

As I set up equipment to start work, I had an audience of one little girl. "Mama was fixing the TV herself," she said. "Then she jumped up quickly, fell over the flower stand, and said a lot of words she won't let me say!"

Mrs. Joe came from the kitchen, grinning shamefacedly.

"Blabbermouth!" she exclaimed to her daughter. Then she asked me, "Why did I get a shock from that little tube? I thought it was the picture tube that shocked you."

"It so happens that this metal cage contains the parts that produce high voltage. The cage has two purposes. One is to prevent radiation from affecting other circuits; the other is to stop people from poking their fingers among the parts," I answered cheerfully. "You probably touched the metal terminal of this 1B3 socket which has a direct connection to the picture tube anode."

"I'll keep my fingers out of it after this," she promised.

"When you get hurt by a TV," the youngster asked, "do you say naughty words too?"

I didn't dare answer that.

I settled down to fix the set. It wasn't too difficult; checking the tubes showed up a bad sync amplifier. I replaced this and the damper tube. With all the tubes restored to their proper sockets, the set worked fine.

Another little trick DIY's can play on a serviceman is the simple act of pulling wires loose. A yoke lead pulled loose from the pin of the yoke connecting plug, then carefully pushed back in but not soldered, once created a very nice intermittent B-boost failure that took me some time to locate.

After a few such experiences I've learned to be on the lookout for loose wires. Any lead that is exposed is vulnerable. Sometimes they

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19 TRANSISTORS
ALL CRYSTAL CONTROLLED
TRULY PORTABLE ONLY 7½ LBS.

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SAVE HUNDREDS OF DOLLARS

...with the ALL NEW SENCORE MX129 FM STEREO MULTIPLEX GENERATOR AND ANALYZER

It has been established by all Radio and TV manufacturers that you must have a generator of this type to service FM stereo receivers. Here is a new field just waiting for qualified men, a field that is growing as fast as color TV. Multiplex is simple to service with this generator. If you can service an FM receiver, you can service multiplex once your have the MX129.

Look at the outstanding features of this all transistorized Sencore unit and you will see why it is the most versatile, most portable, most trouble free unit on the market. It is just like having your own FM stereo transmitter on your bench or service truck. All signals are crystal controlled and instantaneous because there are no tubes to warm up. Powered by 115 volts AC to insure top performance at all times.

The MX129 produces all signals required for trouble shooting and aligning the stereo portion of the FM multiplex receiver and can be used as a stereo demonstrator by feeding in left and right audio signals into the jacks marked LEFT and RIGHT EXT. SIG. This unique feature will allow you to demonstrate stereo to the customer even when a stereo program is not being broadcast.

The MX129 becomes a complete trouble shooting analyzer with the addition of a meter calibrated in peak to peak volts and Decibels. No other equipment is required for checking channel separation or alignment. A jack marked EXT. METER is provided for connecting the meter to the stereo speakers or at other points after detection.

Here are the signals available on the MX129 for alignment, trouble shooting and analyzing:

- FM-RF carrier with composite multiplex audio signal just like that transmitted from the FM station: 38kc suppressed carrier, 19kc pilot and 67kc SCA signal. This signal available at RF output cable.
- Multiplex signal is formed by either 60 cycle or 1000 cycle internal tones for greater flexibility in testing.
- Full control over left and right channel amplitude (and therefore modulation). Built-in meter is used to set controls for equal modulation of FM carrier. Channels can be turned completely off when desired.
- 19kc pilot calibrated directly in percentage of modulation; can be generated separately for 19kc amplifier peaking by turning down left and right channels.
- External 67kc SCA (subscription) signal available at jack marked SCA OUT (67KC) for trap adjustment. This signal, not found on some high priced multiplex generators, is very important on new stereo receivers with adjustable 67kc traps.
- Composite signals, same as described above, available on jacks marked COMP. OUT for signal injection beyond the FM detector.

SENCORE / **426 SO. WESTGATE • ADDISON, ILL.**

Circle 18 on literature card

have been carefully reconnected—to the wrong terminal.

CAUTION . . . Children at Work

I have also learned that the small fry who intently watch a serviceman at work in their home are the DIY's of the future.

I serviced for a family, none of whom (that I knew of) would do more than turn their television on. I had, at one time, been called just to adjust the vertical hold.

This time, I was informed that the sound had quit. I tested tubes routinely and found the audio output tube defective. Putting in a new one did not bring the sound back. As I listened and considered other possible failures, I realized that even the normal hiss and hum were absent. I expected to find a bad audio output transformer or speaker.

The speaker was mounted in the bottom of the console cabinet. When I looked at it, I saw that the leads had been cut off and neatly twisted together.

I asked the lady, "Has the household handyman tried to work on this set?"

"Oh no," she quickly answered. "I never touched it, and I'm sure Jim didn't."

"Look!" I pulled the wires out so she could see the handiwork.

"Well! I wonder . . . ?"

She called Dick, the thirteen year old. When he came in, his mother asked, "Did you do this to the TV?"

"Sure. I saw Charlie twist the wires together that time the switch wouldn't work. That made the set go till he got a new switch. I thought I could get it talking for a while by twisting the speaker wires."

"What can I do with a boy like that?" the mother asked.

"I suspect some manufacturers would give a great deal to be able to reproduce sound without some form of speaker," I replied. "See that he gets an education. He might be the man they're waiting for."

Costly Experience

Some DIY's may sorrowfully learn that "fixing" their own TV is an expensive way to save money. But I haven't learned to accept at face value everything they tell me and act accordingly.

If, for example, I would install a new CRT for each customer who thought he needed one, I'd get a note of thanks from the government when my income tax return went in.

But humane impulses, and a strong desire to avoid being considered a cheat, lead me to argue (even with DIY's) against putting unnecessary parts in their TV sets.

Still, I haven't always been right.

One DIY came in and said, "I think I need a new picture tube."

I've heard this so much I'm always skeptical (but hopeful).

"You can't really tell about that unless you test the old one," I told him.

"Isn't there any other way of being sure?" he asked.

"No."

"Well, what is this?" he opened up a paper sack he had in his hand, and I looked in.

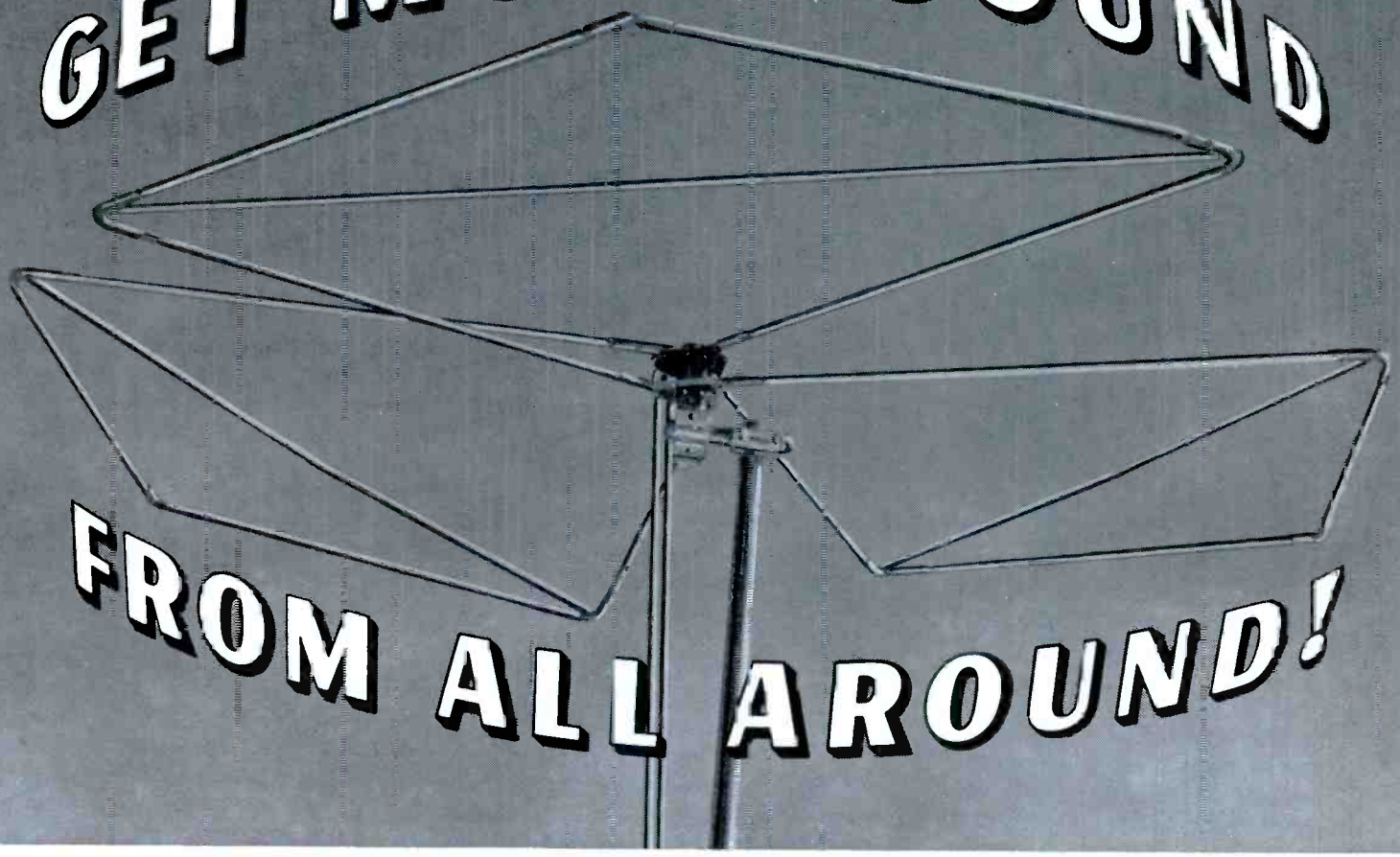
"It's the broken neck of a picture tube," I answered.

"My set quit; and when I removed the back, it slipped out of my hand and broke this off. Doggonit! I know I need a new picture tube!"

When a DIY is sure he's right, I won't argue with him. And you shouldn't either. Just accept his money meekly. ▲

Now! Without any help from a rotator...

GET MORE SOUND FROM ALL AROUND!



Model 4407G

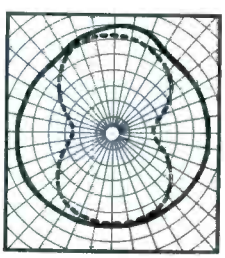
CHANNEL MASTER FM STEREO RONDO

WORLD'S FIRST TRULY OMNI-DIRECTIONAL ANTENNA! There's a real need for an FM antenna that receives stations strongly from all directions—without a rotator. Turnstiles are supposed to do the job—but they do not! They have weak sides that drop off up to 8 DB.

The FM Rondo is a spectacular breakthrough in FM antennas. It has no weak sides. It picks up strongly from all directions. Thanks to its unique "Tri-Di" dipole design, the Rondo has a roughly circular reception pattern which remains constant on all FM frequencies; provides up to 7.4 db more gain than turnstiles; gets more stations.

The Proof is in the Polar Pattern!

Rondo has true Omni-directivity with up to 7.4 DB more gain.

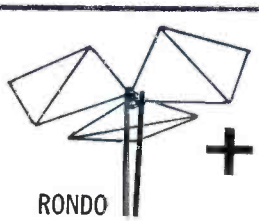


Compare Rondo (solid line) with turnstile (dotted line). Turnstile patterns are "peanut-shaped". Drop-offs are high as 8 DB. A single bay Rondo is as good as a single bay turnstile on its *strongest* sides—but up to 7.4 DB *better* than turnstile on its weak sides.

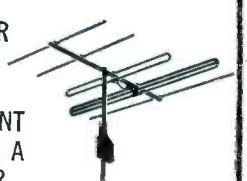
IF PRODUCT OR PERFORMANCE DEFECTIVE • Good Housekeeping • REPLACEMENT OR REFUND TO CONSUMER GUARANTEES

CHANNEL MASTER
ELLENVILLE, N.Y.

TRY THIS for Maximum Omni-Directional Performance in Fringe Areas... at Lowest Cost:



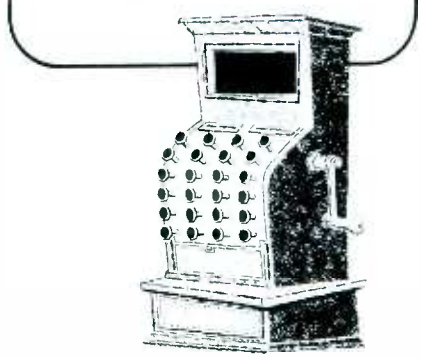
RONDO + TELSTAR FMX BOOSTER = GREATER POWER THAN A 5-ELEMENT YAGI ON A ROTATOR



DOLLAR & SENSE *Servicing*

by Forest H. Belt

you can MANAGE for profit



Two months ago, the first part of this article began the discussion of how an ordinary service technician could develop skill in *managing* his business, and thus increase his profits. A few who tried the steps we suggested have taken the trouble to tell us that these ideas really work. The odd thing was—they were *surprised* that they worked!

Certainly, they work! They are procedures that all successful businesses—from the smallest to the largest—use in one form or another every day of their existence. In presenting them in one form, we hope to encourage every shop owner and technician to increase his ability to manage a business.

In the first installment, we repeatedly pointed out that "to earn a profit, you must take in more money than you spend." We didn't say how much profit you should make, for that is a matter of your own choice. We also suggested that, if you are making a profit that satisfied you, there is little need to read what follows; obviously, you are already a good manager. However, if you'd like to increase your profits, there are a number of ways you can do so.

If our proverb of profit—earn more, spend less—is correct, the ways to improve profit fall into two categories—income and expense. Last time, we discussed a method of analyzing your business records and developing ways to *increase income*; this time, we will discuss how you can take clues from your profit-loss statement to help you *reduce expenses*. If you can cut expenses, at no sacrifice in income or business relations, you will increase the money you can put into your pocket each month.

The "Feel" of Expense

By now, I'm sure you're convinced that you will need a profit-loss statement if you are to manage a business of any kind. No matter how simple or how complicated your statement, you must know how to get the information you want from it. Exactly what information you get, and what you do with this information, will determine your success or failure.

First, let's get the "feel" of what we're talking about. What is expense? It's what you pay out for supplies. It buys the time of your employees. It pays the rent on your shop. It gets you a service vehicle, and keeps it running. It pays the phone bill. It buys the parts you put in sets, it pays for sets you sell, and it fills the inventory you keep on your shelves (whether catching dust or moving freely). Advertising and promotion, which makes your shop what it is and helps you to increase your income, is an expense. In other words, from a standpoint of analysis, you can consider any expenditure of your money as expense.

Expense is classified into several categories, however, and you must learn to distinguish one from the other. There is *current expense,* which usually can be considered as those bills which you pay monthly. There is *cost of merchandise,* a different kind of expense which you pay out for items which you will subsequently resell; money spent for parts, accessories, and sets would fall into this classification. Lastly, there is *long-term expense* such as money you borrowed to go into business, the mortgage on your building, or the money it takes to keep your test equipment up-to-date and modern. All of these represent money you have to pay out in one way or another if you are to stay in business.

What To Do About Expense

It is absolutely necessary to know which expenses you can do something about, and which you can't. While we won't go into every type of expense you will encounter in the electronics servicing business, we are going to show you examples of the type of *thinking* and analysis you are going to have to do, using the expense and cost-of-sales figures of your profit-loss statement. Learn how to apply this type of thinking, and do it a little more each month; you'll soon find yourself classed as a true businessman, instead of a struggling technician.

Cost of Sales

Take a look at the profit-loss statement shown in Table 1. Gross sales are broken down into two categories—Sets, and Parts and Accessories. Beneath, the Cost of Merchandise is also divided into the same categories. We can use these figures to decide if there is anything we can do to lower the expense of buying the merchandise we sell—parts, sets, or accessories.

Here's one line of thought our analysis might take: Are we paying too much for our parts and the accessories we sell? In this month, their cost was slightly more than 61%. Turning this around, we can figure that our gross profit from parts and accessories was 39%—

Table 1—P-L Statement Month of March 1962

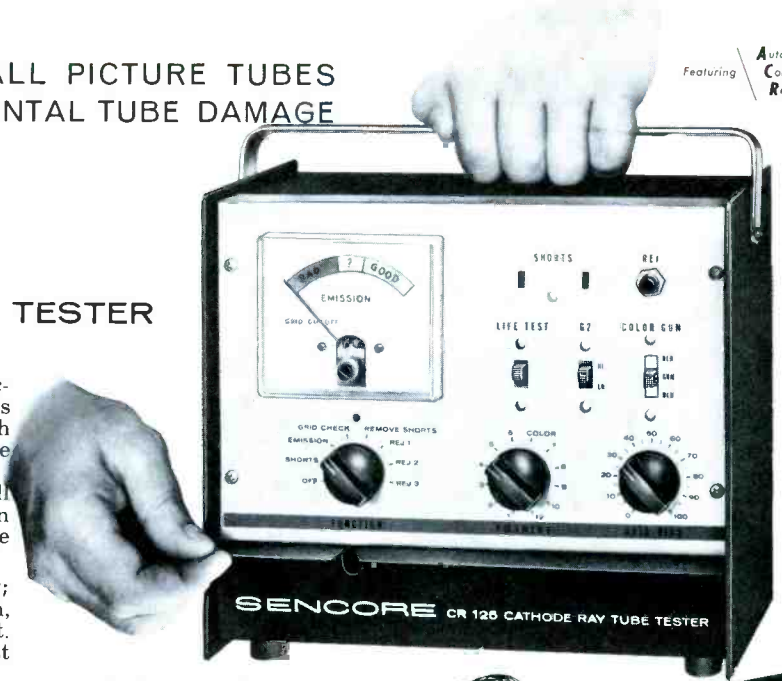
Gross Sales:		
Set Sales	$2759.55	
Parts and Accessories	958.67	
Service Labor	1438.76	
		$5156.98
Cost of Merchandise		
Sets	$1942.87	
Parts and Accessories	587.30	
		$2530.17
Profit on Sales		$2626.81
EXPENSES:		
Service Salaries (excluding owner)	$ 680.00	
Outside Labor (ant. work)	85.00	
Rent	150.00	
Supplies—Ofc. & Shop	27.35	
Utilities	73.79	
Phone	37.69	
Vehicle Expense	177.65	
Insurance	77.50	
Taxes, Licenses (prorated)	27.54	
Repairs and Maintenance	18.76	
Acctg., Banking, Legal	26.75	
Depreciation	42.00	
Advertising and Promotion	93.85	
Interest on Loans	26.87	
Miscellanous	173.67	1718.42
Net Income		$ 908.39
Owner's Withdrawal		600.00
Net Profit:		$ 308.39

CHECKS AND REJUVENATES ALL PICTURE TUBES
WITHOUT ADAPTORS OR ACCIDENTAL TUBE DAMAGE

Featuring Automatic Controlled Rejuvenation

The All New SENCORE

CR125 CATHODE RAY TUBE TESTER



An all new method of testing and rejuvenating picture tubes. Although the method is new, the tests performed are standard, correlating directly with set-up information from the RCA and GE picture tube manuals.

Check these outstanding features and you will see why this money making instrument belongs on top of your purchasing list for both monochrome and color TV testing.

Checks all picture tubes thoroughly and carefully; checks for inter-element shorts, cathode emission, control grid cut-off capabilities, gas, and life test. Checks all picture tubes with well filtered DC just like they are operated in the TV set.

Automatic controlled rejuvenation. A Sencore first, preventing the operator from over-rejuvenating or damaging a tube. An RC timing circuit controls the rejuvenation time thus applying just the right amount of voltage for a regulated interval. With the flick of a switch, the RC timer converts to a capacity type welder for welding open cathodes. New rejuvenation or welding voltage can be reapplied only when the rejuvenate button is released and depressed again.

Uses DC on all tests. Unlike other CRT testers that use straight AC, the CR125 uses well filtered DC on all tests. This enables Sencore to use standard recommended checks and to provide a more accurate check on control grid capabilities. This is very important in color.

No adaptor sockets. One neat test cable with all six sockets for testing any CRT. No messy adaptors, reference charts or up-dating is required. The Sencore CR125 is the only tester with both color sockets. (Some have no color sockets, others have only the older type color socket.)

All six sockets, including latest color socket, on one neat cable.

Checks each gun individually in color tubes

No draggy leads. A neat, oversized compartment, in the lower portion of the CR125 allows you to neatly "tuck away" the cable and line cord after each check in the home.

Model CR125 ..... **$69.95**

MODEL CR128
For the man on the go. Same as above but in all steel carrying case $69.95

PS127 DELUXE WIDE BAND OSCILLOSCOPE AT A SURPRISINGLY LOW PRICE

This all new 5 inch oscilloscope offers the finest in performance, portability and appearance. Vertical amplifier frequency response, flat within 1 DB from 10 CPS to 4.5 mc and only 3 DB down at 5.2 mc insures true waveform reproduction. Vertical amplifier sensitivity of .017 volts RMS for one inch deflection on wide band (without band switching) is found only on scopes costing hundreds of dollars more. High input impedance of 2.7 megohms shunted by 99 mmfd (or 27 megohms with 9 mmfd with built-in low capacity probe), insures minimum circuit loading. For the first time, waveforms can be viewed in TV horizontal and vertical output circuits with the low capacity probe that will withstand up to 5000 volts peak to peak. To top that, the vertical amplifier attenuator controls are calibrated directly in peak to peak volts for fast direct reading of all peak to peak voltages.

Horizontal amplifier extended sweep range from 5 to 500 kc in five overlapping steps and frequency response from 10 CPS to 1 mc within 3 DB insures linear sweep and positive sync. External inputs for horizontal sweep and sync, intensity modulation, and smart two-toned case and "designer" styled controls brands the PS127 a truly professional oscilloscope.

PS127 ..... **$169.50**

Circle 22 on literature card

which isn't bad, at all. Therefore, it would little behoove us to spend great lengths of time and effort trying to squeeze this percentage of cost downward, for—at best—we could only hope to gain 1% or 2%.

Next, we'd wonder about the cost of sets we sell. They cost us, this month, 74% of what we sold them for. If we want a better margin, we'd better find a way to get them at less cost, or quit selling them at less-than-normal prices. However, our gross profit margin is 26%—again, not too bad for the type of merchandise. At least we know what we'll have to do if we want to improve the margin.

This kind of analysis could work the other way, too. Suppose our cost-of-sales analysis shows we were making a 34% profit on sets. Knowing this is out of line, our managerial minds would wonder why. Checking, we also note that total sales are dwindling from month to month—a sure sign that our selling prices are too high, or that our set cost us so little we must be selling shoddy merchandise (people are bound to find out).

The point, then, is to keep your eye on these cost (expense) ratios, and be ready to analyze *any* notable deviation from normal. Once the problem is found and evaluated, remedying it is much easier; unless it is found, no action is possible.

Current Expense

It is in the area of current expenses that the cost-analyst can usually have a field day. There are so many ways hidden expenses can get into the profit-loss statement that it takes years of experience to be able to sit down and pick them all out.

Years of experience, we said. And what is it that you're developing as you sail along through month after month of operating your own business? Why, of course, you're accumulating those years of experience. And if you will concentrate your attention on the problem of cost-cutting just once a month, you can eventually have your ship sailing as trimly as that of any large corporation.

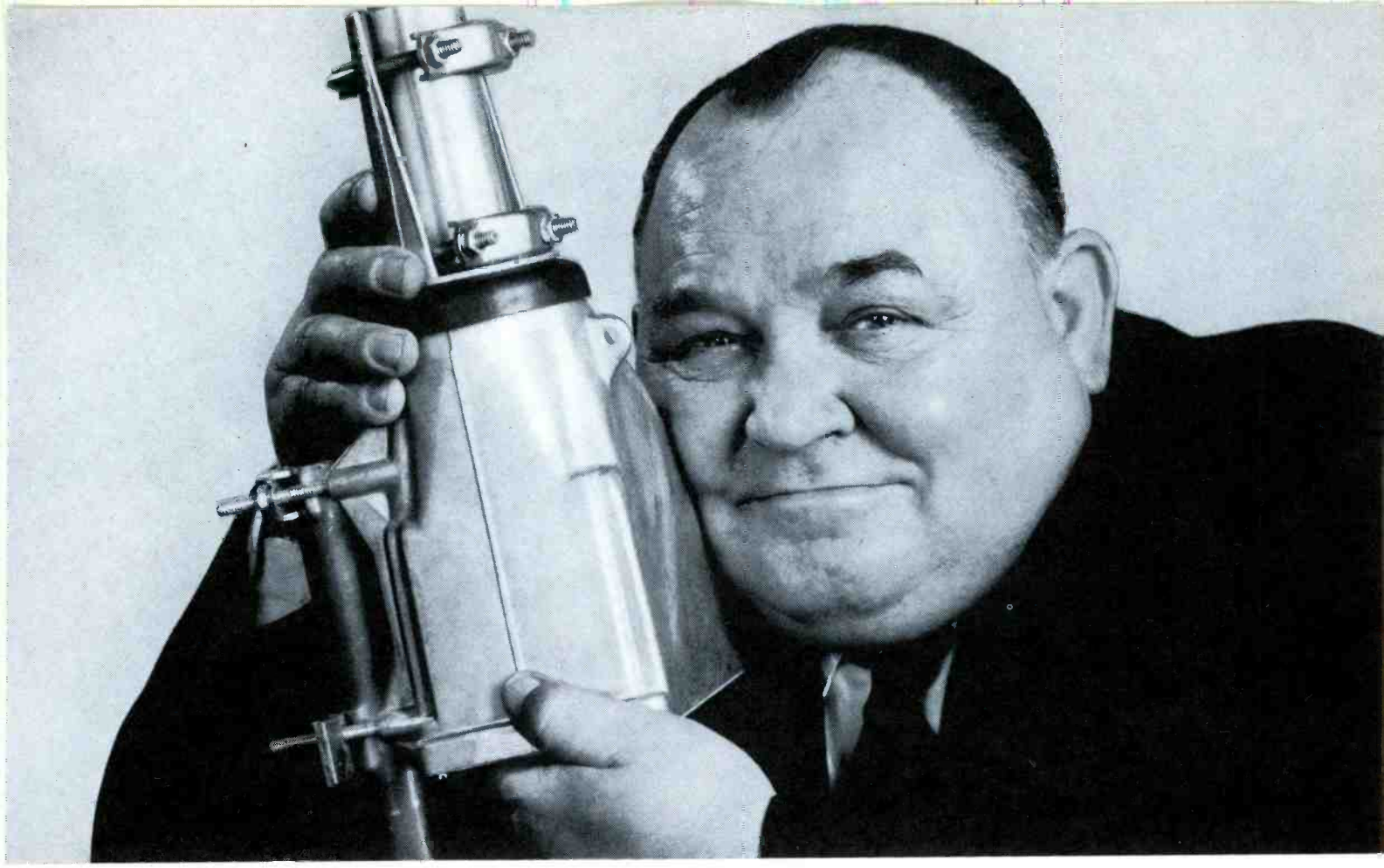
Let's take a closer look at the comparative expense sheet shown in Table 2. In the column naming the expense categories, are "ideal" percentage figures that relate expense to gross sales—a generally accepted measure of whether expenses are too high or too low. Each expense figure is also accompanied by its percentage of gross sales. Three major columns are provided for comparisons: Last Month, which is taken from the profit-loss statement shown in Table 1; This Month, which we'll discuss; and Month Last Year, for comparison only, which we won't use in our discussion.

Let's assume that we examined our profit-loss statement last month, made some calculations and decided that we needed to improve our expense record—indeed, it represented 18.3% of our gross sales, quite a bit above the 16% we had set for our goal.

Next, we went down the list of expense items, thinking something like: Rent—that's fixed and we're stuck with it, unless we change buildings; besides, it doesn't exceed our "ideal." Supplies—a bit high, and perhaps we can reduce it by minding our

Table 2—Comparative Expense Sheet

Expenses		This Month		Last Month		Mo. Last Year	
*Figures Show Ideal Percentage of Sales ↓		$	%	$	%	$	%
Rent	3.0	150.00	2.9	150.00	2.9		
Supplies	.3	18.65	.4	27.35	.5		
Utilities	.7	65.85	1.3	73.79	1.4		
Phone	.5	21.55	.4	37.69	.7		
Vehicle Exp.	3.0	139.65	2.8	177.65	3.4		
Insurance	1.4	77.50	1.5	77.50	1.5		
Taxes, Licenses	.5	27.54	.5	27.54	.5		
Repairs, Maint.	.2		0	18.76	.4		
Acctg., Bank, Legal	.7	24.45	.5	26.75	.5		
Depreciation	1.0	42.00	.8	42.00	.8		
Advertising	2.0	85.55	1.1	93.85	1.8		
Interest	.3	26.87	.5	26.87	.5		
Miscellaneous	2.4	139.45	2.8	173.67	3.4		
Total	16	819.06	15.5	953.42	18.3		
Sales		5063.65		5156.98			



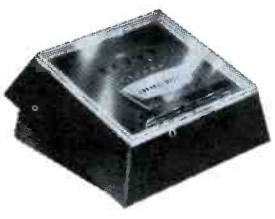
Here's the only excuse you may have for not installing the world's best manual rotator at our REDUCED PRICES...

...you just don't use manual rotators in your area!

Say, on the other hand, you *do* sell them. And believe with all your heart in selling the very best. What else can you do then but go with Channel Master rotators? Especially when you can now get our manual model at reduced prices.

This is the one rotator, remember, that makes all others look like also-rans; because it alone has the high torque to turn the heaviest antenna array easily—plus the ruggedness to keep it on course in foulest weather.

For instance: In addition to simplest fingertip control, accurate repeatability, continuous instant direction indication, (and lots of other good features), only Tenn-A-Liners give you:



model 9520

- Built-in *hard-steel* thrust bearings (not soft aluminum parts). So friction-free the Tenn-A-Liner will turn ice-loaded installations as heavy as 330 lbs.
- *Hard-steel* precision-machined gears (not stamped). So rugged that they won't strip or bind. Will continue to operate even in 70 mile gale winds.
- *Pushbutton* "On-Off" Switch (brand-new) that prevents reception interference caused by wind vibration.

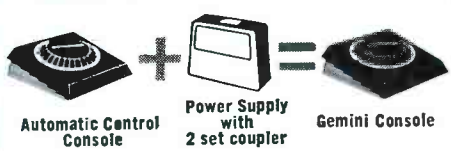
... **now** *what's your excuse for not calling your nearest Channel Master distributor?*

NEW! Unique Gemini Rotator/Amplifier.
...for fast, neat *2-in-1* installations that save you money 4 ways.

(A simple explanation of what the Gemini is—for those dealers who have heard about this product's terrific profit success story).

Tenn-A-Liner Rotator + Fringe-Area Booster = Gemini Rotator-Amplifier

(Where's the booster? It's hidden in the rotator).



Automatic Control Console + Power Supply with 2 set coupler = Gemini Console

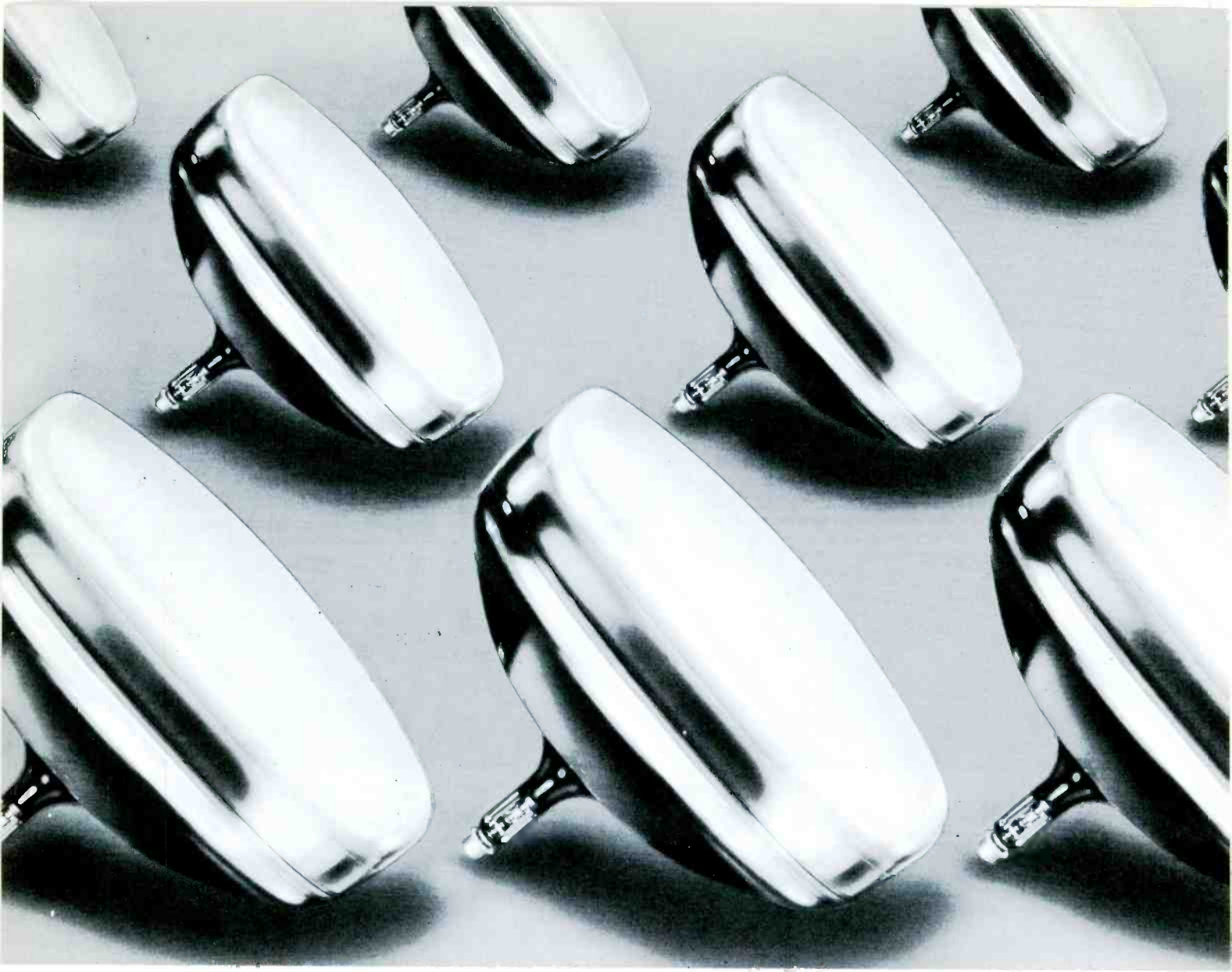
World's first all-in-one rotator-amplifier combination! Only 1 unit on mast—1 housing on set—1 transmission line.
Choice of 2 Models:
NEW! TV/FM Gemini, Model 9518.
"TV ONLY" Gemini, Model 9527
(includes Built-in FM Trap).

Tried our superb Automatic Rotators? There's nothing better. They're available at our regular prices.

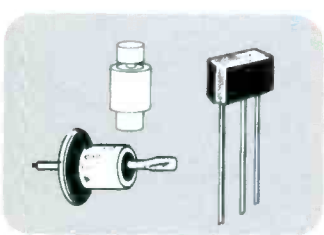
CHANNEL MASTER ROTATORS

Circle 24 on literature card

ELLENVILLE, NEW YORK

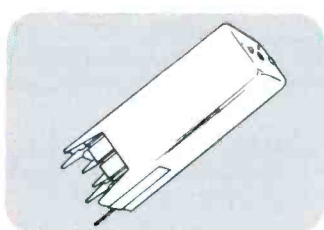


THE QUALITY OF YOUR SERVICE DEPENDS ON THE PARTS YOU USE... DEPEND

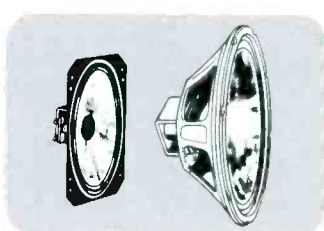


Diodes, Rectifiers, Condensers and Resistors
Complete variety for all makes and models.

Universal Controls
With or without on-off switch. Standard taper, 3 inch shaft, half flat. 1 meg, 2 meg, 500 K. Complete selection. Fit Philco and other makes.



I.F. Transformers
For printed circuits, 4 lug, 5 lug or 6 lug types . . . to fit Philco or other makes. Dependable Philco Quality.



Replacement Speakers
All sizes, round, oval or rectangular types. 3.2, 8, 16, 20 ohms. From tiny 1¾" to giant 15" sizes.

Philco Receiving Tubes
To fit any make, any model TV or radio, manufactured to exact Philco standards, thoroughly inspected. Original factory cartons.

Rotary Switch Antenna
High gain type with 6 position switch for best possible signal selectivity. 3 section brass dipoles. Padded cast iron base.

Contact Cleaner
Philco TV and Radio Contact and Control Cleaner, Lubricant in self spray can, complete with protective cap and spray nozzle.

Philco TV Yoke
Genuine Philco TV yokes, made to original factory specifications. Accurately wound and inspected. Packed in individual boxes, ready to install.

There's a Philco Fully Stocked Parts Center Near You!

IF YOU NEED A PHILCO PART...YOU CAN GET IT FAST...HERE'S WHY

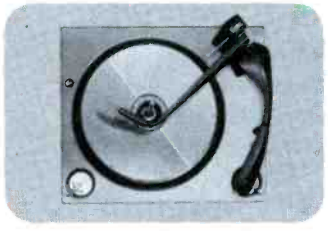
1. Philco has a nationwide network of Parts distributors—THERE'S one in your area.
2. Philco distributors are backed up by Parts Warehouses with millions of dollars in Parts inventory.
3. NEW Parts for NEW Philco models are shipped automatically along with the NEW products.
4. All Parts orders are handled by experienced Parts specialists.
5. ALL EMERGENCY orders are transmitted over the nation's largest industrial communications system and processed within 24 hours.

Whatever you need—whenever you need it—if it's a Philco Part just dial your Philco distributor. He has thousands of Philco Parts right now on his shelves. If the item you need is temporarily out of stock—he can get it for you FAST. You may DEPEND on your Philco Parts distributor.

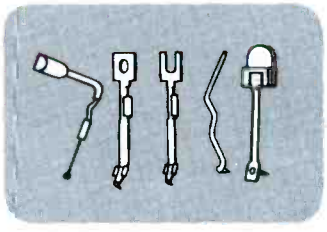
Customer Confidence Begins When You Use Genuine Philco Star Bright 20/20 Picture Tubes

Every CR Tube you replace represents a high-dollar service sale for you . . . and your customer. Play it safe with a brand that's known for Quality . . . PHILCO. All material and parts used in the manufacture of Philco Star Bright 20/20 Picture Tubes are new except for the envelope, which prior to reuse, has been inspected and tested to the same standards as new envelopes.

ON YOUR PHILCO DISTRIBUTOR FOR ALL YOUR PARTS AND ACCESSORIES



M62A 4-speed Record Changer
Intermixes all size records. Lightweight tone arm with retractable scratch protection assembly and famous Euphonics U8 cartridge. Changer ideal for built-in installations or "modernizing" record playing equipment. Template and instructions included.



Philco Phono Needles
A complete selection of types and numbers for Philco and most all other makes. Carefully made, attractively-packaged. ALL TIP TYPES and sizes, including Diamond. Special now available—"THE BIG 18 KIT." This attractive compact metal case contains 18 of the industry's fastest selling needles.

Your Philco Distributor Features These Famous Makes

PHILCO • PHILCO-Bendix • CROSLEY • EVEREADY Batteries and Flashlights • CAROL Cables • GOODRICH V-Belts • GC Products • AUDIOTEX • WALSCO Products • COLORMAGIC Antennas • PRECISION Test Equipment • SPRAGUE Capacitors

Philco Parts are Available Through a nationwide network of Parts Distributors. Mail the Coupon Today for the Name of the One Nearest You.

PHILCO Factory-Supervised Service®

Philco Parts & Service Operations
C & Tioga Streets, Phila. 34, Pa.

I am interested in receiving information about special Philco Parts offers, prices and facts. Please send me the name of the nearest Parts distributor.

Name_____

Address_____

City_____ Zone____ State_____

PARTS AND SERVICE OPERATIONS

PHILCO®

A SUBSIDIARY OF Ford Motor Company

buying carefully; of course, it may be high because of some large purchase (such as stationery) that will be used over an extended period. Utilities—very high, but that's because of winter heat; the average will probably be okay, although it would bear watching.

And so we continued down the list, reasoning about this, questioning that, until we'd decided on a couple of categories that might definitely need checking into—vehicle expense and that catch-all, Miscellaneous. We found several items of the Miscellaneous category that we could reduce a bit. We also found that we'd not been routing service calls very efficiently, so we started working on that problem.

The results of our actions can be seen in the This Month column of Table 2. We managed to cut vehicle expense to less than 3% of gross sales, resulting in a tidy savings of $38. The miscellaneous category reflected a saving of $34.22. The telephone charge was lowered when we took out some extensions we'd been letting collect dust. We also began watching long-distance calls, using letters when time would permit. The saving this month was $16.14.

Other slight reductions appeared, too, but not as a result of our expense-checking program. Repairs and maintenance showed a reduction to zero; this was coincidental, as no equipment happened to fail during this month. The bank charge was slightly less, and its category showed the saving.

All in all, we effected a savings of $88.36 as the direct result of our investigation into expenses. The remaining $46.00 reduction just happened. Sales were down slightly this month, but our savings almost offset the entire amount.

Salaries

There is only one way to save money on salaries—get more for your money. Naturally, this doesn't mean that you shouldn't lay off help if business is bad, but you'll never gain anything by reducing anyone's salary. So calculate your salaries carefully, and be sure you get your money's worth from your employees. Hire capable, trustworthy technicians, pay them well, and expect good work.

Your total service payroll, when added to any outside service labor charges you pay, should never exceed 55% of your service income. If it does, better look at service procedures and charges, and improve your profit picture. (In the example shown in Table 1, a portion of the service payroll can be attributed to delivery of sets sold; in more elaborate bookkeeping systems, this would be charged to the Cost of Sales.)

The Method

These examples naturally sound easy, and it would be fine if every technician could put all these steps to work tomorrow. However, let's be practical; every little bit of improvement is going to help, so let's take on these improved management practices a little at a time.

Start this month. Pick one item on your expense sheet, preferably something like that hazy "Miscellaneous" category, and calculate exactly what percentage of your gross sales is required to pay that portion of your overhead. Then decide what a fair and proper percentage should be, and figure out some steps you might take to reduce your expenditures to meet the new standard. Then get to work on it.

Find it and Fix it in ½ the time!

EASILY SOLVES "TOUGH DOGS"... INTERMITTENTS ... ANY TV TROUBLE

B&K MODEL 1076 TELEVISION ANALYST

BLACK & WHITE AND COLOR

NOW WITH KEYED RAINBOW COLOR DISPLAY

By Easy Point-to-Point Signal Injection, You see the Trouble on the TV Screen and Correct it—Twice as Fast and Easy!

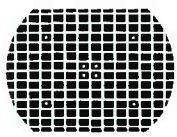
Simplified technique stops lost hours never recovered on **"tough dogs", intermittents,** and **general TV trouble-shooting.** This one instrument, with its complete, accurate diagnosis, enables any serviceman to cut servicing time in half . . . service more TV sets in less time . . . satisfy more customers . . . and make more money.

With the Analyst, you inject your own TV signals at any time, at any point, while you watch the generated test pattern on the picture tube of the television set itself. This makes it quick and easy to *isolate, pinpoint, and correct* TV trouble *in any stage throughout the video, audio, r.f., i.f., sync and sweep sections* of black & white and color television sets—*including intermittents.* No external scope or waveform interpretation is needed. Checks any and all circuits—solves any performance problem. Gives you today's most valuable instrument in TV servicing—*proved by thousands of professional servicemen everywhere.*

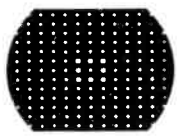
Available on Budget Terms. As low as $30.00 down.

Net, $329.95

SIMPLIFIES COLOR TV SERVICING, TOO



Enables you to troubleshoot and signal trace color circuits in color TV sets, or facilitate installation.



Generates white dot, crosshatch and color bar patterns on the TV screen for color TV convergence adjustments.

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Circle 27 on literature card

Next month, see how much improvement you've made. Then pick another item for evaluation. Figure out what you can do about it. If you're absolutely sure you can do nothing, move on to another category and save the tough ones for after you have more experience. Don't try to cut in categories that will result in reduced income. For example, you could cut advertising and promotion to the bone, but you'd only lower your income and that would reduce profit. Concentrate your energies on items that will not reduce income in any way. As your skill grows, you'll figure out ways to work at reducing the other expense categories, too, and you'll find a way to do it without losing any income. That will come when you master this technique of being a manager.

Each month, take on a new expense item; but don't forget the old ones. Once you get them down, keep them down. You'll find it easier and easier as you go along. Work on lowering expenses, and on boosting income, and you may be startled by the sudden improvement in your profits.

And That's It

Now take a little glimpse into the future, and imagine yourself sitting at your desk over the few months that will have just passed. You've improved your income slightly each month, as we outlined in the February part of this article; and you've reduced your expenses slightly each month, as pointed out in this section. If you weren't making money before, you certainly will be. And if you are now, you should be able to sit back and take a deep breath of satisfaction at the additional growth your business has shown since you actually became a MANAGER. ▲

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Circle 29 on literature card

Notes on Test Equipment

analysis of test instruments . . . operation . . . applications

by Stephen Kirk

Low-Cost Signals

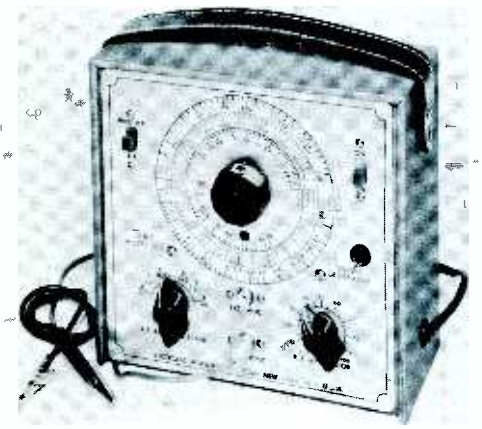

Fig. 1. This simple, uncluttered generator gives complete FM and TV signal coverage.

A small, compact AM signal generator is a desirable piece of test equipment in any radio or TV shop. The Electronic Measurements Corp. Model 502 shown in Fig. 1 is a simple, uncluttered generator which completely covers FM and TV frequences. Its frequency range is 115 kc to 108 mc on fundamentals, and it produces good second harmonic signals up to 216 mc. The size of the cabinet, excluding the carrying handle, is just 7" x 7" x 3". The output cable is terminated in a phono plug at the generator end and two alligator clips at the output end.

The frequency ranges are selected in six steps by the front panel RF RANGE SELECTOR. Also on the front panel are: the ON-OFF switch, the MOD RF-RF switch, the RF ATTENUATOR, the RF OUTPUT jack the EXT MOD input jack, the frequency-setting dial with vernier control, and a neon panel lamp.

The circuitry is fairly standard, as you can see by the schematic in Fig. 2. A 12AT7 twin triode tube is used as a combination modulator and Colpitts RF oscillator. Internal modulation of 400 cps is generated by a neon bulb and an RC time-constant circuit that gives a sawtooth output waveform. This sawtooth voltage is coupled to the grid of the modulator tube. For external modulation, or when no modulation is desired, the neon circuit is disconnected with the MOD RF-RF switch.

As you can see by the circuit diagram, different plate voltages are supplied to the 12AT7 RF oscillator for each band change. This tends to keep the generator output constant for all frequency ranges.

We checked the 502 against our frequency standard and found the calibration was good, even on the high frequency bands. This was encouraging, since many inexpensive signal generators have poor calibration, with no easy way of recalibrating. The 502 uses slug-tuned coils that should make recalibration easier if it ever becomes necessary.

We used the 502 to check and align both an AM and an FM receiver and had no problems. The attenuator, as with all signal generators, should be kept at the lowest level that will produce a reasonable signal, especially when using internal modulation. This prevents receiver overloading that may cause the signal to "ride through" the circuit and give a false indication of circuit sensitivity.

We connected an FM tuner output into the external modulation jack and used the generator as a converter to listen to the FM signal on an AM radio. It worked out well. Modulation fidelity, if our ear was a good guide, was excellent.

This instrument should make a useful addition to most any shop's test equipment inventory. It is easy to operate, stays on frequency well (after a five-minute warmup), and doesn't take up a lot of room on the bench.

For further information, circle 66 on literature card.

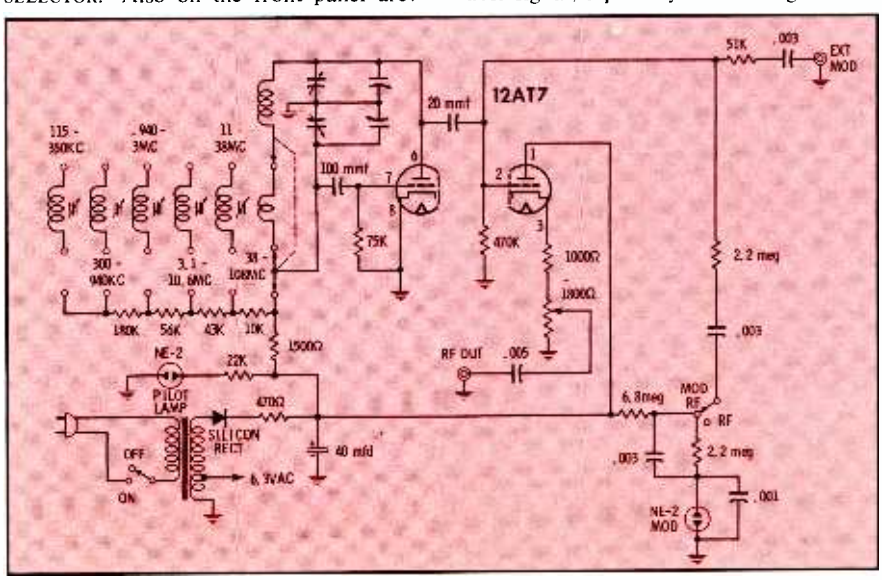

Fig. 2. This Colpitts oscillator schematic shows plate-voltage compensation circuit.

Updated CRT Checker

The new Model 445 B & K picture tube rejuvenator-tester pictured in Fig. 3 is an updated and refined version of the Model 440.

Three neon lamps are used, as in the 440, to determine discontinuity in, or shorts between, elements. This is done by placing an AC voltage between the picture tube elements and a neon bulb circuit, as shown in Fig. 4. Since G1 and G2 go positive with respect to the cathode on one half of the AC waveform, they will draw current if the cathode is emitting properly. This will cause only one side of each neon bulb to light. However, if a short or leakage is present, the neon will 'see" AC and both sides will glow.

Fig. 5 is a somewhat simplified schematic of the test circuit used in the 445. The effective cathode emission is read as the first-anode current of the zero-biased picture tube. Note that a three-position switch, labelled HI-LO1-LO2, determines the amount of test voltage placed on G2. Since there is a possibility of damaging the CRT if the wrong G2 voltage is used, a chart is supplied listing the G2 and heater voltage settings for all picture tubes.

The rejuvenation circuit is virtually the same as used in other B & K models. When the DYNAMIC INTENSIFIER button is depressed (see Fig. 6), a high positive voltage is placed on G1 of the picture tube. This creates a high surge of cathode current and tends to break up anv "crust" that may have formed on the cathode. The 445 has three rejuvenation positions —LOW, MED, and HI. They are the same except that on MED and HI positions the heater voltage is increased by 35% and 85% respectively. Emission should be checked after each rejuvenation attempt; no attempt should be made to rejuvenate a tube that has satisfactory emission, or the tube may be damaged. If emission goes up temporarily in the MED and HI position, but falls off to below normal on the regular emission check, a CRT brightener may be the answer.

The same circuit used for rejuvenation is also used in the REMOVE SHORTS position, except here the heater voltage to the picture tube is turned off so the cathode will not be damaged by prolonged high current. This circuit is also used to make cathode welds by depressing the DYNAMIC

Fig. 3. Modern CRT tester supply adequate heater power to properly check color tubes.

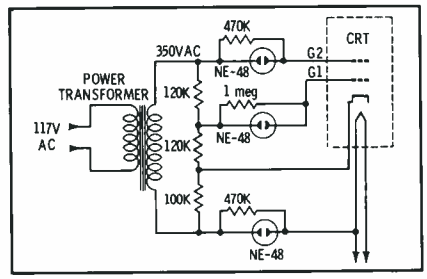

Fig. 4. Neon lamp for each element—G1, G2, filament—checks for shorts or continuity.

INTENSIFIER button and gently tapping the neck of the picture tube, with the function switch in the DYN-HI position. You should see an arc inside the tube neck if the weld takes place. Cathode welds are not always permanent and should not be trusted until the set has been turned off and on several times, allowing time for the cathode to completely cool. This will expand and contract the joint, and if the weld is not solid it will almost invariably open up again.

Color tubes are checked with a separate two-socket cable on the 445. A switch on the front panel selects any one of the three color guns for testing or rejuvenating. Relative emission among the guns is often more important in color-tube checking than the actual emission; that is, each gun should show approximately the same emission. If one gun is excessively higher or lower than the others, it almost surely indicates that the picture (especially the black-and-white picture) will be difficult to set up properly. Rejuvenation of the color picture tube is sometimes successful, but it should not be attempted if you are not

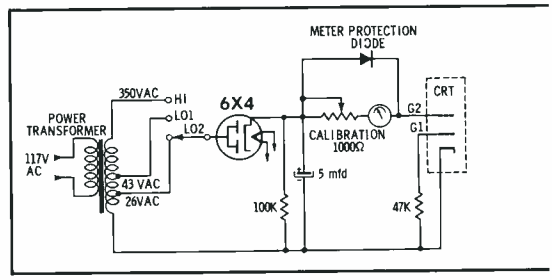

Fig. 5. Simplified schematic of the circuit used to measure effective cathode emission.

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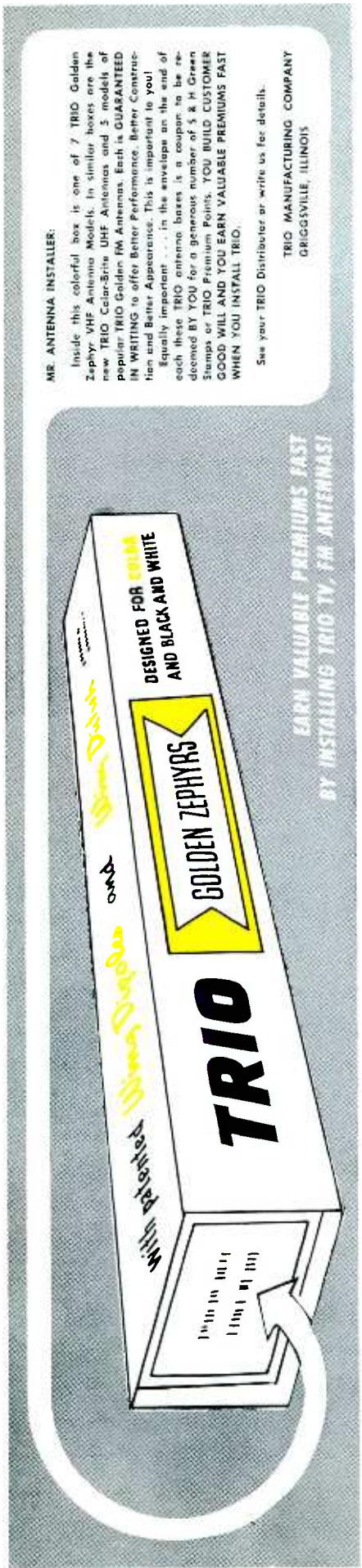

Circle 30 on literature card

absolutely sure the picture tube is at fault. Some slight difference always exists in the color guns and may be considered normal.

Some testers in the past have failed to check color CRT's properly because of inadequate heater current from the tester transformer (a color tube requires three times that of a normal black-and-white CRT). This has been solved in the 445 by providing a special color tap on the transformer, selected by the front panel switch.

We checked several good monochrome tubes and one new color tube to get a feel for the tester. Operation was easy and all readings seemed to be accurate.

A set came in that had been running with a brightener for almost six months and was now so dim it could hardly be seen in daytime. This was one of those "impossible" rejuvenation jobs and we didn't expect much. But it did respond to rejuvenation by the 445 in the MED position; and—with the brightener still on it—was considerably brighter, without any of the telltale milkiness that indicates over-rejuvenation.

Another tube was made considerably brighter and came on more quickly with a fast rejuvenation in the LO position.

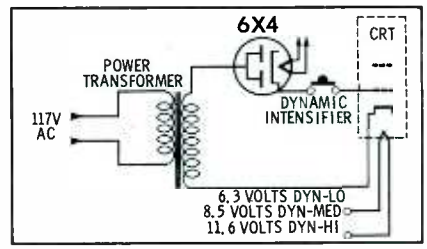

Fig. 6. Rejuvenation circuit, with a choice of filament voltages, also removes shorts.

Tester-rejuvenators can help you sell picture tubes. They let the customer see the condition of his tube; and if a rejuvenation attempt is made and is not successful, the customer is in a more receptive mood to purchase a new CRT. Rejuevnation should not be sold as a "sure cure," but as a stopgap measure until the customer is ready to purchase a picture tube. Sometimes rejuvenation may last for many months, and some technicians offer the customer a refund of the rejuvenation fee if a picture tube is needed within a specified time—such as thirty days.

For further information, circle 67 on literature card.

Constant Power

This Model P-612 power supply (Fig. 7) was developed by Delco Radio especially for servicing "Wonder Bar" signal-seeking radios, both tube and transistor types. It is suitable for servicing all kinds of car radios or for use anywhere a low-voltage high-current highly filtered DC supply is needed. It will supply up to 8 amps at 8 volts and up to 5 amps at 16 volts, with output filtering equal to 1,500,000 mfd. The resultant low ripple is accomplished by a transistorized electronic filter circuit.

The special problem of testing and repairing the signal-seeking radio (especially those with solenoid tuner return) is the need for an instantaneous current of about 16 amps at the end of each dial sweep. With a regular power supply, having pi-network filtering, the added current requirement usually drops the output voltage drastically and the mechanism "hangs up," not returning far

Fig. 7. Transistor-regulated power supply is capable of unusual performance under load.

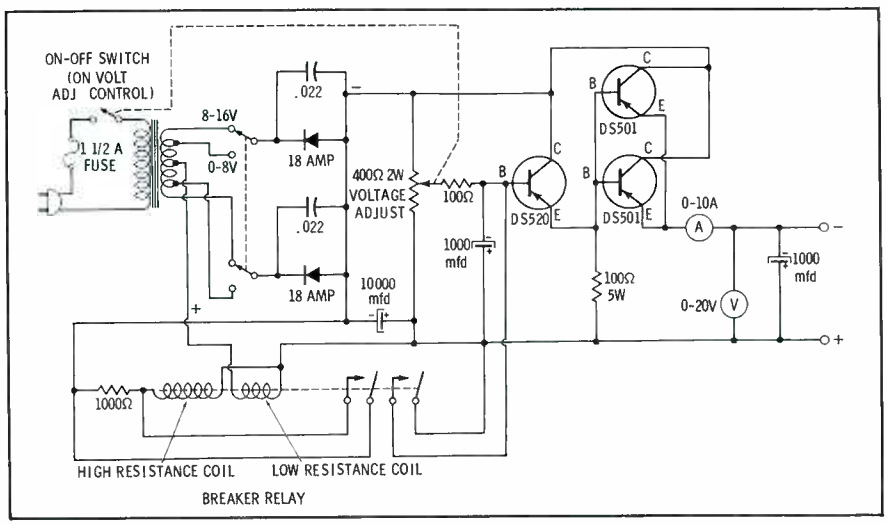

Fig. 8. Special overload circuit uses a relay that has two separate actuating coils.

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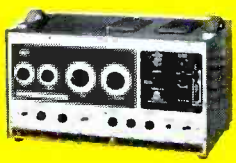

Model 1076 Television Analyst

Model 850 Color Generator

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enough to open the return switch; as a result, the solenoid overheats. Increasing the power supply voltage to around 16 volts (for a 12 volt radio) will return the solenoid but this leaves excessive voltage on the radio for making other service checks and adjustments.

To overcome this regulation problem, this supply uses transistor control of the output voltage. The complete circuit is shown in Fig. 8. A tapped transformer supplies low voltage AC to full-wave silicon rectifiers. A switch selects either of two voltage ranges: 0-8 or 8-16 volts.

The P-612 output circuit differs considerably from the conventional choke and capacitor filter circuit of Fig. 9A. Here, all current must pass through a fixed-resistance filter choke. And even though the resistance of the choke is only ½ ohm, there is still a drop of 5 volts in the output voltage if the output current is increased to 10 amps. This kind of circuit presents no problems when current drawn is constant, since the DC voltage to the filter input can merely be stepped up to overcome the loss in the choke. The problem arises when recurring surges of high current are required—such as during the returning of the signal-seeking tuner solenoid.

Fig. 9B shows a simplified version of the transistor-controlled circuit used in the P-612. The voltage reaching the circuit from the rectifiers is filtered first by 10,000 mfd capacitor C1. A 400 ohm pot, R1, is shunted across the rectified voltage. Adjusting the arm of R1 varies the base voltage of the transistor and so, effectively alters the emitter-collector resistance of the transistor. Since this resistance is in series with the negative side of the output line, it controls the output voltage.

This takes care of the voltage control but has no effect on regulation or filtering of the output voltage. The latter is done by C2 which is tied directly from the positive side of the line to the base of the transistor. Any sudden change in output voltage is immediately impressed on the base to counteract the change. For example, if the voltage instantaneously goes down (as a result of ripple or of increased output current), the voltage on the base of the transistor also lowers (becomes more negative); this causes the transistor to conduct more, providing greater negative output voltage and counteracting the initial loss. This may mean that, as more output current is drawn, the resistance in series with the output voltage is reduced automatically to provide less voltage *drop* and thus more output voltage.

We connected the P-612 in the lab, first to a 6 volt radio having a vibrator power supply. We connected a scope directly across the power supply terminals to check the ripple. With the radio off, there was no discernible ripple with the scope at full gain. With the radio drawing 6.5 amps at 8 volts, the total ripple voltage was just .08 volt peak to peak, including the considerable hash from a rather reluctant vibrator.

We then connected the supply to a transistor signal-seeking Delco radio (12

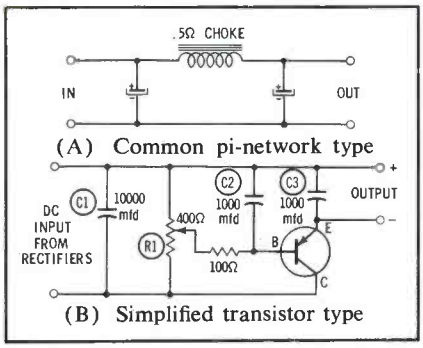


Fig. 9. Old versus new, in filter circuits.

volt). With the radio on and drawing slightly under 2 amps, there was only about .01 volt ripple. With the P-612 voltmeter set at 11.5 volts we started the radio seeking. When the pointer had scanned across the dial, the solenoid flipped it back without a hitch.

Realizing that this low ripple and extremely good regulation would be useful for checking transistor radios with class-B output stages, we connected the P-612 to a portable transistor radio. There was absolutely no discernible hum in the radio output, nor was there any change in output voltage (using a sensitive DC scope as the monitor) as the radio was played at full volume.

The P-612 has two built-in protective devices to prevent damage should the load become excessive. The first is a 1½ amp line fuse. The other is a quick-acting circuit breaker that disconnects the output transistors should the output leads be accidentally (or purposely) shorted.

The circuit breaker relay has both high resistance (voltage operated) and low resistance (current operated) coil windings. In normal operation, the points on the relay are open. All output current passes through the current coil on the relay, but with normal loads there is not enough pull to close the contacts. The voltage is connected through a 1000 ohm resistor to the negative side of the line and the other end connects to the positive side. The resistor reduces the current through the coil enough that the relay points will not close, but the relay is kept "ready" so excessive current through the current coil will close the points.

When the points close, due to an overload, the voltage-coil resistor is bypassed, and the voltage will hold the relay in. The second set of points shorts the base of the DS520 transistor to its emitter; this cuts off the control transistor and, since it is DC coupled to the output transistors, also cuts them off—removing the output voltage and protecting the transistors against damage.

The breaker stays closed until the power supply is turned off, and the output voltage will not return. Even after the unit is off, the charge on the 10,000 mfd capacitor holds the relay closed for an additional 8 to 10 seconds; then the relay will open up and the output voltage will return if the supply is turned back on. ▲

For further information, circle 68 on literature card.

Tough Dog

(Continued from page 33)

(A) Signal at AFC grid

(B) Horizontal sync signal

(C) Input to video amplifier

Fig. 7. Waveforms in receiver with critical horizontal sync; traced to defective balun.

pulse. Further checking in the horizontal sync-separator circuit revealed that R96 (Fig. 6) had dropped from 6800 ohms to less than 500 ohms. Replacing this resistor with a 6800-ohm unit cured the critical hold. The horizontal sync signal then appeared as in Fig. 5C, and the combined waveform looked like Fig. 5D.

A study of Fig. 6 will show why some horizontal locking action is possible despite the defect in R96. The sync section contains separate vertical and horizontal sync separators. The vertical sync separator is fed from the video amplifier through an RC network with time constants favoring the vertical. The horizontal sync is fed through networks favorable to horizontal pulses. The outputs of both separators are fed to the same sync amplifier (V18), and the horizontal pulse is coupled from the plate through C91 to the *Synchroguide*. Thus the trace in Fig. 5B is the horizontal pulse coming through the vertical separator. Since time constants in this stage are not correct for a sharp horizontal sync pulse, the broad integrated pulses result. The same symptoms have been encountered in other RCA models.

In the case of another older model RCA, the cause of critical horizontal

Fig. 8. Waveforms distorted similar to those in Fig. 7; caused by open video peaking coil.

sync was as unusual as the combined signal observed on the AFC grid. The odd waveform is shown in Fig. 7A. It resulted in my checking next the sync output. This gave the trace in Fig. 7B. Scoping further back to the video amplifier revealed the trace in Fig. 7C, which was present at the video-amplifier input. Since this last waveform indicated trouble in the video signal circuits, I took a more critical look at the picture, which I had previously accepted as pretty good, considering the age of the receiver. A more critical examination of the picture revealed a grainy appearance in the background. Grain is a distant cousin of snow, and since snow relates to trouble in the RF stage my troubleshooting was directed to that stage. There I found the culprit which, unlikely as it may seem, was an unravelling balun.

About a month after my bout with this RCA, I worked on an old Crosley with critical horizontal sync. Using the scope to examine the combined sync and sample signal on the *Synchroguide* showed a trace identical to Fig. 7A. The sync pulse looked identical to that shown in Fig. 7B. I thought, "Obviously another bad balun." One more look at the set changed my mind—the Crosley didn't use a balun; instead it used a continuous tuner similar to those used in older model DuMonts. This discovery led me to grab the scope probe to again check the video amplifier. The trace shown in Fig. 8 was obtained at the video-amplifier plate. The waveform at the video detector was not as distorted. Checking the video-amplifier components brought to light a defective peaking coil. That's a *long way* from the tuner.

Oscillator Coils

So far, no mention has been made of the adjustment of the ringing (phasing) coil, because most servicemen are familiar with this adjustment. This is not to de-emphasize the importance of correct adjustment. Some technicians are in the habit of adjusting the phasing coil in every *Synchroguide*-equipped receiver. Others seldom adjust the coil if the set has a hold control as part of the oscillator-coil core.

However, in some more recent *Synchroguide* circuits, the oscillator core is fixed. A portion of this cir-

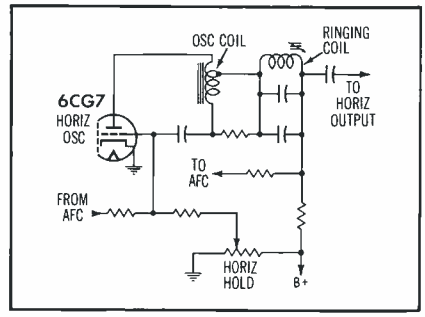


Fig. 9. A modernized form of *Synchroguide*.

cuit is shown in Fig. 9. One such receiver I recently serviced seemed extremely sensitive to ignition noise from passing cars. It was impossible to correct the trouble by adjusting the phasing coil to produce a correct scope trace of the sine-and-sawtooth combination waveform. With the horizontal in best sync, the sine-and-sawtooth signal appeared as in Fig. 10. Adjusting the ringing coil to raise the level of the sine wave only led to a loss of horizontal sync.

After considerable troubleshooting failed to locate a faulty component, I decided to reposition the core in the oscillator coil. These cores are positioned at the factory and locked in place with wax. I heated the core and removed it entirely. Next I adjusted the hold-control potentiometer to midrange. Then the core was slid into the coil until horizontal synchronization was obtained with a correct sine-and-sawtooth-signal present on the scope. Some additional wax was melted into the coil to hold the core in this new position, and the repair was complete.

Conclusion

While this article has been concerned chiefly with the most common type of *Synchroguide,* the servicing procedures apply to any of the variations. By applying this knowledge of unusual circumstances, the serviceman should be able to solve tough-dog *Synchroguide* problems with little trouble. ▲

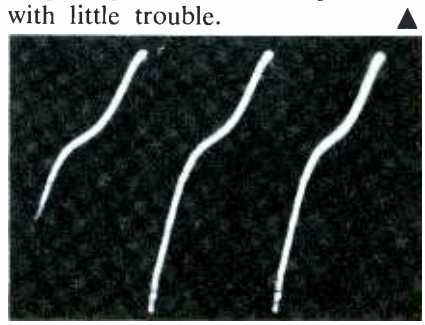


Fig. 10. Abnormal waveform resulting from improper placement of slug in oscillator coil.

Any type of TV lead-in...

BELDEN makes it!

Your BELDEN distributor has it!

PERMOHM* 8285 . . excellent for color TV. Gives stronger, clearer UHF and VHF signals under conditions of extreme salt spray, industrial contamination, rain, and snow. 300 Ohm.

WELDOHM 8230 . . resists pulling, whipping, twisting. Weldohm has two and a half times the flexing life, and one and a half times the breaking strength of ordinary 300 ohm lead-in.

COAXIAL TRANSMISSION LINES—RG/U AND FOAM RG/U TYPES . . low-loss signal transmission for multiple TV installations such as motels.

STANDARD 300 OHM LINE 8225 . . low losses at high frequencies. Well suited for use with FM receiving antennas.

CELLULINE* 8275 . . installs easily . . no end sealing necessary. Has excellent resistance to sun, abrasion, and wind. Delivers strong UHF and VHF signals. 300 Ohm.

DECORATOR CABLE 8226 . . for interiors . . neutral color blends into decor of any room. No dark brown color to contrast with light carpets or walls. 300 Ohm.

Your Belden distributor has a complete line of Belden TV lead-in cable . . . in standard lengths for easy handling. He also carries microphone and shielded power supply cables; hi-fi, stereo, and phonograph cables; power supply cords; multi-conductor portable cordage; antenna rotor cables; hook-up wire; TV and cheater cords; aluminum ground wire . . . plus many other related items.

Better Built . . . Better Buy . . . **Belden**
WIREMAKER FOR INDUSTRY
SINCE 1902 — CHICAGO

WELDOHM, PERMOHM, CELLULINE are Belden Trademarks Reg. U.S. Pat. Off. *Belden Patents U.S. 2,782,251 and 2,814,666

8-9-3

cord sets and portable cables • electrical household cords • magnet wire • lead wire • automotive wire and cable • welding cable

Circle 34 on literature card

Troubleshooter

(Continued from page 23)

Record a tape at several levels, playing each recording back, with a distortion analyzer *connected to the output of the recorder. Increase the recording level until the reading on the analyzer increases rapidly. This point is, for practical purposes, 100% tape saturation.*

This Is A Sawtooth?

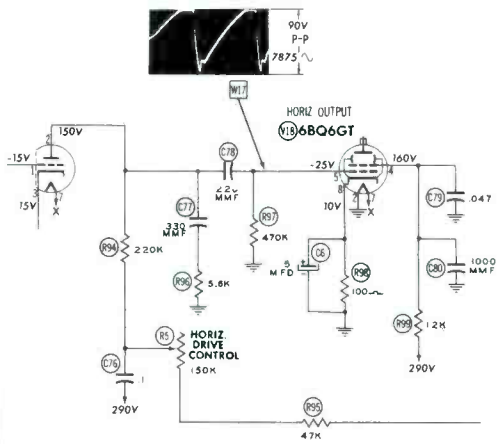
An Airline Model 35WG-3060B (PHOTOFACT Folder 212-2) has given me a lot of trouble. After replacing a bad flyback transformer, I still had no high voltage or raster, until I applied a drive signal from an outside source to the grid of the horizontal output tube. Since this test resulted in a normal raster, I knew I had horizontal-oscillator trouble; yet I can't pin down the *kind* of trouble I'm facing.

The oscillator is not dead, but does not seem to put out enough drive or the right kind of signal. Replacing all resistors, and substituting silver mica units for all capacitors, has not helped. All voltages on the oscillator tube seem to be okay, but there is only a volt and a half of negative bias on the grid of the output tube. The peak-to-peak voltages at the grid measures 120 volts with either a scope or an AC VTVM. It has the odd shape shown in the attached sketch when the oscillator is driving the sweep circuit, but the substitute signal appears to have a normal sawtooth waveshape.

R. SHEARER

Albuquerque, N. Mex.

The strangely shaped drive waveform is most probably due to a greatly shortened RC time constant in the sawtooth-forming network between the oscillator and output tube. I strongly suspect an open C77 or R96, or a faulty connection to one of these components. Removal of this network causes the oscillator to put out a virtual square wave, like the one you have sketched. Since the grid of the output tube is held at the positive peak value of the signal voltage through most of each cycle, the tube cannot drive the flyback circuit in proper fashion, and flyback current will be excessive. The long duration of the positive peak also explains the lack of bias on the output tube. ▲

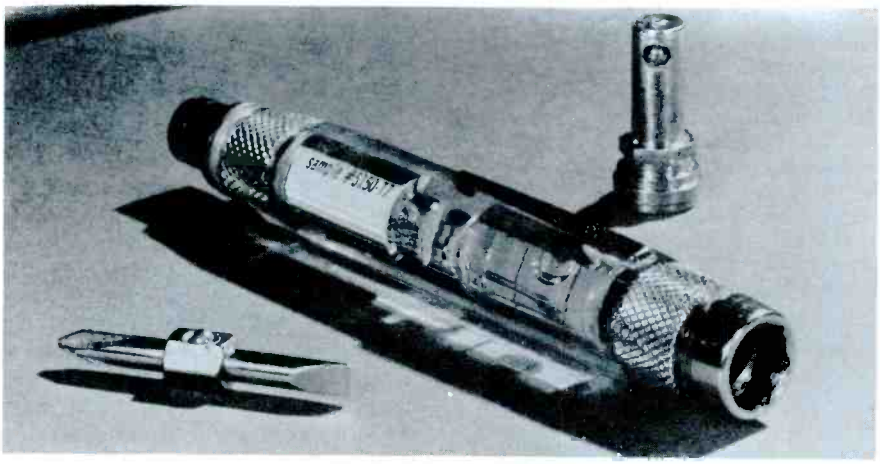


GRID WAVEFORM OF OUTPUT TUBE

"I agreed to carry it to your car, but you didn't tell me you parked in front of your house!"

Product Report

For further information on any of the following items, circle the associated number on the Catalog & Literature Card.



Pocket Tool (135)

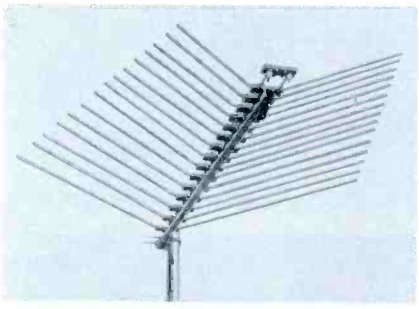
A service tool that clips to the pocket is the new compact "7 in 1" by **Exclusive Products Co.** In addition to containing a high voltage tester, the tough "Tenite" butyrate handle also houses an accurate 1" spirit level, a 3/8", 1/4", and 5/16" hex socket, a standard screwdriver, and a Phillips attachment. All tool parts are hardened tool steel, nickel plated.

Chassis on High (136)

A versatile fixture that situates a chassis at any desired height for assembly, test, and service work has been developed by **Matrix Engineering Corp.** The Model 701 features a worm gear transmission that assures the simplest and most practical arrangement to safely lock the chassis in any desired position within the unit's 360° rotation range.

Log-Periodic UHF Antennas (137)

A new series of UHF antennas based on the log-periodic concept is being produced by **JFD Electronics Corp.** The new units are available in four models to suit



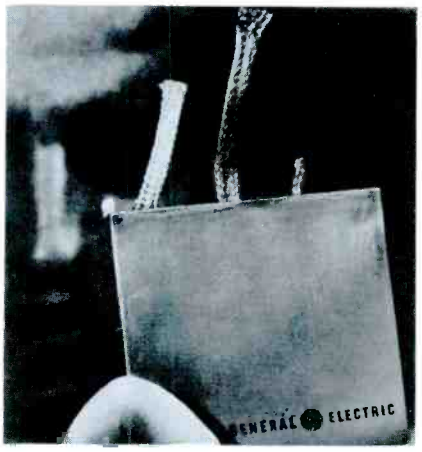
local, suburban, fringe, and deep-fringe areas. V-dipoles in the 3/2-wavelength mode achieve horizontal-plane half-power beamwidths between 28° and 35°. This narrow beam improves rejection of multipath signals and interferences. For deep fringe and special problem areas, phasing bars are available for stacking the antennas. These same bars can be used to couple several antennas beamed toward different directions.

Mono Speaker for Stereo (138)

A monophonic extension speaker system can be used with stereo sets using an HM-90 matching transformer developed by the **Microtran Co.** This new transformer is designed to take both left- and right-channel signals and mix them together to provide one balanced "center" channel. Net price is $6.33.

Marine and CB (139)

The "Escort" is one of a line of **Pearce-Simpson** radiotelephone units introduced at a recent boat show in Florida. This particular unit is a Citizens-band transceiver, with 8 fixed channels and a receiver tunable for all 23 CB channels. The set can be used on 117 volts AC or 12 volts DC, and features squelch control, output metering, signal-strength meter, 1/2-uv sensitivity for squelch opening, and complete hand wiring. With 5 watts input, the "Escort" delivers 3 watts of RF power into a 52-ohm load. The transceiver, complete with two crystals, microphone, power cables, and mounting cradle, sells for $229.95. The company also builds a variety of marine radiotelephone equipment.

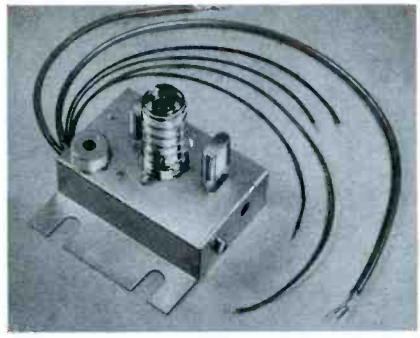


Rechargeable Battery (140)

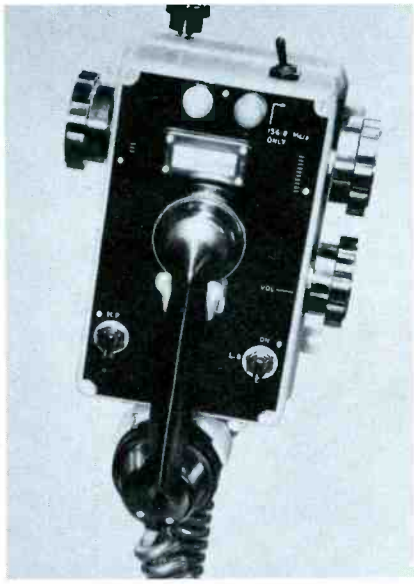
A rapid-charge battery which holds promise both for space uses and for powering portable tools and appliances is a new development at **General Electric.** Although conventional sealed batteries require about 15 hours to recharge, this sealed cadmium cell may be recharged in less than an hour, actual time depending on battery size. Ratings now available are: 3, 6, 12, 20, and 40 ampere-hours.

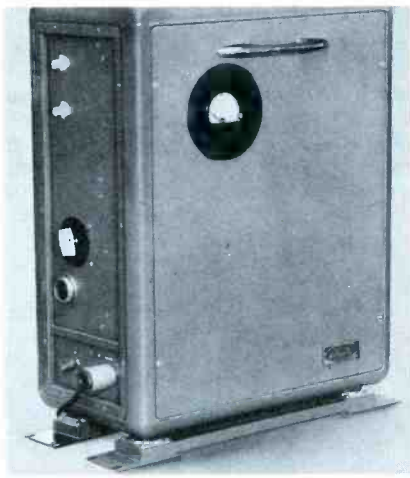
Adapter for Keyed Rainbow Display (141)

A new Model A-106 Adapter to provide crystal-controlled keyed rainbow color display and more accurate horizontal synchronization for Model 1076 Television Analysts is announced by **B & K Mfg.,** Division of Dynascan Corp.,



Chicago, Illinois. This crystal-controlled circuit is already being incorporated in the current Model 1076 Television Analyst. The new adapter provides a crystal-controlled keyed-rainbow display for better definition of each color bar in the pattern. The adapter also improves horizontal stability. Net price is $35.95.





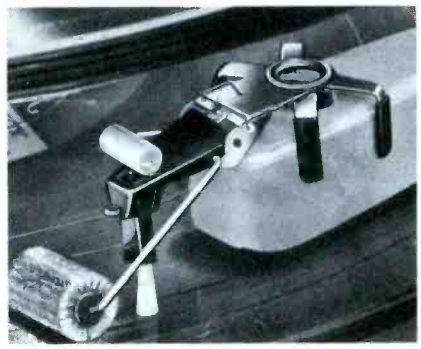
Marine VHF Sets (142)

VHF-FM two-way radios for marine use have been added to **Raytheon Company's** line of electronic communication and navigation aids. The sets cover the band from 156 to 162 mc and have an override selector for Channel 16, the international VHF safety-and-calling frequency. Covering all 28 international VHF channels, the new Model RAY-124ME28 consists of a transmitter-receiver with built-in power supply, and a control unit, loudspeaker, and antenna. Remote operation at one or two locations is optional. Cabinets are made of aluminum. The single-chassis unit hinges outward for maintenance.

CB Frequency Meter (143)

The **Budelman** Type 17A4 frequency meter can be used as a field-strength meter or for measuring Citizens-band frequencies in the 27-mc band. Rated accuracy is .001%. It operates from self-contained batteries, making it useful in the field as well as on the bench.

The instrument indicates frequency difference directly in kilocycles per second on a calibrated meter. It can be equipped with up to four crystals for measuring up to 12 Citizens band frequencies. Each crystal permits measurement of three channels—the one for which the crystal serves as a zero reference, the channel 10 kc below, and the channel 10 kc higher.



Record Duster (144)

The "Changer Dust Bug," made to fit any changer arm, removes static and dust while it protects the record surface. This $5.00 tone arm attachment is manufactured by **Elpa Marketing Industries, Inc.,** and has a plush-pile cleaning head with added antistatic agent to eliminate dust and microscopic dirt ahead of the stylus.

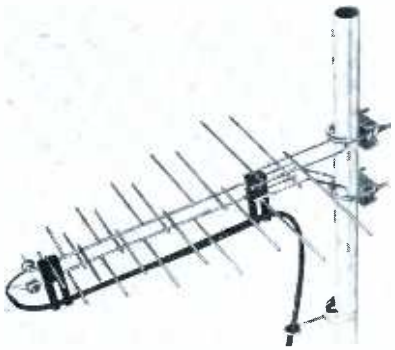
Extends Tube Life (145)

A new fin-type heat-dissipating tube shield is now being marketed by **Cool-Fin Electronics Corp.** Called the CFT-16ELDS, the new tube shield reduces

temperature up to 60° below bare-bulb temperature, and increases the life of KT88, 6336, and tubes with similar envelopes.

Wire Cutter (146)

A wire cutter specifically designed for cutting the nickel leads used in welded modules is a new product of **Hunter Tools.** The A150 features a steel insert along the cutting edge to lengthen service life, increase the tool's hardness and cutting abilities, and insure more precise cutting. An exclusive feature of the Hunter A150 is the method of attaching the steel tip. The cutter is designed so the tip is exposed along the cutting edge but is protected by the body of the plier on all other surfaces, thus reducing chances of the insert breaking away.



New UHF Antenna (147)

A new UHF television antenna, based on principles used in the U.S. satellite program, has been announced by **Blonder-Tongue Laboratories, Inc.** The "Golden Dart" rounds out a line of UHF products which includes converters, boosters, amplifiers, and couplers. List price of the antenna is $5.95.

Replacement Transformers (148)

Merit Coil & Transformer Corp. has added several new replacement transformers to their existing line. Among these is the HVO-225, a horizontal flyback transformer designed to replace several Setchell-Carlson types. This transformer nets for $8.78.

New Paging Equipment (149)

A line of transistorized encoders for use with pocket paging equipment has been announced by **Multitone Electronics, Ltd.** The new encoders are preset for automatic coding and call duration, and have provision for connecting a speech unit, remote control units, or remote triggering. They are serviced with interchangeable circuit boards.

Two codes permit identification of urgent messages or speech calls. Speech can be transmitted by plugging in a new noise-cancelling dynamic microphone that has a built-in preamplifier. The Type EA4 transistorized desk model provides 70 individual paging channels. Receivers with the new encoders weigh only 5 oz. and are 1/2" thick. ▲

INDEX TO ADVERTISERS

FREE Catalog and Literature Service

*Check "Index to Advertisers" for further information from these companies.

Please allow 60 to 90 days for delivery.

ANTENNAS AND ACCESSORIES

69. *ALLIANCE*—Brochure describing *Tenna-Rotor* Model C-225.
70. *ANTENNACRAFT*—Catalog sheet, illustrated in color, with information on connecting a UHF and a VHF antenna together using intercoupler G1483W.*
71. *CORNELL-DUBILIER*—Copy of informative booklet titled "Improved TV and FM Reception."*
72. *FINNEY CO.*—Brochure describing newly introduced duo-twin driven antenna, *The Explorer*, especially designed for fringe-area reception.*
73. *GC ELECTRONICS*—Specification sheet No. FR-542-G on *Colormagic* fringe-area antenna, and exact replacement cross reference guide for indoor TV antennas.*
74. *JERROLD*—"*J-Jacks* at the U.S. Office of Education" brochure describing distribution system for off-the-air and closed-circuit television.
75. *JFD*—Specifications and operating information on *Transis-tenna* and newly designed, long-range LPV log-periodic TV antennas. Illustrated brochure showing entire line of indoor antennas and accessories for TV and FM. Data sheets on UHF antennas.
76. *KRECKMAN CO.*—Catalog No. H64, listing complete line of communications antennas.
77. *MOSLEY ELECTRONICS* — Illustrated catalog giving specifications and features on large line of antennas for Citizens band and amateur applications.*
78. *TRIO*—Illustrated sheets showing line of antennas for TV and FM reception; also includes information on *Color-Brite* line of UHF antennas for color reception.*
79. *ZENITH*—Informative bulletin on new line of log-periodic vee-type antennas for FM, and monochrome and color TV.

AUDIO & HI-FI

80. *ATLAS SOUND*—Specification sheets describing new economy Model EC-10 paging and talkback speaker for intercoms, low power paging systems, and Citizens band transceivers.*
81. *FANON-MASCO*—Five catalog brochures describing intercoms for industrial, home entertainment, and other applications.
82. *GIBBS SPECIAL PRODUCTS*—Folders describing principles of sound reverbration and *Stereo-Verb* reverbration units for automobiles.
83. *OAKTRON*—"The Blueprint to Better Sound," an 8-page catalog of loudspeakers and baffles giving detailed specifications and list prices.
84. *OXFORD TRANSDUCER*—Product information bulletins describing complete line of loudspeakers for all types of sound applications; including replacements for public address and intercom systems.*
85. *QUAM-NICHOLS* — New hi-fi catalog listing specifications and response limits for coaxial, extended-range, low-frequency woofer, and tweeter speakers, in addition to other components.
86. *SHURE*—New catalog covering microphones, cartridges, and tone arms.
87. *SONOTONE*—Product brochure on ceramic microphone, Model CM-10A-39.*
88. *SWITCHCRAFT*—Bulletin No. 137 describing stereo-headphone adapter that permits operation of two headphones from single output.

COMMUNICATIONS

89. *AMECO*—Catalog No. G4 listing large line of RF equipment for amateurs, servicemen, laboratories, and industry; also includes list of technical books.
90. *CADRE*—Catalog sheet on complete line of Citizens band radios.
91. *E. F. JOHNSON*—4-page, full-color brochure on new all-transistor *Messenger III* Citizens band transceiver.*
92. *PEARCE-SIMPSON*—Booklet on how to choose and use marine radio telephones; brochures on complete line of two-way communications equipment, including the *Companion* and *Escort* line.
93. *COMMUNICATIONS CO.*—Specifications brochure describing *Comco* Model 684 UHF-FM two-way radio.

COMPONENTS

94. *ASTRON* — Serviceman's capacitor-replacement chart, designed to hang on the wall, gives capacitance, DCWV, size, and price.
95. *BUSSMANN*—Bulletin, SFH-10 on new compact fuseholder 1⅝" long, and completely water-proof; takes ¼" x 1¼" fuse; easily converts to 9/32" x 1¼" fuse by changing screw type knob.*
96. *CLAROSTAT*—1964 service components catalog.
97. *COMPONENTS SPECIALTIES*—Catalog listing line of *Speco* electronic replacement components.
98. *E-Z-HOOK*—Product sheet describing all types of clips, adapters, test leads, and probes for servicing applications.
99. *OHMITE*—Bulletin No. 105 describing new 3 and 5¼ watt *Brown Devil* wirewound resistors; explains increased wattage rating of present sizes.
100. *PERMACEL* — 16-page condensed data book describing line of pressure-sensitive tapes; includes specifications, features, and uses.
101. *RCA BATTERIES*—Brochure No. 1P1162, illustrating various selection of counter merchandiser display racks and promotional items on radio batteries.*
102. *RAWN CO.*—Product sheet and instruction bulletin gives description and uses for *Plas-T-Pair* kit; permits quick, sure repair of all types of plastic material—knobs, cabinets, etc.
103. *SPRAGUE* — Chart C-457 (designed to hang on wall) showing all popular TV, radio, and hi-fi replacement components.*
104. *TRIAD*—Technical data sheet on newly introduced color TV deflection yoke, YC-300-1.
105. *WUERTH*—Brochures describing *Surgistor* and other protective devices for electronic equipment.

SERVICE AIDS

106. *CASTLE*—How to get fast overhaul service on all makes and models of television tuners is described in leaflet. Shipping instructions, labels, and tags are also included.*
107. *PRECISION TUNER* — Literature supplying information on complete, low-cost repair and alignment services for any TV tuner.*
108. *ELECTRONIC CHEMICAL* — Product sheet on *No-Noise* line of chemical aerosols.
109. *STANDARD KOLLSMAN*—Catalog page and installation instructions for built-in UHF converter kit.*
110. *WORKMAN* — General catalog No. 102; fusible resistor and circuit breaker cross-reference guides; information on transistorized auto ignition system; and power converter sheet No. 25C.
111. *YEATS*—The new "back-saving" appliance dolly Model 7 is featured in a four-page booklet describing feather-weight aluminum construction.*

SPECIAL EQUIPMENT

112. *ACME ELECTRIC*—Complete specifications and applications for control-type magnetic amplifiers with capacities from 5-1000 watts and voltage ranges from 24-160 volts.*
113. *AMPROBE* — Descriptive literature explaining company's trade-in program on chart recorders.
114. *GREYHOUND*—The complete story of the speed, convenience, and special service provided by the Greyhound Package Express method of shipping, with rates and routes.
115. *TERADO*—Literature on Models 50-202 and 50-191 power inverters, designed for operating 110-volt equipment from automobiles, boats, and other low-voltage power sources.
116. *VOLKSWAGEN* — Large, 60-page illustrated booklet "The Owner's Viewpoint" describes how various VW trucks can be used to save time and money in business enterprises; includes complete specifications on line of trucks.

TECHNICAL PUBLICATIONS

117. *CLEVELAND INSTITUTE OF ELECTRONICS* — "Pocket Electronics Data Guides" with handy conversion factors, formulas, tables, and color codes. Additional folder, "Choose Your Career in Electronics," describes home-study electronics training programs, including preparation for FCC-license exam.*
118. *HOWARD W. SAMS*—Literature describing popular and informative publications on radio and TV servicing, communications, audio, hi-fi, and industrial electronics; including special new 1964 catalog of technical books on every phase of electronics.*
119. *MOTOROLA*—Brochure describing home-study course on servicing FM two-way radio; includes section on transistors and transistorized equipment.

TEST EQUIPMENT

120. *B & K*—Catalog AP-21R describing uses for and specifications of new Model 1074 Television Analyst, Model 1076 Television Analyst, Model 850 Color Generator, Model 960 Transistor Radio Analyst, new Model 445 CRT Tester-Rejuvenator, new Model 250 Substitution Master, Model 375 *Dynamatic* VTVM, Model 360 *V-O-Matic VOM*, Models 700 and 600 *Dyna-Quik* Tube Testers, and Model 1070 *Dyna-Sweep* Circuit Analyzer.*
121. *EICO* — New 32-page, 1964 catalog of test instruments, hi-fi components, tape recorders, Citizens band, and amateur radio equipment.*
122. *HICKOK*—Complete descriptive and specification information on newly introduced equipment—Model 662 installer's color generator; Model 580 portable tube tester; Model 727 multiplex generator; Model 235A portable field strength meter.
123. *JACKSON*—Complete catalog describing all types of electronic test equipment for servicing and other applications.
124. *LAMPKIN LABORATORIES*—Informative booklet tells "How to Make Money in Mobile Radio Maintenance."
125. *MERCURY*—Literature describing line of test equipment, including self-service tube testers.*
126. *SECO*—Product sheet describing Model 88TC *caddy pack* tube tester; a tube caddy with built-in tester.*
127. *SENCORE*—Question-and-answer bulletin on requirements of color TV and FM multiplex test equipment.*
128. *SIMPSON*—Latest series of VOM's are described in test-equipment bulletin; also information on line of automotive test equipment.*
129. *TRIPLETT*—Brand new test equipment catalog No. 45-T, listing complete line of testers and accessories.

TOOLS

130. *BERNS*—Data on unique 3-in-1 picture-tube repair tools, on *Audio Pin-Plug Crimper* that enables technician to make solderless plug and ground connections, and on new-style *ION* adjustable "beam bender" for CRT's.*
131. *ENTERPRISE DEVELOPMENT*—Time saving techniques in brochure from Endeco demonstrate improved desoldering and resoldering techniques for speeding up and simplifying operations on PC boards.*
132. *KESTER SOLDER*—Informative "Soldering Simplified" booklet gives valuable tips on the art of soldering.

TUBES & SEMICONDUCTORS

133. *SEMITRONICS*—New updated 16" x 20" wall chart CH10 lists replacements and interchangeability for transistors and diodes.
134. *AMERICAN ELITE* — 48-page semiconductor catalog and technical notes on *AEG* selenium rectifiers, including bridge and voltage-doubler circuits.

PF REPORTER

SPECIAL COMMUNICATIONS SUPPLEMENT

CONTENTS

For the Reader

One of our continuing aims is to bring you—our reader—bigger and better issues, jam-packed with articles on subjects that make you a better technician and build up your income and profits. Your needs and interests take precedence over any other consideration in planning the features that appear regularly in PF REPORTER.

Certain subjects obviously command more interest than others, and satisfy needs that are more widespread. Your expressed needs and wants have resulted in our regular special issues—on color TV, transistors, test equipment, and other important and popular subjects.

One field of specialization is emerging rapidly as worthy of *special* consideration—the business of two-way radio communications. Few fields are growing as rapidly as this one. There are more than 300,000 two-way radio systems in operation (not counting CB or amateur stations), and two-way sets number above 2,000,000. Many of you have expressed your need for strong, informative articles and accurate servicing information for this type of equipment. This Communications Supplement is our answer to your demand.

Study this supplement carefully. We are considering adding it to PF REPORTER every quarter-year—in January, April, July, and October. You can help us decide. Our wish is to supply this quarterly Supplement only for those who really need it and who want to increase their knowledge and technical ability in the field of communications servicing.

A portion of this page is a questionnaire. You can do us a great favor if you'd take a moment to answer the six questions and mail the questionnaire to my attention. Here's your chance to let us know easily and directly what you want or don't want. May we hear from you?

Sincerely,

The Editor

1. Do you like this quarterly Supplement idea?

2. What article in this one do you like most? Why?

3. Which do you like least? Why?

Other Comments:

4. What subjects do you consider of most importance to the communications service technicians?

5. Is four times a year often enough?
More often? How many times?

6. Would you pay $2.00 per year to have the Supplement bound into your copy of PF REPORTER every third month? (PLEASE DO NOT SEND ANY MONEY at this time!)

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NEW

Lower voltage checks for Nuvistors and all new frame grid tubes, as demanded by tube manufacturers, but not found on other tube checkers.

NEW

Speedy indexed set-up cards to reduce "look-up" time. No more cumbersome booklets, or incomplete charts.

NEW

Simplified panel layout reduces set-up time — prevents set-up errors.

NEW

Streamline styling with rounded corners and rubber feet, prevents marring Furniture — presents that "Professional look".

NEW TC 130

Checks them all . . . including Novars, Compactrons, Nuvistors, 10 pin tubes — plus Picture Tubes!

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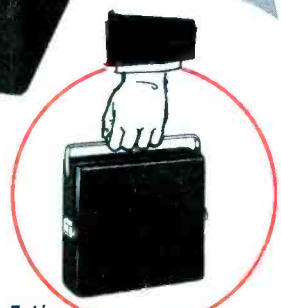


Only 7 Lbs. . Smaller Than A Portable Typewriter

Here's the famous MIGHTY MITE, America's fastest selling tube checker, with an all-new look and many new exclusive features. MIGHTY MITE III brings you even greater portability, versatility and operating simplicity beyond comparison. Controls are set as fast and simply as A-B-C right from the speedy set-up cards in the cover. The new functional cover can be quickly removed and placed in a spot with more light for faster reading of the set-up data or "cradled" in the specially designed handle as a space saver as shown above. New unique design also prevents cover from shutting on fingers or cutting of line cords as in older models.

In a nut shell . . . the MIGHTY MITE III is so very popular because it checks for control grid contamination and gas just like the earlier "eye tube" gas checkers (100 megohm sensitivity) and then with a flick of a switch, checks the tube for inter-element shorts and cathode emission at full operating levels. Sencore calls this *"the stethoscope approach"* . . . as each element is checked individually to be sure that the tube is operating like new. User after user has helped coin the phrase *"this checker won't lie to me"*. Most claim that it will outperform large mutual conductance testers costing hundreds of dollars more and is a real winner in finding those "tough dogs" in critical circuits such as color TV and FM stereo.

See Your Parts Distributor--And See The Mighty Mite III For Yourself!

SENCORE **426 SOUTH WESTGATE DRIVE ADDISON, ILLINOIS**

Circle 39 on literature card

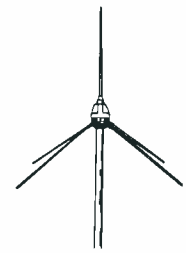
Form No. 222

Communications Antennas

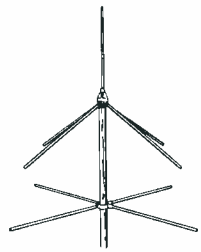
There is considerable choice of base station antennas available for communications equipment. Some are general purpose and others are specialized. Here is a brief description of the characteristics and use of each type classified in a recent survey. From the accompanying charts you can decide which antenna type suits the coverage needs of your customer, pick the frequency range, and find the names of the manufacturers who offer this type.

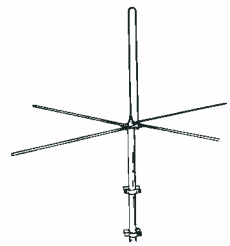
Of the omnidirectional types, the *dipole* antenna's pattern is the most "donut" shaped. It is the most simple, and usually the least expensive.

A *ground-plane* antenna consists of a quarter-wave vertical radiator and an artificial ground. It is omnidirectional horizontally, but the vertical pattern is narrower than that of the dipole.

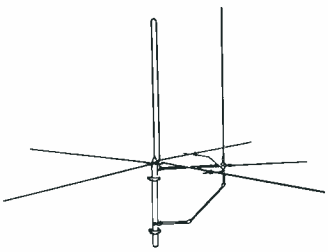


The *duo-ground-plane* type (sometimes called an "isoplane") has an extra ground plane which, because of its position and shape, lowers the radiation angle.





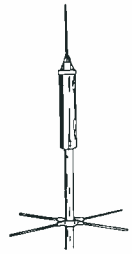
The grounded end of the radiating element of the *unipole* (folded ground plane) antenna provides a path for corona discharge and minimizes lightning hazards. Gain is similar to a ground-plane type.

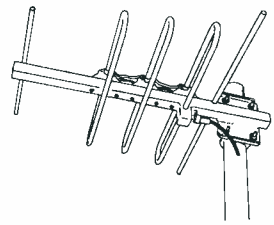


Cardioid is the term applied to a unipole type that includes a grounded reflector to give a horizontally cardioid pattern (with gain of more than unity).

The *coaxial* antenna has a quarter-wave vertical radiator with a quarter-wave "skirt" below it. The skirt takes the functional place of the ground plane Gain is higher than with the ordinary ground-plane antenna.

A lower vertical radiation angle is achieved by using a ground plane below the skirt of a coaxial type. This is called a *co-plane* antenna.

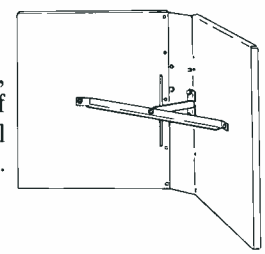




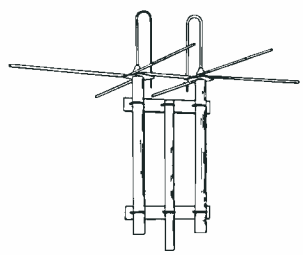
Extreme gain and directivity are possible with the *yagi* antenna—a combination of dipole radiator with reflectors and directors.

High gain can be combined with omnidirectivity by stacking dipoles vertically. Such a combination is called a *collinear* antenna.

For a high front-to-back ratio, a single *corner-reflector* type of antenna or an array of several units may be used.



The term *bidirectional unipole* is very descriptive of this dual unit that provides a "figure-eight" pattern to reduce side interference.



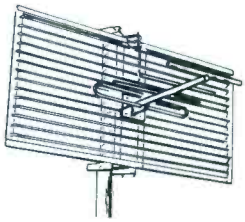
The *stacked unipole* configuration maintains the advantages of the unipole and adds the capability of increasing gain and arranging for desired directivity.

As more skirts are added below the radiator on the coaxial antenna its vertical pattern narrows, and gain increases significantly. This type can be considered a *stacked coaxial*. With three, the term "triple-skirt" is often used.

Special Antenna Types / Manufacturer	Bidirectional Unipole	Stacked Unipole	Stacked Coaxial	Folded Coaxial	Cardioid Coaxial	Screen-Reflector Yagi	
Andrew Corp.	X						all for high band VHF
Hy-Gain Antenna Prod.		X					
Herb Kreckman Co.			X				
Motorola				X	X		
Taco						X	

Replace the projecting rods of the typical unipole antenna with a coaxial skirt section and you have a *folded coaxial* design. This type has the advantages of the unipole in a simple unit with a low radiation angle.

A grounded element added to the folded coaxial type as a reflector gives it the added characteristic of directivity. Because of its design and the resulting pattern, this is called a *cardioid coaxial* antenna.



If the reflector section of a conventional yagi antenna is replaced by a screen, the resulting type is a *screen-reflector yagi*, which has greatly increased gain and front-to-back ratio. ▲

Antenna Type / Manufacturer	Dipole	Ground-plane	Duo-Ground-plane	Unipole	Cardioid	Coaxial	Co-plane	Yagi	Collinear	Corner Reflector	freq range ▼
Andrew Corp.	X	X		X	X						low band VHF
Herb Kreckman Co.		X	X	X		X	X				
Mark Products	X										
Motorola		X		X	X	X					
Taco								X			
Andrew Corp.				X	X	X			X	X	high band VHF
Cush Craft								X			
Hy-Gain Antenna Prod.		X				X					
Herb Kreckman Co.		X	X	X		X	X				
Mark Products	X								X		
Motorola									X		
Regency Electronics, Inc.						X					
Taco								X			
Andrew Corp.								X	X	X	UHF
Cush Craft								X			
Hy-Gain Antenna Prod.		X									
Herb Kreckman Co.		X	X			X	X				
Mark Products	X								X		
Motorola									X		
Taco								X			

the MISALIGNED RF Stage

Sensitivity was good on the bench, but . . .

by Richard Martin

It was just before closing time when an oil truck drove into the shop garage and blew those malicious air horns. The shock wave rattled the windows.

"Got a bad one here, boy!" the driver shouted as he cut the motor.

Being in the middle of dipping a final amplifier on a 10-watt transmitter (which demanded my full attention), I ignored him for the moment. Besides, I had intended to lock up after I got rid of this taxicab radio. "Maybe he'll go away if I don't answer him," I thought to myself.

When I heard the truck door slam, I knew I was wrong. As he was marching up to the bench, I finished peaking the output and turned to meet him. "What can I do for you?" I asked.

"I can't get the dispatcher on that thing you call a radio," he grated, jerking his thumb over his shoulder.

Musing over this statement, I turned back and tightened the high-voltage cage over the final. He might mean that he can't hear the dispatcher's messages; or he could mean the dispatcher can't hear him.

"Dispatcher can't hear you, huh?"

"I dunno, mac, I can't hear *him*; so how would I know if he can hear me?"

So! He's got receiver trouble. Now why didn't he just tell me that instead of making me play this guessing game?

"Have a seat; be with you in a minute," I said patiently.

"Well, make it snappy, buddy. I've still got five more deliveries to make before I quit; and I'm in a *big* hurry. The old lady's got a bug about going to a drive-in tonight, and she'll clobber me if I'm not home for supper."

"*She'll* clobber you? You may not have to wait . . . ," I thought as I disconnected the dummy load and connected the antenna. I keyed the mike and called the taxi dispatcher for an on-the-air check. Everything okay; so I put the radio back in the cab; and the driver took off, leaving me alone with my last customer of the day—or so I hoped. Just to be sure, I let down the garage door, drew the shades on the shop door, and locked the door.

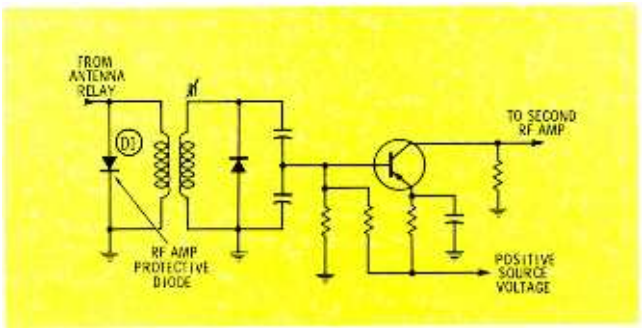


Fig. 1. Diode D1 keeps static discharge from reaching RF amplifier.

After I finished this nightly ritual, the truck driver growled, "*Now* are you going to take care of me, pal?"

Since I didn't feel very much like a pal to him, I just said, "Yep." I hopped into the cab of his truck, turned on the ignition and radio, and waited for the radio to warm up. It was one of those new transistorized jobs. "Sure hope I can fix it quick," I thought.

Just then "squelch" noise emitted from the speaker. I waited for another half-minute to be sure the transmitter tubes were warm, and then keyed the mike. "Unit 17 at radio shop to dispatcher," I called into the mike.

No answer; in fact no traffic at all. I couldn't even hear other trucks in the system; and they were undoubtedly calling in for any final deliveries of the day.

"Radio shop to dispatcher," I said once again. Still nothing.

"Radio shop to any unit," I tried as a last resort. Again nothing.

Switching off the radio and ignition, I told the driver I'd have to put the set on the bench. I unlocked the case, disconnected the cables, and removed the radio from its case. It was mounted upside down on the ceiling of the cab—on the passenger's side where no one ever sits. Quite a tight fit, too. When I finally got it loose, it came tumbling down on me, almost knocking me out of the cab.

I placed the radio on the bench, connected the power and control cables, and checked the receiver metering points with the test set. The oscillator checked okay; limiters, too. Injecting a strong signal into the receiver, I noted that the limiter reading didn't increase as much as it should.

"Losing too much signal in the front end, I'll bet," I said, unintentionally, just loud enough for the truck driver to overhear.

"Don't much care where you're losing your signal, mac; find it and get that set working. Like I told you, I'm in a hurry."

From experience with this particular model of radio, I suspected that the protective diode across the antenna input (Fig. 1) was either partially or completely shorted out. I turned the radio over and removed the protective cover from the RF amplifier strip. With a pair of small sidecutters, I carefully reached in and clipped loose the ground side of the diode. Instantly, the limiter reading shot upscale and the low-IF reading rose considerably—indicating normal operation.

I reduced the signal-generator output and noted the attenuator indicated .5 uv at full quieting. "Not good enough for this particular radio," I thought to myself,

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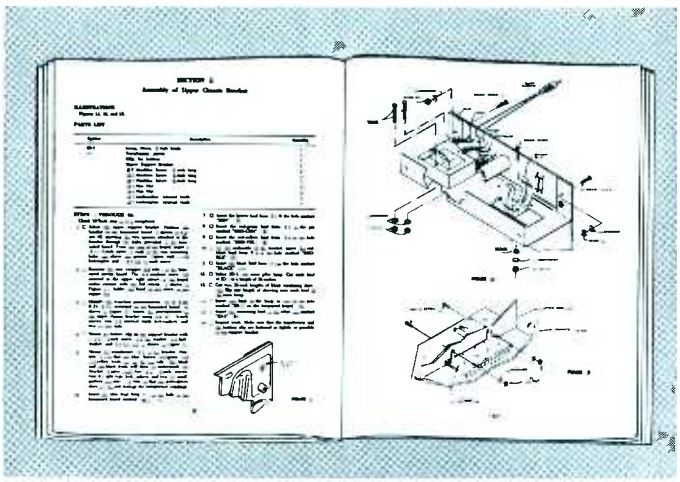

Each sub-assembly is described in a separate section with illustrations applying to that sub-assembly available at a glance. No cross referencing necessary.

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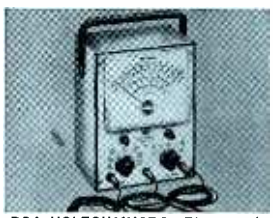

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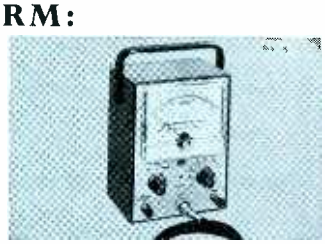

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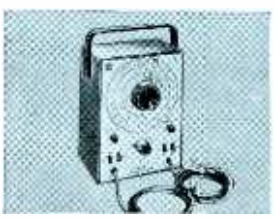

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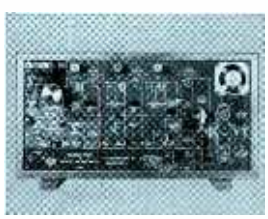

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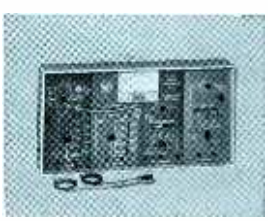

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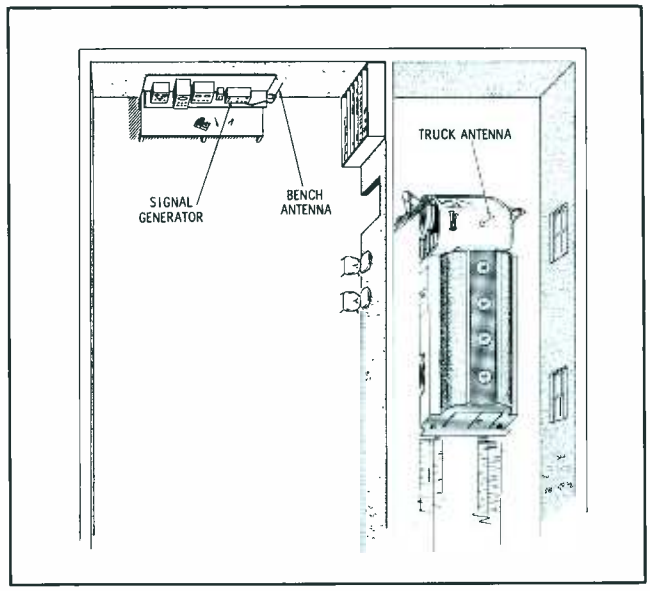


Fig. 2. Receiver checked by radiating signal from generator.

"but I'd better not touch alignment with this guy in such a hurry."

I removed the diode from the circuit and inserted a new one. Once again I checked sensitivity; still okay. I disconnected the generator and connected the RF wattmeter to the antenna receptacle. Quickly setting the frequency and deviation meter to the proper frequency, I spoke into the mike and checked the power output, frequency, and modulation deviation all at once. Everything okay here, too.

When I made an on-the-air check with the bench antenna connected to the radio, the dispatcher's reply was loud and clear—full quieting.

"Well, now, that only took a few minutes," I said to the driver as I disconnected the antenna, lifted the radio off the bench, and headed for the truck.

"Yeah, that's all right!" he said, "Now I can get outta here."

I climbed into the cab and swung the radio up into its case and placed the lid on. After locking the unit in place, I connected the cables, slid down in the seat, and turned the ignition on.

After the transmitter warmed up, I called the dispatcher. In waiting for a reply, all I heard was the squelch circuit trying to open the audio amplifier—just an intermittent popping and crackling for about three seconds. "Certainly this can't be the dispatcher transmitting," I thought. "His transmission would be loud and clear. Must be another mobile unit operating out in the county."

"He probably stepped out of the office for a minute," the driver suggested. "The radio's all right. Climb down outta there and I'll take off."

"No. Let's wait a minute," I replied. I hopped down from the cab, went over to the bench, and turned the modulation meter towards the truck. Getting back into the cab, I called the dispatcher again. Still no answer. However, the transmitter was working; I could tell from the modulation meter.

I went for the signal generator. Since it would be awkward getting the instrument into the truck cab, I connected it to the bench antenna (Fig. 2), set it on the correct frequency once more, and cranked the

signal level to full output. With a normal receiver this near the generator, full quieting should occur. However, in this case, it didn't. Opening the squelch control in the truck produced only the hiss normally heard in two-way receivers; no signal coming through at all.

"Now what the devil . . . !" I muttered to myself. "I *know* the receiver works; I just fixed it. Maybe the signal generator isn't set properly."

Just then the shop phone rang. It was the oil company dispatcher. He said he had answered me both times I had called, but that apparently I hadn't heard him. I thanked him and asked if he wanted the driver to leave his radio so he could finish his deliveries. We would work on the radio the next morning, and have it ready by noon. (It was now well past closing.)

"It's up to the driver," the dispatcher decided.

I asked him to hold on a second, and asked the driver what he wanted to do. He said that, as much as he didn't want to, he'd wait, because he needed his radio in the morning as much as he did now. I told this to the dispatcher, and he just grunted, "Okay, but he isn't getting overtime while he's hanging around there."

Figuring I better not mention this to the driver, I said goodby and hung up.

So! Still got receiver troubles, huh? What could it be? It worked okay on the bench. "Maybe I knocked something loose or put the circuit board in a twist when I put the radio back in the case," I thought, remembering a similar case last week. I took the radio out of the cab and set it on the bench once again. After connecting the power and control cables, I checked sensitivity; still .5 uv, and right on frequency.

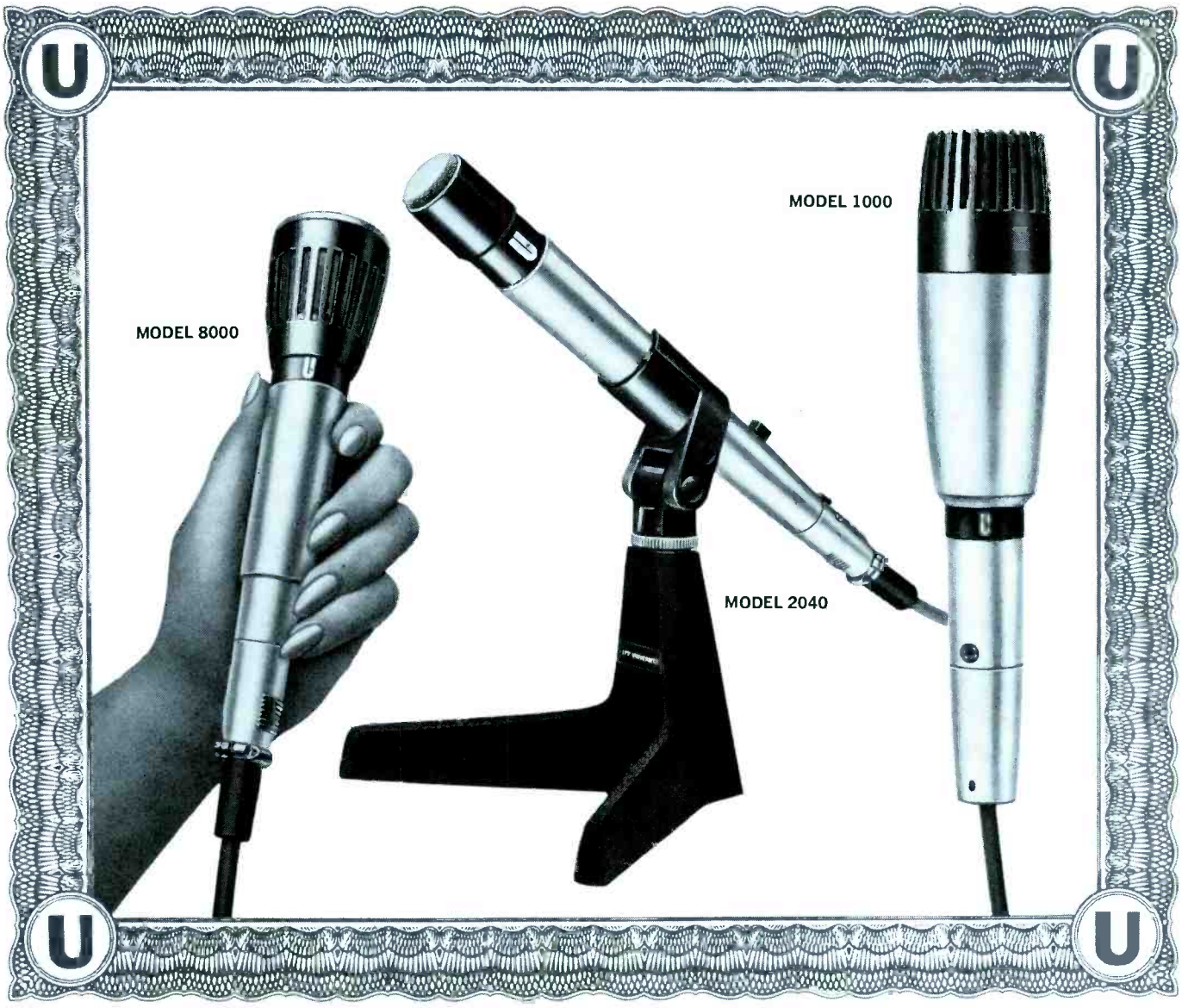
"Now what could be causing a loss of sensitivity in the cab, but not on the bench?" I wondered. "Well, let's see: The antenna must be okay since the dispatcher can hear my transmissions. Perhaps the trouble is a voltage-sensitive transistor."

I reduced the battery eliminator output from 12.1 volts to 11.5 volts and again checked sensitivity. No change. "So it isn't a voltage-sensitive transistor," I mused. "Maybe something will show up if I inject more A-voltage than normal." I reached over to the eliminator and turned it up to 13 volts, but the only change was from .5 uv to .3 uv. I ruled out heat troubles in the practically airtight case because the set hadn't worked the instant I turned it on.

I injected 10 uv of signal into the receiver and tapped and pried components and the PC boards all along the signal path from antenna relay to speaker plug. Defiantly, the limiter and low-IF meter readings stayed the same—no reduction to indicate a signal loss.

"Couldn't be in the power supply, 'cause there's no circuit there that serves the receiver alone," I said to myself, "and the transmitter works fine."

At a loss to explain the trouble, I took the radio back to the truck. I loosened the power and control cable clamps above the windshield and let the cables drop to the seat. Connecting the cables to the radio, I tried another check with the dispatcher, hoping I would learn something about the trouble. No such



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luck; he answered. I heard him okay, and I was more baffled than ever.

I slipped the radio back into its case and tightened it down without the cover. Again I called the dispatcher. This time I heard the popping squelch again.

"Now, we're getting warm!" I thought. "It positively has something to do with the radio being in the case. I'll bet if I remove all external grounds I'll get a signal." I went back to the service bench and made sure the signal generator hadn't changed frequency. I gingerly slipped the radio out of its case, upside down, and held it clear. No change; the set was still dead. Holding the radio near my head, I turned it over quickly to see if anything would happen. Instantly, the signal came through. At last! Whatever is wrong with this little "jewel" occurred only with the set upside down.

As I slowly turned the set over several times with my ear near the chassis, I became aware of a faint "clunk," like something falling against metal. I took the radio back to the bench and took the RF amplifier cover off again.

Carefully, I poked among the RF components. Nothing loose; so I turned the radio upside down. "Plunk!" Something fell out and bounced behind a parts can. I moved the can, and there lay a coil slug.

"Well, well," I said, "what have we here?"

"Beats me, doc, what *have* you got there?" a voice said from over my shoulder.

"This, my good friend," holding up the slug for him to see, "may well be the cause of your trouble," I said.

"Okay, so fix it!" he said.

"Okay, so I will," I smiled at him.

Slipping the slug back into the form, I screwed it down a couple of turns and turned the radio over again. The slug stayed in place.

I connected the generator and checked the sensitivity. It was about .6 uv; so I adjusted the other coil slugs in the front end of the receiver for a peak meter reading. The meter reading at the low-IF amplifier increased about 50%. The generator attenuator indicated that sensitivity was now .4 uv—even with the radio upside down.

Jubilantly, I disconnected all cables, took the radio back to the truck, fastened it into its case, and checked with the dispatcher. This time he came through fine. I reached over and turned the volume down and asked him for a ten-count. As he complied, I hit the radio several times with my fist to see if the slug would come loose. It didn't.

With the driver standing just outside the open cab door, I told the dispatcher the radio would be all right now, but that it had a broken part which would need attention when the driver had an hour to spare.

"Whoops, wait a minute," I said.

I went around to the passenger's side and climbed in once more. With my nut driver I quickly refastened the cables over the windshield.

I climbed down and went over to the overhead door controls. With the door raised, the driver backed out, turned around, and was gone with a blast of air horns and a cloud of parking-lot dust. I punched the "down" button, went over to the file box, and pulled the card on his radio. . . . ▲

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FREQUENCY SYNTHESIS

Multichannel transmitters with few crystals . . . by Keith Bose

In modern electronic equipment, there are applications in which each individual frequency must be accurately controlled within limits so close that crystal oscillators must be used. Crystals are expensive, and in many cases it is physically difficult to mount a crystal for each desired frequency in the allotted space.

What It Is

Frequency synthesis is the process in which a large number of stable frequencies may be obtained with comparatively few crystals. It is based on the double-superheterodyne process. When two signals of differing frequencies are combined in a *nonlinear* impedance, other frequency components will be created. These other frequencies are mathematically related to the two original frequencies. Of most interest in frequency synthesis are the components equal to the sum and the difference of the two original frequencies.

In an ordinary superheterodyne receiver, for example, the frequency difference between the local oscillator and the incoming signal forms the IF. The mixer tube acts as the nonlinear impedance necessary to create the intermediate frequency. It is apparent that some combination of oscillators and nonlinear impedances can be devised to create many discrete frequencies from a series of accurate signals.

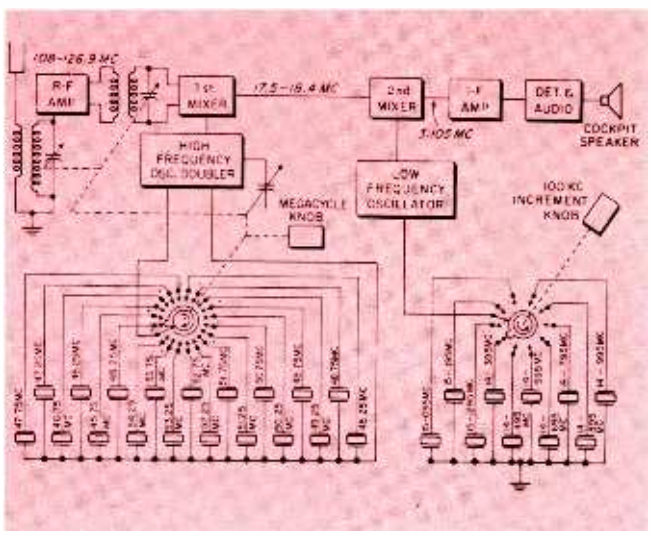

Fig. 1. Diagram of dual-conversion receiver using frequency synthesis.

Applications

Crystal-controlled signal generators which produce signals from frequency synthesis are available for laboratory use when such accuracy is required. The greatest use of frequency synthesis is in the field of aviation communications, but some CB makers are developing 23-channel transceivers that don't necessarily need 46 crystals.

The frequency of aircraft transmitters must be maintained within ±.01%. Such stability is most conveniently obtained with crystals. Aircraft operating under all weather conditions must employ transmitters capable of operating from 118 to 135 mc in increments of 50 or 100 kc. Rather than a separate crystal for each channel, frequency synthesis is used in these transmitters to provide up to 360 channels with relatively few crystals.

Frequency synthesis is also used in aircraft receivers to generate accurate local oscillator signals. The reason for this is that a pilot must be able to tune at once to a specified channel without the inconvenience of tuning a dial. Obviously, dial settings vary with temperature and humidity or as tubes and other components age. If a pilot is required to dial to a station, a crucial part of a message can be lost. The better aircraft receivers, therefore, employ frequency synthesis.

The technique of frequency synthesis is the same regardless of the application in which it is used. For purposes of illustration, several examples of frequency synthesis in aircraft equipment will now be described.

It is possible to arrange a system so that frequencies may be generated in increments by switching crystals. Aircraft systems are arranged so that they may be "tuned" digitally; that is, frequencies may be changed in digital increments.

An example of a receiver using digital tuning is shown in the block diagram of Fig. 1. Twenty-nine crystals cover the band from 108 to 126.9 mc in 100-kc steps. The first IF in this double-conversion set is obtained by doubling the frequency of a third-harmonic crystal

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Fig. 2. Tuning controls for a communications set.

and then combining with the incoming signal in the first mixer. The frequency from the high-frequency oscillator-doubler is chosen to be between 17.5 and 18.4 mc (.9-mc spread) below the incoming signal, and this difference-frequency (IF) is coupled to the second mixer. The low-frequency oscillator is switched in 100-kc increments. This oscillator operates about 3.105 mc below the output frequency of the first mixer.

The control dials of this receiver are arranged as in Fig. 2. The frequency selector consists of two selector switches—the center control for 1-mc increments and the peripheral control for 100- or 50-kc increments. The megacycle knob selects the crystal for the input to the first mixer. A 100-kc (.1-mc) knob allows selection of the crystal for the low-frequency input to the second mixer.

Another application of frequency synthesis is in a VHF transmitter, part of which is shown in Fig. 3. This unit employs 19 crystals to cover the range from 118 to 126.9 mc. One section of the dual triode (V101B) acts as a low-frequency oscillator; the other section (V101A) forms a high-frequency oscillator. Together, these oscillators provide a total of 90 possible

"First we jam her radio with this tunable oscillator—then I'll drop over and offer to fix it."

frequency combinations. The high-frequency oscillator is controlled by the megacycle switch (S101), and the .1-mc switch (S102) selects crystals for the low-frequency oscillator. The output of the high-frequency oscillator is fed to the control grid of mixer V102, and the output of the low-frequency oscillator is fed to the mixer cathode from the oscillator cathode. The mixer output is tuned to the sum of the two oscillator frequencies, and the sum frequency is doubled twice in the stages that follow the mixer. The transmitter output frequency, therefore, is:

$$\text{Output} = 4(F_h + F_l)$$

where

F_h is the high-frequency oscillator frequency,

F_l is the low-frequency oscillator frequency.

The megacycle control switch (S101) is ganged with C109A in the plate circuit of the mixer. As the megacycle switch is rotated through its range, the tuned plate circuit of the mixer passes the sum frequencies in a band from 29.5 to 31.725 mc. The first and second doubler stages which follow (not shown in the schematic) also have trimmers which are ganged to the megacycle switch. This tunes the respective output circuits within a range that will generate the desired harmonics.

Another interesting system of frequency synthesis is contained in the transceiver, shown in Fig. 4. This system generates frequencies in 50-kc (.05-mc) increments. The first injector supplies frequencies in 1-mc increments from 130.485 to 147.485 mc. The output of the first injector is fed to both the first mixer of the receiver section and the mixer of the transmitter section. The output of the first mixer in the receiver will be 11.535 to 12.485 mc throughout the band. The first IF stage tunes broadly and passes these frequencies to the second mixer. The second-injector frequencies

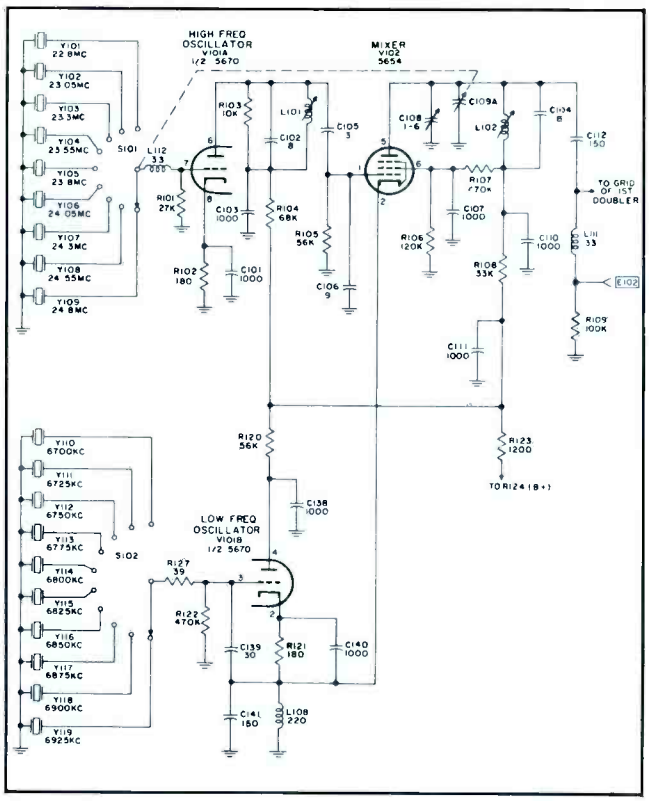


Fig. 3. Frequency synthesizing arrangements in a VHF transmitter.

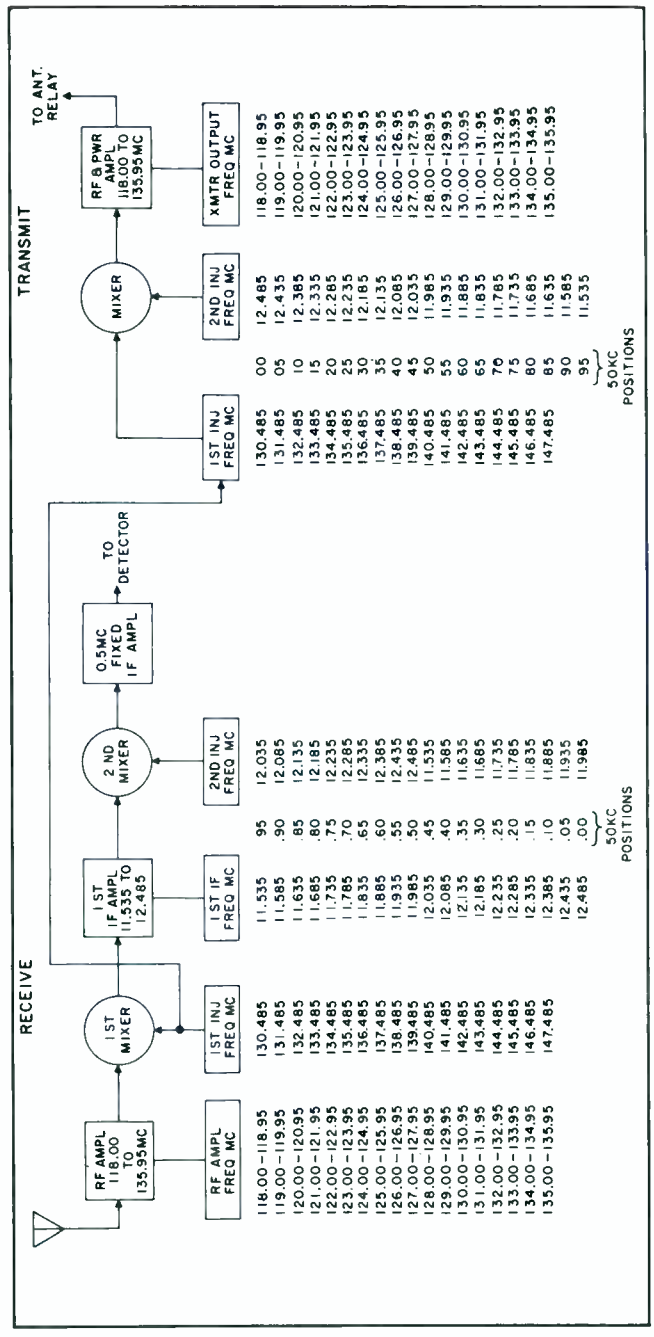


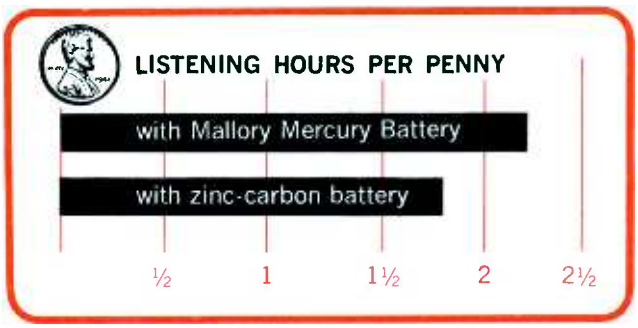
Fig. 4. Synthesizing circuits for both transmitting and receiving.

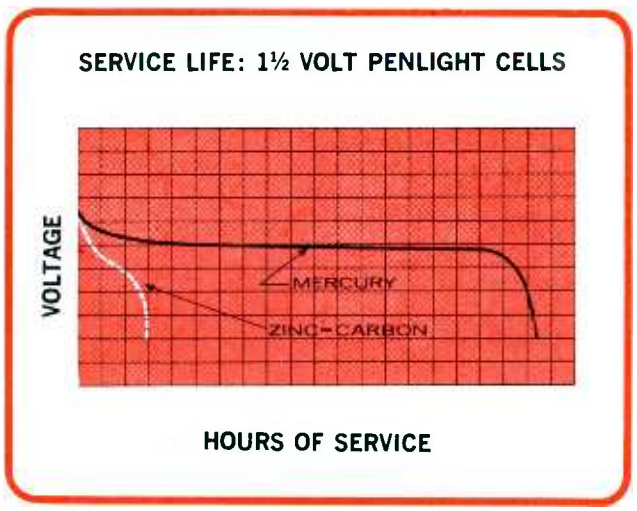
range from 12.035 to 11.985 mc in .05-mc increments. When these components are mixed with the first IF, a constant .5-mc IF results. In the transmitting mode, the output frequency is synthesized by injecting frequencies from 12.485 to 11.535 mc in .05-mc (50-kc) increments into the transmitter mixer.

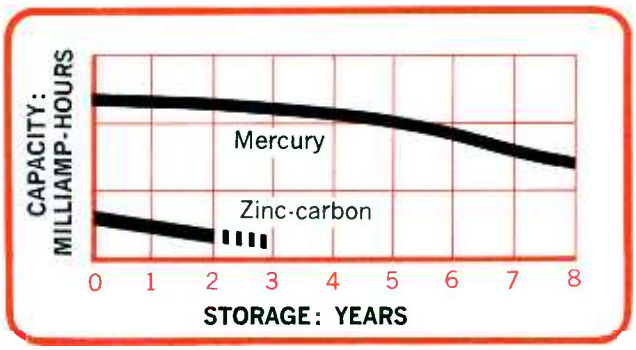
Conclusion

Each year more equipment utilizing frequency synthesis is being produced. Solid-state circuitry is becoming commonplace. There is continuous research directed toward finding methods of producing more frequencies with equipment of minimum weight and physical size. Although frequency synthesis is most widely used in aircraft electronics, this technique is also used in missile work for generating timing signals and in other advanced applications. You'll see it in CB equipment, too. ▲

Why Mallory Mercury Batteries work better in transistor radios







There are a lot of good reasons why more and more people are using mercury batteries in their transistor radios. And the reasons boil down to this—they're a better value, and they give better performance.

To get a comparison between mercury batteries and ordinary zinc-carbon batteries, let's look at a typical transistor radio. This radio uses size "AA" penlight batteries and has a current drain of 15 milliamperes. The Mallory Mercury Battery is the ZM9 and the zinc-carbon type would be the NEDA type 815. The ZM9 retails for 75¢ versus 20¢ for the 815. Got the picture?

Here's where the fun begins. The ZM9 will operate the radio for 165 hours versus only 35 hours for the zinc-carbon battery. This means that for one penny you'll get 2.2 hours of listening pleasure using the ZM9 versus 1.75 hours for the zinc-carbon battery. In other words, it costs you 0.57 cents per hour to use the zinc-carbon compared to only 0.45 cents for the mercury battery.

We're not through yet. Let's get back to *listening pleasure*. The mercury battery has essentially a flat discharge curve. This means that it presents a more constant voltage to the transistors. Result: you don't have to keep turning the volume control up while you're listening AND the radio *sounds* better because there's far less distortion.

Had enough? There's one more important point. Suppose you put the batteries in the radio and use it only slightly. Those 20¢ zinc-carbon batteries go "dead" in a few months whether you use them or not. But the mercury batteries can be stored 2 to 3 *years* and still deliver dependable power. Plus the fact that Mallory Mercury Batteries are guaranteed* against leakage in your transistor radio.

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Circle 48 on literature card

MODULATION LIMITERS FOR TWO-WAY

Learn your way around in clipper circuits.

by Edward M. Noll

Some months ago (October 1963), we discussed the operation and troubleshooting of audio clippers in receivers for communications. There are many basic similarities between those clippers and the limiters used to prevent overmodulation in transmitters.

As was pointed out in the first article, the purpose of a modulation limiter is to clip off voice-signal peaks so a higher average level of modulation can be maintained. This increases the average level of demodulated audio at the receiver, raises the intelligibility of the signal, and increases the reliable transmission range. In this article, we are going to analyze these noise-limiting circuits in communications transmitters.

Limiter Action

The communications technician adjusts the signal level in the audio section of a transmitter with gain or deviation controls. Their purpose is to set a level of voice-peak clipping that doesn't introduce distortion or reduce the average modulation percentage. Speech is a very irregular waveform and occasional peaks are much greater in amplitude than the average level of the voice signal. It is these voice peaks that are clipped off by the modulation limiter in the same manner that high-amplitude noise pulses are removed by a clipper in the receiver.

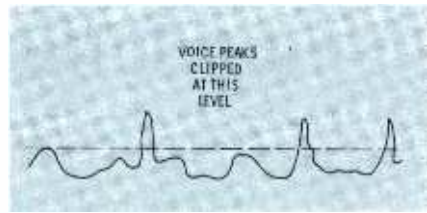

Fig. 1. Most effective power is below line.

Fig. 1 shows how clipping off voice peaks above a certain amplitude level leaves most of the audio waveform energy below the limiting level. The portion below the limiting line can be amplified considerably and fed to the modulator; the result will be greater efficiency in the modulator, since there will be no high peaks to drive the modulator into distortion or overmodulation.

A quick review of limiting or clipping action could be helpful in understanding modulation limiters. Although the basic audio-clipper circuit (Fig. 2) looks like a half-wave rectifier, it must respond to the modulation peaks rather than the average level of the signal.

This can be accomplished by the use of either self-bias or external bias. The effect of biasing the "rectifier" circuit is shown in Fig. 2B. The anode of the diode is positive with respect to its cathode, so the diode normally conducts. When an

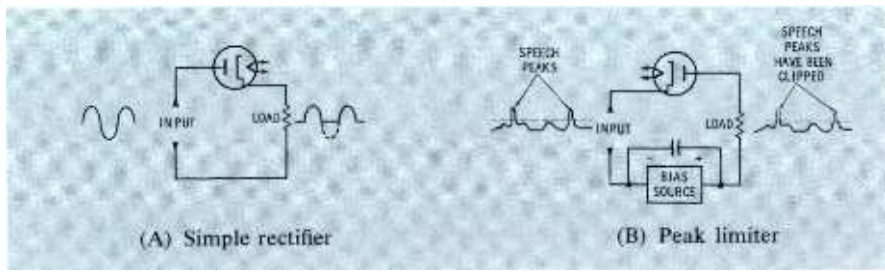

Fig. 2. Noise limiter circuits bear a strong resemblance to ordinary diode rectifiers.

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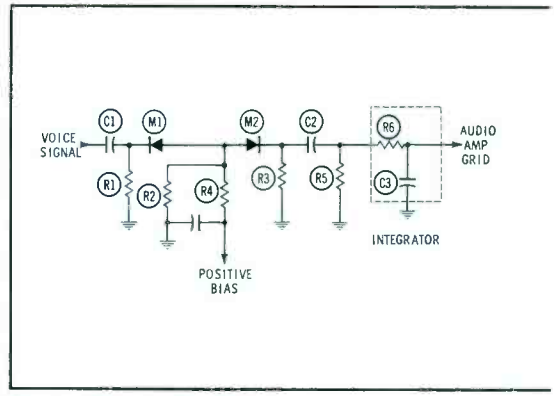


Fig. 3. Series-diode circuit is most common.

audio signal is applied to the cathode, the diode current tends to follow the signal excursions, developing the signal across the load resistor. The level of input signal is insufficient to swing the cathode positive at any time; thus, the signal is not rectified but merely coupled through the diode.

However, a very strong voice peak will have an amplitude greater than the diode bias. When such a pulse occurs, the cathode will be driven positive with respect to the plate, and the diode will not conduct. As a result, the voice peak will not be developed across the output resistor, and is thus clipped from the output signal.

It is significant that the simple diode circuit of Fig. 2B can limit only the positive excursions of the complex voice waveform. In most transmitters, there are also negative peaks that should be removed. Just as two diodes can be made to rectify both positive and negative portions of a sine wave in the secondary of a power transformer (full-wave rectifier), an arrangement of two diodes can be used to limit both positive and negative peaks in a speech amplifier.

A Practical Limiter

One simple type of modulation limiter is shown in Fig. 3. Either tube or semiconductor diodes can be used, although the trend is to semiconductors. In a two-way transmitter, the limiting stage is often positioned between the first and second speech amplifiers. The level at which limiting occurs depends on the positive bias applied to the anodes of the two diodes by divider network R2-R4.

The first series-connected diode (M1) clips off positive voice peaks. Positive peaks on the cathode that

exceed the bias voltage applied to the anode cut the diode off.

Negative peaks are conducted by the first diode and appear across resistor R2. They are thus applied to the plate of second diode M2. If their amplitude is above the limiting level set by the bias network, they will cause the second diode to cut off. Thus, both positive and negative voice peaks are removed and do not appear across output resistor R3.

Spurious signal components are generated by any clipping action. They can produce distortion, increase bandwidth, or in other ways adversely affect modulation. Fortunately, these frequency components are usually above the desired voice frequencies. Consequently, a resistor-capacitor integrating combination or a low-pass filter often follows the modulation limiter. The integrator blocks the transfer of high-frequency components and helps restore the smooth shape of the original waveform.

In many communications transmitters, it is customary to include a simple RC integrator plus a low-pass filter. The low-pass filter provides additional attenuation of unwanted harmonics because the audio high-frequency limit of most communications systems is around 3000 cps.

The audio amplifiers of a communications transmitter must provide enough audio gain ahead of the modulation limiter to keep normal speech levels near the point of limiting. In addition, the stages that follow must have enough gain to permit a high average modulation percentage. Of course, too much clipping can distort the speech, so the preamplification mustn't overdrive the limiter. Too much gain following the limiter will cause overmodulation of the transmitter. The

"Let's get one thing straight at the outset . . . I'm here to fix your set and nothing else, and I can lick any kid in the joint!"

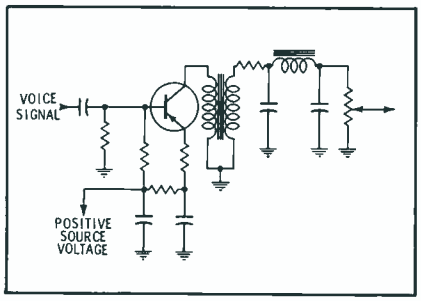


Fig. 4. Single transistor clips both peaks.

modulation level control usually follows the limiter.

Whether the transmitter is amplitude or frequency modulated, proper adjustment is best obtained by using a modulation meter at the transmitter output. Checks with an oscilloscope can help locate adjustment or circuit defects when there is modulation distortion.

A Transistor Unit

A transistor modulation clipper is shown in Fig. 4. A low-level signal can drive a transistor stage from cutoff to saturation with ease. At the same time, the transistor will still operate with full gain and low distortion for any signal amplitude that falls between the limits of saturation and cutoff. Thus a transistor amplifier very early in the speech system can provide effective voice-peak clipping. Here's how it works:

When the base-emitter junction of a transistor is reverse-biased, no emitter-base current flows. As a result, the collector current is cut off. For a PNP transistor it is the positive voice peaks that swing toward cutoff. If an NPN transistor is being used, it is the negative voice peaks at the base that are clipped off by cutoff action.

As transistor forward bias is increased, a point is reached at which there is no further increase in base current with rising signal amplitude. Thus, collector current is also limited. For a PNP transistor, this limiting action removes negative modulation peaks. Oppositely, positive modulation peaks are removed by saturation in an NPN circuit.

Actually, in a transistor circuit, saturation can also be the result of collector-base current flow. If the voice peaks on the base exceed a certain level, it places a forward bias on the base-collector junction. This results in collector-base current flow to the input circuit, which limits any further increase in base-emitter bias current. This action is comparable to the flow of grid current in a vacuum-tube stage that employs grid limiting.

As with the diode-type limiter, the transistor limiter must be followed by suitable integrating components and an additional low-pass filter. Again, the modulation level control follows the modulation limiter circuit.

Checking Limiters

Testing the action of modulation limiters is not at all difficult. An audio generator and oscilloscope (or an AC VTVM) are all that is necessary for troubleshooting. Here is a test procedure that will work with almost any type of limiter, and will check the system from mike input right up to the modulator.

Use just enough signal output from the generator—1000 cps is a good test frequency—to be visible on the scope. Make sure the modulation control is set for maximum modulation. It is important in this first step that the limiter not be

driven to the point where it begins limiting.

Apply the signal to the mike input point, and trace it through each stage of the speech amplifier. You should find gain across the speech amplifier stages. There should be a slight loss in the limiter section, and a loss across the RC networks following. If there is a stage of amplification between the limiter and the modulator, make sure the signal actually is amplified.

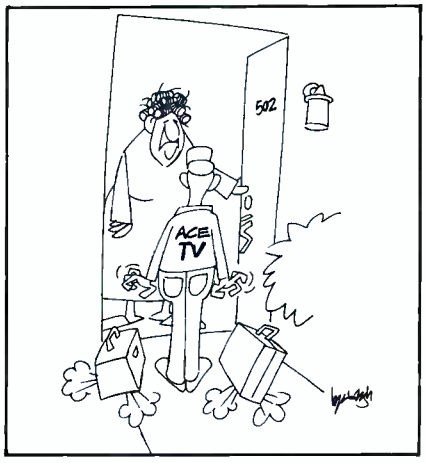
Next, set the modulation control at its half-way point. Connect the scope or VTVM at the output of the first speech amplifier, and see if raising the generator output level causes an increase in signal output. Do the same for the second speech amplifier, or whatever other stages precede the limiter section. All of these stages should show an increase in output whenever the generator output is increased; they should accept increased signal right up to their point of overloading—signified by severe distortion, which points up the advantage of using a scope.

Then connect the scope or VTVM at the output of the integrator network. Turn the generator output control up and down, and note the signal level at which the scope or VTVM indicator ceases to increase. This proves that the limiter is working.

Set the generator output just below the point of limiting. Try resetting the modulation control of the transmitter to see if it will control limiting below the half-way point. It should reduce the signal at the scope or VTVM as it is turned for less modulation. Return the control to midrange.

Set the generator output level just above the point of limiting. Try setting the modulation control for higher modulation. The scope indication should rise correspondingly. Set the generator a little higher; again, moving the modulation control should result in a higher indication on the scope or VTVM.

Finally, make the last two tests with the indicator connected right at the input to the modulator. If all is well, the results will be the same as with the scope or VTVM connected at the output of the limiter.



Conclusion

Obviously, the important ingredients for servicing transmitter modulation limiters are an understanding of the circuits, a knowledge of servicing techniques, and the test instruments we've described. The stages shown are the common ones, but most others are based on some slight variation of these two basic types. Careful maintenance of the modulator and its associated circuits can result in better than average communications for your customer than would be possible if you didn't understand how to check these stages. Become familiar with them and you can do the job your two-way customers deserve. ▲

FOR INDUSTRIAL COMMUNICATIONS

by Leo G. Sands

Industry is making wide use of Citizens-band radio for short-range communications because it costs less than FM two-way radio—and in many cases does the job as well. CB is used in industry for several different applications: expediting the operation of material-handling vehicles, paging personnel, and other interoffice and interplant communications; some units are used for remote control of cranes, gates, and other mechanical devices.

Most CB *hobbyists* operate class D Citizens-band stations in the 27-mc band. But, industry is using all four types of CB radio: class A and class B in the 460-470 mc band, class C and class D in the 27 mc band (see Table 1).

Uses for Class D

The use of class D (27 mc band) CB radios in industry is restricted to the few localities where the band is not congested by hobbyists. A major railroad, for example, is using CB radio for point-to-point communication from a main-line point to a branch-line office. In order to achieve the required range and reliability, large rhombic antennas are used. The system is in an area far removed from populous areas and very little interference from hobbyists is experienced.

In one large industrial plant, 23-channel sets are used for office and plant intercommunication. Each set is normally left tuned to a channel assigned its particular office. Anyone wanting to call that office switches his set to their channel. Hence, it is possible for 23 conversations to take place at the same time, without interference; each is on a different channel. Since the range between offices and buildings is short, plug-in antennas suffice and reduce possible interference from hobbyists in the vicinity.

The interference problem is minimized with CB sets equipped with tone squelch. Some units that will operate on any of the 23 available channels, have a built-in tone squelch that can be used for ringing a bell to alert the called party.

In a paper-container plant, fork-lift trucks are equipped with radio which enables a supervisor to contact his driver at any time. A loud-

Table 1

Citizens Band Station Classes and Channels

Station class	Max. Power (watts)	Number of channels	Band (mc)	Functions
A	60	48	460-470	Voice communications
B	5	1	465	Voice communications Radio control Multi-channel
		49*	460-470	Voice communications Radio control
C	5	6	26.96-27.26	Radio control
	30	1	27.255	Radio control
D	5	23	26.96-27.26	Voice communications

*Only when transmitter is type-accepted for class A and operated at 5 watts or less.

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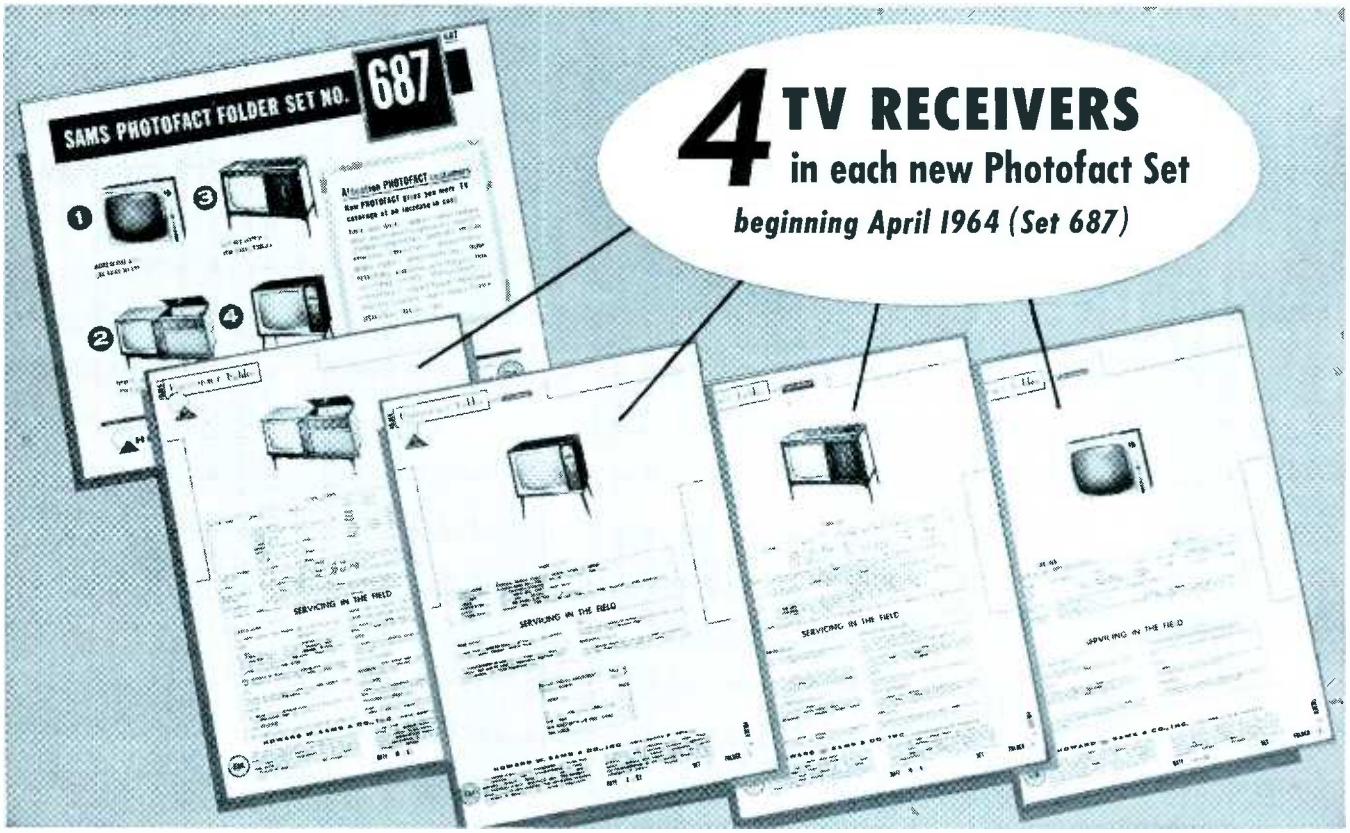

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Dial used with class A Citizens band radio lets driver dial desired station or number.

speaker connected to the supervisor's base station and placed outside his office enables him to receive calls from drivers when he's on the loading platform.

At a large electrical equipment plant, fork-lift trucks and a small locomotive are radio equipped, enabling the supervisor to contact his drivers and expedite the flow of materials. A similar system is in use at one large grocery warehouse.

Plant security officers have CB sets in their cars, and those on foot carry CB walkie-talkies for communicating with their supervisor at alarm headquarters. Since the walkie-talkies are used for communicating with licensed CB sets—even if they qualify for unlicensed operation—they must meet FCC technical standards for class D stations.

Walkie-talkies are often used at construction sites by personnel on foot (and riding construction elevators), for communicating with a supervisor equipped with a fixed CB set. They are also used in large parking lots, garages, and apartment

Metal box contains resistors to drop voltage to 12 volts on electrically-propelled vehicle.

This tiny locomotive is radio-equipped, as are fork-lift trucks used at this same plant.

houses for communicating with maintenance personnel.

The foregoing are typical industrial applications of class D Citizens-band radios. Equipment cost is quite low, ranging from around $70 to as much as $350. Most sets are in the under-$200 class. Power input to the final RF power amplifier is limited to 5 watts and antenna height to 20′ above the structure on which the antenna is mounted.

Class A Stations

Industrial CB radio systems also operate in the 460-470 mc UHF band. Class A stations employ FM sets similar to those used in the Business and Manufacturing radio services. Power input to the final stage is limited to 60 watts, but there is no restriction on antenna height. Communication from a base station to a mobile unit 20 miles distant is not uncommon when the base station antenna is effectively located. Class A stations may operate on only one of 48 channels; which one is specified in the station license. Class A stations, while intended primarily for voice communications, can be used for facsimile transmission and other purposes when special permission is granted by the FCC.

Requirements for Class B

Class B stations have 49 channels available to them in the 460-470 mc UHF band—the same 48 channels allocated to class A stations plus one wideband channel on 465 mc. Class B stations can use any channel without special permission, but they must use equipment that has been type-accepted by the FCC and operate the transmitter with no more than 5 watts input. Antenna height

is restricted since the center of the radiating portion of the antenna must be within 25 feet of the control point. Class B stations can be used for voice communication, radio control, and other types of emission, as long as channel-occupancy limits are not exceeded.

For point-to-point communication, class B stations can use microwave-type equipment, with carefully aimed beams. Since a class B station operating on 465 mc can occupy up to 4.95 mc of band space, it is possible to employ multiplex equipment to provide a large number of voice and control channels.

There is also another kind of class B station—a low-cost transceiver which has a self-excited transmitter and a superregenerative receiver. When properly installed and used, sets of this type provide short-range communications and are free of skip interference from distant stations because of the high operating frequency. Sets of this type are still being produced, although they have been largely superseded by class A and class D type sets.

Class C for Control

Portable transmitters that transmit tone signals for control of cranes and other machines are licensed as class C stations in the 27 mc Citizens band. There are six channels available for this purpose. On five of the channels, transmitter power input is limited to 5 watts; on one channel, 27.255 mc, up to 30 watts of transmitter power may be used.

Another industrial application for class C stations is the opening and closing of gates and doors by personnel in vehicles. A push button causes a tone-coded radio signal to be transmitted; this signal actuates

Citizens band radio has many uses around aircraft depots. Here's one mounted on tractor.

Extension loudspeaker at base station permits more flexibility of personnel in charge.

the door or gate control mechanism through a fixed radio receiver. In some cases, the vehicle is equipped with a telephone dial. The driver dials a prescribed number to open a specific door or gate, another to turn lights on and off, etc. The dial keys an audio oscillator that modulates the class C transmitter. At each point where some apparatus is to be controlled, there is a radio receiver equipped with a dial-pulse decoder.

While most remote control systems operate as class C stations, some are authorized in the 460-470 mc UHF band. They use either a low-cost class B transmitter operating on 465 mc, or a class A transmitter operating on one of the 49 specific channels under a class B license and with transmitter power limited to 5 watts input.

When the control signal is less than 1 second in duration, and does not recur more than once every 30 seconds, the control transmitter may operate on any frequency above 70 mc and no station license is required. However, the transmitter must conform to the requirements of Part 15 of FCC Rules and Regulations.

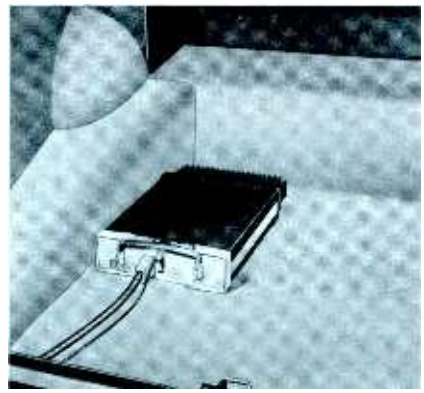
Both class A and D are used on material vehicles. Unit here is class A (460-470 mc).

Selling to Industry

Industry is a good market for the independent service shop operator selling CB equipment. Each prospective customer is generally interested in several CB sets, not just one or two (as is the case with hobbyists). Furthermore, industry wants equipment to operate with a minimum of down-time and is therefore an excellent service prospect. Almost every plant of reasonable size has several materials-handling vehicles. And many have vehicles that operate out of the plant area, but well within the 5-10 mile reliable range of CB sets.

Since down-time is often costly, it is a good idea to have spare sets available when servicing industrial CB installations. The 23-channel types are best for this purpose when the customers use class D equipment, since they are suitable for use in *any* system.

Installation sometimes poses some problems. At most base-station sites, AC power is usually available and most vehicles operated on roads are equipped with 12-volt storage batteries. But, materials-handling vehicles are apt to have a battery rated at 24, 32, 64 volts, or higher. Since no standard CB sets are designed to operate from these voltages, it is necessary to provide means for reducing or converting the voltage. An AC type CB set can be used with a DC-to-AC inverter to convert the DC battery voltage to 115 volts AC. Some makers build rotating-type inverters and motor generators for providing AC from almost any DC voltage.



Some class A radiotelephones are designed for installation in trunk of the automobile.

On a materials-handling vehicle, a plug-in base-loaded antenna may be attached directly to the CB set's antenna receptacle. Or, one of the short, loaded CB antennas can be installed on the vehicle body; the whip on these is only a little more than a yard long.

Class D Citizen-band radio equipment is available direct from manufacturers and through many distributors at discounts that allow the seller to compete with other CB dealers. Class A equipment is also available directly from some manufacturers at dealer discounts. Class C equipment is generally sold at radio parts distributors and hobby shops, but should be available on a direct basis from some manufacturers.

There are no figures on what percentage of the CB sets now in use are used by industry. Applications for CB station licenses from both hobbyists and industry are running at a rate of more than 20,000 per month. It is estimated that the average CB licensee buys three sets. This indicates that some 60,000 CB sets are being sold each month, representing annual business volume of $72,000,000 per year. Obviously, CB is well worth investigating as an added source of income. ▲

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