POPULAR ELECTRONICS

MARCH 1958

35 CENTS

Tubes Play Games

- Electronics and I.G.Y.
- Anot
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Fi

THE ACCENT IS ON VALUE... A LOW PRICED GENERAL COVERAGE RECEIVER

A new low-priced general coverage receiver featuring smart, modern styling.

Receiver is directly calibrated for the four general coverage ranges and five bandspread ranges for the amateur bands (80-10 meters).
Covers 540 KC to 40 MCS. Voice or CW.

NC-188 FEATURES:

- ★ Calibrated bandspread for 10, 11, 15, 20, 40 and 80 meter amateur bands. Separate tuning capacitors, knobs, and scales for general coverage and bandspread.
- ★ Large easy-to-read 12 inch slide-rule dial with combination edge and backlighting. Has large tuning knobs with two pointers for two scales; general coverage and bandspread.
- ★ Adequate over-all selectivity with nine miniature tubes including rectifier.
- ★ Has gang-tuned RF amplifier stage for increased sensitivity and image rejection.
- ★ Covers 540 KC to 40 MC in four bands.
- ★ Two IF amplifier stages and two audio stages with tone control.
- ★ Separate antenna trimmer on front panel.
- ★ Separate High Frequency oscillator tube for increased stability. Oscillator is temperature compensated and ventilated for increased stability.
- ★ Separate RF and AF gain controls.
- ★ Series type automatic noise limiter.
- ★ Receives AM, CW and SSB signals. BFO provided for CW and SSB.
- ★ Has "S" meter on front panel for signal strength indication and more accurate tuning.
- ★ Provision for balanced or unbalanced antenna input at 50 to 300 ohms.
- ★ Handsome two-tone gray cabinet.

COVERAGE:

BAND	GENERAL COVERAGE	BANDSPREAD
A	.54-1.6 MC	
B	1.6-4.7 MC	3.5-4.0 MC (80 meters)
C	4.7-15 MC	6.9-7.30 MC (40 meters)
D	14.0-40 MC	14.0-14.35 MC (20 meters)
		20.4-21.5 MC (15 meters)
		27.0-30 MC (10/11 meters)

TUNING SYSTEM: Separate general coverage and bandspread tuning capacitors connected in parallel on all bands. Bandspread, used primarily for tuning the amateur bands, can be used as vernier for general coverage use. Separate antenna trimmer control.

AUDIO SYSTEM: Two-stage audio amplifier with single 6AQ5 output tube provides 1.5 watts at less than 10% distortion. A handsomely styled accessory speaker is available. Phone jack.

SENSITIVITY: Under 2.5 microvolts (10 DB signal/noise ratio).

SELECTIVITY	NORMAL
6 DB	5.2 kc
60 DB	22 kc

CONTROLS: Main tuning; bandspread tuning; antenna trimmer; band selector switch; RF gain control; AC ON/OFF and AF gain control; stand-by-receive switch; noise limiter switch; tone control switch; BFO pitch control; AM/CW switch.

TUBE COMPLEMENT:

RF Amp.	6BA6	2nd IF Amp.	6BA6
Freq. Conv.	6BE6	Det, AVC and ANL	6AL5
HF Osc.	6C4	1st AF and BFO	12AT7
1st IF Amp.	6BA6	AF Output	6AQ5
		Rectifier	5Y3GT

OTHER SPECIFICATIONS:
Antenna Input: 50-300 Ohms, Balanced or unbalanced.
Size: 16-13/16" Wide x 10" High x 10-7/8" Deep.
Finish: Handsome two-tone gray wrinkle finish.
Shipping Weight: Approx. 35 lbs.
Optional Accessories: Matching Speaker.

Only $15.95* down
Up to 20 months to pay at most Receiver Distributors.
*Suggested Price: 159.95**
**Prices slightly higher west of Rockies and outside U.S.A.

Eight out of 10 U.S. Navy ships use National receivers

tuned to tomorrow

SINCE 1914 **National** COMPANY, INC.,
Malden 48, Mass.

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POPULAR ELECTRONICS

VOLUME 8 NUMBER 3

MARCH 1958

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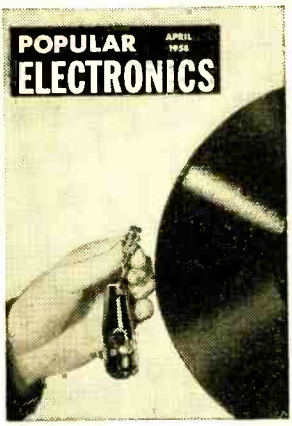
(Also see page 6 for DEPARTMENTS)

Cover photo by Daniel Rubin Studios
Games courtesy of Abercrombie & Fitch

Average Net Paid Circulation 261,625

DEPARTMENTS

COMING NEXT MONTH (APRIL)



(ON SALE MARCH 25)

Stereophonic music has heretofore been available only on prerecorded tapes, but now the third dimension has been added to music reproduction from disc records. POP'tronics' April cover shows the new stereo cartridge designed at Electro-Voice Inc. that uses only one diamond stylus yet picks out the music from two tracks cut into the sides of a single record groove. Secret of its operation is that the needle connects to two ceramic units which develop the two separate audio outputs.

How to . . . build a converter for receiving signals from U. S. satellites . . . substitute parts when you can't wait for the mailman . . . catch a vanishing ball . . . improve your tape recordings . . . these are but a few of the articles you'll find in the April issue.

IN THIS MONTH'S

RADIO & TV NEWS

(MARCH)

Receiving U. S. Satellite Signals
The Magic of Stereophonic Sound
Monitor Your Tone and Frequency
Upgrading the Hi-Fi Amplifier
Twelve Volts—Heater and Plate

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handsome hand-rubbed oak carrying case

Just 2 settings on the NEW FAST-CHECK TUBE TESTER Model FC-1

tests all tubes completely, accurately and in seconds — RIGHT ON THE SPOT

The FC-1 is the only tube tester in its price range to give a complete tube test of over 600 tube types in seconds without multiple switching or annoying checking of roll charts. You make every call pay extra dividends by merely showing your customer the actual condition and life expectancy of the tube. The extra tubes you sell each day will pay for the FAST-CHECK in a very short time.

WIDE RANGE OF OPERATION

Checks quality of over 600 tube types, which covers more than 99% of all TV and radio tubes in use today, including the newest series-string TV tubes, auto battery-type 12 plate-volt tubes, 0Z4s, magic eye tubes and gas regulators • Checks for cathode-heater and cathode-grid shorts and detects inter-element leakage up to 1.5 megohms • Checks for life expectancy.

Model AD-1 PICTURE TUBE ADAPTER — Also available for the FC-1. Checks all picture tubes (including the new short-neck 110 degree RCA-type picture tubes) for cathode emission, shorts and life expectancy. Also rejuvenates and restores cathode emission of weak picture tubes.

Model AD-1 (factory wired only) **$4.50**

Model FC-1W factory wired **$58.50** Net

Model FC-1K semi-kit form **$48.50** Net

OUTSTANDING VALUE FEATURES

Checks each section of multi-purpose tubes simultaneously. If one section is defective the tube will read "Bad" on the meter scale • 41 tube sockets accommodate all present and future tube types • Less than 10 seconds required to test any tube • Large D'Arsonval type meter is extremely sensitive, yet rugged . . . with two multi-color "Good-Bad" scales • Selection of 12 filament voltages • Line isolated • 7-pin and 9-pin straighteners mounted on panel • Large easy-to-read quick reference chart for over 600 tube types in use today • New tube listings furnished periodically.

Here's an *in-circuit* condenser tester that *does the whole job!*

The IN-CIRCUIT CONDENSER TESTER Model CT-1

Actually steps in and takes over where other in-circuit condenser testers fail. The tremendous range of operation makes it an absolute must for every serviceman.

Checks in-circuit:

Quality . . . including *leakage*, shorts, opens, and intermittents • Value of all condensers 200 mmfd. to .5 mfd. • Electrolytics for quality — any size • Transformer, socket and wiring leakage capacity.

Checks out-of-circuit:

Quality . . . including *leakage*, shorts, opens, and intermittents • Value of all condensers 50 mmfd. to .5 mfd. • Electrolytics for quality — any size • High leakage to 300 megohms • New or unknown condensers.

JUST A FEW FEATURES OF THE CT-1

Ultra-sensitive 2 tube drift-free circuitry • Multi-color scale gives simultaneous readings of both quality and value in-circuit or out-of-circuit • Cannot damage circuits • Electronic eye balance indicator for even greater accuracy • Line isolated • Fully shielded.

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Model CT-1K kit form **$24.95** Net

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- ☐ Model FC-1K (semi-kit) . . $48.50 —$12.50 within 10 days. Balance $9.00 monthly for 4 months.
- ☐ Model AD-1 CRT Adapter (wired) $4.50
- ☐ Model CT-1W (wired) . . . . $34.95—$9.95 within 10 days. Balance $5.00 monthly for 5 months.
- ☐ Model CT-1K (kit) . . . . . $24.95—$9.95 within 10 days. Balance $5.00 monthly for 3 months.

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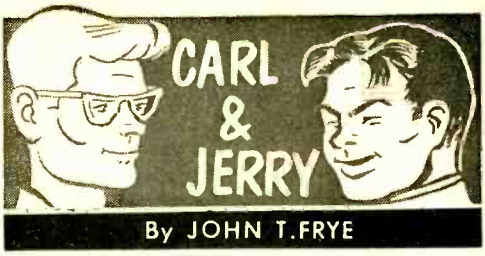
City ..... State .....



A Nickel's Worth

CARL AND JERRY were walking back to school after their lunch hour. "Walking" is really too staid a word to describe their gait—at least Carl's gait. He was flipping salted peanuts into the air one at a time with his thumb and then staggering wildly as he tried to catch the peanuts in his gaping mouth.

"Seven out of ten!" he announced triumphantly, putting the sack of nuts into his pocket and taking out his money to count it.

"With a satchel-mouth like yours, I don't see how you missed any," Jerry commented. "Now what's the matter?" he asked as Carl stopped short.

"This is what's the matter!" Carl exclaimed, holding up a shiny nickel. "That doggone clerk gave me a Canadian nickel when I bought the peanuts."

"Let me see it," Jerry said, taking the coin from Carl's fingers. "Say, you don't have anything to gripe about. This is Canada's famous Victory Nickel that was coined during the war. See, it's dated 1945. It was made of chrome-plated mild steel to conserve nickel, and it has an unusual feature of interest to hams. Around the edge of the 'tails' side, spelled out in International Morse Code, is the motto: 'We Win When We Work Willingly.' You have to have a sharp eye to make it out."

"How come you know so much about it?"

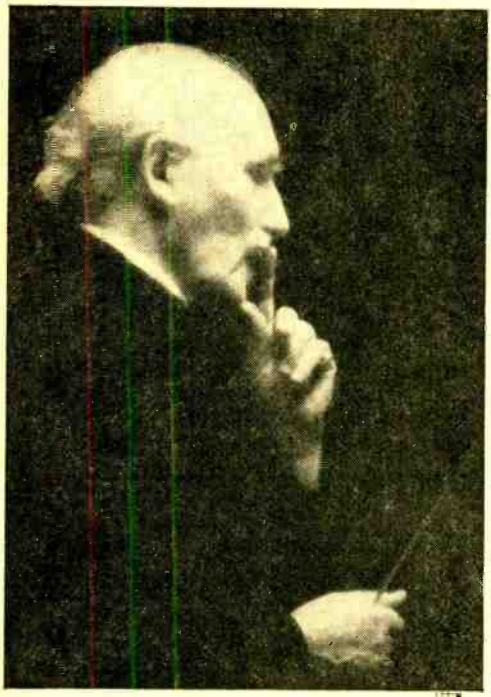
"My cousin got one for me when she was up in Canada on a fishing trip, and I read up on it. See; here's mine."

As a mollified Carl returned his coins to his pocket, he noticed that Jerry had a pair of earphones crammed into the pocket of his coat and that he was carrying some sort of tiny electronic gadget in his hand.

"What's that under-nourished looking thing?" he demanded.

"It's a little transistor audio oscillator that's supposed to operate on very low power," Jerry explained. "According to an article in last December's POPULAR ELECTRONICS, it should oscillate on the power furnished by a cell battery composed of a silver coin and a piece of paper soaked in salt water; but I can't get this one to take

RCA VICTOR and Book-of-the-Month Club



ANNOUNCE THE FORMATION OF

The RCA Victor Society of Great Music

. . . its common-sense purpose is to help serious lovers of music build up a fine record library *systematically* instead of haphazardly. By doing so, they can save **ALMOST ONE THIRD** of what they would pay otherwise for the same RCA VICTOR Red Seal Records.

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✶ Thereafter, continuing members can build their record library at almost a **ONE-THIRD SAVING.** For every two records purchased (from a group of at least fifty made available annually by the Society) *members will receive a third* RCA VICTOR *Red Seal Record free.*

✶ A cardinal feature of the plan is **GUIDANCE.** The Society has a Selection Panel whose sole business it is to determine "must-have" works for members. Members of the panel are as follows:

DEEMS TAYLOR, composer and commentator, Chairman.
SAMUEL CHOTZINOFF, General Music Director, NBC
JACQUES BARZUN, author and music critic
JOHN M. CONLY, editor of *High Fidelity*
AARON COPLAND, composer
ALFRED FRANKENSTEIN, music critic of *San Francisco Chronicle*
DOUGLAS MOORE, composer and Professor of Music, Columbia University
WILLIAM SCHUMAN, composer and president of Juilliard School of Music
CARLETON SPRAGUE SMITH, chief of Music Division, N. Y. Public Library
G. WALLACE WOODWORTH, Professor of Music, Harvard University

HOW THE SOCIETY OPERATES

EACH month, three or more RCA VICTOR Red Seal Records will be announced to members. One will always be singled out as the *record-of-the-month,* and unless the Society is otherwise instructed (on a simple form always provided), this record will be sent to the member. If the member does not want the work he may specify an alternate, or instruct the Society to send him nothing. For every record purchased, members will pay only $4.98, the nationally advertised price of RCA VICTOR Red Seal Records (plus a small charge for postage and handling).

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Carl & Jerry (*Continued from page 8*)

off that way. The transformer isn't the one specified, and that may have something to do with it. Anyway, I'm going to take it to the physics lab and put it on that variable-voltage power supply—and see just how much voltage and current are needed.

"Say, not to change the subject," he went on, "but do you want to help me with a little job before we go back to class?"

"Depends," Carl said warily.

"The mike on Mr. Stagg's desk in the office won't work; so he can't issue those thrilling communiques of his to the classrooms. He asked me if I would try to find the trouble. There's nothing wrong with the mike, because when I used another mike cable to hook it to the amplifier it worked okay. The trouble must be in the cable itself.

"According to the installation blueprint, this cable goes down through a hole in the floor under the desk, on down through a crawl space, and into a small storage room in the basement. Then it runs along the rafters for a short distance and comes back up through a partition into the amplifier located in that cloakroom just off the office. I think the cable is probably shorted or broken somewhere down in the basement."

"You want to look for it right now?"

"Yeah. Mr. Stagg suggested I do it during the spring vacation that starts right after school is out today, but I'd rather get it over with."

THE TWO BOYS entered the deserted basement, walked past the furnaces, and picked their way through a rubble of loose coal to the door of the little storeroom.

"It's a good thing the coal is about gone," Jerry shouted above the din of a nearby air-compressor and a couple of water pumps. "When this bin is full, the door of the storeroom is covered up."

The little room had no windows, but a switch on the wall turned on a naked bulb on the unfinished ceiling. Almost at once the boys spotted the black mike cable looping from rafter to rafter.

"Get that stepladder out there and let's have a closer look," Jerry suggested.

Carl got the ladder, and Jerry climbed up to where he could reach the cable.

"Hey, Carl, come up and look at this," he invited. "The guy who installed the mike cable fastened it to the rafters with bare staples, and he drove this one home so hard it nearly pinched the cable in two. See, it's entirely shorted out."

As Carl stood on the ladder below his friend, there was a sudden loud roar and the door that had been standing a little

Carl & Jerry (*Continued from page* 10)

ajar suddenly slammed shut. The noise—which sounded like a landslide—continued; and the boys could hear solid objects bumping against the closed door.

"Holy cow!" Carl gasped, "what's going on?"

The boys scrambled down off the ladder and rushed to the door; but even though they threw their full weight against it, they couldn't budge it.

"A truck must have backed up to that outside chute and dumped several tons of coal down it," Jerry said. "It's banked up against the door."

"And still more coming," Carl observed, as the thumping roar started again.

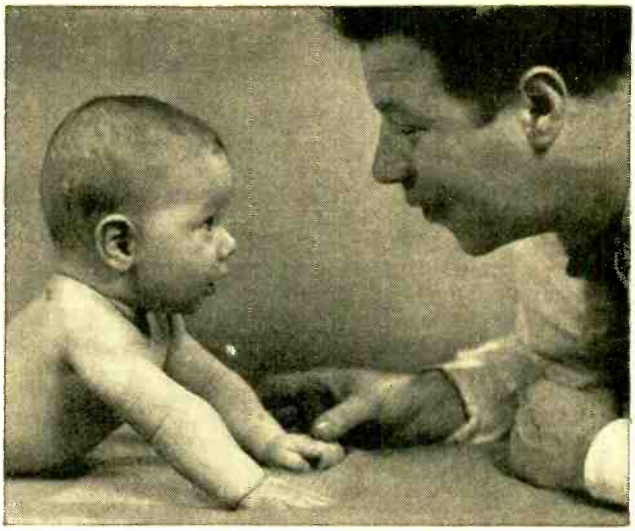
"Let's yell for help," Carl said, coughing because of the coal dust that sifted in around the cracks of the door.

THEY SHOUTED until they were hoarse, together and separately, but they had little hope of being heard. After the coal trucks had left, they could hear the rumble of the noisy boiler room only faintly through the door.

"Jer, I'm scared," Carl admitted as he looked wildly around the narrow confines of the small room. "No one knows we're down here, and they'd never think of looking for us behind a coal pile. Spring vacation starts in a couple of hours and then this building will be practically deserted

. . . The noise continued; and the boys could hear solid objects bumping against the closed door. "Holy cow!" Carl gasped, "what's going on?" . . .

YOUR MOVE, DAD!



The first frantic months of fatherhood are over. You have time now to really enjoy the new baby—and time to really think ahead.

There's plenty to think about. And lots to plan for. What kind of a Dad will you be? What kind of a provider?

One thing's sure: now you've got to earn more money! About $500 a year more, to start with. *But how?*

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Carl & Jerry (*Continued from page* 12)

for five days until school opens again."

"I know," Jerry muttered, with a face that looked strangely pasty in the glare of the unshaded bulb. "I'm just as scared as you are, but that's not going to do any good. It's a crazy time to remember quotations, but a saying of Teddy Roosevelt's is in my mind: 'Do what you can where you are with what you have'."

Jerry put the little transistor oscillator, the earphones, a small r.f. choke, two pennies, three nickels, and a quarter on the floor. All Carl could produce was the peanuts, a penknife, two nickels, two dimes, and a crumpled piece of paper.

"It's not much," Jerry said with a sigh.

"Had we better start rationing the peanuts?" Carl asked.

"You better not eat any," Jerry said grimly. "Water, not food, will be our worst problem if we don't get out of here; and eating salty peanuts isn't going to help that a bit."

"Know what you mean," Carl said, licking his lips. "I'm dying for some now."

JERRY was hardly listening. Instead his eyes were roving over every inch of the walls and ceiling of their prison, which seemed to grow smaller by the minute.

"The mike cable!" he suddenly exclaimed. "The amplifier is left turned on all the time school is in session. A switch on the mike mutes it. If we could only put some sort of signal into the cable, it would be piped all over the building."

"Might just touch the center lead of the mike cable and send code with the resulting hum," Carl suggested.

"We can try that as a last resort, but I'm afraid someone would think the amplifier was blowing up and shut it off. If this oscillator would only work, the musical note it puts out would get the attention we want. Suppose you cut that short out of the mike cable and bring the 'hot' end down here where we can reach it. I'll try again to make this transistor oscillate with a 'coin-cell.'"

In a short time, Carl had the end of the cable going to the amplifier ready for making a connection. Wire from the choke coil furnished leads for connecting the oscillator to the cell. Jerry made the cell by licking a piece of paper, sprinkling it with salt from the peanuts, and placing the wet paper on a quarter. He connected the coin to the positive lead of the oscillator, and touched the negative lead to the moist paper. Nothing happened. Nor did a bat-

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Carl & Jerry (*Continued from page* 14)

tery of two cells connected in series produce any better results.

"The oscillator must require more current than is furnished by these simple cells," Jerry said despondently. "Hooking them in series doesn't help because it doubles the resistance; otherwise, if the cells had lower resistance, we'd get more available voltage by hooking them in series."

"How about combinations of different coins?" Carl suggested.

"It's worth trying," Jerry answered, picking up a penny.

The pennies didn't work; neither did the first nickel tried; but when he slapped the next nickel on top of the paper and touched it with the wire, the oscillator gave out with a weak tone in the earphones.

"Hey, it's the Canadian nickel!" Jerry shouted. "Fix up another cell with your nickel and a dime and let's hook them in series."

"Okay, but you'll have to lick the paper," Carl said. "Dry as I am, all I could do with my tongue is dust it."

WHEN the two cells in series were hooked to the oscillator, it sang with a strong clear note. Carl held a cell in each hand, and Jerry made ready to key the oscillator into the amplifier by simply touching one of the output leads to the center conductor of the mike cable while the other output lead was fastened to the shield braid.

"I'm going to start 'SOS,' " he announced. "We've got to let people know we're trying to send a message before they think something is wrong with the amplifier and shut it off."

Very slowly he began touching the wires together, and the boys imagined they could hear a muffled roar coming from somewhere. Carefully Jerry spelled out: "SOS, SOS. Trapped in room behind coal in basement." Over and over he sent the message. Every few minutes the paper would dry out and the oscillator would quit until the bits of paper were licked again.

All at once the boys heard rattling outside the door and a muffled voice shouting, "Can you hear me?"

Carl and Jerry nearly deafened each other replying, and soon they heard the most beautiful sound in the world: the scraping of shovels against the coal outside the door. It was only minutes until the door was pulled open and the two boys walked out through a trench of coal into a

Carl & Jerry (*Continued from page* 16)

basement nearly filled with teachers and fellow students.

"Could you hear our message all right?" Carl asked Mr. Stagg, the principal, who looked funny but somehow more human with a coal scoop in his hand and his face smeared with coal dust.

"Could we hear it?" he boomed. "You just about turned every speaker cone in the building wrong-side-out!"

AFTER the hubbub was over, and Carl and Jerry had started for home, Carl said: "Say, Jer, why do you figure the Canadian nickel worked?"

"It must be that chrome-plating works with the silver coin to make a cell which puts out more current," Jerry said. "I believe the present U. S. nickel is made up of 25% nickel and 75% copper and that the present Canadian five-cent piece is 98.5% pure nickel. Both of them are probably better coins, but they can't hold a candle to that chrome-plated job when it comes to making a cell."

"If I ever gripe again about getting a Canadian nickel, I hope someone hits me with a double whammy!" Carl said earnestly. —30—

. . . Jerry keyed the oscillator into the amplifier by simply touching one of the output leads to the center conductor of the microphone cable . . .

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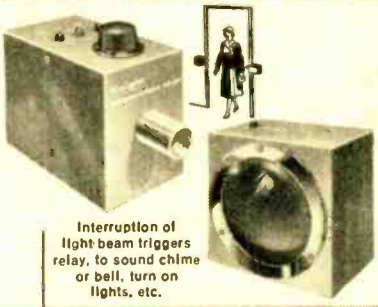

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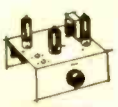

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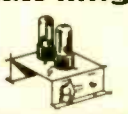

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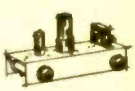

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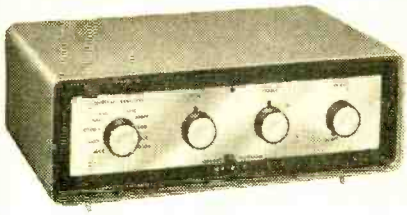

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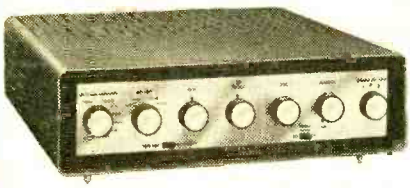

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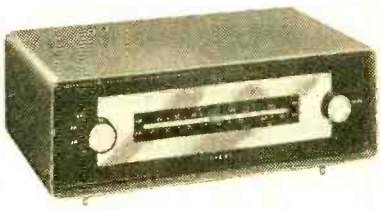

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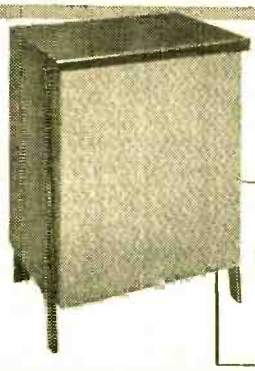

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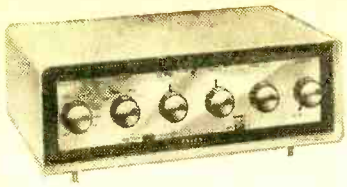

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■ I have built many of your home projects and find them very useful and fun to construct. I have a diathermy machine with two FV-20 tubes and would like to know if it is possible and practical to build a transmitter out of such a unit.

DOMENIC CAVOLO
Cleveland, Ohio

It is possible but not usually practical. The unit you have is probably using the power tubes as a push-pull self-excited oscillator. You need to convert this stage to an amplifier, and add a crystal oscillator or VFO, and at least one driver stage. Other refinements might be needed, depending on space available and bands of operation desired. We would suggest that the power supply be salvaged; but if it's an old diathermy, it may only contain a high-voltage power transformer—rectifier tubes, chokes and filter capacitors would then be needed.

She Sent Her QSL Card, Too

■ Here's another gal who reads and enjoys your magazine. The ham column was especially helpful to me when I was studying for my ticket.

MYRLIN KIRK
Los Angeles, Calif.

Specialty Issue

■ It seems to me that some months of the year your magazine publishes an extra good edition. One of these better-than-average months, I would say, was the October 1957 POPULAR ELECTRONICS which featured such articles as "Save That Old Radio," "Economy Multitester," "Wrap It Up with Off-the-Air Recording," and "Junior Fi for the Small Fry."

I don't think it would be stretching too far out on the limb to say that issue had as much "info" within its pages on radio, phono, and tape recorders as several other publications combined. The feature I liked best was: "I Hear You Talkin'" which described the construction of a transistor intercom.

J. B.
Philadelphia, Pa.

Fine business. Incidentally, regarding the article "Make Your Own Economy Multitester" on page 73 of the October issue, if anyone has difficulty in obtaining the Stancor Transformer specified, the Merit P3046 is a correct substitute.

Toy Tape Recorder Can Be Had

■ In your October 1957 issue, on page 92, I saw an article on a transistorized tape recorder called "Bambinophon." Could you please tell me its approximate cost and where or how to obtain one. I can easily reach any store in New York City or Philadelphia.

JOHN SANKY
Pennsauken 8, N. J.

■ Using my clumsy ninth-grade German, I wrote Dr. Windhaus concerning the toy tape recorder

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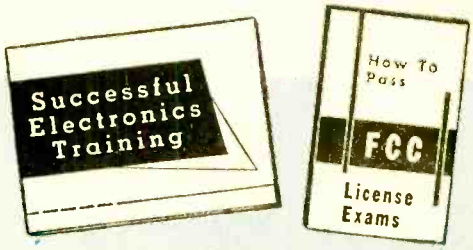

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James Glen:

James Glen:

When Jim enrolled, he was a temporary employee of the City of Tacoma, Washington. In the space of 14 months, he completed the Master Course and received his first class license. He is now installing and maintaining mobile and microwave equipment.

James S. Glen, Jr.
2920 Knob Hill Road
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In what kind of work are you now engaged? . . . . . .

In what branch of Electronics are you interested? . . . . . .

Name . . . . . Age . . . . .

Address . . . . . .

City . . . . . Zone . . . . State . . . . .

PE-36

Letters

(*Continued from page 24*)

"Bambinophon." Dr. Windhaus is not the one to contact for the letter will be referred to an American firm, Filnor Products, Inc., 101 W. 31st St., New York 1, N. Y. The "Bambinophon" is marketed under the name of "Teltape" in the U. S. and is available for $29.95 from Filnor.

DUDLEY GLASS III
Beverly Hills, Calif.

VHF Ear Becomes Radar Receiver

■ Just a line to let you know that you are putting out a real good magazine. Keep up the good work. A while back I built your "VHF Ear" and have seen some of the comments on it, so I thought I'd give you mine.

I took the "Ear" to the San Francisco International Airport to test. The airport has a full sweep radar, and every time the "dish" swung my way I could hear the "ping." I was right on the observation deck, so I had lots of variety. Can anybody who has built the "VHF Explorer's Receiver" (February, 1957) help me out with more info on it?

JOHN F. FISHER
724 Seventh Ave.
San Mateo, Calif.

Good Luck!

■ I want to say "thanx" for the short-wave listings in your November '57 issue. I just bought my Hallicrafters S85, and with your listing in my hand, look out, World, I'm here. Have followed your magazine from the first issue.

ROY BRAND
Bronx 52, N. Y.

Television DX Fan

■ I enjoyed the DX television article in the January issue of POPULAR ELECTRONICS and would like to see more of the same. I sincerely enjoy your *After Class* and *Carl and Jerry* articles. My friends and I believe this is the best magazine on electronics on the market.

THOMAS BRAZIER
Blythe, Calif.

We Multiply by Two Too Often

■ I'd like to call your attention to the goof in *After Class* for January '58. Under the subtitle "Denary to Binary," last paragraph, it reads, ". . . since 128 is 2^8." You should have stated that 128 is 2^7, as can be easily seen. I thoroughly enjoy your magazine when there aren't mistakes. Seriously, I follow many of your articles closely and like them all.

JAMES E. HOWARD
Los Angeles 19, Calif.

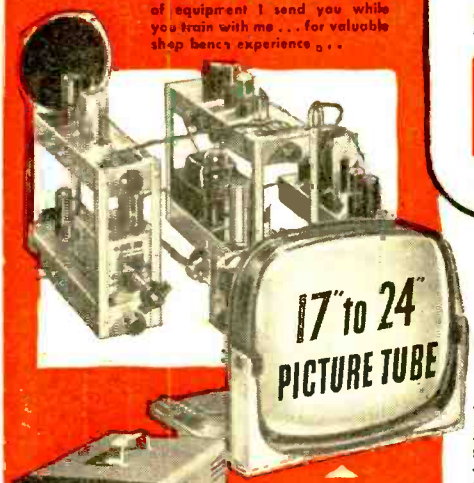
You're so right about the powers of two. —30—

PLEASE!

POP'tronics receives nearly 1000 letters a month from readers. Many request plans for special construction projects, analysis of service problems or opinions of commercial equipment. We wish it were possible to comply with individual personal attention but we do not sell plans, analysis or advice.

Learn PRACTICAL RADIO-TV with 25 BIG KITS

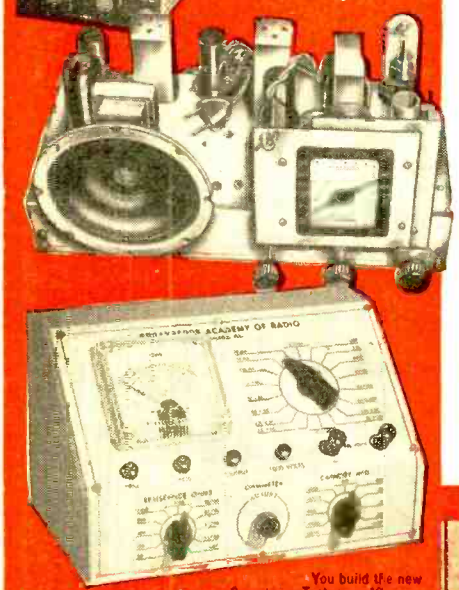
of equipment I send you while you train with me . . . for valuable shop bench experience . . .



The new Sprayberry Training Television receiver, built and tested in sections.

I now offer this fine modern oscilloscope.

You build this powerful 2 Band superhet radio receiver.



You build the new Sprayberry Tester . . . 18-range Volt-Ohm-Milliammeter readings.

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Frank L. Sprayberry
Educational
Director

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Why wait—get into Radio-Television fast! I will train you in as little as 10 months to step into the top paying Radio-Television field as a much-needed Service Technician! You will train entirely at home in your spare time . . . which means you can train as fast or as slowly as you like. You have a choice of THREE Sprayberry Training Plans . . . one *exactly* suited to your needs. My easier-than-ever payment terms make it possible for you to get set for the good jobs in Radio-Television without the slightest strain on your budget! Get the true facts . . . just mail the coupon for my big new 56 page fact-filled catalog plus actual sample lesson—both FREE.

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My students do better because I train both the mind and the hands. Sprayberry Training is offered in 25 individual training units, each includes a practice giving kit of parts and equipment . . . all yours to keep. You will gain priceless practical experience building the specially engineered Sprayberry Television Training Receiver, Two-Band Radio Set, Signal Generator, Audio Tester and the new Sprayberry 18 range Multi-Tester, plus other test units. You will have a complete set of Radio-TV test equipment to start your own shop. My lessons are regularly revised and every important new development is covered. My graduates are completely trained Radio-Television Service Technicians.

NEWEST DEVELOPMENTS

Your training covers U H F, Color Television, F M, Oscilloscope Servicing, High Fidelity Sound and Transistors.

MAIL THE COUPON—See what's ahead in Radio-TV . . . No Salesman Will Call On You!

The coupon below brings you my big new catalog plus an actual sample Sprayberry Lesson. I invite you to read the facts . . . to see that I actually illustrate every item in my training. With the facts in your hands, you will be able to decide. No salesman will call on you. The coupon places you under no obligation. Mail it now, today, and get ready for your place in Radio-Television.

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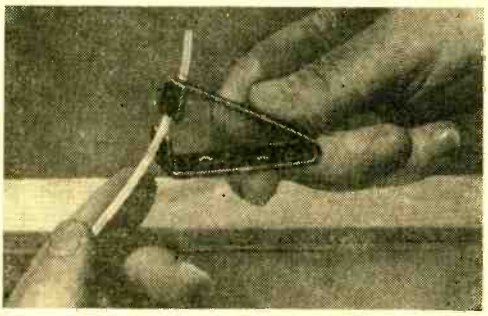
Address_____

City_____ Zone____ State____

TIPS and TECHNIQUES

IMPROVISED WIRE STRIPPER

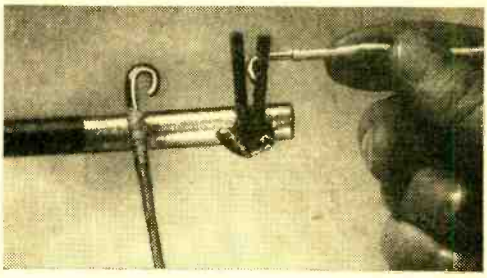
A good wire stripper can be made from a small strap hinge. Just cut off the ends



of the hinge at the beginning of the first screw holes, then bend over about ½" of each end so that they come together in scissor fashion. With a triangular file, dress the edges so that they will grip the insulation of a wire end introduced as shown here. Press down on the sides of the hinge just enough to cut the insulation as the wire is forcibly withdrawn. —*K. M.*

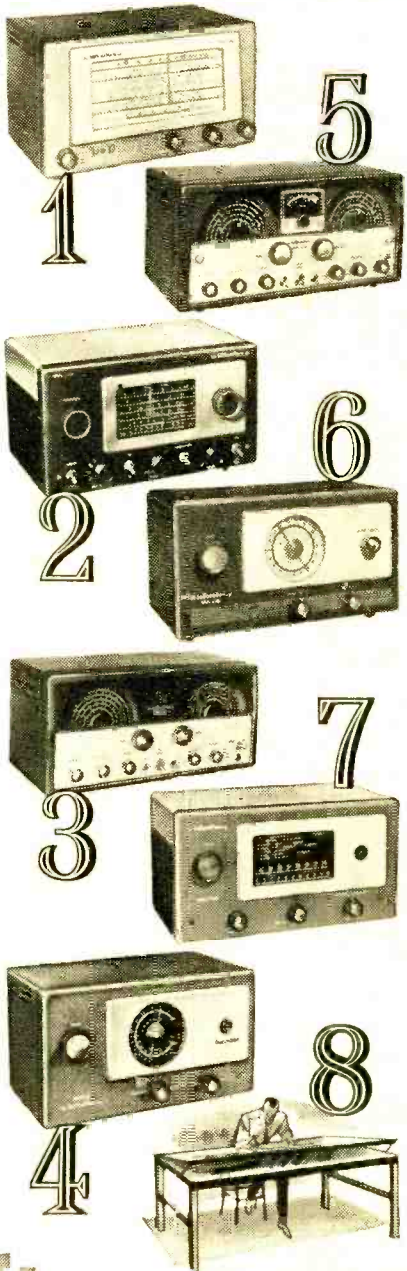
WIRE LOOPER

This simple tool will save time and do a good job of forming loops at the ends of



wire for making connections. Two 1½" headless bolts are welded at one end to a piece of bar or scrap iron which serves as a handle. Separate the free ends of the bolts to make a narrow "V." The stripped end of the wire to be looped is introduced from the rear and merely given a pull towards the front, forming a perfect loop. Spacing of the bolts allows the tool to handle wire

8 reasons why the world's most respected name in communications is hallicrafters



model S-38D $49.95

Wonderful starting point for the new amateur or short-wave listener. Same meticulous engineering found in all Hallicrafters equipment—at down to earth prices. Coverage: standard broadcast from 540-1650 kc. plus 3 short wave bands from 1650 kc. to 32 Mc.

model S-53A $89.95

Has easy-read overseas dial with international stations indicated. Electrical bandspread and logging scale. Complete with 5 in. speaker, headphone jacks plus phono-jack. Two stages of i.f. Coverage: standard broadcast from 540-1630 kc. plus four SW bands over 2.5—31 and 48—54.5 Mc.

model S-85, S-86 $119.95

A superb receiver that pulls them in on 10, 11, 15, 20, 40 and 80 meter amateur bands. Over 1000° calibrated bandspread gives better selectivity on large easy-to-read dial. Features separate tuning condenser and built-in PM 5" speaker. Coverage: Broadcast band 540-1680 kc. plus three S/W bands 1680 kc—34 Mc. S-85 AC, S-86 AC-DC.

model S-94, S-95 $59.95

Advanced models that bring in emergency radio, police and fire calls. Newly engineered FM chassis provides low frequency drift and low noise figure. Modern styling with simplified control gives easy operating. Coverage: S-94—30 to 50 Mc; S-95—152 to 173 Mc.

model SX-99 $149.95

The best at its price with all features demanded by DX enthusiast. Has "S" meter, separate bandspread tuning condenser, crystal filter and antenna trimmer. Easy-read dial has over 1000° calibrated bandspread through 10, 11, 15, 20, 40, and 80 meter amateur bands. Coverage: standard broadcast 540-1680 kc. plus three Short-Wave bands 1680 kc-34 Mc.

model S-102, S-106 $59.95

The only inexpensive complete receivers for 2 and 6 meter bands. New models with all of Hallicrafters famous engineering. Have 7 tubes with rectifiers, built-in 5" PM speaker, low frequency drift, compact bandspread design, phone jacks. Coverage: S-102—143 to 149 Mc. in 2 meter band; S-106—49 to 55 Mc. in 6 meter band.

model SX-104, SX-105 $89.95

Two new high frequency crystal controlled/tunable receivers at low cost. First time available on single band receiver. Ideal for monitoring government marine, fire, police and other emergency frequencies. Coverage: SX-104—30 to 50 Mc.; SX-105—152 to 173 Mc.

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Export Sales: International Operations, Raytheon Manufacturing Co., Waltham, Massachusetts

Tips

(*Continued from page* 28)

of all ordinary sizes. If desired, the bolts could be welded to one side of a tool case, or even to the shank of another tool such as a screwdriver, instead of being given a special handle as pictured in the photograph. —*K. M.*

SIGNAL TRACING AID

When practicing with a signal tracer on a receiver, the probe is touched to the input grid lug, and to the plate lug, on the tube socket of each stage. Students and novice experimenters often find it difficult to find the correct lugs in a hurry. It's a good idea to mark the input grid and the

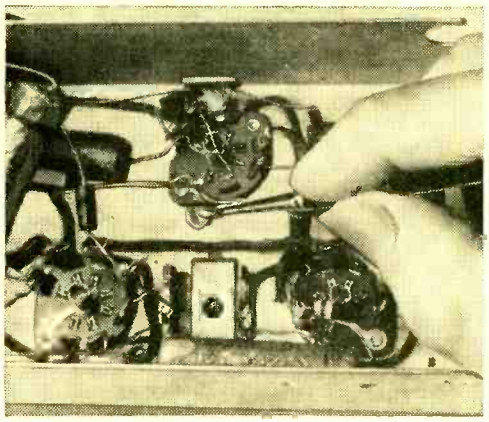
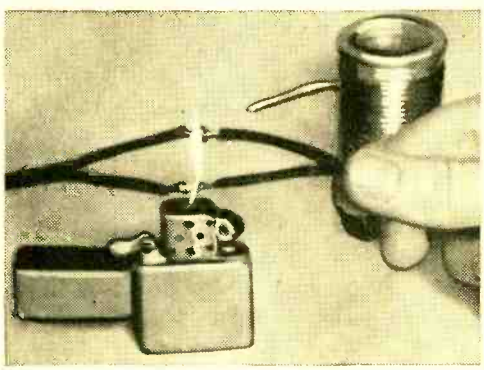


plate lugs with spots of paint so that they can be located readily. Put the paint on the chassis, side of socket, or on a wire lead, as close to the desired lug as possible. The EIA (RETMA) color code may be used for convenience. —*A. T.*

WHY HEAT AN IRON?

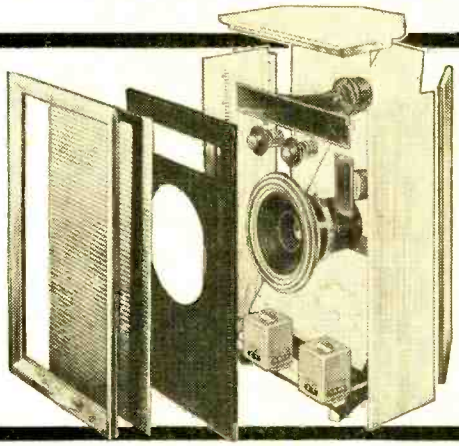
If you just have a couple of wires to solder together, there's no need to wait



several minutes for your iron to heat. Instead, use the flame of your lighter and some grade 50/50 or 60/40 resin core

(*Continued on page* 96)

FOR HI-FI ON A BUDGET, FOLLOW THE ELECTRO-VOICE BUILDING BLOCK PLAN



Start with your basic speaker and improve your compatible E-V high-fidelity system one economical step at a time by adding Electro-Voice Speaker Building Blocks.

Here, we've started with an SP12—12-inch coaxial driver. *Later, you add BB2*—a T35 very-high-frequency driver, X36 crossover and AT37 level control with wiring harness. BB2, Net $50. *Still later, augment with the BB4*—to smooth and disperse treble range. It includes T25A treble driver with 8HD horn, a second crossover—800-cps X8—and a second AT37 level control with wiring harness. BB4, Net $114.

Build Your Own E-V Speaker Enclosure with a Pre-Cut 'Do-It-Yourself' Kit.

There's no thrill like building your own speaker enclosure! Economize on your hi-fi system without sacrificing quality by assembling an E-V knock-down, pre-cut, pre-shaped and pre-drilled kit of korina plywood. Korina is high quality, fine-grain hardwood, naturally light in color and may be finished to match any shade. There are seven models to choose from.

Shown dis-assembled is E-V's KD 6 kit. In one short evening you can assemble a duplicate of our factory-built ARISTOCRAT enclosure of folded-horn corner design for use with 12-inch drivers or separate multi-way systems. Mounting boards are factory cut and fitted for later, easy addition of E-V treble and VHF drivers. KD6, Net $39.

These "DO-IT-YOURSELF" Books Show You How To Build It

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Each book gives complete, easy-to-follow, step-by-step instructions, diagrams and photos. Makes it simple to build your Hi-Fi Speaker Enclosure with an E-V K-D Kit—or with your own materials purchased at your local lumber yard and hardware store. Get the book of your choice *today* from your nearest E-V High-Fidelity Distributor.

Model IB1—For Patrician	$1.50
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Model IB3—For Centurion	1.00
Model IB4—For Regency	1.00
Model IB5—For Empire	1.00
Model IB6—For Aristocrat	1.00
Model IB7—For Baronet	.75

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POP'tronics BOOKSHELF

"RECEIVING AERIAL SYSTEMS" by I. A. Davidson. Published by Philosophical Library Inc., 15 East 40 St., New York 16, N. Y. 152 pages. Hard cover. $4.75.

Skylines of the major cities are sprouting a forest of TV antennas, and the problems associated with their installation are plaguing technicians daily. This practical little volume will help tremendously in clarifying a host of these problems.

The book is divided into four parts. The first part outlines the subject in general terms and explains impedance and gain directional characteristics, the second part discusses antenna types, and the third—their installation. Of special interest to the more technical-minded is the fourth section which is devoted to measurements and the derivation of technical data.

Recommended: to all dealing with the design, construction and installation of antennas for home radio and TV reception.

"BASIC ELECTRICITY" by Rufus P. Turner. Published by Technical Division, Rinehart & Co., Inc., 232 Madison Ave., New York, N. Y. 396 pages. Hard cover. $6.50.

This book is intended as a text for beginning students of electricity. Those who know the author's writings from the pages of POPULAR ELECTRONICS have come to appreciate his ability to make his explanations really clear. In this volume, his step-by-step method leads the reader gradually from the elementary to the more complex aspects of electricity without losing clarity at any point.

All the various aspects of the field are covered, from the physical fundamentals of electricity, through d.c. and a.c. circuits, transformer and motor theory, etc., to a final chapter on introductory electronics. Practical topics, such as wiring, telephone circuits, and test instruments are also treated at length. Each chapter is followed by a summary and comprehensive review questions through which the reader can check his understanding of the material presented.

Recommended: to beginning students of basic electricity. —30—

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Let National Schools, a Resident Technical School for over 50 years train you for today's unlimited opportunities in electronics! Our Shop Method trains you to be a MASTER-TECHNICIAN. Completely up to date, developed by experienced instructors and engineers, your Telerama Course will teach you all phases of the industry quickly, clearly and correctly. You can master the most modern projects, such as Color TV, printed circuits — even prepare for FCC License without taking a special course. You can handle sales, servicing, manufacturing, or make good money in your own business. SEND FOR FACTS TODAY!

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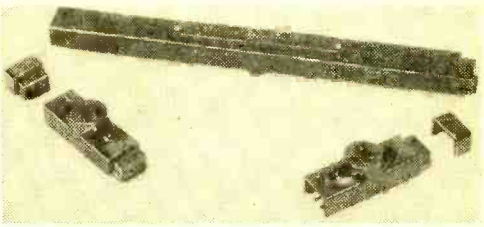
Complex and tangled electrical wiring arrangements for multiple-tool workbench setups can be eliminated by a new Pierceway five-piece three-wire outlet kit. With



it, you can install a compact system equipped to handle tools which require grounded outlets as well as those using conventional outlets.

Completely shockproof and approved by the Underwriters Laboratories, the 3W-4 kit is made of non-metallic, non-corrosive, and heat-resistant molded plastic, with male and female ends which lock firmly in a variety of interchangeable arrangements. List price $8.25. (*A. H. Massey, Inc.*, 111 Third St., Derby, Conn.)

VOLT-OHM-MILLIAMMETER

Quicker operation, increased sensitivity, higher accuracy and greater dependability are claimed possible with an improved version of the Simpson 260 volt-ohm-milliammeter. Among the new features of the Series III, as it is called, are: a polarity reversing switch that eliminates lead reversal; spread-out scales for faster readings; and a rugged printed circuit. A 50-μa. basic meter movement gives complete current coverage in six steps. A full-wave bridge rectifier has enabled the a.c. sensitivity to be increased to 5000 ohms per volt, and the frequency response now covers 5 to 500,000

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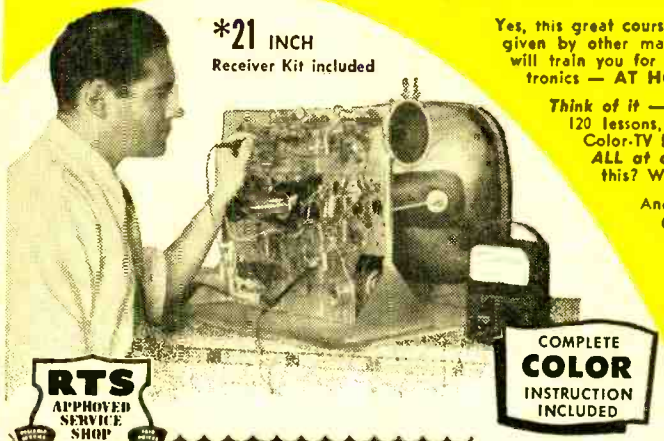

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This 35 year old training organization — called RTS, that's Radio-Television Training School — wants to establish a string of Radio-TV Repair Shops in principal cities throughout the U. S. So far, 36 such shops are NOW IN BUSINESS AND PROSPERING. We are signing contracts with ambitious men to become future owners and operators of these shops in all areas.

FOR UNSKILLED INEXPERIENCED MEN ONLY — WE TRAIN YOU OUR WAY!

We must insist that the men we sign up be trained in Radio-TV Repair, Merchandising and Sales by our training methods—because WE KNOW the requirements of the industry. Therefore, we will TRAIN YOU . . . we will show you how to earn EXTRA CASH, during the first month or two of your training period. YOU KEEP YOUR PRESENT JOB. TRAINING TAKES PLACE IN YOUR OWN HOME, IN YOUR SPARE TIME!

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find out how you can open
A REPAIR SHOP OF YOUR OWN

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When you are ready and qualified to operate one of our RTS-Approved TV Repair Shops ***WE WILL SUPPLY AND FINANCE EVERY BIT OF EQUIPMENT YOU NEED TO GET STARTED*** plus an inventory of parts and supplies. In other words *we will stake you* . . . **AN OFFER NEVER MADE BEFORE BY ANY TRAINING ORGANIZATION.** Under the RTS Business Plan you receive:

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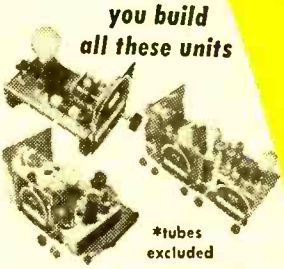
3. Letterheads, calling cards, repair tickets, etc.
4. Basic inventory of tubes, parts, supplies.
5. Complete advertising and promotional material.
6. Plans for shop arrangement.
7. Instructions on how to go into business.
8. Continuous consultation and help.
9. The right to use RTS Seal of Approval, and the RTS Credo.
10. The right to use the Famous Trade Mark.

you build all these units



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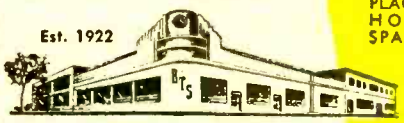

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Address _____

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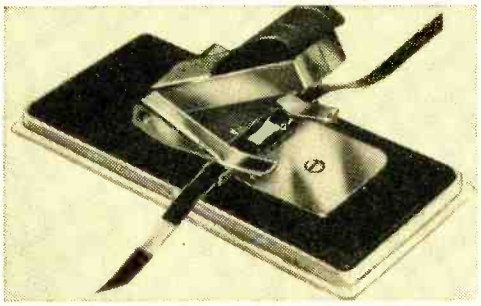
Tools

(*Continued from page* 34)

cycles per second. Price, $43.95. (*Simpson Electric Company,* 5200 W. Kinzie St., Chicago 44, Ill.)

IRISH TAPE SPLICER

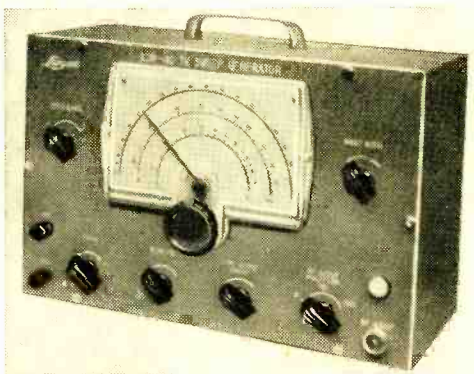
Designed for fast, precise tape editing and repairing, the Irish tape splicer will make a neat, professional splice in seconds. It cuts two rounded indentations in the tape splice, giving it a narrow waist and leaving the edges of the tape which con-



tact parts of the recorder entirely free of adhesive. With this splicer, as little as ¼" of tape need be removed to make a splice. List price, $8.85. (*ORRadio Industries, Inc.,* Shamrock Circle, Opelika, Ala.)

TV AND FM SWEEP GENERATOR

Here is a sweep-signal generator for FM and TV visual alignment without marker provisions—for those who already own an r.f. generator. The LSW-40 features a 2-mc. to 260-mc. range in two bands with a



variable sweep width of 0-12 mc., oscilloscope sweep output and electronic retrace blanking.

The sweep system is a highly linear, electromagnetic type. Power line connections and the oscillator are shielded for minimum r.f. leakage. Housed in a sturdy metal cabinet with carrying handle, finished in gray wrinkle, the LSW-40 measures 8" x 12" x 5" and weighs 18 lb. Net, $59.50, complete with 75-ohm and 300-ohm coaxial cables. (*Lafayette Radio,* 165-08 Liberty Ave., Jamaica 33, N. Y.) —30—

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PROGRESSIVE TEACHING METHOD

The Progressive Radio "Edu-Kit" is the foremost educational radio kit in the world, and is universally accepted as the standard in the field of electronics training. The "Edu-Kit" uses the modern educational principle of "Learn by Doing." Therefore you construct, learn schematics, study theory, practice trouble-shooting—all in a closely integrated program designed to provide an easily-learned, thorough and interesting background in radio.

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You will receive all parts and instructions necessary to build 16 different radio and electronics circuits, each guaranteed to operate. Our Kits contain tubes, tube sockets, variable, electrolytic, mica, ceramic and paper dielectric condensers, resistors, tie strips, coils, hardware, tubing, punched metal chassis, Instruction Manuals, hook-up wire, solder, etc.

In addition, you receive Printed Circuit materials, including Printed Circuit chassis, special tube sockets, hardware and instructions. You also receive a useful set of tools, a professional electric soldering iron, and a self-powered Dynamic Radio and Electronics Tester. The "Edu-Kit" also includes Code Instructions and the Progressive Code Oscillator, in addition to F.C.C.-type Questions and Answers for Radio Amateur License training. You will also receive lessons for servicing with the Progressive Signal Tracer and the Progressive Signal Injector, a High Fidelity Guide and a Quiz Book. You receive Membership in Radio-TV Club, Free Consultation Service, Certificate of Merit and Discount Privileges. You receive all parts, tools, instructions, etc. Everything is yours to keep.

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- PRINTED CIRCUITRY

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You will learn trouble-shooting and servicing in a progressive manner. You will practice repairs on the sets that you construct. You will learn symptoms and causes of troubles in home, portable and car radios. You will learn how to use the professional Signal Tracer, the unique Signal Injector and the dynamic Radio & Electronics Tester. While you are learning in this practical way, you will be able to do many a repair job for your friends and neighbors, and charge fees which will far exceed the price of the "Edu-Kit." Our Consultation Service will help you with any technical problems you may have.

J. Stataitis, of 25 Poplar Pl., Waterbury, Conn., writes: "I have repaired several sets for my friends, and made money. The "Edu-Kit" paid for itself. I was ready to spend $240 for a Course, but I found your ad and sent for your Kit."

FROM OUR MAIL BAG

Ben Valerio, P. O. Box 21, Magna, Utah: "The Edu-Kits are wonderful. Here I am sending you the questions and also the answers for them. I have been in Radio for the last seven years, but like to work with Radio Kits, and like to build Radio Testing Equipment. I enjoyed every minute I worked with the different kits; the Signal Tracer works fine. Also like to let you know that I feel proud of becoming a member of your Radio-TV Club."

Robert L. Shuff, 1534 Monroe Ave., Huntington, W. Va.: "Thought I would drop you a few lines to say that I received my Edu-Kit, and was really amazed that such a bargain can be had at such a low price. I have already started repairing radios and phonographs. My friends were really surprised to see me get into the swing of it so quickly. The Troubleshooting Tester that comes with the Kit is really swell, and finds the trouble, if there is any to be found."

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At no increase in price, the "Edu-Kit" now includes Printed Circuitry. You build a Printed Circuit Signal Injector, a unique servicing instrument that can detect many Radio and TV troubles. This revolutionary new technique of radio construction is now becoming popular in commercial radio and TV sets.

A Printed Circuit is a special insulated chassis on which has been deposited a conducting material which takes the place of wiring. The various parts are merely plugged in and soldered to terminals.

Printed Circuitry is the basis of modern Automation Electronics. A knowledge of this subject is a necessity today for anyone interested in Electronics.

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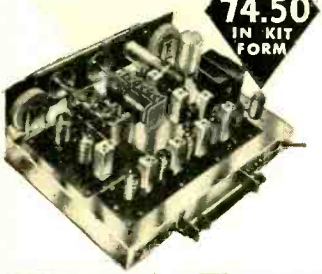


KT-500 74.50 IN KIT FORM

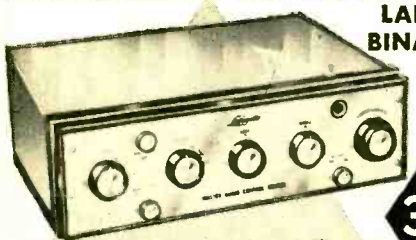
More than a year of research, planning and engineering went into the making of the Lafayette Stereo Tuner. Its unique flexibility permits the reception of binaural broadcasting (simultaneous transmission on both FM and AM), the independent operation of both the FM and AM sections at the same time, and the ordinary reception of either FM or AM. The AM and FM sections are separately tuned, each with a separate 3-gang tuning condenser, separate flywheel tuning and separate volume control for proper balancing when used for binaural programs. Simplified accurate knife-edge tuning is provided by magic eye which operates independently on FM and AM. Automatic frequency control "locks in" FM signal permanently. Aside from its unique flexibility, this is, above all else, a quality high-fidelity tuner incorporating features found exclusively in the highest priced tuners.

The 5 controls of the KT-500 are FM Volume, AM Volume, FM Tuning, AM Tuning and 5-position Function Selector Switch. Tastefully styled with gold-brass escutcheon having dark maroon background plus matching maroon knobs with gold inserts. The Lafayette Stereo Tuner was designed with the builder in mind. Two separate printed circuit boards make construction and wiring simple, even for such a complex unit. Complete kit includes all parts and metal cover, a step-by-step instruction manual, schematic and pictorial diagrams. Size is 13¾" W x 10⅜" D x 4½" H. Shpg. wt., 18 lbs.

The new Lafayette Model KT-500 Stereo FM-AM Tuner is a companion piece to the Models KT-300 Audio Control Center Kit and KT-400 70-watt Basic Amplifier Kit and the "Triumvirate" of these 3 units form the heart of a top quality stereo hi-fi system.

KT-500.....Net **74.50**

LAFAYETTE MASTER AUDIO CONTROL CENTER with BINAURAL CHANNEL AND DUAL VOLUME CONTROL.



KT-300 39.50 IN KIT FORM

- **Self-Powered • DC On All Filaments**
- **24 Positions of Equalization**
- **Tape Head Input, High Impedance**
- **Dual Cathode Follower Output Stages**

This is not only the finest hi-fi preamp characterized by unmatched features, but it has been functionally designed to keep pace with the conversion of your present hi-fi system to binaural (Stereophonic) sound. Incorporates an extra channel and dual volume control for binaural reproduction. Features include DC on all tube filaments, negative feedback in every stage, dual cathode follower output stages and latest printed circuit construction. Less than 0.09% IM distortion and less than 0.07 harmonic distortion at 1V. Hum and noise level better than 80 db below 3V. Uniformly flat frequency response over entire audible spectrum. 7 inputs for every type of phono, tuner or tape. Tasteful styling, brilliantly executed. Size 12¾" x 9⅛" x 3¾". Shpg. wt., 10½ lbs.

KT-300—Lafayette Master Audio Control Kit Complete with cage and detailed assembly instructions. .....Net **39.50**

LT-30—Same as above completely wired and tested with cage and instruction manual. .....Net **59.50**

KT-400 69.50 IN KIT FORM

- **Conservatively Rated At 70 Watts**
- **Metered Balance And Bias Adjust Controls**
- **Inverse Feedback • Variable Damping**
- **Available In Kit And Wired Form**

DELUXE 70 WATT BASIC AMPLIFIER

Here's ultra-stability in a 70 watt basic power amplifier employing highest quality components conservatively rated to insure performance and long life. Features matched pair KT 88's and wide range linear Chicago output transformer, variable damping control, meter for bias and balance and gold finish chassis. Frequency response 10-100,000 cps ± 1db. Hum and noise 90db below full output. IM distortion less than 1½% at 70 watts, less than 0.3% below 30 watts. Harmonic distortion less than 2% at 70 watts from 20 to 20,000 cps ± 1db. Output impedance 4, 8 and 16 ohms. Handsome decorative cage perforated for proper ventilation. Size 14½ x 10 x 7⅜" including cage and knobs. Shpg. wt., 40 lbs.

KT-400—Lafayette 70 watt Deluxe Basic Amplifier Kit complete with cage and detailed assembly instructions. .....Net **69.50**

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Lafayette is proud to present its 6 Transistor Superhet Receiver Kit KT-119. This kit represents the optimum in sensitivity, selectivity and stability. You'll be amazed at its superior commercial quality! You'll be elated with its surprising performance! The circuit uses 3 high frequency RF Transistors, 3 dependable audio Transistors and Crystal Diode and features a specially matched set of 3 I.F.'s, Oscillator, High-Q Loop, Class B Push-Pull Audio Amplification, and Transformer Coupling in audio and output stages. Special care has been taken in the design for exact impedance matching throughout to effect maximum transfer of power. Has efficient 2¾" speaker, and earphone jack for private listening. Complete with all parts, transistors, pre-punched chassis, and easy-to follow step-by-step instructions. 6" x 3½" x 1½". Shpg. wt., 3 lbs.

KT-119—Complete Kit—Less Case and Battery ..... Net **29.95**
MS-339—Sturdy, attractive brown leather case with carrying strap for KT-119 Shpg. wt., 1 lb. ..... Net **2.95**
MS-279—Sensitive matching earphone ..... Net **2.39**

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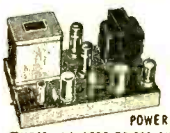

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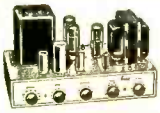

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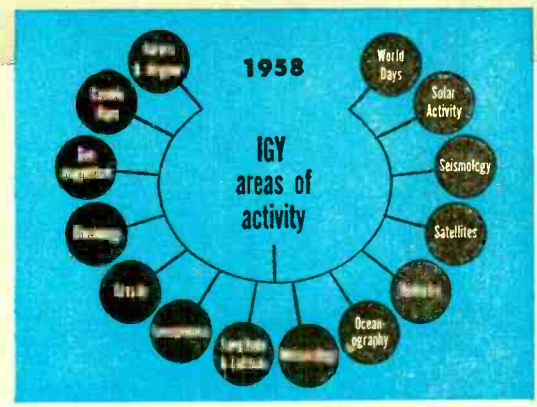
Electronics and IGY

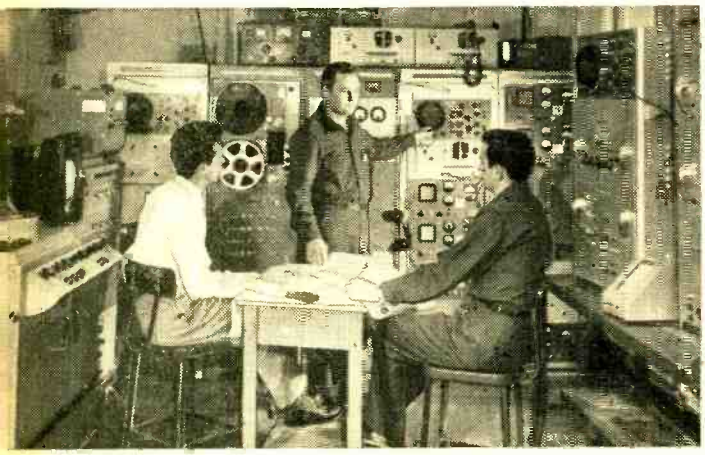
Amateurs are aiding science's greatest international effort



By MIKE BIENSTOCK
Associate Editor

SCIENTISTS are in the midst of a concerted assault on the secrets of Mother Earth the likes of which have never before been attempted. The International Geophysical Year will not end until December 31, but by that time some 5000 scientists of 67 nations will have accumulated enough data to keep electronic computers clacking for years. The results, when they finally become known, are expected to increase the knowledge of the planet we inhabit by a thousandfold. We Earthlings are compressed between two oceans—the mass of atmosphere extending above us for 200 miles or more, and the mass of water, plumbed to a depth of more than 35,000 feet. We are familiar with just the fringes of these oceans, and even there the acquaintance is only nodding. Of the land area of our world, our deepest oil well has only scratched the surface. We barely have touched the edges of Antarctica.

Interior of aircraft (right) instrumented for ionospheric research. The instrument in the foreground measures the heights of the layers in the ionosphere using vertical incidence pulses.



Measuring telemetered data from rockets in flight at an installation in Manitoba, Canada. At the far left is a telemetry recorder which takes data from airborne rockets; in the center is the main recorder which puts data on tape; the ballistic camera master control is at the right.

It has been said that we know more about the stars, since we are able to stand off and take a good look at them, while here on Earth, so close to our subject, we grow cross-eyed trying to view the "big picture." Actually, it is suspected that we are off several hundred feet in our measurement of distances between continents.

Fields of Research. The IGY has planned, since 1954, to concentrate in one 18-month period investigation into the fields of aurora and airglow, cosmic rays, geomagnetism, glaciology, gravity, ionospherics, longitude and latitude, meteorology, oceanography, rocketry, satellites, seismology, solar activity and "World Days." The latter are periods of all-out concentration on one subject when there is sufficient warning of some unusual event in that field, for example, sunspot activity.

Most of the effort is being devoted to the atmosphere and the electrical phenomena which occur there.

Besides the professional scientists giving all their energies to IGY, thousands of amateurs volunteer time as observers to aid the effort. Project Moonbeam, organized to use the abilities of radio amateurs and others, has been vital in tracking the earth satellites, despite the fact that the observers were forced to make a quick switch from 108 mc. (the frequency originally decided upon) to 20 and 40 mc., which the Soviet Sputniks employed.

Tracking Systems. The primary system for tracking satellites by radio and recording their telemetered signals is the "picket fence" of Minitrack stations manned by professionals. The supporting Moonbeam program uses a simpler Mark II Minitrack system as well as a different setup, Microlock. Both use phase comparison techniques, and the equipment is simple enough to be built by amateurs.

In addition to radio tracking, visual and photographic observations are used by amateur groups.

While the satellites thrown into orbit by the Soviets and the United States are expected to reveal an astonishing amount of information in regard to the nature of the upper atmosphere, cosmic rays, auroras and the ionosphere, other devices mainly dependent on electronics are already con-

tributing extensive data to the effort.

For instance, radiotelescopes around the world are concentrating their antennas on the sun. Sunspots seem to be related to tremendous explosions on the sun that shoot out streams of charged particles, ultraviolet light and x-rays. Immediately after such "storms" on the sun, violent atmospheric disturbances occur. Very quickly short-wave communications fade, auroras burst forth in the northern and southern skies, cosmic ray intensity increases and the magnetic field of the earth shifts rapidly.

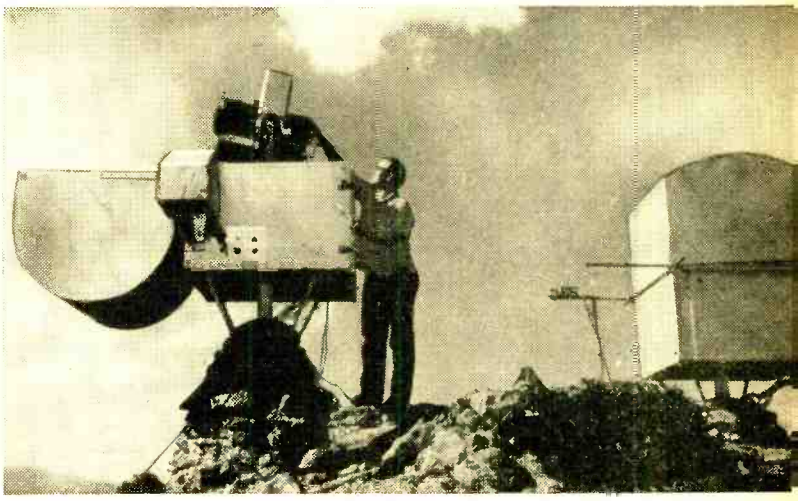
Strangely enough, not all sun "storms" cause these upheavals on earth. One of the things IGY is attempting to discover is the reason for this.

All during IGY, when such storms are detected, the world warning center at Fort Belvoir, Va., will be sending out alerts for special "World Days," during which scientists concentrate all of their energies on measuring whatever disturbances may occur. Up go "rockoons" (rockets launched from balloons) and Aerobee rockets fitted with delicate instruments to measure the intensities of x-rays, cosmic rays, ultraviolet radiation and such. A close check on the "shifting" of the E and F layers of the ionosphere is kept to determine the relationship of sunspots to such movements. Already a new layer of ionization, 12 miles below the lowest point, has been discovered. It was learned that this new layer was caused by solar x-ray emission associated with solar flares. Meanwhile, the normal layers of ionization, E and F, seem to remain stationary during a blackout, contrary to former opinion. It may be, therefore, that radio blackouts are caused by signal absorption in the newly discovered layer.

Watch on the Mountain. A new instrument, the recording photometer, keeps watch on Fritz Peak, Colorado, to determine the change in the intensity of airglow—a light so faint we can barely see it. This phenomenon is believed to come from some chemical reaction of oxygen, sodium and other ions in the D layer, about 60 miles up, and may be affected by solar storms.

Cosmic rays are getting the once-over for another reason: they give us an important clue to the character of the earth's magnetic field. Since they are charged particles, they are deflected by the earth's magnetic lines of force. Near the magnetic poles, where the lines are nearly vertical, there is little deflection, and therefore a greater intensity of cosmic radiation than along the magnetic equator, where the lines are close to horizontal. About 100 stations around the earth are measuring constantly the strength of cosmic rays, using two delicate electronic instruments, a neutron counter, sensitive to low-energy rays, and a meson "telescope," more sensitive to high-energy radiation. Collating the hundreds of thousands of readings of these instruments, scientists should be able to obtain a much better understanding of the shape and intensity of the earth's magnetic field.

Another important study will be that of "whistlers," faint chirping and whistling noises discovered during the First World War. Back in 1950 it was learned that these noises are actually caused by low-frequency waves from lightning discharges, which follow the earth's magnetic

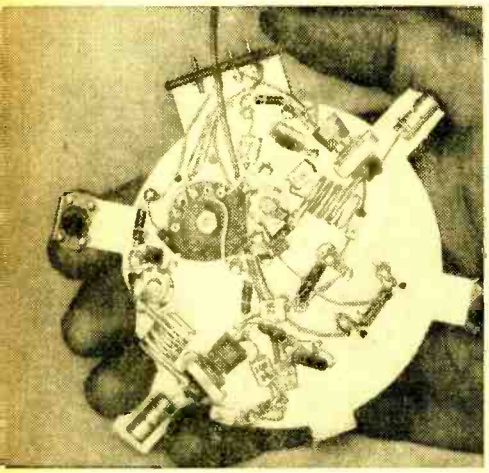


Scanning photoelectric photometer selects and measures the intensity of light too faint for the human eye and records its changes. This airglow camera is at Fritz Peak, Colorado.

lines of force from the point of origin, out into space, and back along the lines to the opposite hemisphere.

A huge antenna has been erected across a ravine in Colorado which is used to pick up these whistlers. A field station nearby amplifies them and records them on tape for future study. Another form of whistle is also being recorded there—the "dawn chorus." These noises, reminiscent of the pipings of frogs at dawn, are thought to be caused by streams of hydrogen ions at the edge of the atmosphere. Study may be able to correlate these noises with the intensity of solar storms.

With the advent of the forward scatter technique, which utilizes the ionosphere to bounce signals back to earth hundreds of miles away, engineers are anxious to learn all they can about this unreliable phenomenon so they can use it more effectively.



Radio transmitter with a 4000-mile range (upper left) is part of the electronic instrumentation of the U.S. earth satellite. Also in the tiny "moon" is a 48-channel encoder (lower left) which receives and encodes data from other satellite instruments for transmittal back to the earth.

The National Bureau of Standards has set up test transmitters in South America to use the forward scatter technique across the magnetic equator. It is suspected that this method will be especially effective because the ionization layer theoretically should line up with the magnetic lines of force, thus making for more even scatter propagation. Again the radio amateurs assist in the IGY program, since many of them listen for these transmissions, especially in the western part of the country and in Mexico, and send their reports to the Bureau of Standards.

Auroras. Another important study is that of auroras. These intensely beautiful phenomena are believed to be set off by streams of hydrogen ions caused by solar storms. The ions are thought to react with the atoms of the upper atmosphere and make them glow like a fluorescent lamp. Some scientists had thought that auroras should occur simultaneously at both of the poles. This has now been established as a fact. Amateur astronomers have been recording the shape and intensity, as well as the angle above the horizon, of auroras in the upper northern regions. Concurrent investigations by meteorologists at the South Pole made the confirming study.

It is believed that auroras occur in daytime, although they can't be seen then. Therefore, observers near the auroral zone use sensitive radars to try to pick up reflections from the electron clouds which accompany auroras during daylight hours.

Although the IGY program will end officially Dec. 31, 1958, a good many projects will continue in operation. As a matter of fact, they may be prolonged indefinitely, especially those that are fairly inexpensive to maintain.

World data centers are being planned in the United States, the Soviet Union and other areas, in which digested results of the observations will be filed for scientists. It is not expected that such results will be put into usable form before 1965, but after that date science textbooks may have to be thoroughly rewritten because of IGY's results. —30—

VIP's Are Hams Too!

It's often a surprise to find who's behind the mike or key at the other end of a QSO

By PERRY F. WILLIAMS, W1UED

INSTALLING some new radio transmitting equipment at an Army base in Cyprus after World War II, Staff Sgt. Pappy Henderson found himself short of several badly needed parts. One evening, while working his ham radio "rig," he sent out a CQ and hooked up with D4AFE in Wiesbaden, Germany. Since this was the location of theater headquarters, Pappy asked the other ham if he knew any "brass" who could pry loose his urgent request for supplies.

D4AFE did considerably better than that—the material was aboard a plane for Cyprus the same day. What Pappy didn't know was that D4AFE was the then Lt. General Curtis LeMay, Commander of the U.S. Army Air Forces in Europe!

Like many prominent men with eight-ulcer jobs, General LeMay, now four-star Vice Chief of Staff of the Air Force, finds needed relaxation through informal radio chats with "neighbors"—perhaps thousands of miles away—through the twentieth-century magic of amateur radio.

One of LeMay's close friends is also an amateur radioman, who got his start as a Navy radio operator. Later he turned to the field of radio entertainment, and built up quite a reputation. Radio amateurs know him as K4LIB; you know him as CBS network star Arthur Godfrey.

Even though Godfrey spends many hours each week using radio and TV professionally, he finds amateur radio a relaxing and enjoyable hobby. When he went on a hunt-

Gen. Curtis LeMay, D4AFE

Arthur Godfrey, K4LIB

Herbert Hoover Jr., W6ZH and K6EV

ing trip to Africa with LeMay last year, they brought along some ham radio gear and kept in touch with the folks in Virginia.

Profitable Hobby. Amateur radio is one of the few fields in which you can be a professional without altering your status as an amateur. A very democratic fraternity—Godfrey and LeMay are known to hundreds of fellow-hams by their first names—America's 160,000 FCC-licensed amateurs come from all walks of life, all ages, all races and creeds, drawn by the attractions of this scientific, many-sided hobby. Some enjoy building equipment, trying out all sorts of circuits and ideas. For others, tinkering as amateurs has led to profitable and enjoyable careers.

Arthur Collins, for instance, first built ham rigs for himself. When other hams became interested in his designs, he formed the Collins Radio Co. and started producing amateur equipment commercially in the 1930's. Today, still a ham (WØCXX), and still producing top-grade ham gear, he heads one of the largest companies making aircraft radio equipment for the airlines and the military.

Another company well known to amateurs and short-wave listeners—Hallicrafters—was founded by amateur William J. Halligan, W9AC. Gilbert Gustafson's hobby, too, has led to a solid career: he is a vice-president of Zenith, in charge of engineering for the huge radio-TV manufacturing concern, while still hamming with the call W9AQS.

HOW TO GET YOUR HAM LICENSE

You don't have to be rich, famous, or an engineer to become a ham. There's no age limit, at either end of life, and there's no charge for the licenses which are issued by the FCC to those who have qualified. Children as young as six have passed the Novice Class examination; one old gent is still hamming at 92.

You can take your studying in easy stages, with actual on-the-air practice in between. The Novice exam requires only an International Morse Code speed of five words a minute—sending and receiving—and a simple written test mainly concerned with FCC rules governing amateur operation. This license is good for a year, and allows low-power operation in four amateur bands, including one band for voice conversations and three for code.

From this license, you can go on to one that's tougher technically but that doesn't require any increase in code speed. This is called the Technician license, and permits operation in most of the very-high-frequency bands. It is becoming very popular, especially in the larger cities and metropolitan areas. A Technician license is good for five years, and can be renewed easily.

The goal of most hams is possession of a General Class license, requiring 13 words per minute in code, and a fairly thorough (though not too tough) exam in radio theory as well as regulations. The General Class amateur can operate "phone" (as hams call voice), code, or radioteletype in every authorized amateur band, and can even operate TV and facsimile in some bands. This license, too, is good for five years and is renewable.

You can either build or buy your equipment. Most hams buy receivers already assembled and tested, because proper checking of a complicated communications receiver usually takes a fair amount of skill and considerable equipment. Some hams build transmitters from scratch, either with a design of their own or one which has appeared in a magazine or technical book. Others buy kits containing the necessary parts, punched chassis, cabinets, knobs, tubes and all, and build their transmitters according to detailed instruction books furnished with the kits. Still others prefer to buy their transmitters wired, tested and ready to plug into the wall.

Adequate transmitting and receiving antennas can be made from wire even by inexperienced people. Later on, you might want a more complicated directional antenna shaped like those used for TV but usually quite a bit larger; there are several types available from many different manufacturers.

Arthur Collins, WØCXX

William J. Halligan, W9AC

Allen B. Du Mont

Dr. Allen B. Du Mont, TV pioneer and head of Du Mont Labs., and Ross D. Siragusa, president of Admiral Corp., while no longer hams, got their start in this hobby. Two well-known scientists, E. Finley Carter, director of the Stanford Research Institute, and Cyril J. Staud, vice-president for research of Eastman-Kodak, are long-time amateurs, with the calls K6GT and K2DQ respectively.

Amateur radio is a proving ground for new ideas. Lt. General Francis H. Griswold, deputy chief of the Strategic Air Command, was quite impressed with the compact yet highly effective "single-sideband" equipment used by amateurs. A ham radio operator himself, Griswold averted the delays which would have been inevitable through professional and military tests and evaluation of the new system—he installed amateur sideband gear in several SAC aircraft and found he could maintain two-way contact with amateurs all over the world while the huge bombers were navigating the globe. Its practicality and efficiency thus quickly proved, the new sideband form of voice transmission has now become the standard for military aircraft.

Specialized Hams. But this hobby is not reserved for engineers and engineers-to-be. Its other facets are appealing to people with little scientific or mechanical bent.

There are the "DX hounds," those who try to hold chats with amateurs in as many different countries, possessions and territories as possible. There are "traffic men," who meet on the air regularly in networks to relay messages for other amateurs and the general public, free of charge.

There are contest fans, who delight in the fast and snappy operating to be found in numerous contests sponsored by the hams' national organization—the American Radio Relay League, foreign societies, and local clubs throughout the country. And there are the hams who specialize in emer-

(*Continued on page* 115)

BOOKS ON AMATEUR RADIO

A set of four useful booklets called the "Gateway to Amateur Radio" is published by the American Radio Relay League, which provides technical books and booklets at reasonable cost to amateurs and would-be amateurs.

Included in the set is the "*Radio Amateur's License Manual*," which contains the full text of the FCC regulations, sample questions and answers, information on where to obtain application blanks and exam papers, and other useful material. A second booklet, "*How to Become a Radio Amateur*," shows you how to build simple transmitters and receivers, and explains in simple terms what makes radio work. The third one, "*Learning the Radiotelegraph Code*," not only tells you how to learn the code, but includes practice material and suggestions for constructing buzzers or oscillators so that you can send the code. The remaining booklet, "*Operating an Amateur Radio Station*," explains many of the "Q-signals," abbreviations and jargon that hams use, and in addition, describes the ARRL and its services.

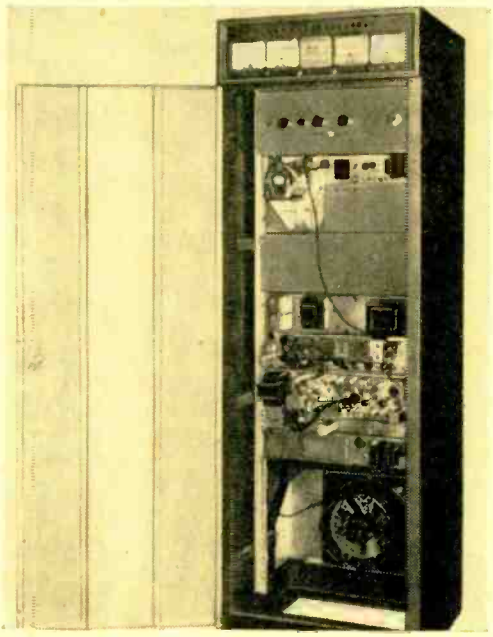
The "Gateway to Amateur Radio" can be obtained in most radio parts stores, or you can write Department P, American Radio Relay League, 38 La Salle Rd., West Hartford 7, Conn., for further information.

Transistorized Metal Locator

Treasure hunters will find the new all-transistor metal locator made by Fisher Research Labs, Palo Alto, Calif., a boon to their efforts. The detector (above) features printed circuits, a plastic case, and single-turn solid aluminum detecting loops. It is said to give more depth penetration than ever before. Battery life is estimated at 1500 hours of continuous operation. Other features include a built-in battery tester, power selection control and a detachable carrying belt. The operating weight of the "Explorer" M-Scope Locator is only 12 pounds.

New U.H.F. Transmitter

General Electric has developed a high-power u.h.f. base station transmitter (below) designed to give mobile system dispatchers wider range. Delivering up to 250 watts, it can be licensed to work in the 450-460 mc. band. The unit will allow dispatchers to talk up to 30 miles, 50% farther than with earlier 15-watt models. This more than doubles the area of coverage, and will help assure better signal reception in ordinarily "dead spots." Automatic voltage regulation assures peak efficiency. All components and test points are readily accessible from front or rear. No hazardous voltages are exposed when the door of the cabinet is opened.



High-Style Home Intercoms Make Their Bow

A series of low-priced wire and wireless home intercoms has been developed by Masco, Long Island City, N. Y. Styled by Stanley Chamberlain, noted industrial designer, the models run from the wireless "Electronic Nurse" at $12.95 to the "Wire-Less-Com," two stations, at $34.95. The wireless models make use of the power line in the home to carry the signal. Below is "E-Z Talk," two stations, at $14.95.

Play Games with Nixie Tubes

By HARVEY POLLACK

YOU CAN THROW AWAY the whirling number wheels, the tumbling golf balls in the squirrel cage, and the gallopin' dominoes! It's much more fun to play Bingo, Roulette, Put-and-Take, Quizzo, boy-girl parlor games, and a host of other games—electronically! By merely pressing a button, you can display a pair of randomly selected numbers for all kinds of numerical games in shining neon lights visible up to 20 feet away.

This simple form of digital presentation is made possible by a modern little electron tube called a "Nixie." Although specifically designed for computer panel read-out systems, the Nixie can be used in any device where any digit from 0 to 9 is to be displayed to a group of viewers.

By using two Nixies, a pair of tiny electric motors, two printed-circuit commutator boards, and a suitable power source, you can make up a game machine that will put new life in the dullest party, spark community and church affairs, and even help the youngsters in the house practice their arithmetic. All you do is push the button. Whirling motors flash the Nixie numbers inside the tubes too fast for the eye to follow. When the button is released, the motors come to rest, leaving two glowing numbers for everyone to see.

CONSTRUCTION

Numerical selection is accomplished by a wiper installed on the motor gear. As the armature rotates, the

"NIXIE" GAMES YOU CAN PLAY

Bingo. This game is played in the usual manner. The players are issued numbered cards on which the numbers are crossed out as the Nixie Gamester reads them out. When all the numbers in any horizontal, vertical, or diagonal row are crossed out, the player calls out "Bingo" and is a winner. Unlike other readout methods, the Nixie numerals are clearly visible to all players.

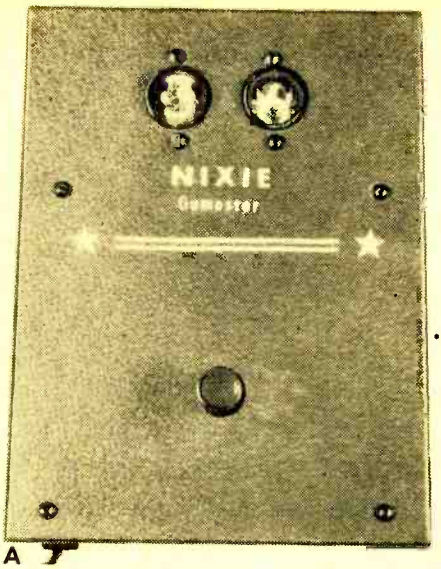
Roulette. A good system to use for this game is the addition of numerals. For instance, if the Nixies show a 3 and a 6, then the winning number is 9. For double zero (00) or a double blankout, all points go to the bank. A large piece of oaktag divided into 18 squares makes a good roulette board.

Monopoly, Cops-and-Robbers, etc. Any game played with dice or a spinning pointer is a natural for the Nixie Gamester. Make up your own house rules as to whether the digits are added or subtracted.

Put-and-Take. For those who remember this game, the advantage of the Nixie Gamester over the old flat-sided top will be apparent immediately. Call the left Nixie digit "put" and the right one "take." The game is played with chips, marbles, picture cards, etc. A pot is started by each player contributing ten items. Then each player takes his turn "putting" and "taking" as the numerals dictate. A double zero or double blankout means "take all."

Party Games. The Nixie Gamester provides a new twist on the ancient games of "Spin the Bottle" and "Post Office." If there are ten couples at the party, each girl and boy are assigned a number (left-hand Nixie for the girls, right for the boys). A tantalizing spin of the motors, and a girl and boy are paired at random to go out and look at the stars. Should there be fewer than ten couples, certain lucky ones may be assigned two numbers, thus doubling their opportunities to have a chance at some social astronomy. In this game, a single or double blankout has no significance.

Quizzo. The group is divided into two teams. As the Nixie Gamester calls out the digits, the "left" team and "right"team must answer questions numbered according to the readout. Other variations of this idea are easy to dream up so that the party can be kept under full steam.

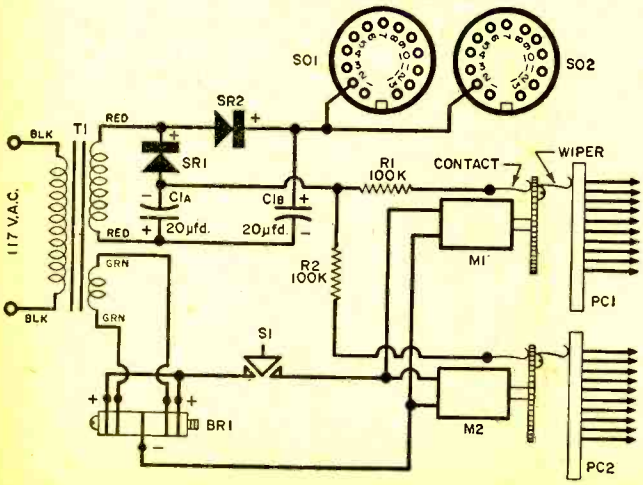


A

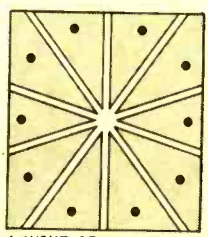
wiper arm contacts successively ten copper segments separated by etched grooves on a printed-circuit board which serves as a commutator.

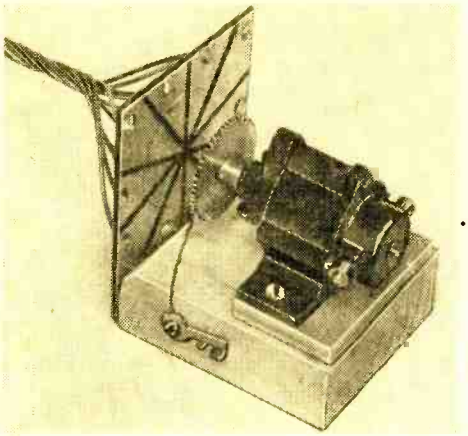
Prepare the Commutators. Using a fine-toothed hacksaw blade, cut a single piece of 2" x 4½" XXXP copper laminate board exactly in half. Make up a little cardboard wedge having an angle of exactly 36° with the help of a protractor. Using the wedge as a template, divide the laminate into ten equal segments of 36° each, and score the copper lightly with a sharp-pointed tool to mark the divisions.

Lay strips of 1/32" resist tape over the score lines and press their adhesive sides firmly down on the copper. Carefully paint the liquid resist over the entire board, leaving about ½" of copper exposed along the



The "Gamester" circuit incorporates a voltage doubler circuit to permit use of an inexpensive power transformer (T1) as a high voltage supply. The transformer's filament winding powers the miniature motors.


LAYOUT OF PC1 AND PC2



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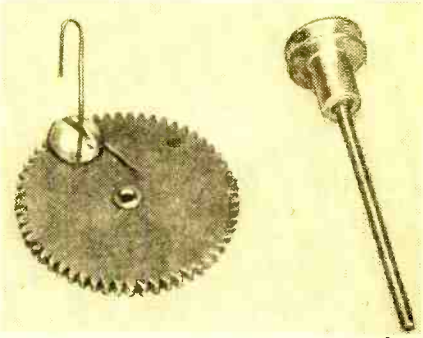
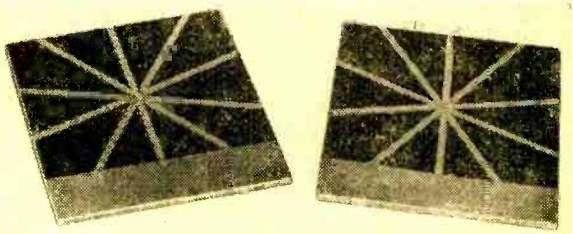


C

TESTED By POPULAR ELECTRONICS



D

PARTS LIST

BR1—Mg.-CuS bridge rectifier, 5.2-volt output, 1.3 amp. (Mallory 1B12R)
C1a/C1b—20-20-μfd., 150-volt dual electrolytic capacitor, not common negative (Cornell-Dubilier EDL 2215SS) or two 20-μfd. units
M1, M2—3-6 volt d.c. motor (Mighty Midget, Lafayette F253)
NE1, NE2—Type 6844 neon Nixie numerical indicator tube (HB-106—Burroughs Corp., Electronic Tube Div., Plainfield, N. J., $10 each)
PC1, PC2—Printed-circuit etched commutator—one 2" x 4½" section of copper laminate XXXP cut in two equal parts (Lafayette PC-D)
R1, R2—100,000-ohm, ½-watt resistor
SO1, SO2—13-pin Nixie socket (HSK-112—Burroughs Corp., $1.50 each)
S1—S.p.s.t. push-button switch
SR1, SR2—130-volt, 65-ma. selenium rectifier
T1—Power transformer, pri. 117 volts, sec. 125 volts @ 15 ma, 6.3 volts @ 0.6 amp. (Stancor PS-8415)
1—7⅜" x 6¾" perforated Bakelite sheet, cut down to 5¼" x 5¼" (Lafayette MS-306)
2—2" x 2¼" x ¾" wood blocks
2—¼" x 1" x 2" pieces of plywood
1—8" x 6" x 3½" aluminum case (Bud CU 2109)
1—3-oz. bottle of liquid etchant (Lafayette PE-3)
1—Bottle of liquid resist (Lafayette PRL)
1—1/32"-wide roll of resist tape (Lafayette PRT-1)
Misc. a.c. line cord and plug, solder, wire, etc.

A Nixie Gamester installed in its grey aluminum cabinet. Activating button is in the center of the front panel.

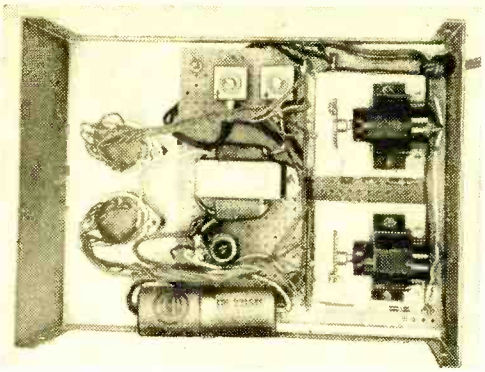
B Completed motor and wiper assembly.

C Large gear with wiper wire in place. Small pulley and shaft are not used.

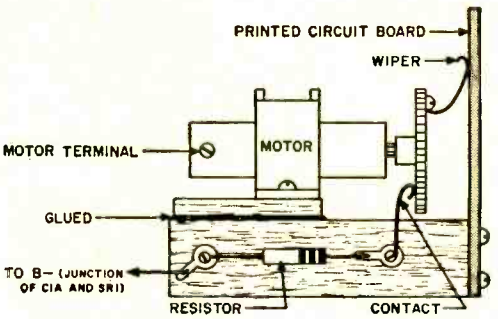
D Commutators after etching. The copper is entirely removed between segments, leaving ten 36° wedges of copper. Note bare ½" strip at bottom.

bottom as shown in photo above. Repeat this procedure with the second copper plate and set both pieces aside to dry for about a half hour.

After this interval, remove the resist tape and immerse the plates in the etchant bath, leaving them in long enough to remove all the copper in the clear grooves between segments and the strip along the bottom. When the etching is complete, rinse the boards in clear running water and then



Parts placement for the underside of the Gamester chassis is shown at left. The motor mounting sketch below gives details of installation technique. You'll find the block dimensions in the parts list on page 51.



brush a little paint remover over them. You'll find that the liquid resist is softened enough in a minute or two so that it can be wiped off with a cloth.

Finally, wash the plates in soap and water and dry them thoroughly. Drill a very fine hole in each segment as close to the outer edge of the wedge as you can work. Tinned hookup wire will be passed through each of the holes for wiring to the Nixie sockets as described later.

Motor Mounting. Loosen the setscrew on the large gear and slip it off its shaft. This will free the pulley and pulley shaft, which should then be removed altogether. While you have the large gear handy, drill and tap a hole to take a *4-36* brass screw about ¼" away from the toothed circumference. The wiper arm is made of thin wire (about #28) folded into a hairpin shape at the end and looped under the screw head. Spring wire is best for this, and phosphor-bronze or steel will do fine. The model illustrated has Nichrome, which happened to be available.

Mount the motor on the two pieces of wood which serve as base blocks. Note that the motor is screwed to a small piece of plywood which raises it enough to permit the gear to spin clear of the larger block. Using short wood screws, fasten the commutator board to the side of the base block so that the clear center of the segments is directly opposite the motor shaft. Thus, as the wiper spins, it will rotate in a circle having the center of the commutator as its center of rotation.

Another piece of the same spring wire serves as the contactor which rides on the back of the gear as the motor turns. It is held in place by another wood screw as shown and its pressure is adjusted so that it doesn't slow down the motor. It's a good idea, too, to connect the 100,000-ohm resistor at this time, holding it in place with a solder lug at each end. *The resistors act as protective devices for the Nixies and must not be omitted.*

Power Supply Assembly. The Nixie Gamester is a.c.-operated. One low-cost transformer supplies the anode power for the numerals and the low voltage for the motors. A full-wave voltage doubler consisting of *SR1, SR2,* and the dual capacitor *C1a/C1b* comprise the anode power supply, while an inexpensive magnesium-copper sulfide bridge rectifier without filtering takes care of the motor drive.

All parts, except the push button and the Nixie sockets, are mounted on a sheet of perforated Bakelite. Wiring is completed outside the case and the finished assembly secured to the case by a long machine screw and brass spacer in each corner.

Wiring the Sockets. After you punch two 1" holes where the Nixies are to go, fasten the little glow tubes and their sockets in place with a 1¼" machine screw through each socket-flange hole. (The di-

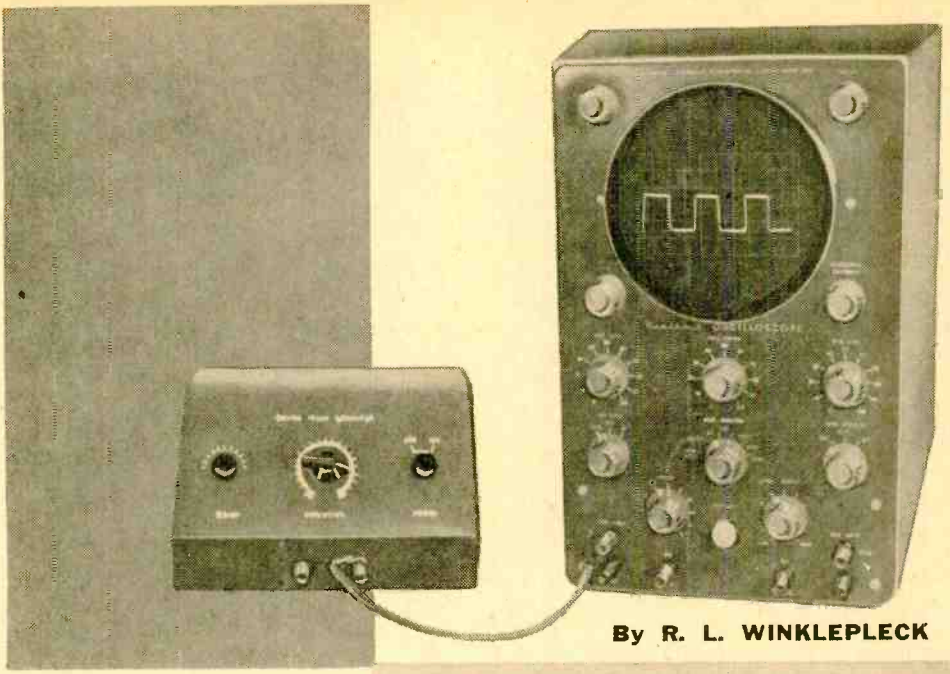
(*Continued on page* 102)

HOW IT WORKS

Nixies. The Nixie 6844 is a gas-filled, cold-cathode numerical indicator tube having a common anode. Each of the numbers is a separate cathode which glows when a potential is applied between it and the common anode. Each tube contains a suppressor screen to minimize darkening of the viewing dome so that long life may be anticipated.

Anode Power Supply. A voltage doubler arrangement is utilized to obtain approximately 250 volts for operating the Nixies. Transformer *T1* has a double purpose: (1) it isolates the entire assembly from the a.c. line, thereby eliminating the possibility of electrical shock from the metal case to other grounded conductors; (2) it provides about six volts of a.c. which is rectified and used as motor drive power. Series dropping resistors *R1* and *R2* limit the current through the Nixies to a safe value. Before applying power, be sure that these resistors are in the circuit and that voltage cannot reach the tubes any other way but through *R1* and *R2*.

Motor-Drive Supply. Six volts a.c. is taken from the low-voltage secondary of the transformer and rectified in the Mg-CuS bridge rectifier (*BR1*). This provides about four volts of d.c., which is more than adequate to run the motors within their ratings.



By R. L. WINKLEPLECK

Build a SQUARE-WAVE GENERATOR for Audio Tests

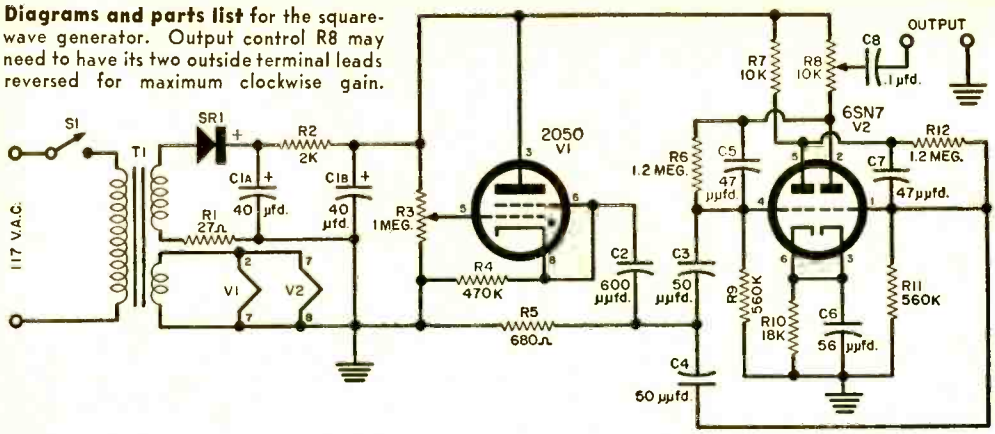
HERE'S ANOTHER ITEM to add to your economy-built shop equipment. It's a practical, workable square-wave generator, complete with only two tubes. If you construct or service equipment, a square-wave generator is a must, for the use of square waves affords a rapid and simple means of checking audio amplifier performance.

A square-wave signal is applied to the amplifier under test and the amplifier output is examined with an oscilloscope. If the amplifier performance is good, the output waveshape will be as square as the input—varying only in amplitude. Defective performance will cause distortion of the squareness, and the form of this distortion tells the initiated much about the amplifier.

Frequency of the generator to be described here is variable from less than 100 to over

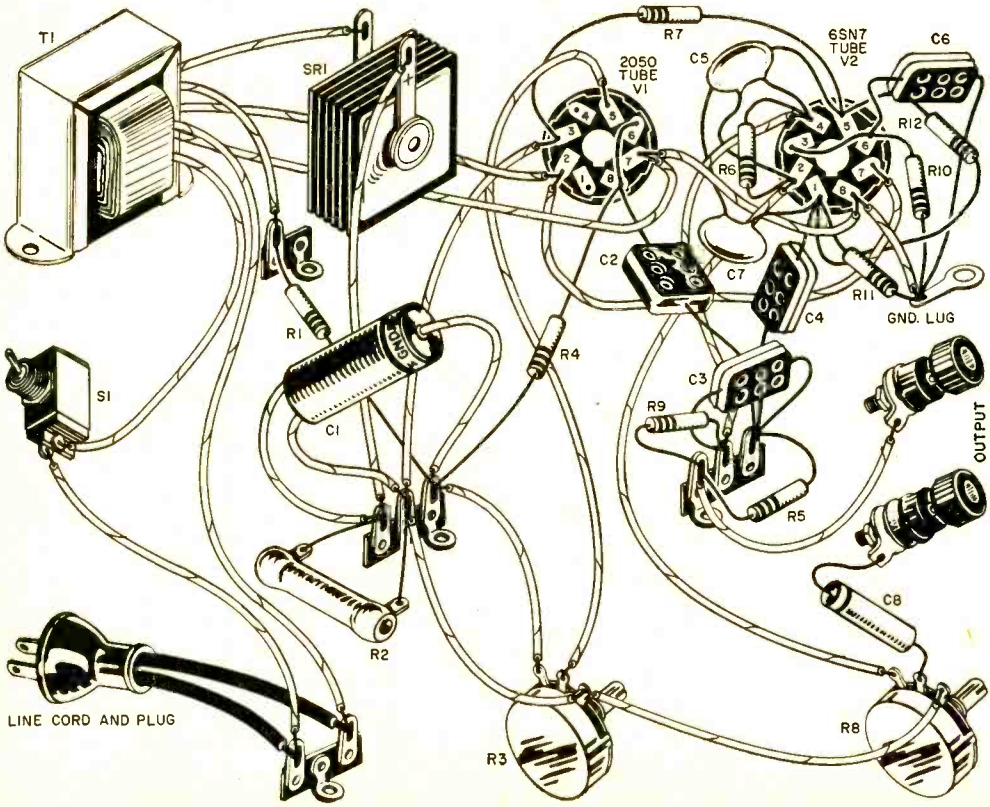
Check your hi-fi equipment with a simple two-tube signal source

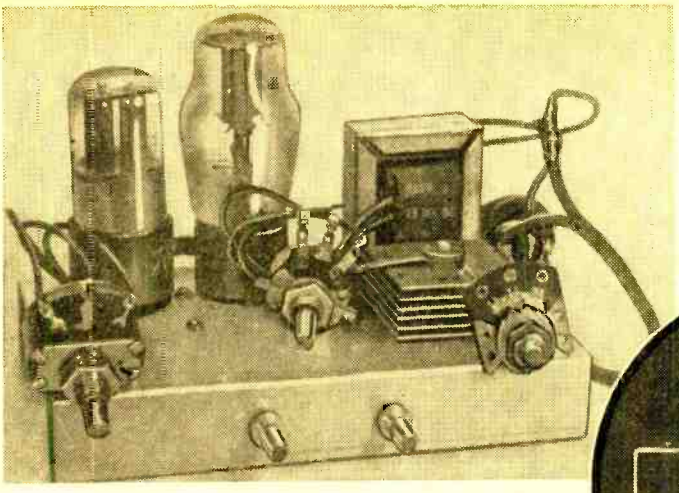
Diagrams and parts list for the square-wave generator. Output control R8 may need to have its two outside terminal leads reversed for maximum clockwise gain.



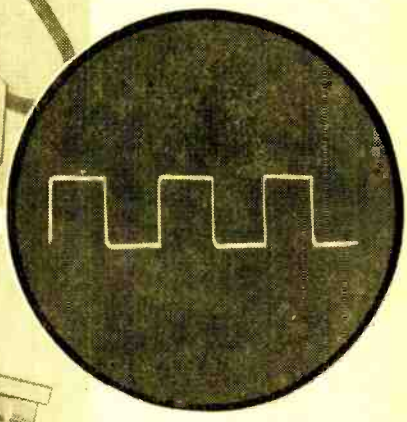
PARTS LIST

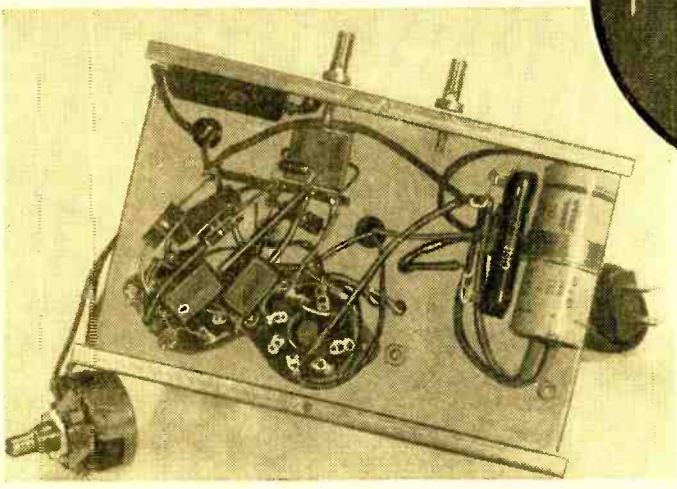
C1a/C1b—40-40 μfd., 150-volt dual electrolytic capacitor
C2—600-μμfd. mica capacitor
C3, C4—50-μμfd. mica capacitor
C5, C7—47-μμfd. mica capacitor
C6—56-μμfd. mica capacitor
C8—0.1-μfd., 400-volt tubular capacitor
R1—27-ohm, 1-watt resistor
R2—2000-ohm, 1-watt resistor
R3—1-megohm linear potentiometer
R4—470,000-ohm, 1-watt resistor
R5—680-ohm, ½-watt resistor
R6, R12—1.2-megohm, ½-watt resistor
R7—10,000-ohm, 1-watt resistor
R8—10,000-ohm wire-wound potentiometer
R9, R11—560,000-ohm, ½-watt resistor
R10—18,000-ohm, 1-watt resistor
S1—S.p.s.t. switch
SR1—65-ma. selenium rectifier
T1—Power transformer (Stancor PS8415 or equivalent)
V1—Type 2050 tube
V2—Type 6SN7 tube
1—6" x 4" x 1" aluminum chassis
1—7" x 4½" x 4¼" sloping-panel cabinet
Misc. 5-way binding posts, terminal lugs, etc.





Top view of completed generator chassis removed from cabinet. Controls mount in appropriate holes cut in front panel.





Parts layout is shown at left. Use of terminal lug strips at the proper positions insures a neat, safe component layout.

2000 cycles per second and output can be varied up to approximately 40 volts peak to peak.*

Construction. Using the components shown, this generator will produce square waves varying in frequency from 400 to 1800 cps. The lower frequency limit can be dropped by *increasing* the capacitance of *C2* or the resistance of *R4*. Conversely, the upper frequency limit can be raised by *reducing C2* or *R4*. If an extremely wide range of frequencies is desired, provision can be made in the design to switch any one of several resistors or capacitors into the circuit.

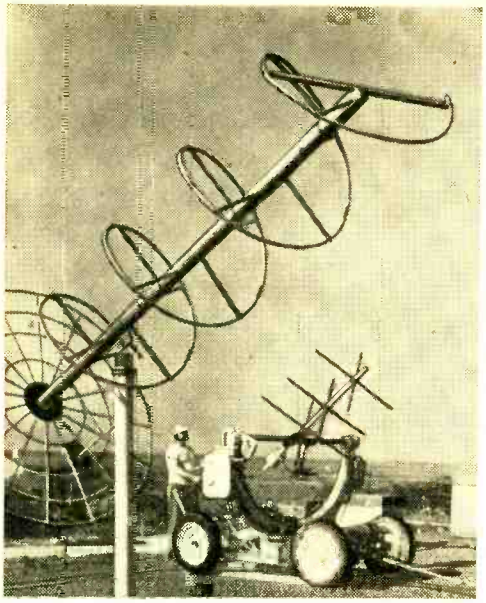
The model is assembled on a 6" x 4" x 1" aluminum chassis which slips into a 7½" x 4½" x 4¼" sloping-panel cabinet. Output posts are mounted on the chassis and slip through holes in the cabinet drilled oversize to provide adequate clearance. The two potentiometers and the switch are mounted on short leads which are brought through the chassis and protected by rubber grommets. These controls are easily fastened in place on the cabinet as the chassis is slid into position. Two self-threading screws hold the chassis in place from beneath.

The illustrations will give you an idea of parts layout, which is not critical. Wiring is direct and a couple of tie strips will offer convenient anchors for some of the resistors and capacitors.

A conventional selenium rectifier power supply uses a transformer to isolate the circuit from the power line. This is always important for test equipment that must be connected to other equipment which may not be so isolated. The filament winding of

(*Continued on page* 88)

* There is a discussion of amplifier testing with square waves on page 57 of the November 1957 issue of POPULAR ELECTRONICS which points up the many advantages of a square-wave generator. How to use one for checking tone controls is explained on page 77 of *this* issue.

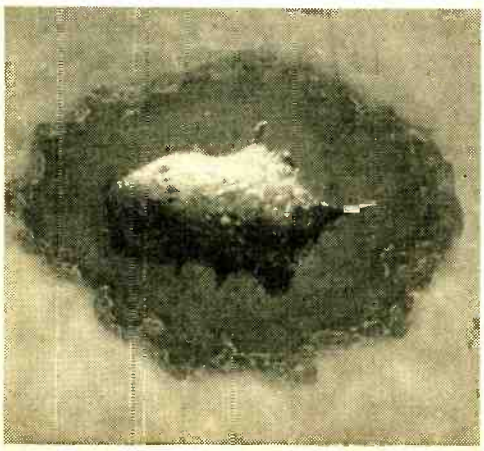


Corkscrew Antenna

Special antennas (above) have been designed to receive telemetered data from pilotless aircraft at a National Advisory Committee for Aeronautics test station. "Turnstile" antenna in background is remotely controlled to track rocket-powered models in flight. The equipment operates on very high frequencies.

Soldering Aluminum

An inexpensive but stable zinc base alloy has been developed at Bell Labs to simplify the soldering of aluminum (below). No flux or vigorous abrasion is needed. Joints that are formed using the new technique are said to be stronger than commercial aluminum itself. The soldering process is simple enough so that it can be adapted for home use.



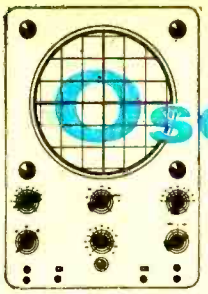
The Machine That Reads

A Bell Telephone Labs engineer has invented a machine that reads handwritten numbers. With some modifications, it could be made to read handwritten letters. The key is a series of seven sensitized lines. Shown below, the machine recognizes numbers by determining which lines have been crossed when someone writes over them with a special stylus. The proper digit then lights up above the plate.

No larger than a typewriter, the device uses transistors and flashlight batteries. So that the written numerals may be read with the least error, mild restrictions are placed on their size and form. These consist of two black dots (see photo) around which the numbers must be formed. Numbers are then sensed by determining which lines are crossed. This is done by a translator, which contains transistorized logic circuits. Since each number has its own set of crossings, the device need recognize only ten different sequences.

Recording Talks

Techniques of tape and disc recording are being discussed in a series of lectures at the RCA Institute, 350 West 4th St., New York City. Under the sponsorship of the Audio Engineering Society, a lecture is given each Thursday at 7:15 p.m., beginning on Feb. 20. Some of the subjects are: "Test Records and Their Calibration;" "Disc Cutting Lathes;" and "Tape Editing Problems." The 15 lectures are designed to cover thoroughly up-to-date techniques developed by leading professional organizations to meet specific problems of disc and tape recording. Subscriptions to the group of lectures cost $35 for AES members and $50 for non-members, while individual lectures are $3 for members of the Society and $4.50 for non-members, payable at the door.



Oscilloscope Traces

Phone Transmitter

Check modulation with a conventional scope and improve your transmitter's output

By HOWARD BURGESS

A FEW MINUTES of tuning on the amateur phone bands brings in a variety of signals. Some are excellent and well-modulated; others are out of this world, or at least they should be. If we listen for a little while to the various operators describing their transmitters, it becomes apparent that many times the best signals are not from the highest powered or most expensive transmitters.

There are several reasons for this apparent paradox. The operator has no control over some of them, but there is one very important factor that he can control—the modulation percentage. To radiate the most effective signal, the modulation must be free of distortion and the percentage of modulation should be high.

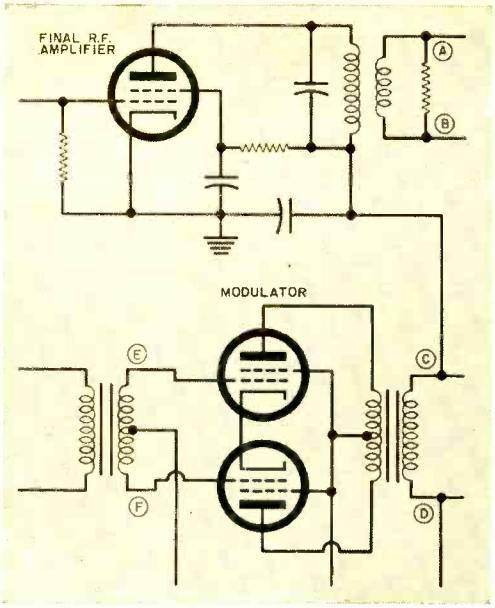
Regulations of the FCC forbid modulation in excess of 100%, but many transmitters in operation cannot approach this figure. A transmitter being modulated 100% will have four times as much "punch" as one being modulated 50% and eight times as much as one being modulated 25%.

Preparation. Before making any transmitter measurements, consider the voltage with which you will be working. Several hundred volts from a husky power supply can be dangerous. Remember also that most oscilloscopes require a high voltage probe if more than 100 or 200 volts are to be measured.

Shown on page 58 is a basic diagram of a typical r.f. power amplifier. This amplifier is modulated with a push-pull modulator. For simplicity, some of the refinements have been left out, but it is typical of many rigs now in use. The letters indicate the test points at which measurements will be made.

When tests are made on a transmitter, the antenna

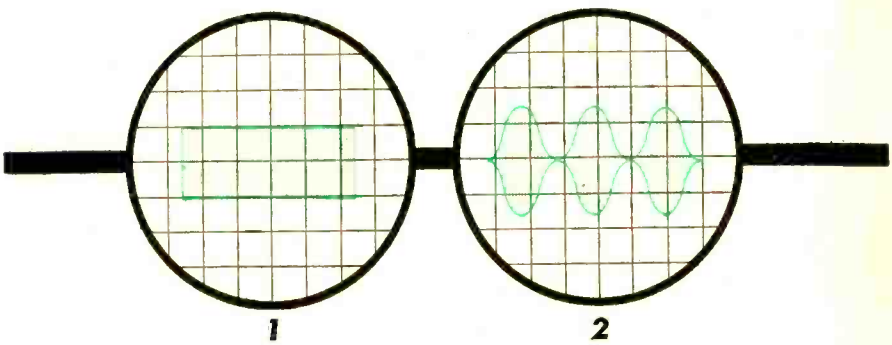
Even small portable transmitters can be brought up to snuff by an oscilloscope waveform check.



The circuit of a typical r.f. amplifier with push-pull modulator. Lettered test points indicate where the oscilloscope probe connection is made for each test trace. See text for complete details of modulation monitoring procedure.

If the microphone gain control is increased slowly, the modulation will begin to show up as peaks and troughs on the pattern. You can now adjust the sweep controls on the scope to give a well-defined picture. If the pattern proves difficult to synchronize, a small amount of signal can be fed from the audio generator to the "Ext. Sync." on the scope. This helps to lock the pattern.

If the transmitter gain control can be increased until a pattern such as that in Fig. 2 is formed, you have a good transmitter and there is little that this article can do for you. However, if you cannot get such a symmetrical pattern, a few simple tests are in order.



should be disconnected and the r.f. output should be dissipated in a dummy load. The audio portion of the transmitter should be fed from a generator coupled into the microphone input. Frequency of the audio generator can be set anywhere between 200 and 1000 cycles.

The test signal should be about the same voltage as the output of the microphone normally used on the transmitter. Test points *A* and *B* are connected directly to the vertical deflection plates of the cathode-ray tube.

Test Method. To begin the tests, turn the gain control to zero. Then turn on the transmitter and tune it to give normal loading into the load resistor. If the sweep circuit of the oscilloscope is now set to some value between 50 and 100 cycles, the transmitter carrier will show up as a wide band, as in Fig. 1.

Problems. Poor modulation can be the result of difficulties in either the r.f. or audio section of the transmitter. Scope patterns showing distortion caused by troubles in the r.f. section are illustrated in Figs. 3, 4 and 5.

When a power amplifier is plate-modulated, a high level of grid drive is required. If the low-level r.f. stages are not supplying enough drive to the grid, the amplifier cannot furnish power output on the peaks, as shown in Fig. 3.

If too much grid bias is used on the r.f. power amplifier grid, the pattern of Fig. 4 will be the result. If too much bias and too little drive is used on the final amplifier, it will show up as the pattern in Fig. 5.

In addition to its use in testing a

transmitter, the scope can be used as a monitor of transmissions. Since it provides instantaneous indications of the peak modulation level, the scope can show insufficient modulation or overmodulation immediately, while the operator is talking. Some amateurs monitor their rigs during all transmissions with a scope.

If the r.f. final amplifier shown in the schematic diagram is to be modulated 100%, the peak audio voltage appearing between test points *C* and *D* must be equal to the d.c. voltage on the plate of the r.f. amplifier being modulated.

Scope as Voltmeter. The oscilloscope can be used as an r.f. voltmeter to check this audio voltage. In a low-power transmitter, a direct connection can be made from *C* to the vertical input of the scope. In transmitters of higher power, a voltage divider probe must be used.

The modulator gain should be reduced to zero before the scope is connected. With the transmitter turned on and properly loaded, gradually increase the gain control and adjust the sweep to give a good trace of the audio signal. The gain should be increased to the point where distortion begins to show on the signal.

At this point, turn off the transmitter and check the vertical calibration of the scope. The calibration is checked by putting enough 60-cycle voltage on the scope to give the same amount of vertical pattern formed by the transmitter audio signal. The 60-cycle voltage can then be measured with an ordinary voltmeter. Remember that the peak audio voltage will be 1.4 times the voltmeter reading.

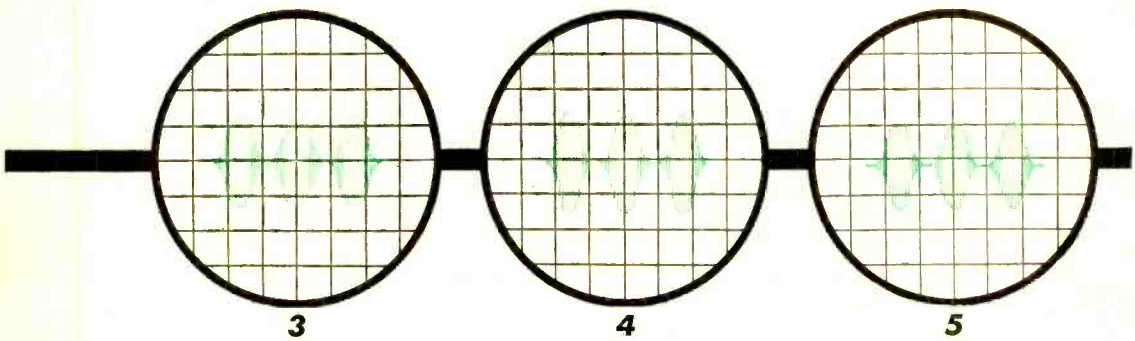
If the audio voltage at *C-D* can reach a value equal to or greater than the d.c. voltage on the final before distortion shows, then the modulator is capable of doing its required work and any trouble is most likely in the r.f. section. If, however, the distortion begins to show before the desired amount of audio voltage is developed, trouble-shooting is in order for the audio section.

Note the point on the gain control at which distortion first appeared. Then move the scope probe to either point *E* or *F*. By moving through the circuit in this fashion, you can find the point where the distortion is originating. We are assuming that the proper modulation transformer and tube combination are being used.

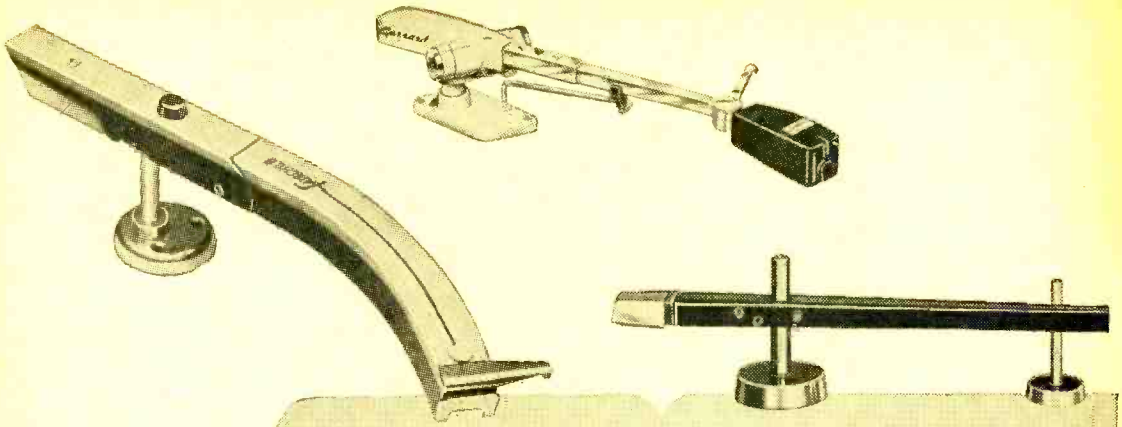
Conclusion. For the benefit of those who are new to the art, all tests made ranging from the microphone input to the output of the modulator transformer will use the regular vertical input (with suitable multipliers) and a sweep to give the desired sine wave pattern. When distortion is present, it is impossible to get a sine wave with any adjustment of the scope.

Because the average oscilloscope cannot pass r.f. through the vertical amplifiers, all measurements on the r.f. section are made by coupling directly to the deflection plates of the cathode-ray tube. Most commercial oscilloscopes have provision for direct connection either on the front panel or on the rear of the cabinet.

For those who are unfamiliar with the use of calibrators and voltage dividers, we are planning to devote a complete article to oscilloscope accessories and their circuits in the near future. —30—



Traces found at test points. Figure 1 shows an unmodulated carrier as picked up at points A-B. Figure 2 shows a 100% modulated signal from a well-adjusted transmitter. Lack of r.f. grid drive produces the scope pattern in Fig. 3. The pattern of Fig. 4 results when there is too high a bias on the r.f. power amplifier grid. Figure 5 shows the results of too little drive on the final amplifier.



Give Your Pickup

WHEN YOU PUT IN that fancy new pickup with the extra-wide range and the extra-light tracking pressure, did your fi go as hi as you expected? Or were you a bit disappointed?

Well, don't land with both feet on the idea that there is something wrong with the pickup. It may be *your* fault. You may be hindering the pickup from giving you the splendid sound it was built to produce. To get this top-quality performance, certain simple rules of installation and operation have to be followed.

In a highly refined pickup, you have just a few grams of stylus force to maintain close contact between stylus and groove, and perfect reproduction depends on that contact. The "feather touch" on the record is dandy for top fidelity and low record wear, but it does mean that you must protect the pickup carefully from outside forces that might push or pull the stylus away from the groove.

This is particularly important because distortion that you couldn't hear before will become disturbing with the better transient response and wider frequency range of the new pickup. It is somewhat like opening the curtains on a stage a little wider, to uncover ugly, unpainted areas at the edges of the backdrop. It means that, for wide range, you must also assure quality in the fringe areas.

On the Track. In addition to loss of full contact with the groove, the main cause of this newly uncovered distortion is incorrect tracking angle. If the stylus is to trace out exactly what the cutter put on the record, the tip of the stylus must vibrate back and forth directly *across* the groove, at right angles to it, as shown at *A* in Fig. 1 (p. 62), i.e., the tip of the stylus moves along a line which runs through the center of the record. If the pickup is twisted around as shown at *B* in Fig. 1, with the stylus vibrating at an angle to the groove, the waveforms in the groove will hit the stylus "on the bias," and the motion will be different. We will have distortion.

The amount that the pickup deviates away from a position square to the groove is the "tracking error." We would like to have zero tracking error at every point on the record. But the cartridge has to twist a bit as it travels across the record, because the usual arm is pivoted at one end. We can place the arm so that the tracking angle is zero at any one point on the record, but everywhere else it will be greater.

Therefore, the problem is to keep the tracking as low as possible, less than five or six degrees at the outside of the record, and about one or two degrees at the inside. This is accomplished on practically all modern pickups by a combination of two things: (1) setting the arm so that the stylus passes a fraction of an inch beyond the turntable center: and (2) angling the head of the arm around so that the cartridge is "set off" the arm ("bent-head arm"). With a bent-head pickup, if the arm is at precisely the right distance from the center of the turntable, the tracking angle will stay within the

a Chance!

By ROBERT SAMPSON

How and where to mount that new pickup so it will give best possible performance

mentioned limits, and distortion produced by tracking error will be practically negligible.

Accurate Angle. "Precisely right" are the vital words in that last sentence. The stylus must pass the right distance beyond the spindle, to within a tenth of an inch, to get the results we want. The manufacturer of the arm will specify a placement. Follow it *exactly.*

Figure 2 shows the measurements involved. There are two ways of finding the right place to put the base of the arm. You can measure the distance from the center of the turntable to the arm base. If this is right, the "overhang" of the stylus beyond the spindle will be right, too. Or you can measure the overhang directly. Most manufacturers specify the arm base to center dimension. With this as radius, you draw an arc of circle, as shown in Fig. 2. The arm base can be put anywhere on this arc.

If you have just the overhang dimension, slide the arm back and forth with one hand while holding a ruler against the turntable spindle. With the stylus point resting on the ruler, you can read the overhang dimension directly. Remember to add one-half the thickness of the spindle to the reading, because you should be measuring from the center of the spindle.

A final way of placing a bent-head pickup, if you know neither the arm base distance nor the overhang, is to use a square. Get a square with a sliding head and, as shown in Fig. 3, put the end corner against the center of the spindle, and slide the head until its inside edge is a little out from where the inside grooves of a record end. Then move the arm around until the cartridge is lined up with the head of the square when the stylus is right at the corner of the square. In other words, the cartridge itself should be exactly at right angles to the line from stylus to center.

Level Turntable. After we get the proper overhang, we must then make sure that the turntable is level. On a slanting turntable, the arm may have a tendency to slide downhill, putting some side pressure on the stylus. This can cause a lot of distortion.

With any bent-head arm, there is a sidewise force developed by the pull of the record friction on the stylus. As shown in Fig. 4, the record pulls the stylus along in the direction *A-B,* and the arm pulls back in the direction *A-C.* It's like tying a rope to a post, carrying it around a person, and giving a pull. The rope will try to straighten out, and the person will be pushed sidewise.

Like the man with the rope "bent" around him, the pickup arm is forced

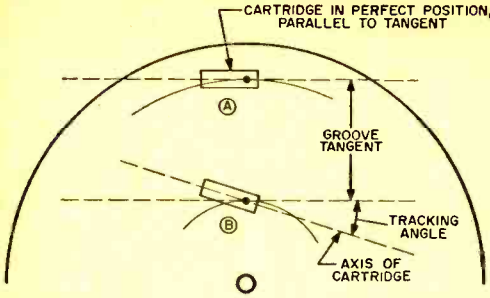


Fig. 1. At position A, cartridge is tangent to groove. At position B, it is no longer tangent and tracking error has developed resulting in distortion.

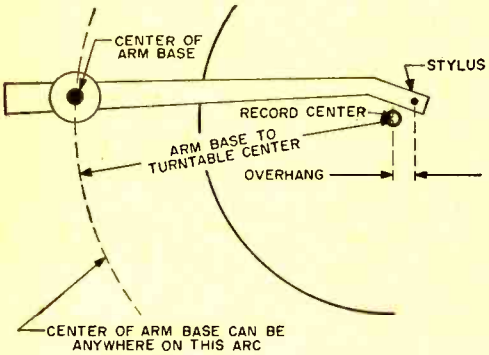


Fig. 2. These are the dimensions you must measure to find the right place for mounting your tone arm.

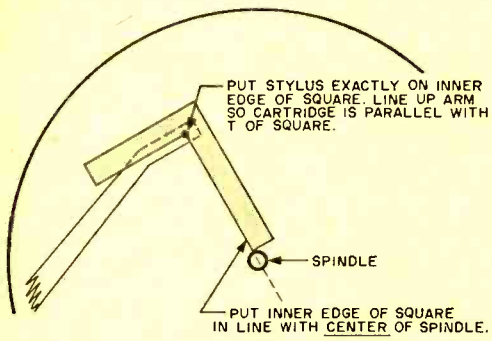


Fig. 3. Use a carpenter's square for proper positioning. Place stylus at innermost record groove.

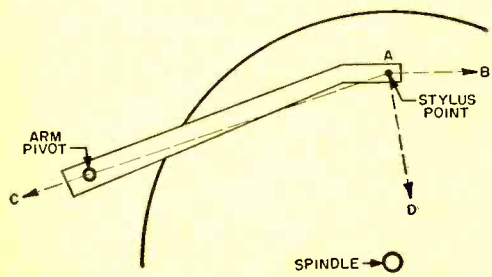


Fig. 4. Record friction pulls along the line A-B, and the opposing force is along the line A-C. The resultant force moves the arm in the direction A-D.

sidewise, toward the inside of the record. The way to offset this sidewise force, and at the same time take care of all leveling problems, is to tilt the turntable slightly so that the pickup climbs a little bit "uphill" as it crosses the record.

To find the right amount of tilt, put on the turntable a blank record, with no grooves, such as an unused recording blank. Start the turntable going and put the stylus down on the moving surface. Then tilt the turntable this way or that until the pickup has the least tendency to move sidewise, either in or out.

Stylus Force. Everybody knows that we must have the right amount of downward force on the stylus for top performance with a high-grade pickup. And too little stylus force is worse than too much, when it comes to causing distortion. The tip of the stylus slides a little up the groove wall on the big swings of the groove. This brings in distortion. A slight loss of contact on strong signals can cause a low-grade distortion—that just takes the bloom off your sound system. If your system doesn't sound quite right, try putting a little more force on your stylus.

You can measure stylus force with one of the numerous gauges now on the market for that purpose. Set it to the manufacturer's recommendations.

Another way to set the stylus force is to use one of the test records designed to tell you when you have full contact between tip and groove. On the record is a series of steady tones in bands at gradually increasing levels. Start at a low level, where you will almost certainly have full contact, and get your ear used to the sound of perfect reproduction.

Then, moving up to higher levels, you finally come to a point where the sound is a little buzzy, or distorted. If this band is a little above normal loudness, as specified on the test record, your stylus force is about right. If it is very far above normal levels, you can reduce the force a bit. If you didn't quite make normal loud levels, you need more stylus force.

No Binding. Finally, your pickup arm must move as free as a bird on the wing, so that it doesn't hold back against the pickup. The very high compliance—freedom of stylus vibration—in your new pickup means that high friction in the arm bearings can force the stylus off center. The record groove pushes the stylus toward the middle of the record, but the arm drags back. Result: stylus way over to one side and high distortion.

So get a modern arm, too, with precision bearings in which friction is prac-

(*Continued on page* 117)

Build a "Conversation Piece"

Let the whole family listen in when you telephone grandma

By JOSEPH W. DOHERTY, K2SOO

HAVE YOU EVER made a long-distance telephone call to grandma in New Hampshire, and spent most of the three minutes trying to give each of the kids a turn on the phone? Have you ever sat frustrated, listening to your wife's one-sided conversation with a friend, wondering what was behind the string of "Yes," "No," "Maybe," and "Uh, huh"?

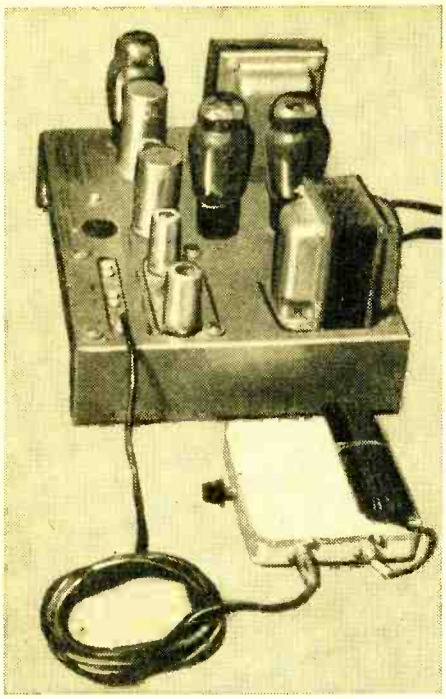
Fret no more. You can make telephoning a family affair by building the "Conversation Piece," at a cost of about $6, and never again wonder what your mother-in-law or your friend is saying about you on the other end of the wire.

The Circuit. Basically, this unit consists of a telephone pickup coil (*L1*), available at most supply houses, coupled to a two-stage transistor preamplifier. The output of the preamp is fed directly into the phono input jack of a radio, TV set, or any kind of audio amplifier, low or high fi.

The preamplifier is necessary to build up the low output from the pickup coil to a level comparable to that of the average crystal pickup, in order to drive the tube amplifier. Transistors *TR1* and *TR2* are 2N107's, which operate from a 3-volt d.c. supply consisting of two penlight cells in series. Total current drain in this case is 0.24 ma., insuring long life without frequent battery changes.

Transistors were chosen because they permit the design of a compact unit with a self-contained power supply and the elimination of interconnecting power cable harness. The result is a box measuring 4" x 4½" x ¾".

Construction. Capacitor values are not critical. The limited frequency response of the telephone doesn't dictate the use of expensive miniature electrolytics of large capacitance; the smaller values commonly used for interstage coupling in vacuum-



Complete equipment (left) consists of telephone pickup coil, the "Conversation Piece," main amplifier and loudspeaker. The CP could also be fed into the phono jack of a radio receiver or TV set.

tube amplifiers will suffice for the purpose.

Resistor values are fairly critical and were determined after experimenting to provide the maximum gain possible with the transistors. Because the characteristics of the transistors may vary from one unit to another, it is advisable to use potentiometers to determine the optimum values if you have difficulty in obtaining the required gain with the values shown.

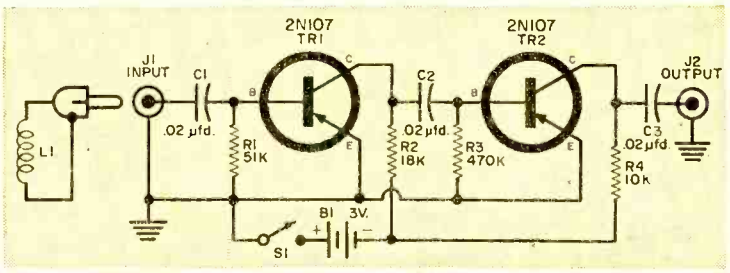
Take care to avoid forward biasing of the base-collector junction and exceeding the maximum collector current rating. Transistor audio interstage transformers could have been used to advantage in this unit but were avoided by the author to keep costs down to minimum.

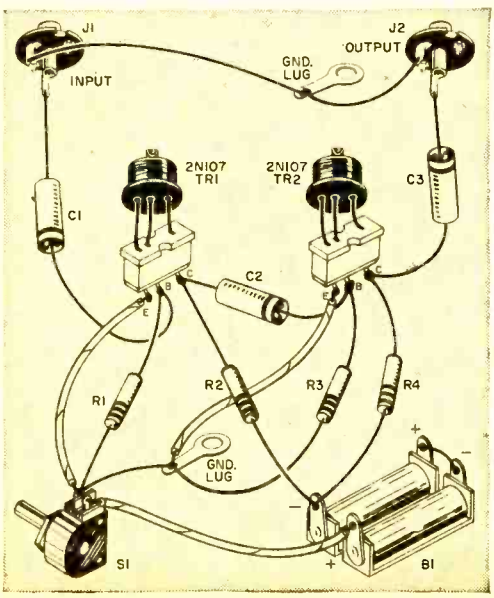
Installation. Operation of the unit is simple. If your phone is located at or near your radio or hi-fi amplifier, the connections can be made permanently if desired—you just turn on the amplifier, and the "Conversation Piece" is ready to go.

If your phone is located in another room, say the hall or a bedroom, you'll have to run a line to the amplifier. This should be a shielded cable to prevent hum pickup from house wiring. The line should run from the output jack of the "Conversation Piece" (*J2*) to the jack on your radio or hi-fi amplifier.

(*Continued on page* 98)

If you build the "Conversation Piece" in a nonconductive box (plastic), join the ground points shown in schematic (right) and in pictorial (below, indicated as ground lugs) with a length of wire.





PARTS LIST

B1—Two 1.5-volt penlight cells
C1, C2, C3—0.02-µfd. capacitor
J1, J2—Phono pin jack
L1—Telephone pickup coil
R1—51,000-ohm, ½-watt resistor
R2—18,000-ohm, ½-watt resistor
R3—470,000-ohm, ½-watt resistor
R4—10,000-ohm, ½-watt resistor
S1—S.p.s.t. on-off switch
TR1, TR2—2N107 transistor
1—Battery holder for the two cells
1—Five- or six-lug terminal strip
1—4" x 4½" x ¾" utility box

Transistor Topics

By LOU GARNER

THE USE of semiconductor devices *other* than transistors is expanding rapidly. Such devices bear approximately the same relationship to the transistor that industrial control tubes, thyratrons, heavy-duty rectifiers, phototubes, and gaseous voltage regulators bear to the vacuum tube.

Small diode detectors and semiconductor power rectifiers have been used for years—even before the invention of the transistor. In addition, many special-purpose semiconductor diodes are either in current production or are being developed. Available units include diodes designed to operate at the Zener point as voltage regulators, and light-sensitive photodiodes.

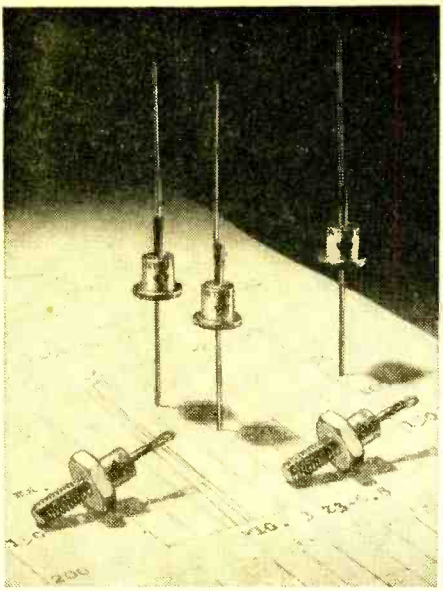
The Zener diode is operated with a voltage applied in its reverse (or high-resistance) direction at or very near to its nominal "breakdown" (Zener) voltage. When the applied voltage increases slightly, the diode's resistance suddenly drops from a moderately high to a very low value. In conjunction with a fixed series resistor, such units can serve as effective voltage regulators and are similar in operation and application to the "VR" series of gas-filled voltage regulator tubes.

Photodiodes are made in a variety of styles and types. Virtually all types of semiconductor materials are used in their construction, including selenium, germanium, silicon, and lead and cadmium sulphides. They range in size from Sylvania's minute 1N77A, a germanium photocell smaller than a matchstick, to the large selenium "sun batteries" manufactured by International Rectifier Corp.

Even General Electric Co.'s Unijunction transistor is, in reality, a special-purpose semiconductor device rather than a conventional transistor. Originally called a "double-base diode," it has characteristics roughly like those of a small gas-filled thyratron tube. G.E. is also developing a special silicon-controlled rectifier which may serve as a possible replacement for both power relays and medium-sized thyratrons.

In fact, almost all semiconductor manufacturers are designing and developing new solid-state devices to replace standard thermionic tubes. RCA, for example, is working on a "Thyristor," which may be oper-

Semiconductor devices currently being produced by General Electric Co. include low-current silicon rectifiers (above, right), and a silicon double-based diode (right, compared in size with Life Savers). The tab protruding from the cap of the diode serves as a ground for shielding purposes.



Zener diodes, such as these 1- and 3.5-watt units available from International Rectifier Corp., make effective voltage regulators.

ated either as a bi-stable switching element or as a conventional high-frequency transistor.

Shockley's new "Bistable" diode is a four-layer silicon device having alternate layers of n-type and p-type materials. When a control voltage is applied to its two electrodes, it can be switched from a high-impedance state with a resistance of from 1 to 100 megohms to a low-impedance state with a resistance of less than 20 ohms. In this respect, its action is much like that of a small neon bulb. It can be used in similar applications, for example, in a sawtooth oscillator or pulse generator.

As designers and engineers learn more about solid-state physics, you can expect to see more new semiconductor devices.

Readers' Circuits. While a good many home experimenters like to work on and to experiment with original circuits, a high percentage prefer to adapt "standard" circuits they have seen in magazine articles and books to their own requirements. Often, this takes as much ingenuity and skill as is required to "dream up" a new circuit. This month we are featuring a pair of interesting circuits which our readers have adapted to their own needs.

Handy Audi. S/Sgt. Jack W. Yundt (AF 14504821, 45 Ftr. Day. Sq., Box 473, APO 117, New York, N. Y.) is, to use his own words, "an amplifier tinker." When he saw Transtopic Experiment No. 15 in the February 1957 issue of POP'tronics (page 85), he decided to turn the original circuit (a simple code practice oscillator) into a multi-purpose audio test instrument. He dubbed his completed test gadget "Handy Audi" (see Fig. 1).

It can be used as: (a) a code practice oscillator (CPO) with loudspeaker output, (b) a CPO with headphone output, (c) an audible tone source, and (d) an audio test signal source.

In operation, a single *n-p-n* transistor is used as a common-emitter audio oscillator, with transformer *T1* serving both to provide the feedback necessary to start and sustain oscillation and to match the transistor to a loudspeaker's low-impedance voice coil. The feedback signal obtained from the transformer is coupled back to the transistor's base electrode through d.c. blocking capacitor *C1*. Base bias current is supplied through *R1* and *R2*. Unbypassed emitter resistor *R3* serves to stabilize circuit operation. Operating power is supplied by a 9-volt battery, *B1*, controlled by s.p.s.t. on-off switch *S1*. The other components and switches permit the circuit's operation to be modified for special applications.

All components used are standard and should be readily available. *R1* is a small potentiometer—its taper is not critical. *R2* and *R3* are ½-watt resistors. *C1* can

(*Continued on page* 118)

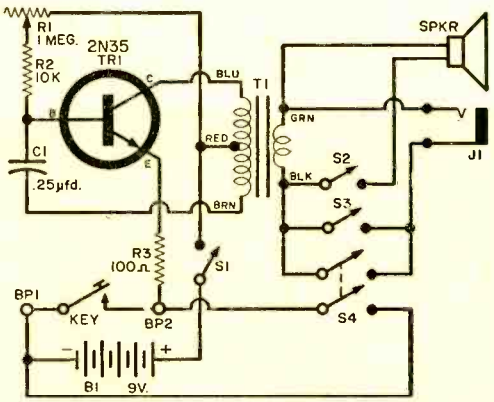


Fig. 1. Jack Yundt's "Handy Audi" test instrument adapted from POP'tronics circuit.

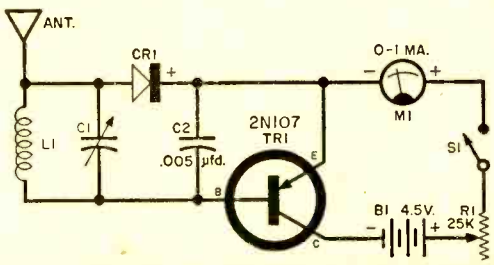
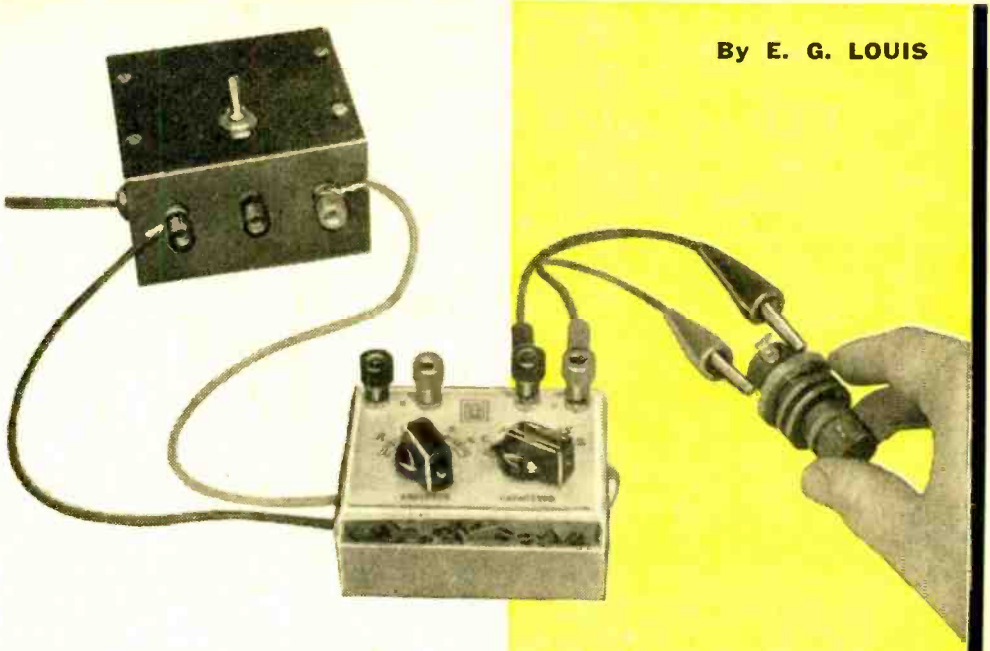


Fig. 2. Ronald Wilensky's simple field strength meter described fully on page 118.

By E. G. LOUIS



Pocket Size Test Instruments

Part 3

Easy-to-build unit will check and measure resistors and capacitors

AS RESISTORS and capacitors make up the majority of electrical parts used in electronic equipment, it is important that both the home experimenter and service technician have adequate means for checking them. Resistors are usually checked with a standard ohmmeter which has a limited range, and few low-cost ohmmeters will give a usable reading at values above 500,000 ohms or 1 megohm. Yet 2 to 20 megohm resistors are encountered frequently in receivers and amplifiers.

Except for electrolytics, capacitors, too, may be difficult to check with standard equipment. For example, a common defect of medium-sized bypass and coupling capacitors is "high leakage," i.e., the capacitor's insulation breaks down and the unit *acts* as if a high resistance were shunted across it. The leakage resistance may be on the order of several megohms—low enough to cause considerable trouble, but not low enough to show up on a standard ohmmeter test.

A simple and easy-to-build *RC* tester can be used to check high resistance values (to 20 megohms or more) and medium-sized paper and ceramic capacitors (0.02 to 1.0 μfd.) for *both* capacitance and leakage. It can be used as a continuity checker for checking low-value resistors, coils and transformer windings . . . for checking for insulation breakdown . . . and as an *RC* substitution box for some values of resistance and capacitance.

Easily assembled in a single evening, the construction of this pocket-sized instrument will cause a minimum of damage to your wallet. If you buy most of the components

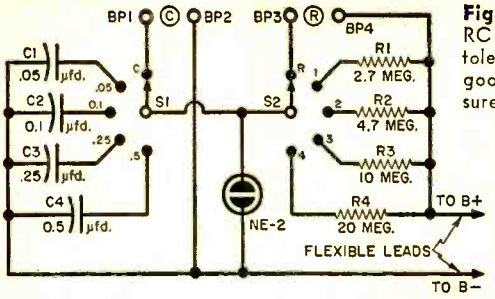
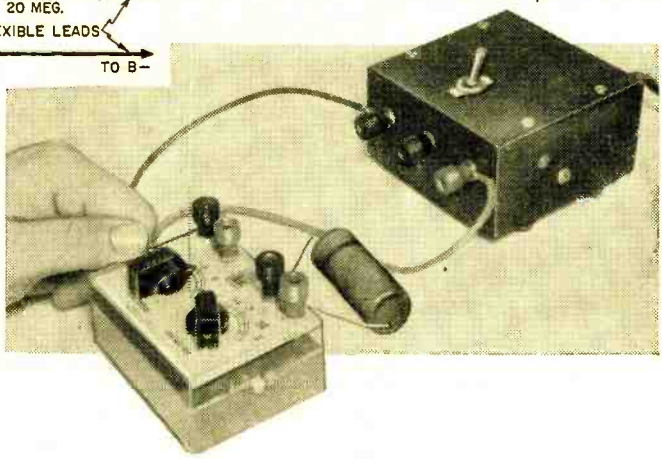


Fig. 1. Schematic diagram of the simple RC tester. Resistors should be of 5% tolerance and the capacitors should be good-quality, low-leakage types to insure proper functioning of the instrument.

A capacitor is shown being tested in the photo below.



PARTS LIST

BP1, BP2, BP3, BP4—Binding posts
*C1—0.05-µfd., 200-volt capacitor**
*C2—0.1-µfd., 200-volt capacitor**
*C3—0.25-µfd., 200-volt capacitor**
*C4—0.5-µfd., 200-volt capacitor**
R1—2.2-megohm, ½-watt resistor
R2—4.7-megohm, ½-watt resistor
R3—10-megohm, ½-watt resistor
R4—20-megohm, ½-watt resistor (or two 10-megohm units in series)
S1, S2—Single-pole, 5-position rotary switch
1—NE-2 neon bulb
1—Small plastic case
2—Pointer knobs
**All capacitors are metalized paper units*

new, your total outlay shouldn't be over five dollars.

Construction. The model is housed in a small plastic box but a metal or wooden case will serve as well. Shielding is not necessary.

Neither parts layout nor lead dress is critical, and you can either follow the general layout of the model or make up a new layout to suit your own requirements. Whichever you do, make sure that the NE-2 neon bulb is visible when the instrument is in a normal operating position.

Be especially careful when installing *R1, R2, R3,* and *R4* (Fig. 1). While any composition resistor might be damaged by excessive heat, high-value resistors are much more susceptible to heat damage than other units. Use a clean, hot, well-tinned soldering iron, and complete each connection as quickly as possible.

If you use a plastic box with a transparent top for a case, you can duplicate the panel of the model. With India ink, draw the dials on a piece of stiff cardboard which will just fit inside the box. Controls and terminals may be labeled by hand or with a typewriter. The completed panel is placed just *behind* the transparent cover and held in place by the mounted switches and other components.

While all the components specified are standard and should be readily available, not all local distributors stock small resistors above 10 megohms. If you are unable to buy a 20-megohm resistor (*R4*) locally, you can connect two 10-megohm resistors in series to obtain this value.

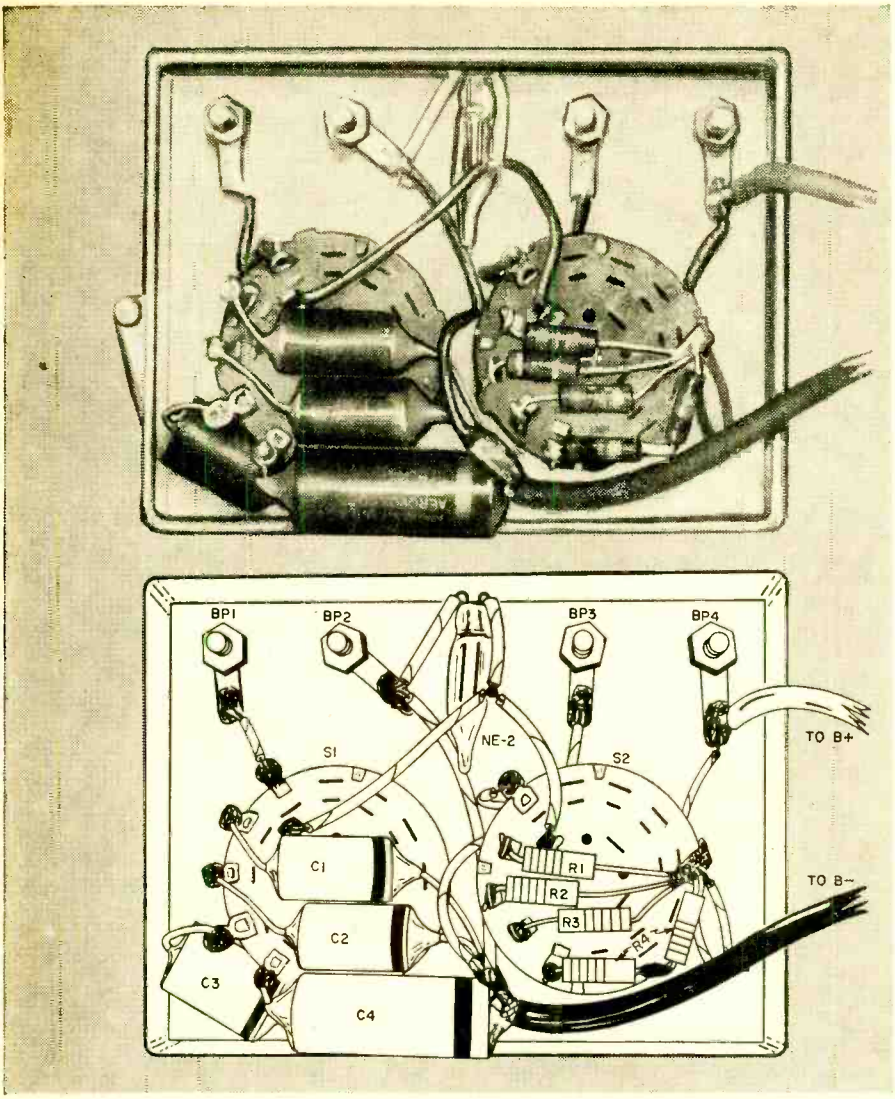
Two flexible leads (B+ and B−) are provided for power supply connections. These may be from 12" to 24" long, and should be terminated in either spade lugs, alligator clips, phone tips, or similar connectors.

With the wiring completed, recheck the circuit for possible errors, accidental shorts, or poorly soldered connections *before* connecting the instrument to a power source or attempting to use it.

Operation. With a selection of known resistor and capacitor values, it is possible to estimate the value of unknown capacitors and resistors with a good degree of accuracy, wherever the capacitor value falls between 0.02 and 1.0 µfd. or the resistor value falls between 1 and 40 megohms. If the unknown capacitor is *open,* or has a very low value, the neon bulb will appear to glow continuously. If the unknown capacitor is *shorted,* the neon bulb will not light or blink. (See Fig. 2, on page 107.)

Since a leaky capacitor acts like a high-value resistor, a suspected unit is checked in the same way that a high-value resistor is checked—by substituting it for the known resistor (*R*). If the capacitor is "good" as far as leakage is concerned, the neon bulb either will not blink (fire) or will blink only once. A suspected breakdown in insulation may be checked in a similar fashion.

When used to make *continuity* measurements and to check low value resistors, the instrument operates as a simple *neon bulb*



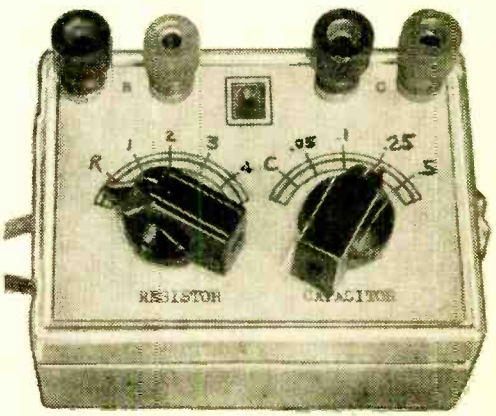
Interior and exterior layout of components for the tester. The miniature metalized capacitors conserve space and have a good leakage factor. Mallory single-gang, non-shorting switches (3215J) have been used for S1 and S2.

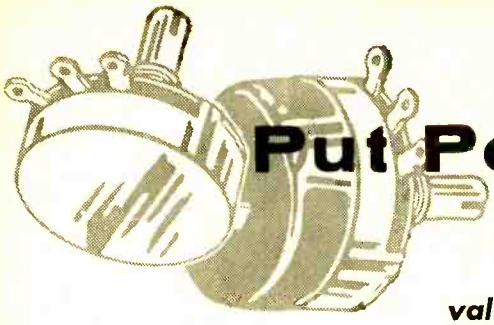
indicator (Fig. 3). The d.c. supply voltage is applied to the NE-2 neon bulb through one of the fixed resistors (*R*) which serves to limit the current to a safe value. Test leads are connected to the *C* terminals *BP1* and *BP2* and *Capacitor* switch *S1* is set in the *C* position.

In operation, the neon bulb continues to glow as long as the circuit to which the test leads are connected is open or has a very high resistance. If the circuit has low resistance, as will be the case when checking a small coil or transformer, for example, the bulb is extinguished, since the circuit being tested acts as a short across the bulb.

Testing. The technique to use depends on the tests you want to make. For all

(*Continued on page* 107)

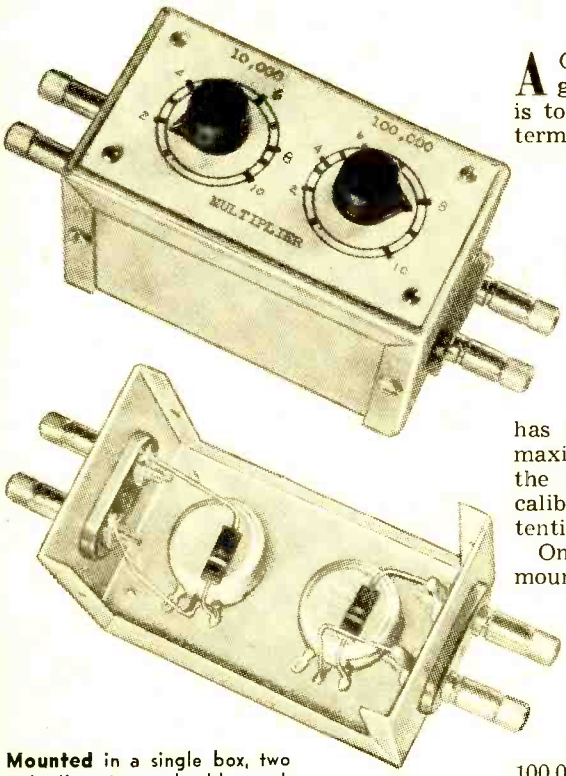




By RUFUS P. TURNER

Put Pots to Work

They can tell you what resistor values to use in experimental circuits



Mounted in a single box, two potentiometers should each have linear taper to insure uncrowded calibration scales. Dials can be calibrated by measuring the potentiometer resistance at various settings.

A GOOD WAY for the experimenter to get a wide range of resistance values is to wire a potentiometer to a couple of terminal posts and mount the whole thing in a box. However, there is one serious drawback to so simple a setup: a potentiometer so used is not very accurate or easy to calibrate below about 10% of the maximum resistance. In other words, the first 10% of the potentiometer's rotation is not usable.

A much better idea is to connect a fixed resistor in series with the potentiometer. If this fixed resistor has a value equal to one-tenth of the maximum resistance of the potentiometer, the unit becomes considerably easier to calibrate and the entire rotation of the potentiometer can be used to advantage.

One of the author's pet schemes is to mount two potentiometers in a single 2¼" x 2¼" x 4" aluminum box. Each potentiometer has a fixed resistor in series and each has its own pair of terminal posts. A 1-megohm potentiometer (*R1*) in series with a 100,000-ohm fixed resistor (*R2*), as shown in Fig. 1, together with a 100,000-ohm potentiometer (*R3*) in series with a 10,000-ohm fixed resistor (*R4*) have greatest all-around usefulness.

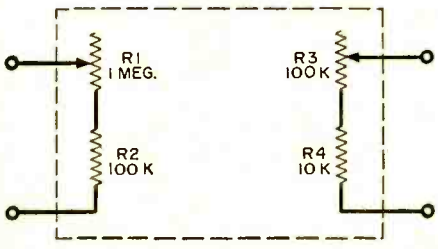
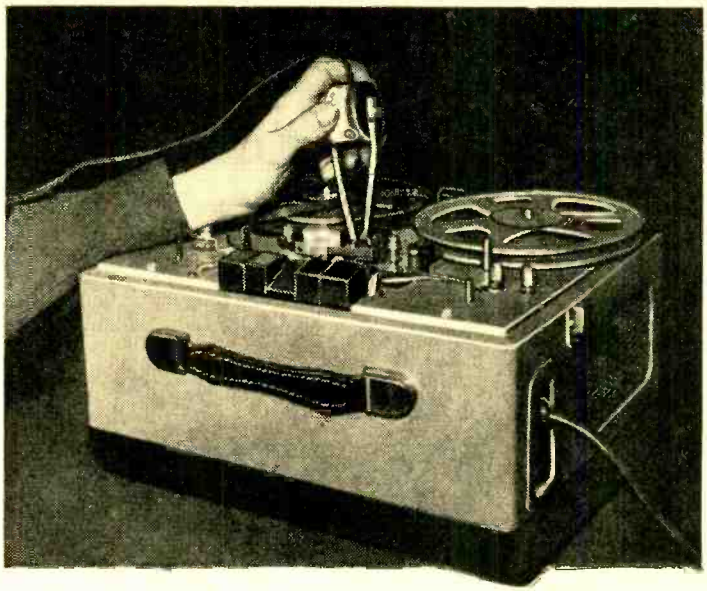


Fig. 1. General-purpose potentiometer-resistor arrangement. The resistors in series should be rated at 1 watt, 5%.

Potentiometer decades of this general construction can be made to serve in several extremely useful specialized applications. Figure 2 (p. 116) shows a circuit variation that will be interesting to experimenters who work a lot with resistance-capacitance-coupled audio amplifiers. The 5000-ohm potentiometer (*R1*) in series with a 510-ohm fixed resistor (*R2*) is used as the cathode bias resistor in an amplifier setup. Continuously variable cathode resistance values between 510 ohms and 5510 ohms are available. The proper bias resistance for any vacuum-tube voltage amplifier is seldom, if ever, outside this range.

A new 500,000-ohm potentiometer (*R3*)

(*Continued on page* 116)



When you use a demagnetizer, withdraw it very slowly from head. Typical operation of Audio Devices Co. unit is shown above.

Don't Let Your Tapes Hiss at You

IF THE TAPES you make on your recorder have developed an annoying hiss that was never present before, it is a warning to examine your machine for certain faults, one or more of which will need immediate correction.

One of the sneakiest of the faults that make recordings hiss is "permanent" magnetization of the playback-record head. Every tape passing this head will be impressed with a degree of constant one-way magnetism, added to the alternating magnetism of the signal being recorded. The one-way magnetism, or "d.c. component" of the signal on the tape, brings up the hiss level sharply.

Other villains causing increased tape hiss are noisy preamplifier tubes in the record or the playback amplifier, and noisy resistors in the circuits of the preamp tubes. The remedy in these cases is obvious. We are going to concentrate here on head magnetization, because its characteristics and cure are much less well known.

A magnetized head can also put an annoying hiss level on commercial prerecorded tapes after one or more passes through the machine. Once such a hiss has been added to prerecorded tape, you're stuck with it. A magnetized head not only lowers the quality of your home tape recordings but can ruin an expensive prerecorded reel with one or two playings.

How does a head become magnetized, and what do you do when it happens? The basic cause of head magnetization is a surge of current that goes through the head in one direction without a completely offsetting surge in the other direction. It can result from one heavy surge, or it can be caused by the accumulation of many small unbalances in head current.

Dangerous surges are produced by such operations as: turning the machine on or off with the gain control advanced; switching from "record" to "play," or any other function change, at high gain; and dropping the microphone, or striking it sharply.

The heavy surges can be avoided by doing all switching—on or off, from one function to another—with the volume controls turned down. Professionals do this as a matter of course. They fade signals in and out with the gain controls, and never start or stop them by turning the machine on or off at full gain.

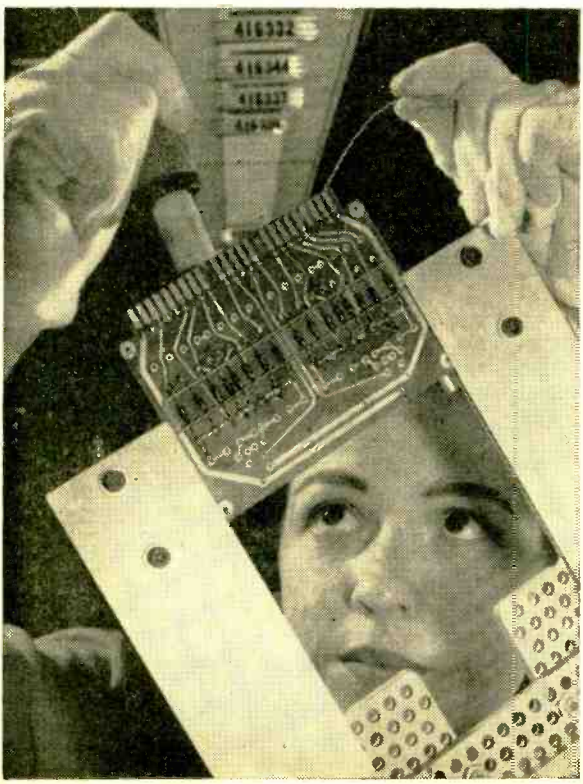
However, even with heavy surges eliminated, the slow "normal" accumulation

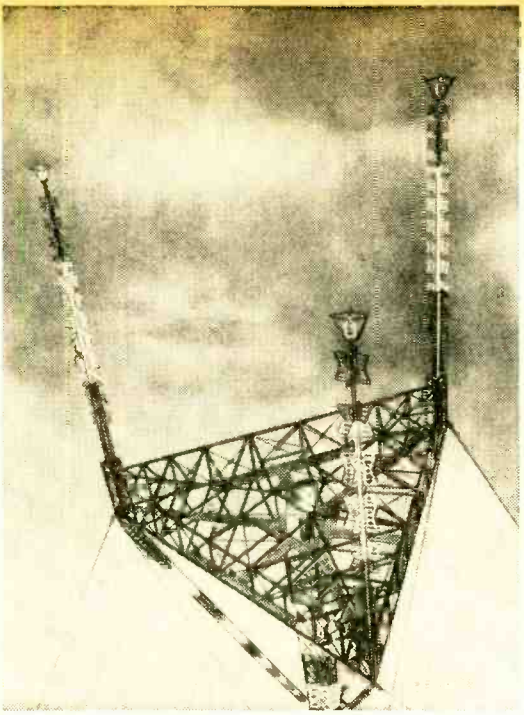
(*Continued on page* 106)

Electronics in the *News*

They do things big in Texas, as witness the world's largest super-accurate clock (right) atop the 30-story Continental Bank Building in Fort Worth. Split-second accuracy is controlled by means of precise time signals from Station WWV. The clock can be read day or night from a distance of three miles or more. Longer than a freight car and taller than a three-story building, it makes one complete revolution every minute and flashes the time in numerals over two stories high.

The first airborne digital computer to go into production (below) is able to make 9600 basic arithmetical calculations per second. It "flies" an Air Force jet automatically through supersonic combat from take-off to touchdown. This computer is manufactured by Hughes Aircraft Company, and is small enough to fit into a table-model TV cabinet.

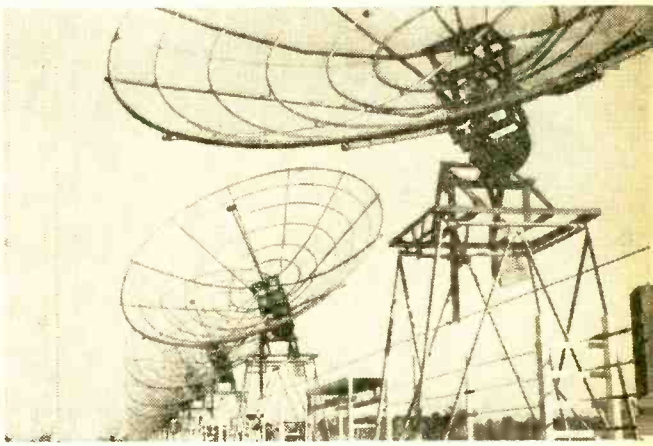


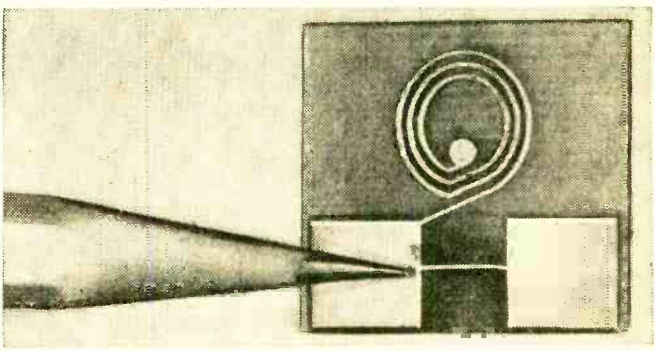


Unique TV transmitting tower being erected in Baltimore (left) bears a triple antenna, giving it a candelabra effect. The entire weight of the 900,000-pound structure, 729 feet tall, will be borne on legs made of U. S. Steel's new T-1 structural steel. Baltimore's three TV stations will each occupy one of the corners with a 107-foot antenna.

Working hard during IGY is the huge Australian crossed-grating interferometer radiotelescope near Sydney (below). Each of two arms bears 64 separate parabolic antenna arrays a half-mile long.

The "Persistor" shown at the bottom of this page was designed by Ramo-Wooldridge for the memory unit of an electronic computer. Super-cold operating temperature of nearly absolute zero (or —459.6° F) permits it to carry out switching operations in 10 millimicroseconds.





Molten metal levitates or floats in air (left and in close-up above) in a new method of purifying the "wonder" metals which may otherwise pick up impurities. A high-frequency alternating current flowing in the coil causes the metal sample to melt at 4500-5000° F and at the same time to float freely in space. The sealed glass vessel contains an inert atmosphere of helium or argon. Some of the metals prepared in this way at Westinghouse are niobium, zirconium and titanium, the so-called "metals of the future."

AFTER CLASS

Special Information on Radio, TV, Radar and Nucleonics

NO MORE VIBRATORS!

I have heard that there are some new automobile radios in which the tube plates work from the car battery without the help of a vibrator power supply. Are there really such tubes? If so, how can they work at such low d.c. voltages?

ANYONE who works with conventional vacuum tubes would be inclined to scoff if he were told that there were tubes which would give excellent amplification, serve as first-class radio detectors, and perform as completely reliable oscillators *with only 12 volts on their plates and screens.*

But he'd be dead wrong! There *are* such tubes! Primarily designed for 12-volt automobile battery systems, they eliminate the most troublesome parts of the more old-fashioned radios—the vibrator, power transformer, rectifier and filter system.

The Old Way. Automobile and pleasure craft receivers have always suffered from the low-voltage handicap. With 12 volts d.c. (or 6 volts in some systems) as the only source of power, the normal procedure for obtaining the required 250 volts d.c. for the plates and screens of converter, local oscillator, and amplifiers is first to chop the d.c. up into pulsations by means of the vibrator. Stepped up to higher voltages with a transformer, these pulses are then rectified and filtered to convert them to d.c. for the tubes (Fig. 1).

But electron tube designers are diehards! With the transistor threatening to pull down the final curtain on them, they have come back with a walloping good encore! The fact that car radio manufacturers are now offering vibratorless receivers featuring the new low-voltage tubes testifies to their overwhelming success.

Problems and Answers. At 12 volts, a conventional pentode amplifier of the 250-volt class cannot do the job for which it was intended. In such tubes it is impossible to maintain a satisfactory plate current level at such low potentials.

The answer was complete redesign of the structure, spacing, and even materials of the tube elements. The geometry of the electrode structures was changed and much closer interelectrode spacing was used, as shown in Fig. 2. Unfortunately, both of these modifications have detrimental side effects: they lead to a substantial increase in the plate-grid capacitance which, in turn, necessitates special circuit techniques to prevent instability and high-frequency losses.

A second serious problem stemmed from the voltage variation of the battery-gen-

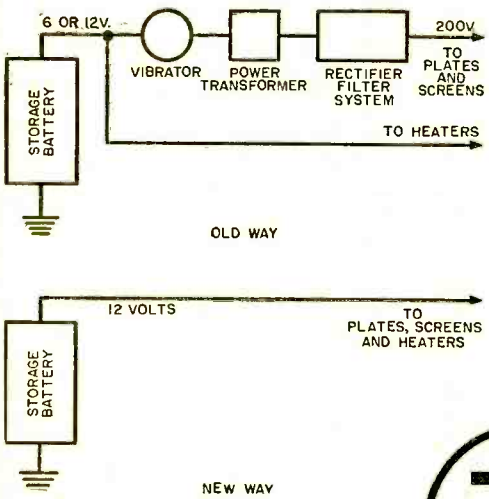


Fig. 1. The new low-voltage tubes make vibrator power packs virtually obsolete.

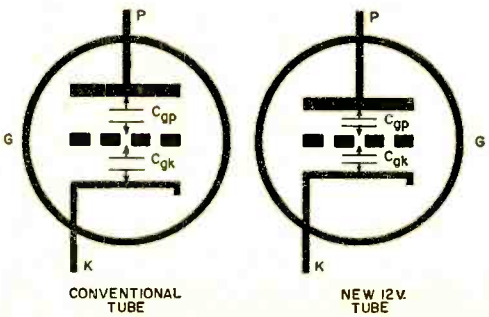


Fig. 2. In the conventional tube, separation of plate, grid and cathode leads to relatively small interelectrode capacitances. They are much larger in the 12-volt series due to closer spacing.

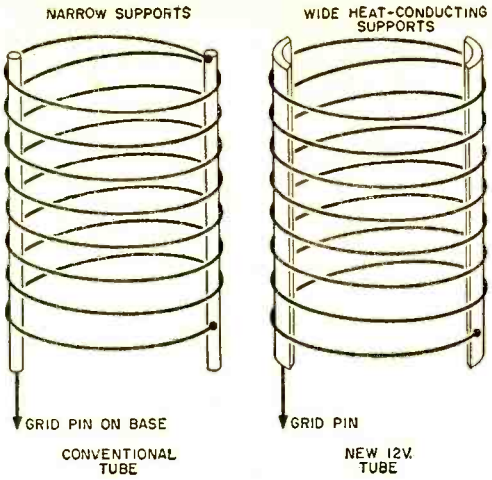
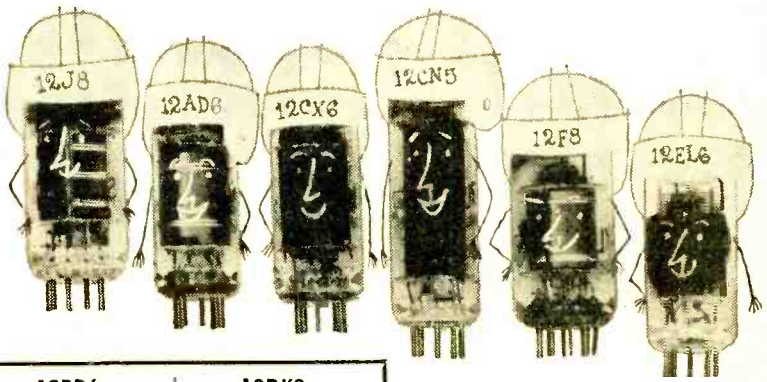


Fig. 3. Wide grid supports act as heat sinks for the 12-volt tubes—help cool the grids by conducting heat away quickly, minimizing grid emission. This is not as great a problem with the older tubes.

lime as easily, and using wide grid supports that would conduct the heat away from the grid wires quickly, much like a heat sink (see Fig. 3).

As moving vehicles constantly pass from live to dead areas and back again, often in quick succession, automatic volume control (a.v.c.) is an absolute requisite for pleasurable listening. A standard auto radio circuit, while receiving a signal of normal strength, produces from −5 to −6 volts for a.v.c. control. Since this is about equal to the actual potential one finds on the



New Faces. "Line-up" of some of the 12-volt receiving tubes designed by Sylvania Electric Products Inc. for use in modern automobile radios.

Characteristics	12BD6 (Standard)	12DK8 (Low-Voltage)
Source voltage	250 volts	12.6 volts
Heater voltage	12.6 volts	12.6 volts
Screen voltage	100 volts	12.6 volts
Plate current	9 ma.	3 ma.
Screen current	3 ma.	1.4 ma.
Transconductance	2000 micromhos	3100 micromhos
Plate resistance	700,000 ohms	40,000 ohms
Tube efficiency	222 micromhos per ma.	1033 micromhos per ma.

Table 1. How low-voltage tube compares with standard pentode.

erator system as the vehicle moves. In a modern automobile, the available voltage jumps erratically between 10 and 16 volts due to the varying speed of the generator and the shifting loads in the form of "off-on" headlights, heater motor, cigarette lighter, etc.

With the battery line voltage at its high point, tube heaters burn too brightly, cathode coatings vaporize more readily, and grids begin to emit electrons. These problems were overcome by carefully redesigning the heaters, selecting new types of cathode materials that would not subplate and screen of one of the new 12-volt tubes in the i.f. strip, some radical engineering was needed.

The solution to the a.v.c. problem was remarkably straightforward. How can we realize control with a much smaller negative voltage? Merely by applying the controlling voltage to *two grids instead of one*. After the negative feedback potential is reduced to make it practicable, it is then fed to both the control grid and the suppressor grid of the r.f. amplifier tube. An even smaller part of the a.v.c. voltage

(*Continued on page* 111)

Screen Jumpers for Radio and TV Receivers

When a permanent magnet (PM) loudspeaker in a console radio or television receiver is located remotely from the main chassis, you will frequently find that connection is made to the chassis by means of a three-wire cable. And, since a speaker voice coil requires only two wires, the

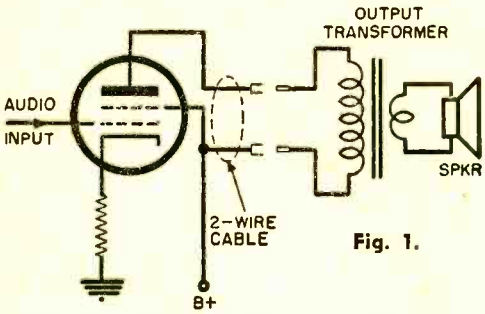


Fig. 1.

three-wire cable seems to have one superfluous conductor, a point that often confuses the uninitiated.

The "secret" of the extra lead is this. It is a common practice in home radio and TV receivers to mount the output transformer on the loudspeaker frame. Since such transformers are usually quite light in weight, there are no physical mounting problems, and there is one less component in a usually overheated and overcrowded area. The possibility of hum pickup or feedback originating from the proximity of the output transformer to other components is eliminated.

Consider the circuit in Fig. 1. It is fully satisfactory as long as the cable socket is not removed from the speaker plug when the receiver is being serviced or is accidentally dislodged. But should this occur, the chances are that the output tube will be damaged.

In normal operation, the screen grid of the output tube does not draw excessive current because of the high plate voltage. Removal of the plug disconnects the plate circuit, leaving the screen still activated, so that all of the electrons which formerly

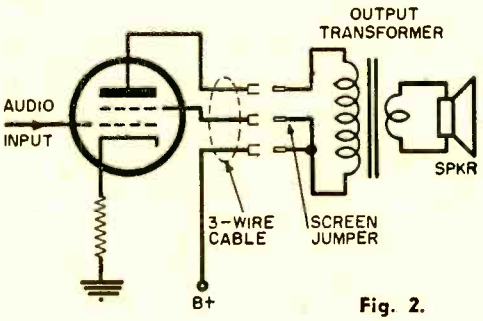


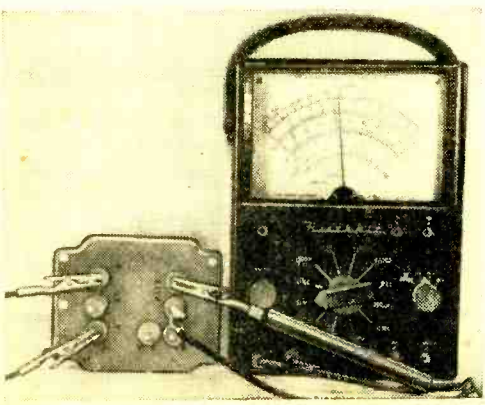
Fig. 2.

went to the plate are drawn to the screen-grid, causing it to overheat seriously.

If a three-wire cable and a "jumper" are installed across the speaker plug, however, as in Fig. 2, accidental or intentional plug removal will remove the B+ from *both* plate and screen, thus eliminating the possibility of tube damage. —*Paul Harvey*

How to Obtain Odd Voltages

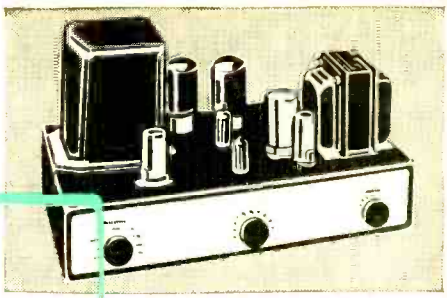
The electronic hobbyist frequently would like to have "odd" a.c. voltages for calibration and other experimental purposes. The usual voltages of 2.5, 5, 6.3, 115 and 250 to 660 volts can be obtained from the secondaries of commonly available filament and power transformers. How-



ever, by changing the method of connection, readings of 0.8, 1.0, 2.1, 20 and 40 volts might be had. The trick is to use the entire high voltage winding or half of it as the primary winding. As an example, with the 117-volt a.c. line connected across a typical high-voltage winding, a voltage of 21.5 volts might be available across the primary winding.

Another trick is to connect two or more of the secondary windings in series in or out of phase. Thus, to obtain 11.3 volts, connect the 5-volt and 6.3-volt windings in series in phase. To obtain 1.3 volts, connect the 5-volt and 6.3-volt windings in series and out of phase. The simplest way to check the mode of connection is to measure the voltages between the outer ends of the series-connected windings.

Remember that the voltages across transformer windings are often quite high. Play safe by disconnecting the transformer from the a.c. line while making changes in connections. —*Forrest H. Frantz, Sr.*



SQUARE WAVES
Check Tone Controls

Use your square-wave generator to find out how effective treble and bass controls can be

By JOHN F. KEIDEL

TONE CONTROLS enable the critical music listener to compensate for minor deficiencies in his hi-fi audio reproducing system. Also, they can correct, to some extent, for undesirable room acoustics, and allow the listener to adjust to suit his individual hearing characteristics.

The Controls. Generally, separate bass and treble controls are incorporated in the amplifier's circuitry. Both are usually continuously variable and function independently of one another. Either may be adjusted to offer a given amount of boost or attenuation in its respective range.

A bass control affects the low-frequency audio spectrum, while a treble control influences the higher frequency region. Assuming that no compensation is required, both controls would be adjusted to a point where the over-all frequency response curve is uniform or flat. Figure 1 (p. 78) is a typical response pattern obtained using tone controls.

Supposedly, a flat response characteristic is obtained when the pointer knobs of these controls are set to an upright or "12-o'clock" position. Unfortunately, normal tolerance variations in components or compromises made in circuit design may not yield the desired flat response at the "12-o'clock" setting, but rather at some other position, say "1 o'clock" or "2 o'clock." Since control settings are judged by ear, this is not extremely important. But it is interesting to note where this condition occurs, since the true flat position is often used as a reference when gaging the degree of compensation for other settings.

More important is the actual effectiveness of the controls—how much boost or attenuation each control can offer. Typical values of maximum frequency boost and cut are shown in Fig. 1, obtained at extreme clockwise and counterclockwise control positions.

Using Square Waves. These provide a positive and rapid means of measuring both flat response settings and over-all circuit effectiveness. Any variation in the shape of a square wave which has been applied to the input of an amplifier can be attributed to the amplifier's non-uniform frequency response.

If low frequencies are lost or attenuated in the amplifier, the top and bottom of the square wave—when reproduced on an oscilloscope—appears tilted. Accentuation of bass frequencies produces tilt in the opposite direction. The standard oscilloscope shows insufficient high-frequency response

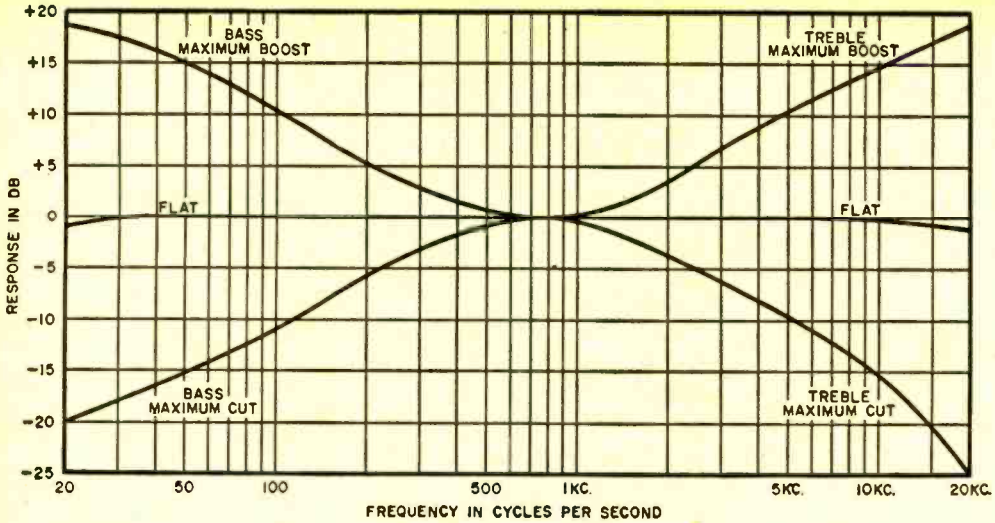


Fig. 1. This is a typical tone control curve. Amplifiers with feedback type controls have different parameters but the "hourglass" shape remains.

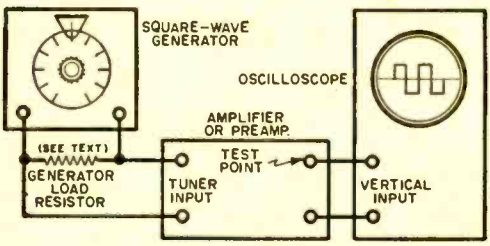


Fig. 2. Test setup used when running square waves through the amplifier.

by a rounding off of the square wave's leading edge. A boost in higher frequencies is indicated by "peaking" in the leading edge.

When the tone controls are adjusted to produce an accurate square wave, the resultant amplifier response will be flat. Few tone control circuits allow adjustment for the reproduction of a perfect or "ideal" square wave. In actual practice, you'll find that square waves put through a tone control circuit will frequently develop "notches" on top and bottom. These are not significant in terms of the over-all sound of your system, but may be misleading if you attempt to set your tone controls by them. A notch close to the leading edge of the waveform will tend to depress the treble range audibly, although the height of the square wave is the same on the leading and lagging edges.

Test Procedure. A square-wave generator and oscilloscope are required for the test. However, since the test frequency range is purposely restricted (500 cps to 2000 cps), neither piece of equipment need be expensive or of top quality. Even an inexpensive square-wave generator should provide good output waveshapes in the 500-cps to 2000-cps range. (See page 53.) Any oscilloscope which will faithfully reproduce a square wave in this range will suffice.

Connect the test equipment and the am-

(*Continued on page* 104)

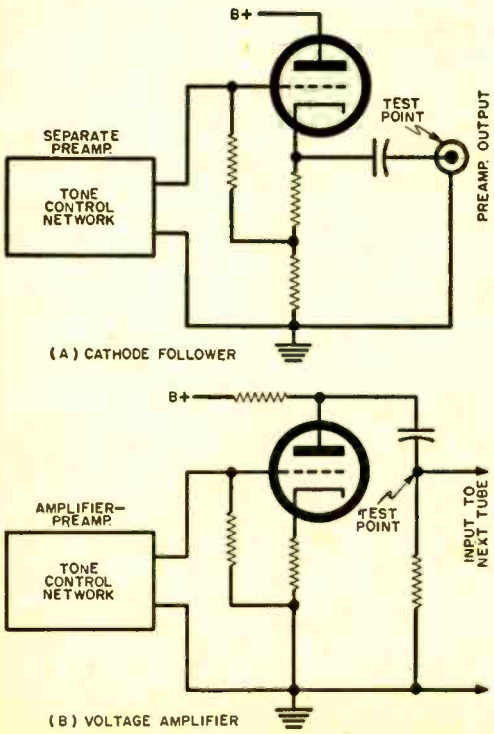


Fig. 3. The points indicated in (A) and (B) will provide the most reliable take-off points for your oscilloscope.

Among the Novice Hams

By HERB S. BRIER, W9EGQ

IN the January column, as part of our discussion of the basic electronic theory on which the General/Conditional/Technician license examination is based, we talked about capacitance and capacitors. This month, we'll cover *inductance* and *inductors,* which are also referred to as coils, chokes, and reactors. First let's learn a bit about current and magnetism before taking up inductance itself.

Current and Magnetism. Imagine that a source of direct current, such as a battery, is connected across the ends of a length of wire or other conductor. An electric current, which consists of electrons in motion, will flow through the wire. If we bring a magnetic compass near the wire, the compass needle will be deflected from its normal position. The greater the current flowing through the wire, the more the needle will be deflected. If we reverse the battery terminals, it will be deflected in the opposite direction.

We have shown that *electrons in motion (electric current) in a conductor generate a rotating magnetic field around the conductor.* We have also found that the direction in which the electrons are moving determines the direction of rotation of the magnetic lines of force. According to the "left-hand rule," *when a conductor carrying current is grasped in the left hand with the thumb pointing in the direction in which the current is flowing (towards the positive terminal), the fingers point in the direction of rotation of the magnetic field.*

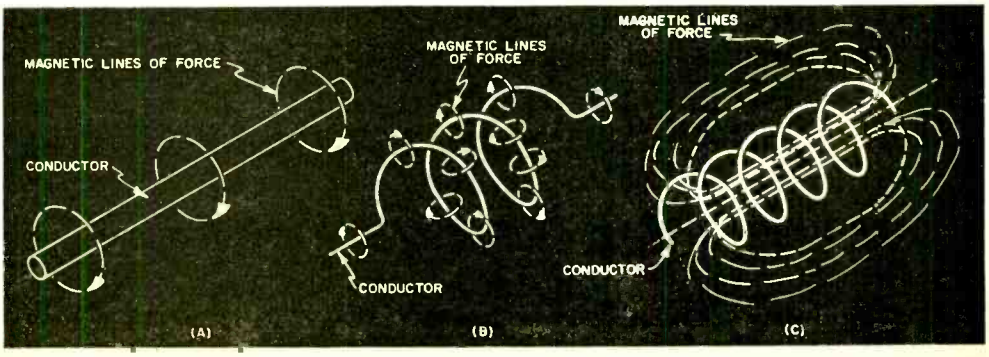
If we substitute a sensitive microammeter for the battery across the ends of the conductor and rapidly move a powerful permanent magnet across the conductor, the meter pointer is momentarily deflected. The direction in which the magnet is moved determines the direction in which the meter pointer is deflected. The speed of the magnet determines how much the pointer is deflected.

Thus, *a magnetic field moving across a conductor induces (causes to flow) a current in the conductor.* A current will also be induced in the conductor if the magnet is held still and the conductor is swept across its poles.

The magnitude of the effect is small in a straight length of wire. If the wire is wound into a coil like thread on a spool, the effect is greatly increased. Then the magnetic lines of force around the wire act upon each turn and on adjacent turns as well. Figure 1 illustrates this action two-dimensionally.

If we insert a soft iron core inside the coil, even more current flow takes place, because the magnetic lines will travel through the iron much easier than through

Fig. 1. How magnetic lines of force around a conductor carrying current (A) are concentrated by winding the conductor into a coil (B); total magnetic flux path around the tightly wound coil is shown in (C).



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air. Consequently, the iron core concentrates the magnetism around the turns of the coil.

Self Inductance. Suppose we connect a coil containing thousands of turns of wire wound around an iron core, a source of direct current, a voltmeter, an ammeter, and a switch, as shown in Fig. 2. When the switch is closed, the voltmeter immediately indicates the full battery voltage across the coil terminals. But the ammeter pointer moves slowly up to a position determined by the resistance of the wire in the coil and the applied voltage.

When the switch is opened, however, the ammeter pointer immediately drops back to its zero position, but the voltmeter pointer flips up far beyond its previous position before it drops back to zero. There will also probably be quite a large spark across the opening switch contacts.

What happened? When the switch is first closed and current starts to flow into the coil, a strong magnetic field starts to build up around the coil. This expanding magnetic field is moving; therefore, it builds up an electromotive force of its own in the coil. This induced electromotive force is exactly opposite to the applied electromotive force. Consequently, it opposes the flow of current into the coil—but it cannot cut off the current *completely.* If it did, there would be nothing to generate the magnetic field. So the current slowly increases to its steady value and supports a steady magnetic field around the coil, but the process does take time.

When the switch is opened, the incoming current drops instantly to zero and kicks the props out from under the magnetic field, which is thus forced to collapse instantaneously. While it collapses, the energy it contains is instantly converted back into an electromotive force in the coil, which builds up in voltage until it is sufficient to arc across the open switch contacts.

These effects are due to the *inductance* of the coil, which is measured in *henrys.* By definition, *a change of one ampere per second in the amount of current flowing through an inductance of one henry generates an electromotive force of one volt in it.* The technical name for a coil containing inductance is an *inductor.* In radio work, the terms millihenry (0.001 henry), abbreviated mh., and microhenry (0.000001 henry), abbreviated μh., are also used.

Applying A.C. Figure 3 shows what happens to the current and voltage in an inductor if an a.c. generator is substituted for a d.c. generator.

For simplicity, let us assume that the a.c. generator voltage is maximum (point *A*) when we close the switch. Immediately, this voltage tries to force current through the inductor. But zip! The resulting magnetic field immediately generates a counter voltage in the inductor, which sharply limits the amount of current that can flow into it. However, as time passes, the generator gradually forces more current into the inductor, even though the generator voltage is decreasing at the same time, until ¼ cycle or 90° later (point *B*), the current reaches its maximum value, just as the generator voltage has decreased to zero.

Immediately, the a.c. generator voltage starts increasing in the opposite (negative) direction and tries to force a current

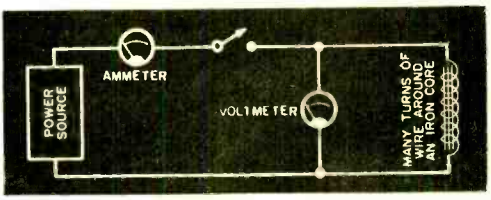
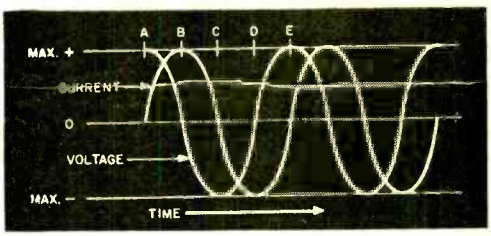


Fig. 2. Theoretical circuit used to illustrate the meaning of inductance as discussed in the text.

Fig. 3. Current and voltage relationships in an inductive circuit when alternating current is applied.



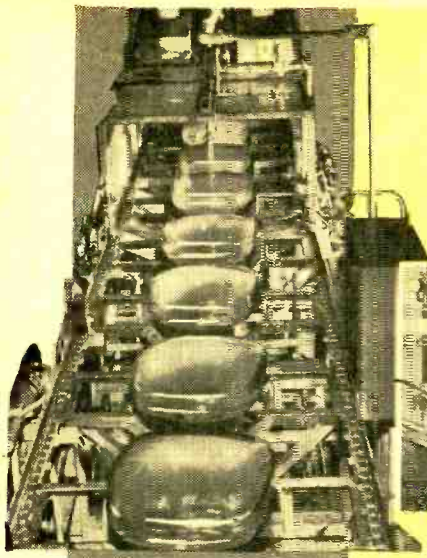
through the inductor in that direction. But, as soon as the current tries to reverse direction, the magnetic field generated by the current flowing in the original direction starts to collapse, and its energy is converted back into an electromotive force that tends to keep the current flowing in the original direction.

At first, the electromotive force from the collapsing field is strong; so the current is high. As the cycle continues, however, this energy is used up, while the generator voltage is increasing. Thus, at the end of ½ cycle or 180° (point *C*), the current has decreased to zero, just as the generator voltage reaches its maximum negative value.

At this point, current starts flowing into the inductor in the opposite direction, and the action of the current and voltage is like that of the previous half cycle. At the end of a complete cycle (point *E*), the current and voltage relations are exactly as they

(*Continued on page* 120)

A TV Tube: As It Is Made—



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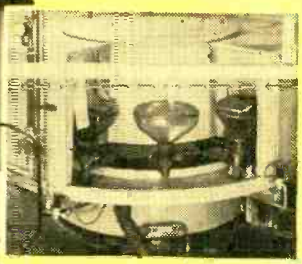
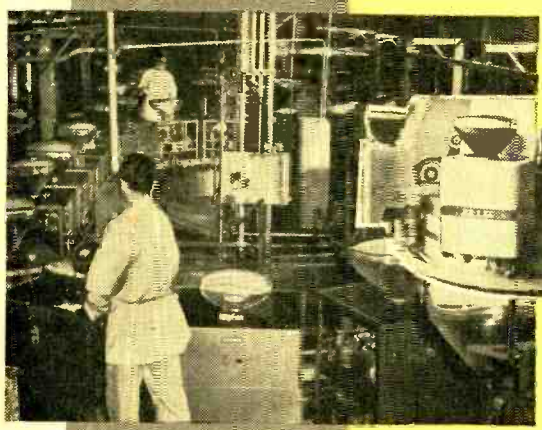


GERMANY

1 Bulb washing with hydrofluoric acid, then water, is done on assembly line at Sylvania, and on circular "washautomaton" at Telefunken. In this and following steps, the process in both plants is generally automatic, but workers move bulbs from one line to next.

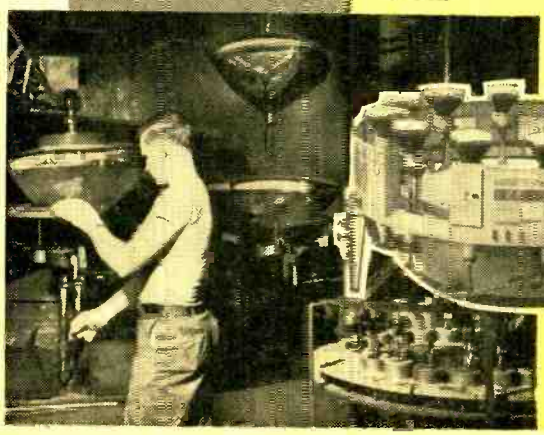


U. S. A.

GERMANY

3 To assure brighter screen and clearer raster, both plants apply an aluminum coating to the inside of the bulb. A small piece of aluminum is heated to incandescence in the evacuated bulb, depositing a micron-thin film of the metal over the interior lacquer coating which was applied earlier.

U. S. A.



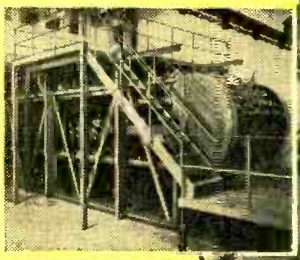
GERMANY

5 The sealing process is the marriage of bulb and gun, effected in both plants on a circular assembly line. While the German photo does not show it, the bulbs must be placed on the line by workers, as in the Sylvania shot. Sealing is automatic, as is following inspection process.

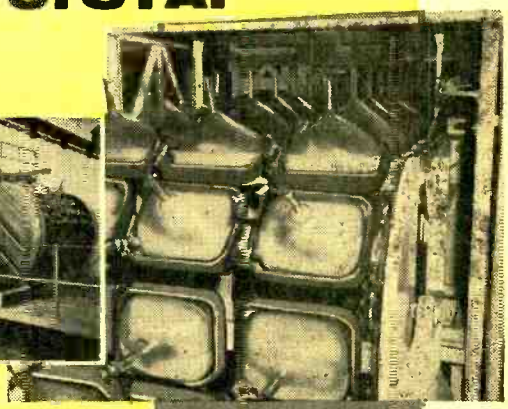
U. S. photos taken at Sylvania Electric plant at Seneca Falls, N.Y.

In Germany–In U.S.A.

2 After "screen settling," bulbs filled with a phosphor solution are "poured" off as they move along vibration-free conveyor belts. When the fluorescent coating has dried, a thin lacquer coating is applied in the same manner, to serve as a base for aluminizing — the next step.

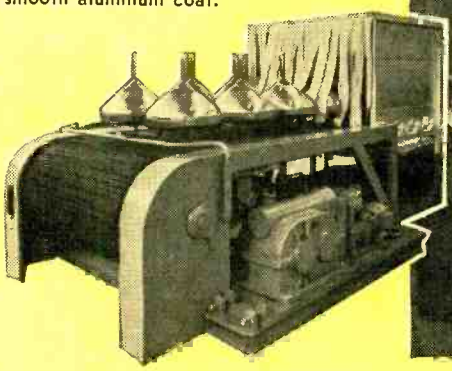


GERMANY



U.S.A.

4 Baking in lehr (oven) removes acquer coat, leaving a smooth aluminum coat.



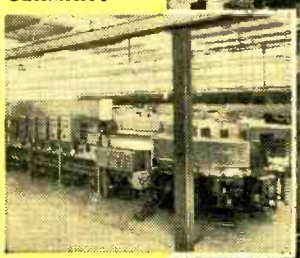
GERMANY

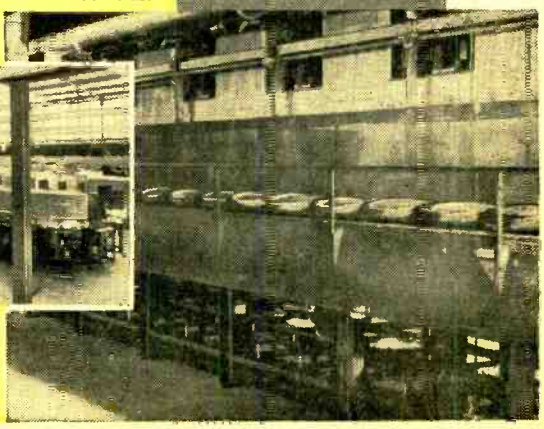
U. S. A.

U. S. A.

6 Evacuating the tubes at high temperature is accomplished on a screened-off line as a safeguard against implosions, which occur infrequently. "Getter" is then flashed to absorb foreign gases, after which the tubes are aged and tested. Inspection and packing are last.

GERMANY





German photos taken
at the Telefunken Company plant at Ulm

Short-Wave Report

By HANK BENNETT

IN PROGRAMING to various parts of the world, *Radio Australia* usually broadcasts in the language or tongue of the people in the target area. In Southeast Asia, New Zealand, and the Pacific Islands, its broadcasts supplement and often replace other stations for normal day-to-day listening. The identification signal is the laugh of Australia's famous kookaburra bird and a music box version of "Waltzing Matilda."

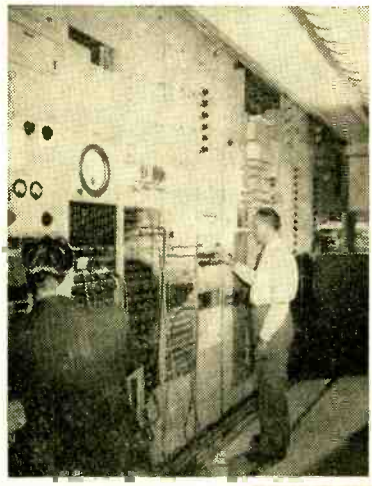
Of the current daily 41½ program hours, 23½ hours are beamed to South and Southeast Asia and the South Pacific Islands, 8¾ hours to Northeast Asia and the North Pacific Islands, 1½ to the British Isles and Europe, 2¾ to the United States and Canada, 1¼ to Africa, 1¾ in French to Tahiti, New Caledonia, and Southeast Asia, 2 hours in Indonesian (morning and evening sessions of one hour each) for Indonesia and Malaya, 1¼ hours in Mandarin for S.E. and N.E. Asia, and 1 hour daily in Thai to Thailand.

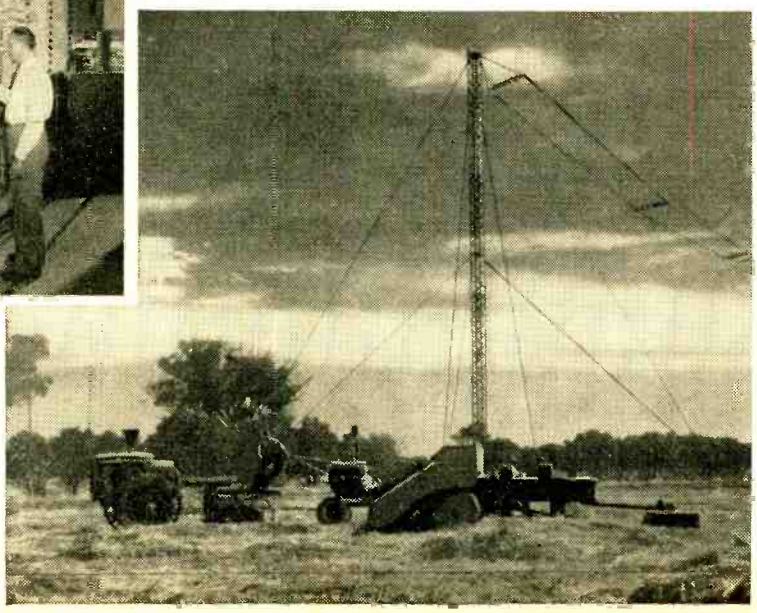
A transcription service was introduced in late 1953. Recordings are taken of talks and offered for rebroadcast on local networks in the various Asian countries. This service has already secured regular rebroadcasts for its material in India, Pakistan, Burma, Singapore, Malaya, Hong Kong, Sarawak, North Borneo, Japan, Thailand, Indonesia, the Philippines, Fiji, and New Caledonia.

Twenty-five news bulletins are broadcast daily, including two in French and two in Indonesian, one each in Mandarin and Thai, one dictation speed bulletin, one daily BBC news relay, and a relay for the Federation of Malaya.

In two short-wave listening polls held in 1956, *Radio Australia* was rated first in world popularity. Letters from overseas listeners now total more than 5000 a month,

(*Continued on page* 123)



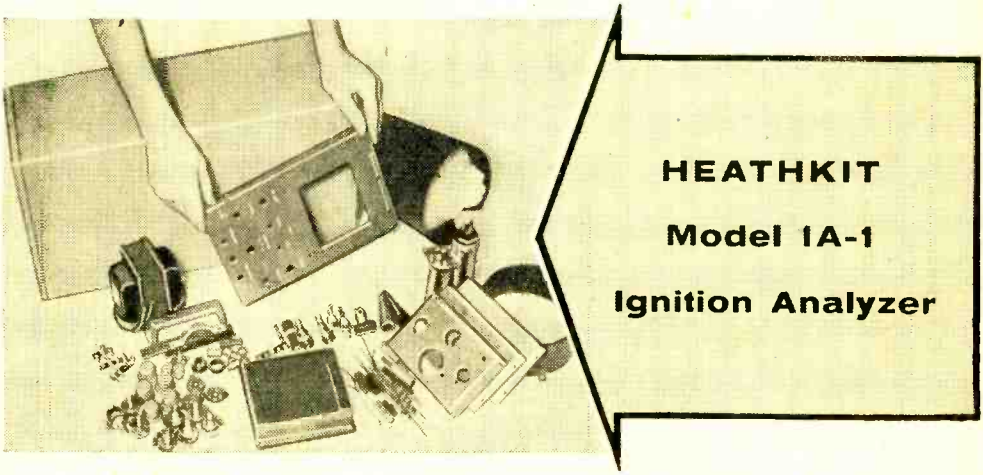


Radio Australia's main switchroom at Broadcast House, Melbourne, is shown above. A number of half-wave stacked arrays with reflectors mounted atop 210'-high steel towers make up the antenna system.

KIT BUILDER'S KORNER

IF YOU ENJOY tuning up your car engine almost as much as you enjoy tinkering with electronics, you'll get a double kick from building the Heathkit Model IA-1 ignition analyzer. This specially designed oscilloscope traces out a picture of ignition system performance on the face of a cathode-ray tube.

Using the ignition analyzer, you can track down a faulty capacitor, check point setting, or pinpoint the one out of six or eight spark plugs that is laying down on the job. With a converter to supply 110 volts a.c. from the car's battery, you can take the analyzer along on a test drive to check the ignition system under actual operating conditions.

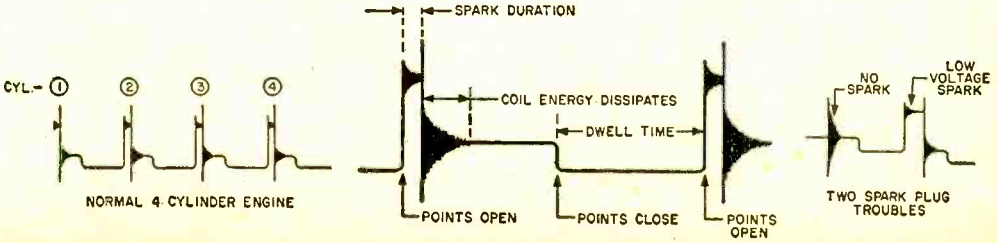


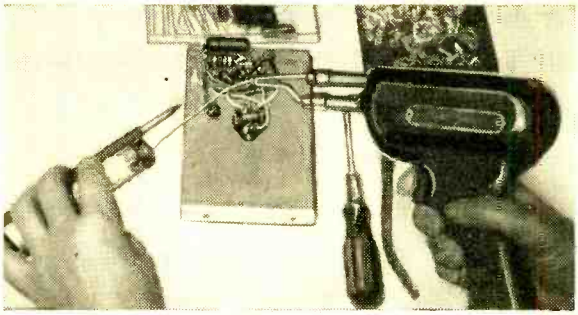
What It Does. A lead connected to the breaker point terminal on the side of your car's distributor picks up the changes in voltage in the primary of the ignition system. When translated into an oscilloscope pattern by the analyzer, these changes show when the points open and close and how the capacitor is functioning.

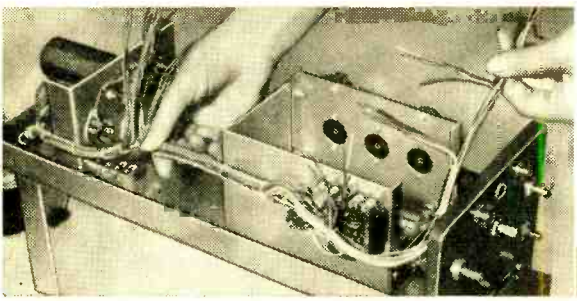
Since the ignition coil is actually a transformer, it will step down the high-voltage spark in the secondary to a low-voltage change in the primary. From this reflected signal, you can determine the condition of the spark plugs and gap settings. The pattern on the oscilloscope screen for a normally operating four-cylinder engine is shown in Fig. 1. The meaning of the waveforms is also shown, and two symptoms of spark plug troubles.

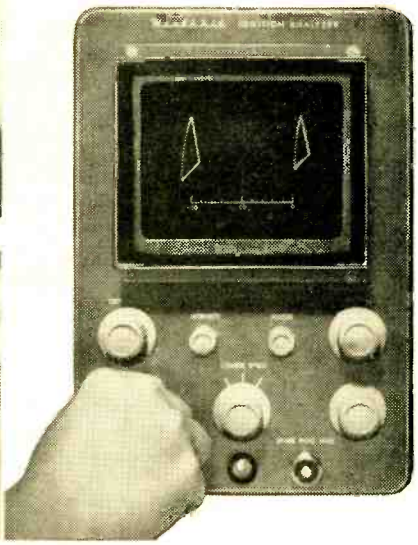
To make sure that the horizontal sweep of the analyzer cathode-ray tube is in time

Fig. 1. Typical ignition analyzer pattern for a normal four-cylinder automobile engine (at left); interpretation of waveform (center); and two examples of defective spark (at right).









Assembly of the three subchassis of the ignition analyzer (top) before mounting them on the main chassis eliminates soldering in tight spots. Precut and tied wiring harness (left) makes interconnection of tube, subchassis and controls a simple and neat wiring job. Double-exposure picture (right) shows change in pattern obtained during test when left-edge control is adjusted.

with the motor, the sweep is triggered by a pulse picked up from one of the spark plug leads. No electrical connection is made to the spark plug. The impulse from the high-voltage spark is induced in a clip attached to the insulated portion of the wire. This trigger pulse is shaped to the proper form to trigger a sweep circuit that starts the trace across the face of the cathode-ray tube.

Putting It Together. You will find the Model IA-1 a fairly easy kit to assemble, even though it has a large number of wiring connections. Construction is simplified by the use of three separate subchassis for the power supply, sweep and deflection amplifiers, and the trigger circuits. Each of these chassis makes a convenient bite-size one-evening construction job for the beginner. A more advanced worker can build the unit in less time.

After the subchassis are wired, they are mounted on the main chassis with the front-panel controls. A time- and error-saving aid for the beginner and old-timer alike is the precut wiring harness that interconnects all of the chassis, front-panel controls and the cathode-ray tube. When you drop the harness into place, you will find that the color-coded wires fall within an inch of so of their proper connection points.

With the harness connected, the analyzer is ready for the front panel knobs and the final bench test. If all circuits have been wired correctly, two temporary wiring connections will produce a special pattern like one of those shown in the photo above. If you get that pattern, you're in business. Disconnect the temporary wiring, add the cabinet, and warm up your car for the final test.

Special Features. The Heathkit ignition analyzer has been designed for construction by people who are more familiar with engines and sports cars than with electronics. Use of a precut wiring harness is a big help in keeping errors to a minimum and eliminating possible confusion. And it will give the wiring of the more experienced worker a professional look.

Another feature that is helpful to the beginner is the short summary at the conclusion of the wiring directions for each subchassis. Here, the connections to be left unsoldered until later are listed, and a brief description is given of the stage just completed and how it functions in the finished instrument.

Comment. Construction of the Model IA-1 is straightforward, and the instruction manual is detailed and well written. A mechanic or sports car fan with no electronic experience would find this kit an interesting challenge but not beyond his ability to assemble. —30—

Square-Wave Generator

(*Continued from page* 55)

the transformer specified is operated at 100% overload, but this causes no serious over-heating and the resultant lower filament voltage probably adds stability to the circuit.

Calibration. It will not be necessary to calibrate the generator if the horizontal sweep of the oscilloscope with which it is used is calibrated. If such is not the case, however, both the scope and the square-wave generator can be quickly calibrated as follows:

Feed the 60-cycle voltage from a 6.3-volt source to the vertical input and adjust scope sweep to show one complete sine wave. The scope is now sweeping at 60 cycles. Attach the output and, with the frequency control on the generator, stabilize five square waves on the scope screen for a generator frequency of 300 cps or ten square waves for 600 cps. From this base frequency, it's possible to work both ways and calibrate both generator and scope at 100-cps points throughout its range.

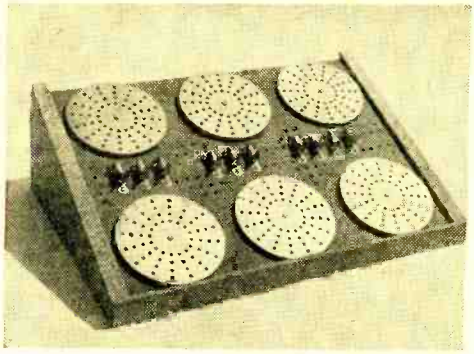
The waveshape of this generator is very good for such an economical unit. Rise time is straight up and down, and the horizontals have only the faintest suggestion of a slope. The only obvious deviation is a slight rounding of the leading edge of the square wave such as is associated with loss of higher-frequency harmonic signals. This is slight, however, and does not seriously mask such a condition in an amplifier which is under test. —30—

HOW IT WORKS

This circuit is basically a bi-stable multivibrator using a duo-triode tube, i.e., a two-stage amplifier with the output of one stage RC-coupled directly to the input of the other. A bi-stable type is designed so that one triode is full on while the other is full off and it is stable in either position. A trigger, properly applied, causes the "off" and "on" states to switch back and forth. This change takes place virtually instantaneously, so that the waveshape at the plate of either section is a square wave with a rise time so short it hardly records on the oscilloscope.

The trigger for the multivibrator is somewhat unusual. It's a type 2050 gas control tube used as a relaxation oscillator. *R4* and *C2* determine the time constant; *but*, by varying the grid bias with potentiometer *R3*, the pulse frequency can be varied over a relatively wide range. The peaked pulse output of the relaxation oscillator is fed, simultaneously, through capacitors *C3* and *C4* to the two grids of the multivibrator. These positive pulses have no effect on the grid of the conducting section since it is already positive but cause the grid of the non-conducting or cutoff section to swing abruptly positive, and this section immediately goes to full conduction while the other is cut off. The following pulse swings the multivibrator sections back again and the two pulses have thus produced one complete cycle of the multivibrator and formed one square wave. This square-wave output is taken from plate potentiometer *R8*, which controls the output gain. Capacitor *C8* in the output prevents loading of the circuit.

Can you think faster than this Machine?



Control Panel of GENIAC set up to do a problem in space ship engineering

Be careful before you answer. GENIAC® the first electrical brain construction kit is equipped to play tic-tac-toe, cipher and encipher codes, convert from binary to decimal, reason in syllogisms, as well as add, subtract, multiply and divide. Specific problems in a variety of fields—actuarial, policy claim settlement, physics, etc., can be set up and solved with the components. Connections are solderless and are completely explained with templates in the manual. This covers 33 circuits and shows how new ones can be designed.

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A MACHINE THAT PLAYS NIM

Yes every GENIAC® comes complete with the materials and circuits for wiring up a machine that plays NIM. No extra charge. See article in January Popular Electronics.

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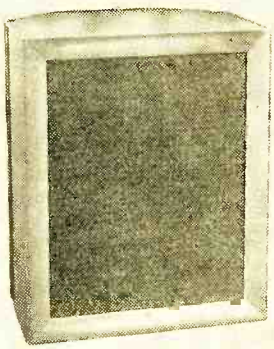
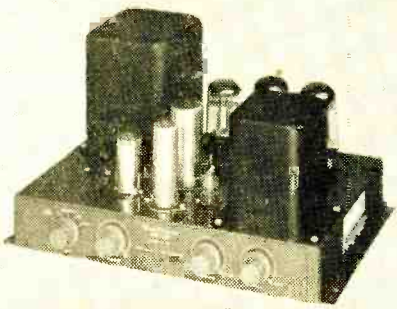


RANGE EXTENDER



A-9C 20-WATT AMPLIFIER

HEATHKIT "BASIC RANGE" HIGH FIDELITY SPEAKER SYSTEM KIT

This amazing speaker system can fulfill your present needs and still provide for future expansion. Fine hi-fi performance the result of using high quality speakers in an enclosure especially designed for them. Features two Jensen speakers to cover 50 to 12,000 CPS within ± 5 db. Power rating is 25 watts, and impedance is 16 ohms. Enclosure constructed of veneer-surfaced plywood, ½" thick, and measures 11½" H x 23" W x 11¾" D. Precut and predrilled for quick assembly.

Model SS-1
$39.95
Shpg. Wt. 30 Lbs.

HEATHKIT RANGE EXTENDING HIGH FIDELITY SPEAKER SYSTEM KIT

Designed especially for use with SS-1 "Basic" system. Contains 15" woofer and compression-type super tweeter. Extends basic unit to 35—16,000 CPS, ±5 db. Impedance 16 ohms. Measures 29" H x 23" W x 17½" D, and is constructed of ¾" veneer-surfaced plywood.

Model SS-1B
$99.95
Shpg. Wt. 80 lbs.

HEATHKIT A-9C HIGH FIDELITY AMPLIFIER KIT

This model incorporates its own power supply and preamplifier. Plenty of power with full 20 watt rating. Four separate inputs, selected by panel-mounted switch, and separate bass and treble controls. Ideal for home or PA applications. Output transformer tapped at 4, 8, 16 or 500 ohms. Response within ± 1 db from 20 to 20,000 CPS.

Model A-9C
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Now you can have full-fidelity FM performance from 88 to 108 mc at reasonable cost. Features temperature-compensated oscillator—built in power supply, and beautiful cabinet. Components prealigned at factory!

Model FM-3A
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HEATHKIT BROADBAND AM TUNER KIT

Tunes standard AM band from 550 to 1600 kc with fine sensitivity and broadband characteristics. Features include built-in power supply and low-distortion detector. All RF circuits prealigned for simplified construction.

Model BC-1A
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HEATHKIT "MASTER CONTROL" HI-FI PREAMPLIFIER KIT

Provides extra amplification, selection of inputs, volume and tone controls, and turnover and rolloff controls, for Williamson-type amplifiers. Beautiful satin-gold enamel cabinet. Derives operating power from amplifier.

Model WA-P2
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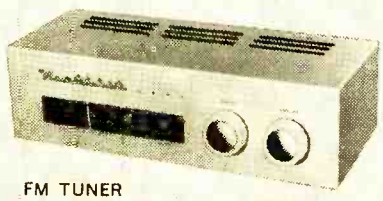
Shpg. Wt. 7 lbs.

HEATHKIT 25-WATT HIGH FIDELITY AMPLIFIER KIT

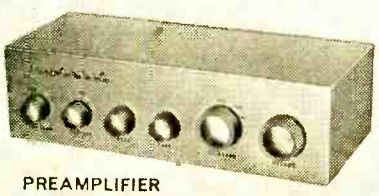
Outstanding 25-watt Williamson-type amplifier employs KT66 tubes and Peerless output transformer, tapped at 4, 8, and 16 ohms. A fine amplifier for the "deluxe" system. WA-P2 preamplifier required for operation. Express only.

Model W-5M
$59.75
Shpg. Wt. 31 lbs.

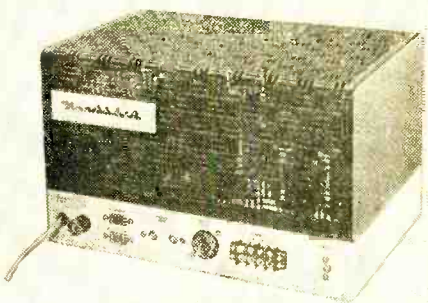


FM TUNER

AM TUNER



PREAMPLIFIER



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HEATHKIT TRANSISTOR PORTABLE RADIO KIT

A new concept in radio reception! Now you can forget about external electrical connections and have fine radio performance anywhere! Low-drain circuit using regular flashlight cells makes battery operation cheaper than power-line operation of table model sets. Tunes 550 to 1600 kc and features a 4" x 6" speaker for "big-set" tone, six Texas Instrument transistors for fine sensitivity and selectivity, built-in rod-type antenna, and unbreakable molded plastic cabinet in "Holiday" gray. Measures 9" L x 8" H x 3¾" D. Appearance and performance are unmatched at this price level. Easy to-build! Shpg. Wt. 4 lbs.

Model XR-1

$34.95

(with cabinet less batteries)

HEATHKIT BROADCAST BAND RADIO KIT

Covers 550 to 1600 kc with good sensitivity and selectivity. Has 5½" PM speaker for good tone quality. Features transformer power supply and built-in antenna. Signal generator recommended for alignment. Cabinet, as shown, available separately. Shpg. Wt. 10 lbs.

Model BR-2

$18.95

(less cabinet)

HEATHKIT CRYSTAL RADIO KIT

Features a sealed germanium diode to eliminate critical "cats whisker" adjustment. Employs two tuning condensers for good selectivity, and covers the broadcast band from 540 to 1600 kc. Requires no external power. Kit price includes headphones. Shpg. Wt. 3 lbs.

Model CR-1

$7.95

HEATHKIT ENLARGER TIMER KIT

The dial of this handy timer covers 0 to one minute calibrated in five-second gradations, so that the timing cycle of a photographic enlarger can be electronically controlled. Built-in relay handles up to 350 watts, and enlarger merely plugs into receptacle of front panel. Also provision for plugging in safe-light. An easy-to-build device that makes a fine addition to any dark room. Shpg. Wt 3 lbs.

Model ET-1

$11.50

HEATHKIT FUEL VAPOR DETECTOR KIT

The FD-1 is a safety device to detect fuel vapor in the engine compartment or other sections of your boat. The detector unit mounts in the area to be checked, and the indicating meter and controls mount on the control panel. Will operate intermittently or continuously, and indicates dangers of fire or explosion to protect your boat and its passengers. Models FD-1-6 (6 volts DC) and FD-1-12 (12 volts DC) operate from boat batteries. Kit even includes spare detector unit. Shpg. Wt. 4 lbs.

6-volt FD-1-6, 12-vt. FD-1-12

$35.95 each

HEATHKIT RF POWER METER KIT

This handy device measures the RF field in the vicinity of a transmitter, whether it be marine, mobile, fixed, etc. Requires no electricity, nor direct connection to the transmitter. Provides a continuing indication of transmitter operation. Merely place it in proximity to the transmitter antenna and it will produce a reading on its 200 ua panel meter when the transmitter is in use. Operates with any transmitter between 100 kc and 250 mc. Includes a sensitivity control for meter. Shpg. Wt. 2 lbs.

Model PM-1

$14.95

HEATHKIT TRANSISTOR RADIO DIRECTION-FINDER KIT

The Heathkit Transistor Radio Direction-Finder model DF-1 is a self-contained, self-powered, 6-transistor super heterodyne broadcast radio receiver incorporating a directional loop antenna, indicating meter, and integral speaker. It is designed to serve primarily as an aid to navigation when out of sight of familiar landmarks. It can be used not only aboard yachts, fishing craft, tugs, and other vessels which navigate either out of sight of land or at night, but also for the hunter, hiker, camper, fisherman, aviator, etc. It is powered by a 9-volt battery. (A spare battery is also included with the kit.) The frequency range covers the broadcast band from 540 to 1600 kc and will double as a portable radio. A directional high-Q ferrite antenna is incorporated which is rotated from the front panel to obtain a fix on a station and a 1 ma meter serves as the null and tuning indicator. The controls consist of: tuning, volume and power (on-off), sensitivity, heading indicator (compass rose) and bearing indicator (antenna index). Overall dimensions are 7½" W x 5⅞" H x 5⅜" D. Supplied with slip-in-place mounting brackets, which allow easy removal from ship bulkheads or other similar places. Shpg. Wt. 4 lbs.

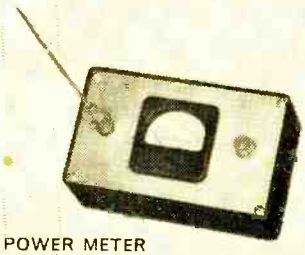
Model DF-1

$49.95

(Available after November 15)

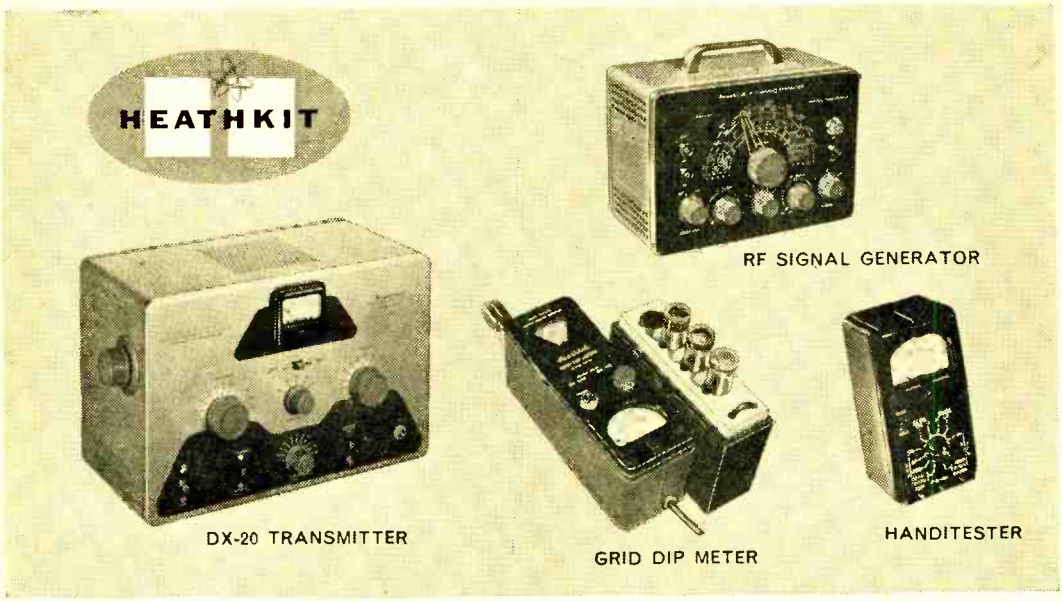
NEW! Heathkits for the boating enthusiast

FUEL VAPOR DETECTOR



POWER METER

RADIO DIRECTION-FINDER



HEATHKIT DX-20 CW TRANSMITTER KIT

This Heathkit straight-CW transmitter is one of the most efficient rigs available today. It is ideal for the novice, and even for the advanced-class CW operator. It employs a 6DQ6A tube in the 50-watt final amplifier circuit, a 6CL6 oscillator and a 5U4GB rectifier. Single-knob band switching covers 80, 40, 20, 15, 11, and 10 meters. The DX-20 is designed for crystal excitation, but may be excited by an external VFO. Pi network output circuit is employed to match antenna impedances between 50 and 1000 ohms.

Model DX-20
Shpg. Wt. 18 lbs. **$35.95**

HEATHKIT GRID DIP METER KIT

An instrument of many uses for the ham, experimenter, or service technician. Useful in locating parasitics, neutralizing, determining resonant frequencies, etc. Covers 2 mc to 250 mc with prewound coils. Use to beat against unknown frequencies, or as absorption-type wave meter.

Model GD-1B
Shpg. Wt. 4 lbs. **$19.95**

HEATHKIT RF SIGNAL GENERATOR KIT

Produces rf signals from 160 kc to 110 mc on fundamentals on five bands, and covers 110 mc to 220 mc on calibrated harmonics. Output may be pure rf, rf modulated at 400 CPS, or audio at 400 CPS. Prealigned coils eliminate the need for calibration after completion.

Model SG-8
Shpg. Wt. 8 lbs. **$19.50**

HEATHKIT HANDITESTER KIT

Measures AC or DC voltage at 0—10, 30, 300, 1000 and 5000 volts. Direct current ranges are 0-10 ma and 0-100 ma. Ohmmeter ranges are 0-3000 and 0-300,000 ohms. Sensitivity is 1000 ohms/volt. Features small size and rugged construction in sleek black bakelite case.

Model M-1
Shpg. Wt. 3 lbs. **$14.50**

HEATHKIT ETCHED-CIRCUIT VTVM KIT

Sensitivity and reliability are combined in the V-7A. It features 1% precision resistors, large 4½" panel meter, and etched circuit board. AC (RMS) and DC voltage ranges are 0—1.5, 5, 15, 50, 150, 500, and 1500. Peak-to-peak AC ranges are 0—4, 14, 40, 140, 400, 1400 and 4000 volts. X1, X10, X100, X10k, X100k, and X1 megohm.

Model V-7A
Shpg. Wt. 7 lbs. **$24.50**

HEATHKIT ALL-BAND RADIO KIT

This receiver covers 550 kc to 30 mc in four bands, and is ideal for the short wave listener or beginning amateur. It provides good sensitivity and selectivity, combined with good image projection. Amateur bands clearly marked on the illuminated dial scale. Employs transformer-type power supply—electrical band spread—antenna trimmer—separate rf and af gain controls—noise limiter and headphone jack. Built-in BFO for CW reception. Cabinet, as shown, available separately.

Model AR-3
Shpg. Wt. 12 lbs. **$29.95**
(less cabinet)

HEATHKIT "GENERAL PURPOSE" 5" OSCILLOSCOPE KIT

This oscilloscope sells for less than the previous model, yet incorporates features for improved performance. The OM-2 provides wider vertical frequency response, extended sweep generator coverage, and increased stability. Vertical channel is essentially flat to over 1 mc. Sweep generator functions from 20 CPS to over 150 kc. Amplifiers are push-pull, and modern etched circuits are employed in critical parts of the design. A 5BP1 cathode ray tube is used. The scope features external or internal sweep and sync, 1-volt peak-to-peak reference voltage, three-position step attenuated input, and many other "extras."

Model OM-2
Shpg. Wt. 21 lbs. **$42.50**

"GENERAL-PURPOSE" SCOPE

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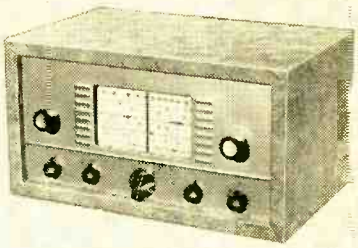

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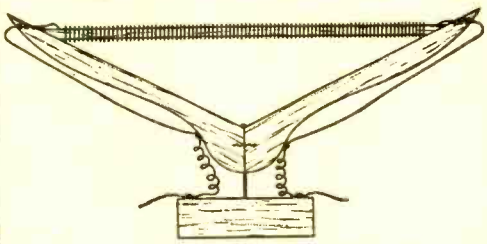
Tips and Techniques

(*Continued from page* 30)

solder. Wrap a short piece of solder around the wire with pliers, and hold the flame of the lighter underneath it. The solder will melt and leave a securely soldered joint. —*J. A. C.*

ROTARY LOOP ANTENNA

Did you know that hanging in your closet is the foundation for a neat-looking loop antenna? Scramble-wind wire down the length of the crossrod of a wooden



hanger and bring the ends through holes drilled in the hanger arms. The metal hook section can be straightened and cut off short to provide a rotary base. —*L. T.*

MINIATURE JACK EXTENSION CORD

A tiny extension cord comes in handy wherever miniature jacks and plugs are used with radios or test equipment. Cut a plastic container to a length of about ¾", and drill a 7/32" hole for your miniature jack. Punch a small hole through the friction lid to pass the thin shielded cord and solder it to the lugs on the jack. Now mount the jack in the container and put on the lid. Solder a plug to mate with the jack (Lafayette Radio MS-281) to the free end of the twin-cord, and the extension cord is ready to use. —*A. T.*

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Albert D. Meeleib, Box 136, Elrama, Pa.	1st	12
Dan Breece, Station KOVE, Lander, Wyo.	1st	12
Richard Meelan, 166 Jerome St., Brooklyn, N.Y.	1st	10
Leo Bishop, 37 Calle Contenta, Flagstaff, Ariz.	1st	12
Carl Deare, Jr., P.O. Box 467, Jeanerette, La.	1st	11
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is easily accomplished by touching the lead of a colored pencil to the edge of each record while it is revolving on the turntable. List the colors and corresponding type of record each represents on a card for reference. —*K. M.*

KIT COMPONENT HOLDER

When assembling kits containing a number of resistors and other small components, a great deal of time can be saved by an orderly arrangement of the components. A good way to do this is to press the components to the sticky side of a pressure-sensitive tape. Component values may be written directly on the tape with a ball point pen. The strip of tape is then placed out of the way at the back of the work area where the parts can be easily reached when needed. Capacitors as well as resistors can be arranged on the tape. —*L. G.*

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"Conversation Piece"

(*Continued from page* 64)

The pickup coil should be placed under the phone base and oriented for the best pickup. No actual connection is made to the telephone at any time. The coil need only be placed next to or under the phone induction coil for satisfactory pickup.

If your loudspeaker and telephone are located in the same room, difficulty might be encountered with acoustic feedback from loudspeaker to phone. This can be cured by either decreasing the gain on the amplifier, by changing the position of the coil, or by rotating the coil slightly. Make sure that the loudspeaker doesn't face the telephone. —30—

HOW IT WORKS

The telephone contains a coil which provides a transfer of energy between the line and the instrument. Around this coil there is radiated an electromagnetic field which varies in step with your voice. The pickup coil (*L1*) has an inductance and, therefore, when it is placed in the vicinity of the telephone, the electromagnetic field induces in it a voltage which varies with the voice. This voltage is transferred from the coil to the two-stage *RC* transistor preamplifier via the input jack (*J1*), where the signal is increased sufficiently to drive the radio or hi-fi amplifier to which the preamplifier is connected via the output jack (*J2*).

Acoustic feedback can occur when the output sound waves emanating from the loudspeaker are picked up by the telephone and are transferred back to the input of the device (*J1*) via the pickup coil. When this sound is fed back to the input with sufficient volume, oscillations will occur, resulting in an echo or ringing effect. At this point the unit is on the verge of oscillation. A slight increase in the magnitude of sound being fed back will cause sustained oscillations—the well-known audio howl. The solution to this problem is to lessen the amount of sound being fed back into the input of the amplifier through careful placement of the microphone (how you hold the telephone) and loudspeaker, or by decreasing the gain of the amplifier.

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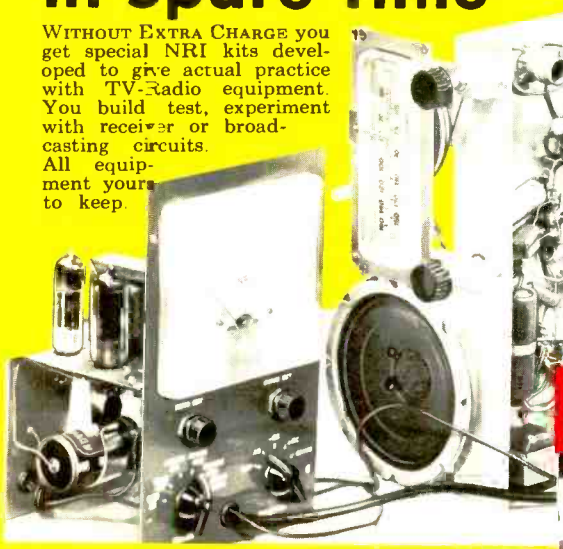

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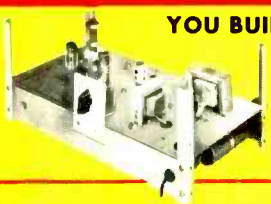

YOU BUILD Signal Generator

You build this Signal Generator. Learn how to compensate high frequency amplifiers, practice aligning typical I.F. amplifiers in receiver circuits. Make tests, conduct experiments.

YOU BUILD Vacuum Tube Voltmeter

Use it to earn extra cash fixing neighbors' sets; bring to life theory you learn from NRI's easy-to-understand texts.

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1J6GT
1L4
1L6
1LA6
1LC5
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1LN5
1S4
1N5GT
1S5
1T4
1U4
1U5
1V2
1X2
2A7
2D21
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3A5
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3CB6
3Q4
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3S4
3V4
4B27
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5AM8
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5AQ5
5AT8
5AW4
5AZ4
5J6
5T4
5T8
5U4G
5U8
5V4G
5V6GT
5Y3
5Y4G
6AB4
6AC7
6AG5
6AF4
6AH4GT
6AK5
6AL5
6AM8
6AN4
6N8
6AQ5
6AQ7GT
6AS5
6AS7G
6AT6
6AU4GT
6AU5GT
6AU6
6BV5GT
6AV6
A6X4GT
6BA6
6AX5GT
6BC5
6BC7
6BE6
6BF5
6BG6G
6BH6
6BJ6
6BK5
6BK7
6BN6
6BL7GT
6BQ6GT
6BQ7
6BY5G
6BZ7
6C4
6CB6
6CD6G
6CF6
6CS6
6CU6GT
6E5
6H6GT
6J4
6J5GT
6J6
6K6GT
6L6
6N7GT
6S4
6S7G
6SA7
6SB7Y
6SC7
6SF5
6SF7
6SG7
6SH7
6SJ7GT
6SK7GT
6SL7GT
6SN7GT
6SQ7
6SV7
6SS7
6T8
6U4GT
6U7G
6U8
6V3
6V6GT
6W4GT
6W6GT
6X4
6X5GT
6X8
6Y6G
7A5
7A7
7B5
7B7
7C5
7C6
7C7
7F7
7F8
7N7
7Q7
7Y4
7Z4
12A6
12AH7GT
12AT6
12AT7
12AU6
12AU7
12AV6
12AV7
12AX4GT
12AX7
12AZ7
12B4
12BA6
12BE6
12BH7
12BY7
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12SA7
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12SJ7GT
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Play Games with Nixie Tubes

(*Continued from page* 52)

ameter of the Nixie is 1.080" so it cannot slip through the hole). In this way, only the face of each tube will be visible through the hole and the display will be much more effective.

Be sure to mount the sockets with pins 1 and 8 in a vertical line, pin 8 nearest the top of the panel. Pass a very short length (about ¼") of the stripped end of hookup wire through each of the small holes in the commutator segments and solder to the copper faces carefully. Don't use too much heat. Trim the ends of the wire off after the solder has cooled.

The actual wiring should be done in a random fashion. Don't connect segment 1 to the socket lug for display number 1, segment 2 for number 2, etc. The numbers should follow each other haphazardly so that it will be impossible to force the motors to stop at any given place. Note that no connection is made to either pin 1 or pin 8 on the socket and that the common anode connection is pin 2.

TESTING

To be sure that your Gamester will play a fair game, run through the following tests:

(1) *Wiper contact*. With power on, slowly rotate each gear by hand and observe the corresponding Nixie. Only one number should glow for each contact of the wiper on a given segment of the copper. If one or more numbers do not appear, bend the wiper so that it makes firmer contact. If more than one number is displayed for any single contact, it means that there is a bridge of copper between segments that was not etched away. A bridge like this can be picked off with a sharp point and the insulating groove cleared.

(2) *Contactor*. While each gear is manually rotated, observe the rear contactor to be certain that it maintains electrical touch with the rear face of the gear throughout the entire rotation.

(3) *Motor spin*. Motors should start instantly when the power is applied and should spin at high speed. If they don't do this, reduce wiper and contactor pressure by bending the wires back very slightly.

(4) *Blankouts*. The small contact surface of the wiper permits it to come to rest occasionally between segments. When this happens, the corresponding Nixie will not glow. Chances of both wipers blanking out on the same spin are very remote. You should, however, run through a number of spins watching for this kind of thing. If it happens too often, the wiper is catching on

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the edge of one of the segments as a result of excessive wiper pressure. A single blankout provides a one-digit readout and is desirable for most games in which the numerical sequence wanted runs from zero to 99 with no numbers missing. —30—

Check Tone Controls

(*Continued from page* 78)

plifier or preamp-control unit under test as shown in Fig. 2. The output from the generator can be applied to any of the following input jacks: tuner, radio, TV, or auxiliary. Do *not* use an equalized phono input. Make sure that any filter circuits, such as rumble or scratch filters, are made inactive by switching them to the "off" or "flat" position.

Adjust the signal generator for a frequency of 1000 cps. View the output of the generator directly, to make sure a good rectangular waveshape is present. Sometimes loading the generator by placing a resistor across its output terminals will improve the output waveshape (at the sacrifice of amplitude).

Should this resistor be necessary, try values in the range of 600 to 1000 ohms. Set the horizontal sweep of the oscilloscope to display two or three cycles of output, and lock in the pattern by adjustment of internal sync.

Once the generator's output has been checked and found satisfactory, you can begin to test the tone control circuit itself. If the equipment under test is a separate preamplifier control unit, it will probably have a cathode-follower output.

The oscilloscope test leads are placed as shown in Fig. 3(A). Should the unit be a preamp-amplifier combination, place the scope's test leads as indicated in Fig. 3(B). Always keep generator output at 0.5 volt or below and your scope gain on full to obtain a stable and well-defined scope pattern. If too large an input signal is used, it will over-drive the amplifier and produce erroneous results.

Of course, if the gain control follows the tone controls, it can be turned down to minimum. The same is true if a preamp-control unit is being tested. Actually, the preamp output does not have to be connected to the power amplifier.

Scope Patterns. With the signal applied to the amplifier, and the oscilloscope properly connected, adjust both treble and bass controls until the waveform looks like the one in Fig. 4(A). The treble control will affect the leading edge of the square wave; the bass control affects the top and bottom of the wave.

A more precise flat position adjustment of the bass control can be obtained at a lower frequency. Shift the frequency of the signal generator to 500 cps to "touch up" the bass adjustment. Vary the bass control until the square wave being viewed has the most parallel top and bottom.

A fine adjustment can be made with the treble control by changing the frequency to 2000 cps. Turn the treble control slightly so that the leading edge of the square wave is straight but does not "overshoot" or peak above the top or bottom of the waveform.

A slight rounding off of the leading edge may be experienced with this 2000-cps signal if your circuit is as given in Fig. 3(B). If such a condition occurs, it will be necessary to use a low-capacitance scope probe or rely on the 1000-cps measurement. Mark both of these settings in a manner that will not mar the control panel.

The remaining waveshapes of Fig. 4 are representative of many commercial amplifiers showing the resultant square wave for maximum clockwise and counterclockwise positions of both controls. A 1000-cps input frequency was used in each instance.

By rotating the bass control to its maximum boost position, a waveshape similar to that illustrated in Fig. 4(B) should result. Figure 4(C) denotes a typical shape for maximum bass rotation. Extreme high-frequency boost of the treble control is shown in Fig. 4(D). The waveshape of Fig. 4(E) is typical of a minimum treble control setting. —30—

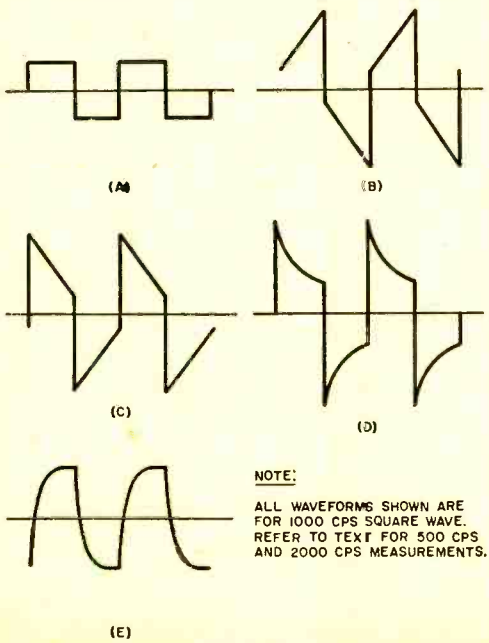

Fig. 4. Waveforms obtained as described in text.

Don't Let Tapes Hiss at You

(*Continued from page* 71)

from unbalanced signals can raise the magnetization to a dangerous level. Such signals include many kinds of voice recordings, engineers believe, and certainly include any distortion in the bias current. On professional machines which are used constantly, the increase in noise from head magnetization has been found to average about 1 db a day. Many professionals, therefore, have adopted a general practice of demagnetizing heads every day.

How can you tell when your head is dangerously magnetic? The effect is far too small to detect by its "attraction" for other metal objects. There is no sure test, but the appearance of hiss on recordings made on a machine that used to make quiet recordings is a definite indication. On many inexpensive home machines, the noise level from other causes is so high that magnetization hiss is drowned out. But when a better-quality machine, which has an inherent low noise level, is subjected to heavy use or switching surges, magnetization hiss will begin to be heard.

Although head magnetization, like death and taxes, is apparently inevitable through slow accumulation, getting rid of it is so simple that no tape enthusiast should

worry about it. Regular treatment with a head demagnetizer is the effective and easy cure.

Most of the commercial head demagnetizers are designed to operate from 117-volt a.c. house current. A strong alternating field is produced across the magnetic gap in the demagnetizer. Brought near the head on the tape machine, this field drives the head to saturation first in one direction and then in the other, repeatedly.

If the instrument is then slowly moved away from the head, the gradually decreasing field leaves the head completely demagnetized. The same principle is used in the bulk erasure of magnetic tape on the reel. The difference is that a more widely spread field is needed to erase a reel of tape all at once, so the instruments made for bulk erasure are considerably larger and of different shape.

How often should you use a head demagnetizer? Well, that would depend mainly on how often you use your machine. A good working rule is to demagnetize after every eight-hours' work with the machine, and before any important recording session. Your own experience and logic will tell you when this rule should be amended in one direction or the other.

If you do demagnetize regularly, you won't be stuck with built-in hiss on your tapes, hiss that is there for good. —30—

Pocket Size Test Instruments

(*Continued from page* 69)

standard tests, however, the first step is to connect the flexible power supply leads to a source of d.c. voltage (100-150 volts). Then you can follow the individual steps outlined below.

High Value Resistance. Connect the unknown resistor to the *R* terminals *BP3, BP4*. Set *Capacitor* switch *S1* to the 0.05-μfd. position. Turn the power supply on and note the rate at which the neon bulb "blinks" with *Resistor* switch *S2* in the *R* position. Gradually rotate *S2* until you find a value of fixed resistance which gives approximately the same blinking rate as the unknown. This is the value of the unknown resistor. If the blinking rate is too high to

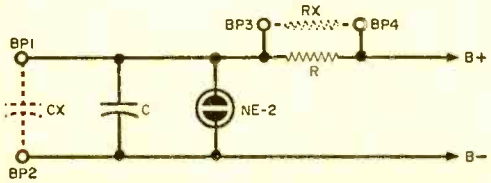

Fig. 2. Schematic breakdown of RC tester circuit when used to check either resistors or capacitors.

follow, try a larger value capacitor by resetting *S1*, and repeat the test.

If the neon bulb fails to light, the unknown resistor is *open*. If the blinking rate is about twice that of the smallest test resistor used, then the unknown resistor is about half that value. Similarly, if the blinking rate is about half that of the largest test resistor used, the unknown resistor is about twice that value. If the blinking rate falls *between* the rates obtained with two of the test resistors, the unknown resistor has a value falling between the two. For example, if *RX* gives one blinking rate, with the rate obtained with the 4.7-megohm resistor being *higher* than that of the unknown but the rate obtained with the 10-megohm resistor *lower* than that of the unknown, the unknown has a value of about 6 or 7 megohms.

High Leakage Resistance. Use the above technique but connect the unknown *capacitor* to the *R* terminals.

Insulation Leakage. Again use the technique employed for checking a high-value resistor, but connect the flexible test leads

HOW IT WORKS

In use, the power leads (B+ and B—) are connected to a d.c. voltage source supplying from 100 to 150 volts. This can be an experimental power pack, a set of batteries, the B supply of a small receiver or amplifier, or the small power supply which was described in the February issue on page 48.

The *RC* tester can be used in any one of several ways. When checking capacitors or high value resistors, the instrument operates on the principle of *dynamic substitution*. This technique can be explained best by reference to the *equivalent circuit* diagram in Fig. 2.

Initially, the *Capacitor* switch (*S1*) is set to select one of the fixed capacitors (*C1* to *C4*), while the *Resistor* switch (*S2*) is set to select one of the fixed resistors (*R1* to *R4*). With the switches set in this way, and the power supply leads connected to an appropriate voltage source, the unit becomes a simple relaxation oscillator having known values of *R* and *C*.

In operation, capacitor *C* is charged slowly through series resistor *R* until the voltage across the capacitor equals the firing voltage of the neon bulb (about 60-80 volts), at which time the bulb fires and acts essentially like a short circuit, discharging the capacitor. With the capacitor discharged, the voltage across it drops below the value needed to keep the NE-2 neon bulb conducting and the bulb is extinguished. The capacitor can then recharge through the resistor.

This action keeps repeating, with the bulb lighting or "blinking" each time it fires. The repetition rate depends on the *RC* time constant and on the supply voltage, and is slow enough so that individual "blinks" may be observed.

If an unknown resistor *RX* is substituted for the known resistor *R*, and the "blinking rate" *increases* (more blinks per second), then the unknown resistor is *lower* in value. Similarly, if the blinking rate *decreases* (fewer blinks per second), the unknown resistor has a *higher* value then the known resistor *R*. The increase or decrease in the blinking rate is proportional to the relative sizes of the two resistors.

The value of an unknown capacitor *CX* can be checked in a similar fashion, by substituting it for the known capacitor *C*, and noting the increase or decrease in the blinking rate. An increase in blinking rate results if the unknown capacitor is smaller than the known capacitor, and vice-versa.

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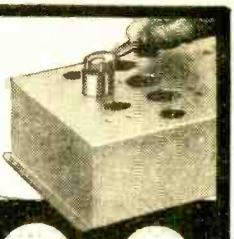

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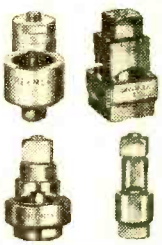

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1C5GT	.40	5AT8	.79	6BH6	.50	6V6GT	.45	12SA7	.47
1C6	.25	5J6	.59	6BJ6	.46	6W4GT	.39	12SG7	.54
1C7G	.25	5T8	.79	6BK5	.67	6W6GT	.52	12SJ7	.44
1D5GP	.42	5U4G	.48	6BK7	.75	6X4	.38	12SK7	.47
1H4G	.45	5U8	.79	6BL7GT	.74	6X5	.38	12SL7GT	.59
1J6GT	.46	5V4G	.57	6BN6	.57	6X8	.74	12SN7GT	.56
1L4	.45	5V6GT	.49	6BQ7GT	.79	7A4	.46	12SQ7	.39
1L6	.54	5X8	.79	6BQ7	.75	7A5	.52	12V6GT	.44
1LA4	.55	5Y3	.38	6BY5G	.57	7A6	.44	12W6	.59
1LA6	.46	5Y4G	.42	6BZ7	.75	7A7	.44	12X4	.36
1LB4	.58	5Z3	.44	6C4	.36	7A8	.44	14A7	.44
1LC5	.48	6A7	.56	6CB6	.50	7AU7	.69	14B6	.44
1LC6	.46	6A8	.46	6CD6G	1.17	7B4	.43	14Q7	.44
1LD5	.56	6AB4	.44	6CU6	.79	7B5	.40	19T8	.69
1LE3	.56	6AC7	.66	6D6	.47	7B6	.41	19BG6G	1.17
1LH4	.63	6AF4	.75	6E5	.43	7B7	.42	25B0GGT	.84
1LN5	.46	6AG5	.49	6F5	.36	7B8	.46	25CA5	.79
1N5GT	.49	6AG7	.68	6F6	.37	7C4	.40	25CD6	1.29
1R5	.50	6AH4GT	.69	6H6	.37	7C5	.41	25CU6	.99
1S5	.45	6AH6	.70	6J4	1.59	7C6	.42	25L6GT	.46
1T4	.50	6AK5	.53	6J5	.38	7C7	.44	25W4GT	.42
1U4	.46	6AL5	.41	6J6	.48	7E5	.44	25Z6	.36
1U5	.45	6AM8	.79	6K6GT	.38	7E6	.44	27	.24
1V2	.70	6AN8	.79	6K7	.38	7E7	.48	35B5	.47
1X2	.66	6AQ5	.45	6L6	.67	7F7	.58	35C5	.47
2A3	.49	6AS5	.47	6N7	.59	7F8	.65	35L6GT	.46
2A7	.54	6AS7G	2.20	6Q7	.39	7G7	.74	35W4	.38
2D21	.95	6AT6	.38	6S4	.39	7N7	.57	35Y4	.38
3A4	.50	6AT8	.79	6S8GT	.70	7Q7	.58	35Z3	.40
3A5	.50	6AU4GT	.64	6SA7	.47	7X7	.64	35Z5GT	.38
3AL5	.52	6AU5GT	.60	6SB7Y	.75	7Y4	.34	39/44	.25
3AU6	.52	6AU6	.42	6SC7	.47	7Z4	.39	50A5	.47
3BZ6	.57	6AU8	.79	6SG7	.40	12A4	.59	50D5	.47
3BC5	.57	6AV5GT	.64	6SH7	.42	12A6	.40	50C5	.47
3BN6	.57	6AV6	.38	6SJ7	.42	12AB5	.59	50L6GT	.44
6CB6	.57	6AW8	.89	6SK7	.49	12AQ5	.49	80	.39
3Q4	.55	6AX4GT	.65	6SL7GT	.56	12AT6	.40	84/6Z4	.45
3Q5GT	.56	6AX5GT	.56	6SN7GT	.56	12AT7	.65	117L7GT	1.25
3S4	.46	6BA6	.46	6SQ7	.46	12AU6	.42	117N7GT	1.25
3V4	.55	6BC5	.49	6SS7	.40	12AU7	.58	117P7GT	1.25
4BQ7	.75	6BC8	.89	6T4	.95	12AV6	.41	117Z3	.36
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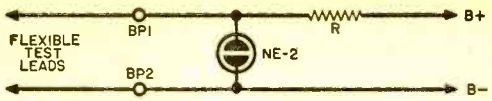

Fig. 3. When the instrument serves as a continuity checker, the test circuit is arranged like this.

to the *R* terminals. For example, if you wanted to check the insulation between a transformer winding and its core, one of the test leads would be connected to the core of the transformer, the other lead to one side of the winding being checked.

Values of Capacitors. Connect the unknown capacitor to the *C* terminals *BP1, BP2*. Set *S2* to one of the fixed resistor positions. Turn the power supply on and note the rate at which the neon bulb "blinks" with *S1* in the *C* position. Gradually rotate *S1* until you find a value of fixed capacity which gives approximately the same blinking rate as the unknown. This is the value of the unknown capacitor.

If the neon bulb *fails* to light or blink, the unknown capacitor is *shorted*. If the neon bulb lights continuously, or if the blinking rate is too rapid to follow, the capacitor is either open or has a low value. Try other fixed resistors (by adjusting *S2*) and repeat the test.

If the blinking rate is twice that of the smallest test capacitor used, the unknown capacitor is about half that value. Similarly, if the blinking rate is half that of the largest test capacitor used, the unknown is about twice that value. If the blinking rate falls between those obtained with two of the test capacitors, the unknown capacitor has a value between the two.

Intermittent Components. If the unknown component (resistor or capacitor) is suspected of having an intermittent defect, try moving its leads back and forth while testing. An intermittent condition will show up as a change in the blinking rate.

Continuity Tests. To use the *RC* tester for continuity tests, connect a pair of test leads to the *C terminals* (*BP1, BP2*) and set *S1* in the *C* position. Set *S2* in one of the fixed resistor positions and turn the power supply on. The test leads are connected across the terminals or leads to be tested. If the circuit is open, the neon bulb will *remain lighted*. If the circuit is continuous, the neon bulb will go dark.

Other Tests. As you gain experience, you should be able to perform many special tests. For example, you can use the tester as a *resistor substitution box* for any of the fixed resistors included in it, or as a *capacitor substitution box* for the fixed capacitor values, as long as the voltage impressed across the capacitor does not exceed the "firing voltage" of the neon bulb. —30—

After Class

(*Continued from page 75*)

is applied to the grid of the i.f. amplifier tube for increased control.

Transistorized Hybrids. At the moment, the most important application of the new 12-volt tubes is found in radio receivers for automobiles and boats with 12-volt ignition systems. Combining the low-voltage tubes with transistorized audio output stages is one popular method of improving the electrical efficiency of the equipment since it results in less current drain on the battery. Such hybrid sets take little more than 1.5 amperes for satisfactory performance as compared with over 4 amperes for conventional vibrator-high-voltage types.

To obtain full audio power output from a transistor, a relatively large driving power is required. For example, a transistor such as the 2N176 is capable of delivering three or four watts of undistorted audio power provided that the input power is on the order of 50 mw. No 250-volt tube, operating with 12 volts on the plate, can pass enough current to provide power of such magnitude. From this need arose the *space-charge-grid driver,* exemplified by the 12K5.

The construction of the space-charge-grid tube is a radical departure from conventional design. One factor that limits the flow of plate current in standard tubes is the repulsion of emitted electrons by the space charge cloud near the cathode. Even when the cathode emitting area is sufficiently large, it simply cannot eject its electrons with enough velocity to penetrate the space-charge barrier with ease.

In the 12K5, the first grid nearest the cathode operates with a positive potential while the normal control grid is situated between this accelerating grid and the plate of the tube. As electrons leave the cathode, they are subject to a strong accelerating potential which breaks the

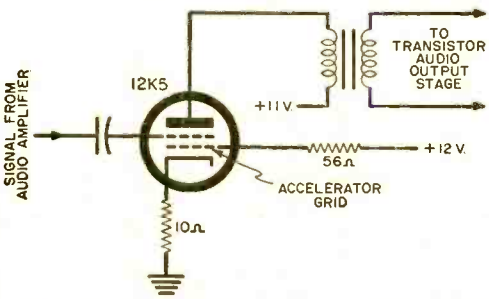

Fig. 4. Typical circuit using the 12K5 driver tube. An accelerator grid carrying a positive charge is located between the cathode and control grid.

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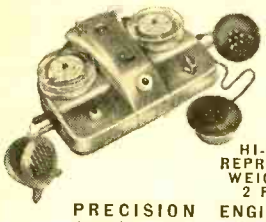

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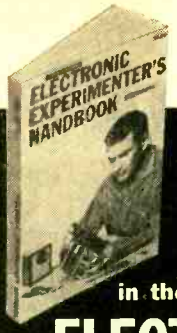

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stream up into thin sheets in which the space-charge density is low (Fig. 4). This makes possible the substantially larger space currents required for adequately driving the transistor audio output stage. *With only 2 volts on the plate of the 12K5,* space currents up to 10 ma. are easily obtained.

Biasing Methods. Still another obstacle presented itself when the first low-voltage tubes were tried out. R.f., i.f., and audio amplifiers are usually biased by means of the voltage drop across the cathode resistor through which the plate current flows. This method of obtaining bias subtracts the bias voltage from the plate-to-cathode potential. With 250 volts on the plate of the tube, the loss of a few volts in the biasing process is minor; but when you start with only a few volts on the plate in the first place, this loss is intolerable.

Thus, in engineering the electrode structures in the new tubes, the elements were placed to take advantage of *contact-potential* bias. Two different metals immersed in an electron stream develop a very tiny potential between them; this potential causes a small current (a few microamperes) to flow from the cathode to the "floating" grid (Fig. 5), thence through a large resistance in the grid circuit back to the cathode. The voltage drop across the grid resistor is large enough, and in the right direction, to make the control grid negative with respect to the cathode by the required amount to obtain the correct bias.

Table 1 (p. 75) compares the characteristics of a 12-volt tube with a standard 250-volt pentode. The more one studies these characteristics, the more one realizes that the new tubes herald a real departure from standard design. They appear ideal for mobile radio equipment and hold promise for many new low-voltage switching and relay circuits. —30—

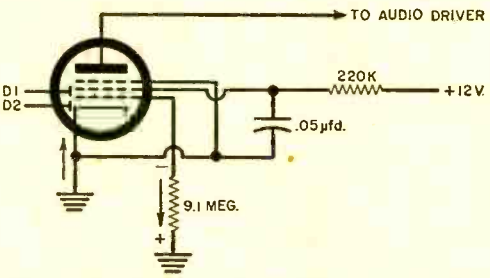

Fig. 5. Contact-potential bias is obtained when very small grid current flow through the 9.1-megohm resistor produces a voltage drop, making grid negative with respect to cathode. This same technique is used in a.c./d.c. receiver detector-a.v.c.-first audio tubes such as the 12AT6 and 12SQ7.

VIP's Are Hams Too!

(*Continued from page 47*)

gency preparedness; through regular drills on the air, they maintain a vast network ready to go into operation whenever floods, fires, hurricanes, storms, or other disasters disrupt normal communications facilities.

Perhaps the largest group—and one which attracts virtually all hams at one time or another—is called the "rag-chewers." These friendly folk like to make new friends by radio, chatting at length about all sorts of things.

From All Walks of Life. Back in 1928, two California hams met by radio and were enjoying a rag-chew. One of them, a Democrat, talked at some length about the virtues of Alfred Smith, who was running for president that year against Herbert Hoover. The other ham didn't seem to have too much to say, and soon signed off. The first wondered a little, then picked up his ham directory to address the usual QSL (acknowledgment) card. The amateur at the other end of his campaign talk turned out to be Herbert Hoover Jr.!

The younger Hoover, now rather well known himself as a petroleum engineer, as a trouble-shooter for the State Department, and as Under Secretary of State from 1954 through 1957, has ham stations at both his home in Pasadena (W6ZH) and his summer home in Santa Barbara (K6EV).

In the field of music, there's Tex Beneke, who took over the Glenn Miller orchestra after the death of its renowned leader. He and his wife Marguerite have both been hams for several years; now living in St. Louis, they are licensed as KØHWY and WØEHR respectively. Peewee Hunt, another well-known orchestra leader, operates W8HBC in Columbus, Ohio. W6UK in North Hollywood, Calif., is owned by the noted guitarist Alvino Rey.

Among royalty, Crown Prince Feisal and five of his royal relatives are amateurs in Saudi Arabia. Former Archduke Anton of Austria was such an ardent amateur that when the Germans occupied his country just prior to World War II he continued operating in a ham radio contest, surrendering only after the contest was over. He survived the war, incidentally, and now is licensed under the calls OE3AH and OE5AH as plain Anton Hapsburg. And the Maharajah Kumar of Sikkim, P. T. Namgyal, is one of the two amateurs in the remote Himalayan country, with the hotly-sought-after call AC3PT.

Relaxing on the Air. Others of the nation's top military men enjoy hamming as

a relaxing hobby. Rear Admiral Henry C. Bruton, Director of Naval Communications, has been a ham a long while, as attested to by his "two-letter" call, W4IH. Brig. Gen. Joseph Stilwell, Jr., son of "Vinegar Joe" Stilwell of World War II fame, is licensed as W4FPE.

Former Commissioner George E. Sterling, who retired from the Federal Communications Commission in 1954, and previously had served in the Radio Intelligence Division and as Chief Engineer of the FCC, has been an active ham for years, with the calls W3DF and W1AE. A prominent hotel executive, Ernest Henderson, president of the Sheraton Hotel Corporation, operates W1UDY near Boston, Mass. WØHBG is the call assigned to Clyde Hendrix, vice-president of Pillsbury Mills. The City Manager of Superior, Wisconsin, W. R. L. Taylor, hams with the call K9IGF. And there is even a ham who is a professional wrestler—"Flash Gordon" Walker, K4INN. —30—

Put Pots to Work

(*Continued from page* 70)

in series with the 47,000-ohm fixed resistor (*R4*), in the same box, is used as the plate load resistance. And here again, the most useful values lie within the same range. Through the use of this circuit, optimum values of triode plate load and cathode bias resistors can be found in a few minutes.

Generally, when working with a pentode amplifier, the plate load resistor is chosen first—some fixed value suitable to the application is decided upon and wired into the circuit. Then, the decade may be used to determine optimum values of screen and cathode resistors for use with the chosen plate load resistor. For pentode screen applications, make *R3* a 2.5-megohm potentiometer and *R4* a 220,000-ohm, 1-watt re-

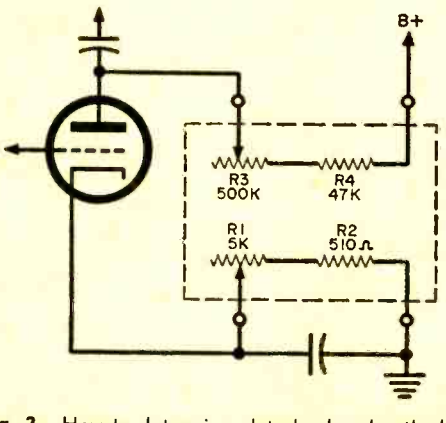

Fig. 2. How to determine plate load and cathode resistors needed in a particular amplifier stage.

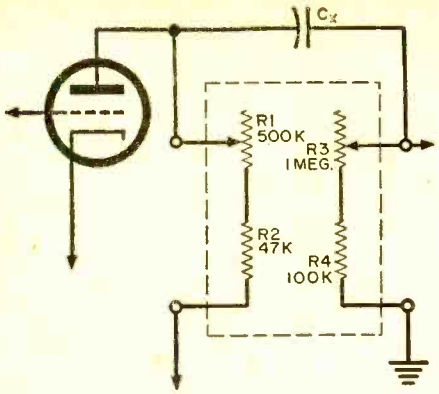

Fig. 3. Vary coupling capacitor values and grid and plate resistors for desired frequency response.

sistor. *R1* and *R2* will still fill the bill with the values given in Fig. 2.

Frequency response of an audio amplifier is determined largely by the values of the plate load resistor, the coupling capacitor, and the grid resistor for the following stage. A handy resistance decade incorporating variable elements for use as plate load and following-stage grid return is shown in Fig. 3. With a handful of assorted capacitors (for use at Cx), the test circuit may be set up and an almost infinite variety of combinations of resistance and capacitance can be set up.

A 2- or 3-stage audio amplifier, even one having a most unusual frequency response (as may be needed in special cases), can be designed quickly and easily by using one of these decades as the coupling element between each stage. When the desired response is obtained, the necessary values of the various resistors are read from the decade dials. Fixed resistors of these values are then substituted in the finished amplifier. —30—

Give Your Pickup a Chance

(*Continued from page 62*)

tically non-existent. Keep dirt out of the bearings. And as a last warning, watch the leads that bring the pickup signal out of the arm. If these leads are too stiff, or if they have a twist which is trying to untwist, they can cut down on the freedom of arm motion.

You have relocated your pickup arm for more accurate overhang, got your turntable leveling right, increased stylus force slightly, and installed thinner, more flexible leads between arm and amplifier. What a difference in sound! Now the pickup can really talk the fine language it was made for. —30—

Transistor Topics

(*Continued from page* 66)

be a tubular paper or miniature ceramic capacitor. *S1, S2,* and *S3* are s.p.s.t. toggle or slide switches, while *S4* is a d.p.s.t. unit. *T1* is an Argonne Type AR-119 transistor output transformer. The PM loudspeaker can be a 3" to 6" unit with a 3- or 4-ohm voice coil. *J1* is a standard open circuit jack; *BP1* and *BP2* are binding posts. The power supply battery, *B1,* can be a standard 9-volt transistor battery or 1½-volt cells.

Sergeant Yundt assembled his unit in a plastic case about the size of a table-model a.c.-d.c. receiver. Since neither lead dress nor circuit layout is critical, however, you can use any size of case you wish.

To use the completed instrument as a CPO with loudspeaker output, connect a hand key to binding posts *BP1* and *BP2* and close switches *S1* and *S2*. With the key depressed, adjust *R1* for desired operation. If headphone operation is preferred, a pair of electromagnetic headphones is plugged into jack *J1,* and switch *S3* is closed. Switch *S2* is opened to silence the speaker.

For use as an audible tone source, the key may be removed. Switches *S1, S2* and *S4* are closed. With this setup, a steady tone is obtained from the loudspeaker. This is handy for such purposes as checking microphone placement in p.a. installations.

Finally, to operate the instrument as an audio signal source, a test probe (simply a shielded lead with a 0.5-μfd. d.c. blocking capacitor in series with the central "hot" lead) is plugged into jack *J1.* Switch *S2* is opened and switches *S1, S3* and *S4* closed. The audio signal obtained from the probe can be used for signal injection tests of phonograph amplifiers, p.a. systems, intercoms or other types of audio amplifiers, including the audio sections of radio and TV receivers.

Field Strength Meter. If, at first glance, the circuit in Fig. 2 looks somewhat like one of the simple diode and transistor receiver circuits you've seen featured in past columns, don't be too surprised. Actually, it is such a receiver, but Ronald Wilensky (KN2ZPV), of 920 East 17th St., Brooklyn, N. Y., has modified the basic circuit for use as an inexpensive field strength meter.

In operation, r.f. signals picked up by the antenna are selected by tuned circuit *L1-C1* and coupled to a 1N64 diode detector, *CR1. C2* serves as an r.f. bypass capacitor, insuring that only the d.c. component of the detected signal is fed to the base-emitter circuit of the *p-n-p* transistor. The transistor, in turn, is used as a common-emitter d.c. amplifier, with its output indicated as a deflection on the 0-1 milliammeter. Oper-

ating power is supplied by a 4.5-volt battery, *B1*, controlled by the s.p.s.t. "power" switch *S1*. Series rheostat *R1* serves as a *sensitivity control*.

Using readily available components, construction is straightforward and should pose no problems. For best results, Ron indicates that the instrument should be assembled in a plastic case. *L1* and *C1* are chosen to cover the frequency band of interest to the individual builder. For the 27.255-mc. R/C band, Ron suggests that *L1* be made up of 12 turns of #16 wire, wound on a coil form ⅝" in diameter by 1" long. *C1*, in this case, can be a 25-$\mu\mu$fd. variable. The antenna's length may be varied to suit individual requirements—Ron used a straightened piece of "coat hanger" wire.

Sun Batteries. Some time ago, we announced that the International Rectifier Corp. (1521 East Grand Ave., El Segundo, Calif.) was planning to introduce a new series of inexpensive *silicon* solar cells. These units are now in full production. They have an active area of about 0.78 square inch.

Mounted and unmounted styles are available in both "standard" and "selected" (optimum output) versions. Prices range from $4.00 for an unmounted "standard" cell (Type No. SA5-PL) to $8.00 for a mounted

"selected" unit (Type No. SA5A-M). A standard cell can deliver over 20 milliwatts into a 4-ohm load with an illumination of 5000 footcandles. Its open circuit voltage at this light level is about 0.45 volt.

Product News. An important step towards the standardization of transistor types has been taken by Raytheon and Tung-Sol Electric. Both of these firms are now producing several transistors under the same EIA-registered type number.

Another new transistor manufacturer has entered the field—Fairchild Semi-Conductors Corp., Palo Alto, Calif. This new firm is sponsored by the well-known Fairchild Camera and Instrument Corp. Present plans call for the development and production of silicon diffused transistors and other semiconductor components.

Zenith and Philco are now producing *fully transistorized* portable short-wave receivers. Both are multiband sets, and sell for well over two hundred dollars each.

RCA has introduced several new transistor types. The 2N404 is a *p-n-p* junction transistor designed for use in switching circuits, has a maximum collector current rating of 100 ma., a maximum dissipation of 120 mw., and an alpha cutoff frequency of 4 mc. The 2N408 is a *p-n-p* junction transistor intended for Class A and Class B audio service in entertainment-type receivers; a pair of 2N408's in Class B push-pull can deliver a 160-mw. output signal with a 9-volt power supply. The 2N407 is similar to the 2N408 except for basing.

Lansdale Tube Company, a division of Philco, has introduced a new series of MADT (Micro Alloy Diffused-base Transistor) v.h.f. transistors. One of these units will serve as an oscillator up to 1000 mc.

That's the show for now, fellows. See you next month.

Lou

Among the Novice Hams (*Continued from page* 81)

were when the switch was closed. These series of actions continue as long as alternating current is fed into the inductor.

Inductive Reactance. Obviously, inductance opposes the flow of alternating current through it. This opposition is called *inductive reactance* and is measured in ohms. The formula for calculating it is: $X_L = 2 \pi FL$; where π (pi) 3.14, F is the frequency in cycles per second, and L is the inductance in henrys. The formula is also correct if the frequency is expressed in kilocycles and the inductance in millihenrys, or the frequency in megacycles and the inductance in microhenrys.

Don Jensen, KN6VXM, worked the 48 states and Europe with a home-brew 6146 transmitter running 50 watts. Now he uses a new Johnson Ranger transmitter.

An example will show that there is nothing mysterious about the formula. Question: *What is the inductive reactance of a 10-henry choke (inductor) at a frequency of 60 cps?* Answer: $X_L = 2 \times 3.14 \times 60 \times 10 = 3768$ ohms. At 600 cycles, its reactance is 37,680 ohms. Inductive reactance is directly proportional to frequency and inductance.

This is just the opposite of capacitive reactance, where the reactance is *inversely* proportional to frequency and capacitance. Another difference between inductive and capacitive reactance is that, in a purely capacitive circuit, the current leads the voltage by 90°, while in a purely inductive circuit the current lags the voltage by 90°.

News and Views

In two weeks on 40 meters, **Jim, KN8IDH/K8IDH,** has made 22 contacts in eight states. He runs 45 watts to his Heathkit AT-1 transmitter, which he modified by using a 6146 tube in place of the 6L6G. Jim receives on a Hallicrafters SX-99 receiver. He offers to help anyone obtain his amateur license . . . . . **Jack, K4OIN,** has made over 350 contacts in 23 states and Canada in about a year on the air. Twenty of the states were worked with a 35-watter built by W4GMD, but he didn't mention what he is now using. However, he receives on an SX-99 . . . . . **Leo, KN2HGR,** uses a 20-watt transmitter, built from an article in POPULAR ELECTRONICS, April, 1955. In less than four weeks, he made over 50 contacts in nine states, five confirmed. He receives on a Hallicrafters S-38D.

Joe, K6VJW, used a WRL Globe Chief transmitter and a Hallicrafters S-85 receiver as a Novice. Now he has a Heathkit DX-100 transmitter and a Collins 75A-4 receiver. He uses

a "K6VJW" vertical antenna about 15' high and works 15 meters only. Joe has worked all states (WAS), all continents (WAC) and 72 countries. He QSL's 100% and gets 87% reply. If you need a California contact and card, Joe is your boy . . . . . **Gary, K9AUB,** has 47 states worked, but he just can't work North Dakota. Please, some North Dakota ham, make a sked with him. He is also looking for an Arizona ham who will work him and send a confirmation (QSL) card. K9AUB works 40 meters with a converted Army "surplus" ARC-5 transmitter running 50 watts and a RME-84 receiver . . . . . **Bill, KN6ZMZ,** got much improved results after replacing his 15-meter dipole antenna with a 128' "Windom." He has worked 31 states, Quebec (VE2) and Sweden (SM) on 15 and 40 meters. Bill excites the "Windom" with a DX-100 running 75 watts. He receives on a National NC-98.

Mel, KN1BAU, says his favorite band is 15 meters, but also works the 80- and 40-meter Novice bands. He likes to "rag-chew" and exchange ideas in his contacts, instead of just exchanging signal reports and "Pse QSL. My address is . . ." and signing off. Mel has worked 32 states—30 confirmed—with his Globe Chief-90 transmitter and S-38D receiver. He has two antennas, a 15-meter dipole and a 40-meter dipole, each fed with coaxial cable. Mel wants to know: "What do you have to do to get QSL cards from General Class hams?"

Jack, KN9JDZ, doesn't think that electronic computers are a bit smarter at solving the math problems in the License Manual than he is. A new monster of a computer had been installed in his department at the U.S. Steel Co. Jack suggested that they give it a real test before accepting it, so they presented this gem to it: Assuming a frequency meter error of 0.1%, what is the nearest frequency to the low-frequency limit of the 7000-7300 kc. band that an amateur can safely operate? After it was programed, lights began flashing, relays clicked, and wheels started whizzing around in the computer. A minute passed, two, three . . . still no answer. After about five minutes, the computer began to smoke, but still no answer! Seven and a half minutes after it started to work on the problem, the computer came up with the answer: 7007.007+ kc.

Don, KN6VXM, works 40 and 15 meters. Using a home-brew 6146 transmitter running 50 watts, he has worked the 48 states and has a WAS certificate to prove it. In addition, he has worked 27 foreign countries, including many in Europe—the hardest continent to work from the west coast. He has two antennas, a 300-ohm folded dipole for 40 meters and a plain dipole for 15 meters. Now, Don uses a Johnson Ranger transmitter he just received for his 15th birthday, as he waits anxiously for his Conditional Class license to arrive. He passed, by the way. . . . **Tommy, KN4RSY,** has worked 27 states in two months on 40 meters. He excites a folded dipole antenna with an Eldico TR75-TV transmitter and receives on an ARC-5 "surplus" receiver operating from a 12-volt power supply. Tom-

my's dad is K4ODE, who works 10 meters with an Elmac transmitter.

"Dee" Miller of McFarland, Calif., forgot to give his call letters, but he has worked over 200 stations in 19 states in four months on the air. He started with a 24-watt home-built transmitter, then graduated to a Globe Chief. Dee receives on a Heathkit AR-3. . . . **Doris** or **"Butch," KN9IXD,** whose picture appeared in the February column, has just received her "Brass Pounder's" certificate from the American Radio Relay League in recognition of the many messages she handled during December.

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How about that letter *you* were going to write to *Among The Novice Hams?* Until next month, 73,

Herb, W9EGQ

Out of Tune

Power Transistor Signal Tracer (*December*, 1957, *page* 55): Parts List shows resistor *R8* as 270,000 ohms; correct value is 270 ohms, as shown in schematic.

Soup Up Your DX with an Antenna Tuner (*November*, 1957, *page* 64): For proper operation of circuit as pi network, connect lug of input switch arm to contact for 80-meter operation. Switch then shorts out coil sections in other positions.

Build a Superregen Pocket Receiver (*June*, 1957, *page* 60): Loopsticks having coil *L2* are no longer available. Any broadcast-band loopstick can be used. Wind 16 turns of wire in single layer ¼" away from present winding. Connect in circuit as *L2*.

—30—

Short-Wave Report

(*Continued from page* 84)

in contrast to 600 a month in 1950, with the biggest increases being noted in the Indonesian and Mandarin sections.

Radio Australia's transmitters, maintained by the Postmaster-General's Department, are rated at 100 kw. (VLA and VLB) and 50 kw. (VLC). The newest, VLD, also 50 kw., was opened in November, 1956. During the Australian Olympic Games, VLD worked with the other stations to provide descriptions of the games in more than 40 languages.

The transmitter site is at Shepparton, 120 miles north of Melbourne. Programs from Melbourne are fed by regular program lines. In the event of a disruption of the lines, programs can be originated from the two studios in Shepparton. Each transmitter can operate on any channel in the authorized short-wave bands from 6 to 22 mc. An additional transmitter, VLG, 10 kw., is located at Lyndhurst, 24 miles southeast of Melbourne.

A number of half-wave stacked arrays with reflectors make up the antenna system. The European and American beams are reversible, the North Pacific beams non-reversible. The arrays are mounted

atop 14 steel towers, each 210 feet high.

Reports and comments are always welcomed by this popular broadcasting unit. All communications should be sent to *Radio Australia,* Overseas Service, Melbourne, Australia.

Current Station Reports

Here are the latest reports. All times are Eastern Standard, 24-hour system.

Aden—The Aden B/C Service, 7170 kc., is strong mornings around 0930-1000 with Arabic music, vocals, and orchestra. Have not heard the reported Eng. anmt at 0940 as yet. *(7)*

Austria—OEI20, Innsbruck, has been noted on 6000 kc. from 1520 with a program of native music and talks. This channel was free of QRM at the time. *(166)*

British Guiana—According to a corrected schedule on the verification card, ZFY, *Radio Demerara,* Georgetown, now employs 5981 kc. and 3255 kc. with 2 kw., and 660 kc. with 10 kw., as follows: Monday through Friday, 0415-2215; Saturdays, 0415-2315; Sundays, 0445-2215. *(MEC)*

ZFY is heard best in the Middle Atlantic States from 0430 to 0600 on 5981 kc. and at 2000-2145 on 3255 kc. Reports go to: British Guiana United B/C Co., Ltd., St. Phillip's Green, High Street, Georgetown, British Guiana, South America. *(104)*

British Somaliland—VQ6MI, *R. Somali* (?), Hargeisa, is strong daily at 0930-1000 on 7126 kc. Native music and anmts comprise most of the programs. Listen for mention of "Hargeisa." *(7)*

Canada—English xmsns from *Radio Canada* are as follows; to the United States at 1955-2045 on CKCX, CHLR; to Europe at 1530-1600 on CKCS, CHOL; to Australasia at 0325-0415 on CHOL, CKLO. Frequencies are: 15,320 kc. (CKCS); 15,190 kc. (CKCX); 11,720 kc. (CHOL); 9710 kc. (CHLR); and 9630 kc. (CKLO). *(298)*

Ceylon—An easy station to log in western areas is the *VOA* relay station in Colombo on 15,120 kc. The popular "Music USA" is broadcast from 1400 to 1600 for the Near and Middle East. ID is given at the open and close. This station is rated at 35 kw. *(61)*

China—*Radio Peking's* English language schedule is as follows: to Eastern N.A. at 2045-2115 on 9665 and 11,820 kc.; to Western N.A. at 2200-2230 on 15,115 and 17,745 kc.; to S.E. Asia I at 0400-0430 and S.E. Asia II at 0730-0800, both on 11,820 and 15,350 kc.; Australia & N. Z. I at 0400-0430, Australia and N. Z. II at 0430-0500, both on 15,060 and 17,835 kc.; India and Pakistan at 1000-1030 on 9700 and 11,805 kc.; North Africa and Middle and Near East at 1400-1430 on 9510 and 11,945 kc.; West Europe I at 1430-1500, West Europe II at 1630-1700, both on 7080 and 9460 kc. *(TF, AN, FW, 104, 240, 318)*

Columbia—HJCA, *Radiodifusora Nacional de Colombia,* Bogota, has moved from 5014 kc. to 4955 kc. and is heard well at 1900-0000, in parallel with 6185 kc. *(100)*

Ecuador—HCJB, *Voice of the Andes,* Quito, is now broadcasting daily in English at 1600-1730 on 15,115, 17,889, and 11,915 kc. with

religious programs beamed to the British Isles and Europe. Signals are strong on all but 11,915 kc. *(16)*

Finland—*Radio Helsinki* is noted at 0700-0730 in English on 17,800, 15,190, and 9555 kc. They reportedly will soon be broadcasting a weekly DX program. *(11)*

French Equatorial Africa—*Radio AEF*, Brazzaville, 15,425 kc., can now be heard closing at 1530 with French anmts and anthem; it varies to 15,432 kc. *(AN)*

Radio Brazzaville is being widely reported on 11,930 kc. with experimental xmsns using a 50-kw. xmtr. It has been noted in western states at 1502-1529 and 1715-1755 and in the east evenings around 2100, music and all-French, except for an English-French language lesson at 1730. The only anmt is for 11,970 kc. (which is in parallel), and apparently the 11,930-kc. outlet has replaced the former 11,745-kc. channel. *(RP, 61, 190)*

French West Africa (Mauritania)—A very rarely reported station is *Radio Station St. Louis* on 6045 kc. It has recently been noted at 1620 with native music and a man announcing in the native Maure language. This

SHORT-WAVE ABBREVIATIONS

A—Approximate frequency
anmt—Announcement
BBC—British Broadcasting Corporation
Eng.—English
ID—Identification
kc.—Kilocycles
kw.—Kilowatts (power)
N.A.—North America (n)
N.Z.—New Zealand
QRM—Station interference
R.—Radio
s/off—Sign-off
VOA—Voice of America
xmsn—Transmission from station
xmtr—Transmitter used by station

one is said to carry Arabic at times but no information is available on any English programs. *(166)*

Germany—*Deutsche Welle*, Cologne, is now operating on 5980 kc. (replacing 11,795 kc.) in parallel with 9640 kc. to N.A. with Eng. news at 2130-2140. A DX session can be heard on these frequencies on the second Monday of each month at 2100. *(104)*

A few of the lesser reported German stations include: *Bayerische Rundfunk*, Munich, 6160 kc., at 0100-0115 with talks and music; *Deutschlandsender*, Koenigswusterhausen, 6115 kc., at 0000 and later after *R. Luz*, Peru, signs off; *Nordwestdeutscher Rundfunk*, Hamburg, 6075 kc., at 0100-0200; *Suddeutscher Rundfunk, Stuttgart*, 6030 kc., at 0100; and RIAS, Berlin, 6005 kc., at 2315-2330 with pop music, 2330 with news, 0100 with talks. All stations feature music and news and talks in German. *(23, 158)*

Ghana—The Ghana B/C Service, Accra, is noted well at 1500 with news and music. *(JR)*

Guatemala—*R. Centro Musical*, Guatemala City, 6050 kc., has increased power to 10 kw. It now relays the programs of the Mexican station XEWW, *La Voz de la America Latina*. Schedule and programs relayed from Mexico are requested. *(WRH)*

Honduras—HRTW, *Union Radio Hondurena*, Tegicigalpa, has moved higher and

is now found on 6168 kc. at 2350 closing in Spanish. *(AN)*

HRP1, *El Eco de Honduras,* San Pedro Sula, has moved to 5990 kc. *(100)*

Iraq—Baghdad is powerful on 7180 kc. at 1540 with Arabic music and language. It closes at 1610 after Arabic news. This one may have QRM at times from the 40-meter amateur operators. *(166)*

Italy—*Radio Roma,* Rome, broadcasts to N.A. daily in English at 1930-1950 on 15,400 and 11,905 kc., and at 2205-2220 on 11,905 and 9575 kc. Reports go to *Radio Roma,* P. O. Box 320, Rome, Italy. *(104)*

Japan—Another rarely reported station is the *Far East Network* outlet on 15,257 kc. This is a low-powered unit and can be noted for short periods only. It was recently heard at 2232 with popular records. *(AN)*

Laos—*Radio Lao,* 7145 kc., is heard at 0830-0845 with music, anthem and news, at 0845-0900 with light music, 0900-0930 with concert music, and closing at 0930. *(7)*

Liberia—The current schedule from ELWA, Monrovia, is as follows: to Ghana and French West Africa on 4835 kc. at 0145-0415 * and 1445-1645 daily, at 0215-0545 and 1445-1615 Sundays; to Nigeria, Sudan, and Ethiopia on 9670 kc. at 0000-0130 and on 11,800 kc. at 1100-1415 daily; to N. A. on 15,200 kc. at 1815-1945 * Tuesdays only and on 9650 kc. at 2000-2130 * Tuesdays only. The sessions marked with an asterisk are also carried in the 19-meter band, probably on 21,535 kc. *(304)*

Malaya—ZHP3, Singapore, is heard well on 7200 kc. at 0630-0643 with Eng. ID, news, and music. *(JR)*

Mauritius—V3USE, Forest Side, continues to wander from 15,060 to 15,090 kc. and can be best heard at 2230-2315 in French (Eng. news at 2300). *(342)*

Mexico—XEQM, Merida, 6105 kc., has a one-hour Eng. program at 2200-2300 Tuesdays only. This program, called "Noches del Mayar," features local folk music and a few Eng. anmts. Reporters on this program will be sent a set of colored pictures of Mayan ruins and scenery around Merida. *(RP)*

A new station located at Ciudad El Mante is operating on 6090 kc. at 0755-2100 with the call XECMT. Reports go to P. O. Box 79, Ciudad El Mante. XEOI, Mexico City, has moved from 6010 kc. to 6110 kc. *(WRH)*

Nepal—An identified station on 7100 kc. is believed to be *Radio Nepal* and is noted from 0900 to 1015/close with news in language and music of the Middle-East type. *(7)*

Nicaragua—YNWW, *Radio Sport,* Granada, has moved from 6140 kc. to 5965 kc. and is being heard at 1900-2300. *(100)*

North Vietnam—Hanoi is being noted on 9935A kc. with Eng. news at 0830, ID at 0845,

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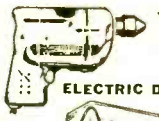
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then Eng. news at dictation speed to s/off at 0900. This is *The Voice of Vietnam. World Radio Handbook* lists Hanoi as being on 9840 kc. *(39)* (Editor's Note: Hanoi has been reported recently by the west coast boys as having an outlet on 9925 kc.)

Pakistan—APK, *Radio Pakistan,* Karachi, can be well heard in Eng. to the United Kingdom at 1415-1500 on 9705 and 11,674 kc. and to S.E. Asia at 2000-2015 on 15,335 and 11,885 kc. A news bulletin is aired at 2000. *(104, 232)*

Peru—OAX1A, *Radio Delcar,* Chiclayo, is now on 6700 kc. where it is heard from 1900 to 0000. *(100)*

OBX4U, *Radio America,* Lima, is heard on 3240 kc. from 0045 to 0058 s/off with Latin American music and all-Spanish anmts. *(RP)*

OAX1D, *R. Chiclayo,* is noted poorly at 2030-2045 and later on 3379 kc. Most Latin American stations have been very poor so far this season, possibly due to high absorption associated with sunspot activity. *(7)*

Poland—*Radio Warsaw's* current schedule to N.A. is as follows: at 0600-0630 on 15,120 and 11,740 kc.; at 0715-0745 on 15,120, 11,755, and 11,740 kc. at 0745-0815 on the same three channels; at 1930-2000, 2000-2030, and 2130-2200 on 17,800, 15,120, and 11,740 kc.; and at 0030-0100 on 15,120 and 11,740 kc. *(338)*

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Esther Cottingham *(338)*, Redwood City, Calif.
Clayton Hallmark *(342)*, Shelby, Ohio
World Radio Handbook (WRH)
A Middle East Correspondent *(MEC)*

Reunion Island—St. Denis, another very hard one to hear, has been noted in Ohio on 7170 kc. at 2356-0010 with news in French. The signal was very strong but heavy Morse interference cut signal readability. *(48)*

Uruguay—CXA60, *Radio Sarandi,* 15,385 kc., Montevideo, has been tuned from 1720-1745 to Europe with anmts in Eng., French, and German. *(BM)*

The following stations are unheard and believed not operating: CXA54, (17,895 kc.); CXA55 (11,965 kc.); CXA57 (17,715 kc.); CXA64 (15,225 kc.); CXA65, (25,855 kc.) *(WRH)*

Clandestine—*Sawt al-Misr Hurrah (The Voice of Free Egypt)* is strong in Europe on both 7091 and 9490 kc. at 1600-1700. *Sawt al-Haqq (The Voice of Justice)* is strong on 6190 and 7211 kc., opening at 1000. *(MEC)* —30—

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TO $100.00 Weekly. Sparetime, Home Operated Mail-order Business. Successful "Beginner's" Plan: Everything Supplied. Lynn, 10420-E National, Los Angeles 34.

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HIGHEST Trade in Allowances Toward Ampex, Concertone, Crown, Ferrograph, Presto, Pentron. Components Accessories. Catalog. Boynton Studio, 10-PE Pennsylvania, Tuckahoe, N. Y.

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DISGUSTED of "HI" Hi-Fi Prices? Unusual Discounts on your High Fidelity Requirements. Write Key Electronics, 120 Liberty St., New York 6, N. Y., EVergreen 4-6071.

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ELECTRONIC Hypnotizer. Simplifies the art of Hypnosis. Diagrams and Operating Instructions $1.25. Kit $16.50. Wired & tested $29.50. C. Carrier Co., 734 15th St., N.W., Washington 5, D. C.

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KORD-ALL'S Elementary Code Course makes learning code easy. Oral instructions throughout. On 12" 33⅓ RPM microgroove record, $3.00 postpaid. Kord-All, Box 444, Warren, Ohio.

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BOOK Manuscripts Considered for national distribution. All subjects welcomed. New authors encouraged. Atten. Mr. Blythe, Greenwich Book Publishers, 489 Fifth Avenue, N. Y., N. Y.

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NEW Liquid Casting Plastic, clear, colors. Embed real flowers, minerals, biological specimens, delicate instruments, electronic parts. Also cold setting resin and fiberglass for laminating, casting, molding, coating. Manual 25¢. Castolite Co., Dept. C-125, Woodstock, Illinois.

MISCELLANEOUS

SONGPOEMS and Lyrics Wanted! Mail to: Tin Pan Alley, Inc., 1650 Broadway, New York 19, N. Y.

"WINEMAKING: Beer, Ale Brewing." Illustrated. $2.00. Eaton Books, Box 1242-C, Santa Rosa, California.

GIFT—tremendous offers—25¢—Hurry Hermsens, 34-15 Knox, Bronx 67, New York.

ONE Million Dollars Confederate Money in $10's, $20's, $50's, $100's etc. Only $2.98. Limit Four Million For Only $10.00. Best Values Company, Dept. #M-75, 401 Market Street, Newark, New Jersey.

PROOF-SETS. 1958 set only $2.50, 1957—$3.00, 1956—$4.00, 1955—$6.00, 1954—$7.00, 1953—$12.00, 1952—$18.00, 1951—$29.00, 1950—$47.00. Complete set 1950-1958 inclusive—$120.00. Postpaid. Prompt shipments. Money-Back Guarantee. Dan's—Dan Morafka, ANA., 432-E 23rd Ave., San Francisco 21, California.

SAVE Your Hair Through Exercise. Instructions $1.00. Bedard, Box 637-G, Detroit 31.

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Model TD-55

Terms: $6.95 after 10 day trial then $5.00 per month for 4 months.

Superior's New Model TD-55

EMISSION TYPE TUBE TESTER

FOR { The Experimenter or Part-time Serviceman, who has delayed purchasing a higher priced Tube Tester.
The Professional Serviceman, who needs an extra Tube Tester for outside calls.
The busy TV Service Organization, which needs extra Testers for its field men.

Speedy, yet efficient operation is accomplished by: 1. Simplification of all switching and controls. 2. Elimination of old style sockets used for testing obsolete tubes (26, 27, 57, 59, etc.) and providing sockets and circuits for efficiently testing the new Noval and Sub-Minar types.

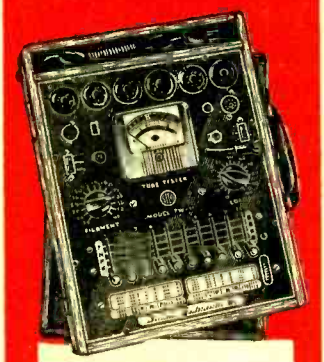
You can't insert a tube in wrong socket
It is impossible to insert the tube in the wrong socket when using the new Model TD-55. Separate sockets are used, one for each type of tube base. If the tube fits in the socket it can be tested.

"Free-point" element switching system
The Model TD-55 incorporates a newly designed element selector switch system which reduces the possibility of obsolescence to an absolute minimum.

Checks for shorts and leakages between all elements
The Model TD-55 provides a super sensitive method of checking for shorts and leakages up to 5 Megohms between any and all of the terminals.

Elemental switches are numbered in strict accordance with R.M.A. Specifications.
The 4 position fast-action snap switches are all numbered in exact accordance with the standard R.M.A. numbering system. Thus, if the element terminating in pin No. 7 of a tube is under test, button No. 7 is used for that test.

Complete with carrying case **$26.95 Net**



Model TW-11

Terms: $11.50 after 10 day trial then $6.00 per month for 6 months.

Superior's New Model TW-11

STANDARD PROFESSIONAL TUBE TESTER

• Tests all tubes, including 4, 5, 6, 7, Octal, Lockin, Hearing Aid, Thyratron, Miniatures, Sub-miniatures, Novals, Subminars, Proximity Fuse Types, etc.

• Uses the new self-cleaning Lever Action Switches for individual element testing. All elements are numbered according to pin-number in the RMA base numbering system. Model TW-11 does not use combination type sockets. Instead individual sockets are used for each type of tube. Thus it is impossible to damage a tube by inserting it in the wrong socket.

• Free-moving built-in roll chart provides complete data for all tubes. Printed in large easy-to-read type.

NOISE TEST: Phono-jack on front panel for plugging in either phones or external amplifier detects microphonic tubes or noise due to faulty elements and loose internal connections.

EXTRAORDINARY FEATURE
SEPARATE SCALE FOR LOW-CURRENT TUBES Previously, on emission-type tube testers, it has been standard practice to use one scale for all tubes. As a result, the calibration for low-current types has been restricted to a small portion of the scale. The extra scale used here greatly simplifies testing of low-current types.

Housed in hand-rubbed oak cabinet **$47.50 Net**

Model TV-12

Terms: $22.50 after 10 day trial then $10.00 per month for 5 months.

Superior's New Model TV-12

TRANS-CONDUCTANCE TUBE TESTER

★ Employs improved TRANS-CONDUCTANCE circuit. An in-phase signal is impressed on the input section of a tube and the resultant plate current change is measured. This provides the most suitable method of simulating the manner in which tubes actually operate in Radio & TV receivers, amplifiers and other circuits. Amplification factor, plate resistance and cathode emission are all correlated in one meter reading.

★ **NEW LINE VOLTAGE ADJUSTING SYSTEM.** A tapped transformer makes it possible to compensate for line voltage variations to a tolerance of better than 2%.

★ **SAFETY BUTTON** — protects both the tube under test and the instrument meter against damage due to overload or other form of improper switching.

EXTRA FEATURE:

Model TV-12 Also Tests Transistors!

A transistor can be safely and adequately tested only under dynamic conditions. The Model TV-12 will test all transistors in that approved manner, and quality is read directly on a special "transistor only" meter scale.

Housed in hand-rubbed oak cabinet **$72.50 Net**

USE APPROVAL FORM ON NEXT PAGE ➡

We invite you to try before you buy any of the models described on this and the following pages. If after a 10 day trial you are completely satisfied and decide to keep the Tester, you need send us only the down payment and agree to pay the balance due at the monthly indicated rate.

NO INTEREST OR FINANCE CHARGES ADDED!

If not completely satisfied, you are privileged to return the Tester to us, cancelling any further obligation.

TRY FOR 10 DAYS

before you buy! ***then*** if satisfactory pay in easy, interest free, monthly payments. See coupon below.

Superior's New Model 70

UTILITY TESTER®

AS AN ELECTRICAL TROUBLE SHOOTER

• Will test Toasters, Irons, Broilers, Heating Pads, Clocks, Fans, Vacuum Cleaners, Refrigerators, Lamps, Fluorescents, Switches, Thermostats, etc. • Will test all TV tubes for open filaments, inter-element shorts, burned out tubes, etc. (Will not test TV tubes for quality. An emission type tester such as the Model TD-55, TW-11 or TV-12 is required to test tubes for quality). • Measures A.C. and D.C. Voltages, A.C. and D.C. Current, Resistances, Leakage, etc. • Will measure current consumption **while the appliance under test is in operation** • Incorporates a sensitive direct-reading resistance range which will measure all resistances commonly used in electrical appliances, motors, etc. • Leakage detecting circuit will indicate continuity from zero ohms to 5 megohms (5,000,000 ohms).

AS AN AUTOMOTIVE TESTER

• Tests both 6 Volt and 12 Volt Storage Batteries • Generators • Starters • Distributors • Ignition Coils • Regulators • Relays • Circuit Breakers • Cigarette Lighters • Stop Lights • Concensers • Directional Signal Systems • All Lamps and Bulbs • Fuses • Heating Systems • Horns • Also will locate poor grounds, breaks in wiring, poor connections, etc.

Model 70 comes complete with 64 page book written in plain easy-to-understand language. Explains laws of electricity, how to proceed with repairs of appliances and automobile circuits, how to test TV tubes, etc. Only. **$15.85 Net**

Model 70

Terms: $3.85 after 10 day trial then $4.00 per month for 3 months.

Superior's New Model 670-A

SUPER-METER

A Combination VOLT-OHM MILLIAMMETER *PLUS* Capacity, Reactance, Inductance and Decibel Measurements

D.C. VOLTS: 0 to 7.5/15/75/150/750/1,500/7,500 Volts • **A.C. VOLTS:** 0 to 15/30/150/300/1,500/3,000 Volts • **D.C. CURRENT:** 0 to 1.5/15/150 Ma. 0 to 1.5/15 Amperes • **RESISTANCE:** 0 to 1,000/100,000 Ohms 0 to 10 Megohms • **CAPACITY:** .001 to 1 Mfd. 1 to 50 Mfd. (Good-Bad-scale for checking quality of electrolytic condensers.) • **REACTANCE:** 50 to 2,500 Ohms, 2,500 Ohms to 2.5 Megohms • **INDUCTANCE:** .15 to 7 Henries, 7 to 7,000 Henries • **DECIBELS:** −6 to +18, +14 to +38, +34 to +58. **Complete with test leads** **$28.40 Net**

Model 670-A

Terms: $7.40 after 10 day trial then $3.50 per month for 6 months.

Superior's New Model TV-40

PICTURE TUBE TESTER

NOT A GADGET—NOT A MAKE-SHIFT ADAPTER, BUT A WIRED PICTURE TUBE TESTER WITH A METER FOR MEASURING DEGREE OF EMISSION—AT ONLY $15.85

Tests ALL magnetically deflected tubes . . . in the set . . . out of the set . . . in the carton!!

- Tests all magnetically deflected picture tubes from 7 inch to 30 inch types.
- Tests for quality by the well established emission method. All readings on "Good-Bad" scale.
- Tests for inter-element shorts and leakages up to 5 megohms.
- Test for open elements.

EASY TO USE: Simply insert line cord into any 110 volt A.C. outlet, then attach tester socket to tube case (Ion trap need not be on tube). Throw switch up for quality test . . . read direct on Good-Bad scale. Throw switch down for all leakage tests.

Only **$15.85 Net**

Model TV-40

Terms: $3.85 after 10 day trial then $4.00 per month for 3 months.

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If not completely satisfied, you are privileged to return the Tester to us, cancelling any further obligation.

SEE OTHER SIDE

CUT OUT AND MAIL TODAY!

MOSS ELECTRONIC DISTRIBUTING CO., INC.
Dept. D-431, 3849 Tenth Ave., New York 34, N.Y.

Please send me the units checked. I agree to pay down payment within 10 days and to pay the monthly balance as shown. It is understood there will be no finance or interest charges added. It is further understood that should I fail to make payment when due, the full unpaid balance shall become immediately due and payable.

- ☐ Model TW-11 Total Price $47.50 $11.50 within 10 days. Balance $6.00 monthly for 6 months.
- ☐ Model 76 Total Price $26.95 $6.95 within 10 days. Balance $5.00 monthly for 4 months.
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- ☐ Model TV-50 Total Price $47.50 $11.50 within 10 days. Balance $6.00 monthly for 6 months.
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Model 76

Terms: $6.95 after 10 day trial then $5.00 per month for 4 months.

Superior's New Model **76**

IT'S A **CONDENSER BRIDGE**

IT'S A **RESISTANCE BRIDGE**

IT'S A **SIGNAL TESTER**

IT'S A **TV ANTENNA TESTER**

Specifications

✓ **CAPACITY BRIDGE SECTION**

4 Ranges: .00001 Microfarad to .005 Microfarad; .001 Microfarad to .5 Microfarad, .1 Microfarad to 50 Microfarads; 20 Microfarads to 1000 Microfarads. Will also measure the power factor of all condensers from .1 to 1000 Microfarads.

✓ **RESISTANCE BRIDGE SECTION**

2 Ranges: 100 ohms to 50,000 ohms; 10,000 ohms to 5 megohms.

✓ **SIGNAL TRACER SECTION**

With the use of the R.F. and A.F. Probes included with the Model 76, you can make stage gain measurements, locate signal loss in R.F. and Audio stages, localize faulty stages, locate distortion and hum, etc.

✓ **TV ANTENNA TESTER SECTION**

Loss of sync., snow and instability are only a few of the faults which may be due to a break in the antenna, so why not check the TV antenna first? Locates a break in any TV antenna and measures the location of the break in feet from the set terminals.

Complete with R.F. and A.F. probes and test leads **$26.95 Net**

Model TV-50

Terms: $11.50 after 10 day trial then $6.00 per month for 6 months.

Superior's New Model TV-50 **GENOMETER**

7 Signal Generators in One!

✓ **R.F. Signal Generator for A.M.**
✓ **R.F. Signal Generator for F.M.**
✓ **Audio Frequency Generator**
✓ **Marker Generator**
✓ **Bar Generator**
✓ **Color Dot Pattern Generator**
✓ **Cross Hatch Generator**

R. F. SIGNAL GENERATOR: 100 Kilocycles to 60 Megacycles on fundamentals and from 60 Megacycles to 180 Megacycles on powerful harmonics.

VARIABLE AUDIO FREQUENCY GENERATOR: Provides a variable 300 cycle to 20,000 cycle peaked wave audio signal.

MARKER GENERATOR: The following markers are provided: 189 Kc., 262.5 Kc., 456 Kc., 600 Kc., 1000 Kc., 1400 Kc., 1600 Kc., 2000 Kc., 2500 Kc., 3579 Kc., 4.5 Mc., 5 Mc., 10.7 Mc., (3579 Kc. is the color burst frequency.)

BAR GENERATOR: Pattern consists of 4 to 16 horizontal bars or 7 to 20 vertical bars.

DOT PATTERN GENERATOR (FOR COLOR TV): The Dot Pattern projected on any color TV Receiver tube by the Model TV-50 will enable you to adjust for proper color convergence.

CROSS HATCH GENERATOR: The pattern consists of non-shifting horizontal and vertical lines interlaced to provide a stable cross-hatch effect.

Complete with shielded leads **$47.50 Net**

TRY FOR 10 DAYS

BEFORE you buy! ***THEN*** if satisfactory pay in easy, interest free, monthly payments. See coupon inside.

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NO INTEREST OR FINANCE CHARGES ADDED!

If not completely satisfied, you are privileged to return the Tester to us, cancelling any further obligation.

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