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NC-188 FEATURES:

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- 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:

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<th>GENERAL COVERAGE</th>
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<td>B</td>
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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

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<th>60 DB</th>
<th>5.2 kc</th>
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<td>60 DB</td>
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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:

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- HF Osc. 6C4
- 1st IF Amp. 6BA6
- 2nd IF Amp. 6BA6
- Det. AVC and ANL 6AL5
- 1st AF and BFO 12AT7
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- Rectifier 5Y3GT

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By JOHN T. FRYE

The Demonstration

School was out for the day, but Carl and Jerry were still in the physics laboratory putting away equipment they had been using in an experiment. Mr. Paisley, the instructor, was setting up apparatus to be used in a demonstration of static electricity the following day. Outside it was pouring rain.

Mr. Paisley vigorously turned the hand crank of the static electricity generator and then hopefully brought one of the charged electrodes closer and closer to the other. Only when the metal balls were nearly touching could a feeble spark be seen to cross the tiny gap.

"I'm afraid we're not going to have a very good demonstration tomorrow," the teacher said with a rueful sigh, as he put on his hat and coat and took an umbrella from the wall closet. "The insulators in this machine are pretty leaky, and with the high humidity we're having the static charge runs off as fast as it's generated."

"Aw, maybe it'll turn out all right," Carl said encouragingly. Both he and Jerry were fond of the gentle, easily embarrassed physics instructor.

"I hope so," Mr. Paisley said wistfully. "Mr. Stagg, the principal, war - told me he expects to visit our class tomorrow."

Neither boy could think of anything to say to this. They understood perfectly why Mr. Paisley had almost said "warned." Mr. Stagg was a positive, dynamic, aggressive person; and he respected only these qualities in others. He considered Mr. Paisley's gentle kindness to be weakness, and was constantly trying to "put some backbone" in the physics teacher - as he expressed it. Quite often "putting in some backbone" came dangerously close to bulldozing.

"I have a dental appointment in ten minutes," Mr. Paisley finally said. "I wonder if you boys would mind locking up the lab when you're through. You can give me back this key tomorrow. I have another one I can use to open up in the morning."

"Sure!" the boys chorused.

"Golly," Carl remarked, after they
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Carl & Jerry (Continued from page 8)

heard the outside door close behind Mr. Paisley, "I feel sorry for him. He's such a nice guy, and he gets so flustered when an experiment doesn't turn out perfectly. He always seems to think it's his fault, even though it's not. With Stagg here tomorrow, he's bound to be rattled."

"Yeah, I know," Jerry said slowly; "and I've been wondering if maybe we couldn't do something about it."

"Such as what?" Carl demanded, pacing restlessly up and down the room. "That stupid static machine should have been sent back for reconditioning long ago, but Stagg won't okay it. He expects Mr. Paisley to make like Thor with a practically worn-out generator. How can we do anything about that?"

"You still got that little Tesla coil we built up a few months back?"

"Sure, but what's that got to do with the price of hay in Lower Slobbovia?"

"We got a four- or five-inch arc out of that thing, didn't we?"

"Y-e-s-s-s, we did! And you're starting to come through to me!"

"Suppose we come back here tonight and fasten the Tesla coil up underneath the desk where it can't be seen. We can connect its electrodes to those of the static machine with very fine wires. It'll be easy to alter the remote-control receiver we use in our miniature motorboat so that it will operate a relay to cut the power on and off the Tesla coil. One of us can operate it by means of our little transistorized R/C transmitter that fits into a coat pocket."

"What a cool, cool idea!" Carl applauded. "If Principal Stagg wants a good demonstration of static electricity, that's what he'll get. What time do you think we ought to come back and hook the stuff up?"

"Well, we don't want anyone to catch us here. I've noticed that the janitor cleans this floor first and then moves down to the next floor; if we wait until after dark, we shouldn't have any trouble keeping out of his way. We can come in through the side alley and walk in the shadow of the building around to that side door next to the band room. Let's go home now and get the stuff together and check it out."

S HORTLY after eight o'clock two furtive shadows, one short and plump and the other tall and athletic, slipped in the side door of the quiet high school. "Can't you walk without sounding like (Continued on page 14)

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Carl & Jerry (Continued from page 10)

a cavalry charge?" Jerry whispered hoarsely as they tiptoed up the stairs.

"You don't sound as though your shoes were half-soled with marshmallows yourself," Carl retorted. "Give me the key and let's get inside the lab."

They didn't dare turn on the room lights, but the flashlights that they had brought along enabled them to see what they were doing. The Tesla coil, which is a high-frequency air coil transformer that achieves very high potentials by means of transformer action and resonated windings, was already mounted on a shelf along with its power supply and the controlling R/C receiver. The shelf had been equipped with brackets that permitted it to be fastened quickly in place beneath the instructor's table.

They ran hair-thin wires from the coil to the two electrodes of the static machine. Then they looped up the chains that made connection with the inside foils of the Leyden jars so that the capacitors would not load the secondary of the Tesla coil or be damaged by the high potential.

When all was ready, they checked the operation of their installation. It worked beautifully! The boys locked the laboratory and slipped out of the building without being detected.

The next day was a real nervetwanger for Carl and Jerry. The physics class was the last period of the day; so they had plenty of time to wonder if anyone would detect the tiny wires connected to the static electricity generator, if the machine might be moved and the wires broken, or if something else would go wrong at the last minute. Finally the last period bell rang, and the boys hurried into the laboratory. A quick, surreptitious inspection showed them that the wires were just as they had left them.

The students had just taken their places when the door opened and the principal, Mr. Stagg, entered. With elaborate care he tiptoed to an empty seat at the rear of the class, while all the students watched his elephantine progress.

Mr. Paisley cleared his throat nervously and said: "Today, students, we are going to attempt an experiment in the generation of static electricity. We are honored to have our principal with us to observe what he tells me has always been his favorite physics demonstration."

Carl and Jerry could see that Mr. Pais-
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November, 1957
Carl & Jerry (Continued from page 16)

released it, and took hold of the insulated handle of one of the electrodes and moved it toward the other.

Jerry watched the metal balls approaching each other until they were an inch apart, then stabbed his thumb down on the switch of the little transmitter in his pocket. Instantly there was a noise like a ripped sheet, and a great ball of yellow flame hissed and spit between the metal spheres for a second or so.

A WAVE OF EXCLAMATION swept through the students. Mr. Paisley's blue eyes opened wide behind his spectacles, and he stared down at the machine as if he had seen a fishworm turn into a boa constrictor.

"Wow!" was Mr. Stagg's unscholarly comment. "You certainly are hot today, Mr. Paisley. I wonder if you could do that just once more."

Mr. Paisley looked up in bewilderment for a second or so, and then he started turning the crank of the machine again, even harder than he had before. When he released the crank and took hold of the handle of the electrode, he did so gingerly, as if he did not know exactly what to expect. This time the metal spheres were a full two or three inches apart when suddenly a writhing, twisting blue arc shot between them.

Startled, Mr. Paisley jerked the electrodes apart. A blue flame played over the whole machine, leaping back and forth between the electrodes and the still coasting wheel, and filling the room with a strong odor of ozone.

"That's enough!" Mr. Stagg said hurriedly as the blue flame abruptly died out. "Man and boy, I've seen some demonstrations of the generation of static electricity, but never anything like that."

He strode to the front of the room and placed a heavy, affectionate hand on Mr. Paisley's stooped shoulder. "With your permission, Mr. Paisley, I should like to address a few remarks to the class... Boys and girls, you have just seen much more than an awe-inspiring demonstration of mysterious electricity here today. You have seen a performance put on by a man with a fine sense of the drama.

"Did you notice how this sly fellow led us all to believe we were going to have to look very closely to see the feeble spark this machine would produce? What a nice touch that was wanting to draw the shades! He knew all along what to expect, of course; but the impression (Continued on page 22)
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November, 1957
Carl & Jerry (Continued from page 18)

made on us was all the stronger because of the masterful buildup. That, students, is teaching at its best."

As he finished speaking, Mr. Stagg started to pat the static machine affectionately. Almost with a reflex action, Jerry closed the switch of the transmitter in his pocket, and a singing blue flame leaped from the tips of Mr. Stagg's fingers to the machine. Fortunately the high-frequency currents produced by the Tesla coil were harmless, but the principal recoiled as though he had found himself petting a cobra.

"That thing just won't die," he said, feebly joining in the laughter that swept over the class. "After this, anything would be an anticlimax; so I'll take the liberty of dismissing the class for the day."

It didn't take long for the eager students to empty the room, but in the confusion Jerry managed to break the fine wires loose from the machine. He and Carl were the last ones out of the door; as they looked back, they could see Mr. Paisley staring in puzzled fascination at the static electricity generator.

"I'm not sure if we did him a favor or not," Jerry muttered out of the corner of his mouth to Carl, "because he's not going to rest easy until he figures out what happened."

"Maybe so," Carl agreed; "but we certainly helped him put on one whining demonstration!"
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LETTERS
FROM OUR READERS

Home Construction

- I built Art Trauffer’s “Simplest Code Practice Set” (July ’57, p. 48), grounding it to a heat pipe in our apartment. But when I pressed the key, instead of a “ground buzz” I received WQXR here in New York. I could think of no explanation. Maybe you can help me.
  
  Ronald Tepper
  Elmhurst, N.Y.

- Apparently the key is acting as a detector. Perhaps your “ground” is acting as an antenna.

- I have recently been experimenting with transistor short-wave radios. I would like to see a few two- or three-transistor projects.
  
  Jerry Supino
  Seattle, Wash.

The article beginning on page 77 of this issue is for you, Jerry.

- Recently I built a Heath amplifier and speaker system. Since then I have added a pair of electrostatic super-tweeters in accordance with an article in your June issue, and the results have far exceeded my expectations. Now I have acquired a 15” dynamic speaker. Could you send me a diagram of a crossover network of about 650 cycles?
  
  Jack Palmer
  Huntington, N.Y.

See page 65 for construction of crossovers of any frequency.

- In the August issue, you published an article called “Make Your Own 85 Coco Speaker.” I have a four-band receiver that has an 8” speaker. A few weeks before I received the August issue, I installed a 4” speaker in the set in much the same way you suggested in the article. I did not put a screen in front of the tweeter. I get good results from it without the screen.
  
  Frank Squires
  Ocala, Florida

Perhaps if you use the screen, Frank, you might detect some difference.

Some Disa and Data

- In what year did Hallicrafters stop making the S-38 receiver?
  
  Sanford Hutson
  Stuttgart, Ark.

They didn’t. It’s now the S-38DB.

- As an avid reader of Popular Electronics since its first issue, I am taking the liberty of asking you a favor. I am the owner of a commercial Echophone Model EC2 (Serial 211525) receiver which is badly in need of alignment and repairs. I have tried unsuccessfully to obtain a schematic from the Hallicrafters Company, and I am told it

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Letters

(Continued from page 24)

is no longer available. Would you therefore, please, in the Letters column, advise any person who will be kind enough to mail me a schematic or equivalent data that I will treat it carefully and return it promptly.

GEORGE R. PRICE
408 77th Street
Brooklyn 9, N. Y.

- I am having trouble in locating a schematic of a receiver that I have and that I would like to get in working order. I have tried all over to locate the schematic and can't seem to find one. The receiver is an Echophone Model ECIA and is a 3-band commercial-type receiver. I would appreciate it very much if one of your many readers who has a schematic and alignment data on this receiver would like to part with it.

A/2c DANIEL C. BRANNAN
9th Radio Relay Sqdn.
Donaldson AFB, S. C.

The "Challenger"

- I have solved the program to win against the "Challenger" (Sept., page 83) and you may come out from behind your bullet-proof steel plate. After about 10 futile tries on paper, the solution came to me—if the machine skips certain lights, I should also. So I made a list of the "stop" numbers, placing them in two columns labeled "Machine and Me," and the answer was obvious: Machine—2, 5, 9, 13, 17, 21; Me—4, 8, 12, 16, 20. I studied the plans for this machine for the past two nights, and hope to build one.

CARL F. GRAEWEALD
Oconomoc, Wis.

- Being ardent fans of your magazine, we read the article on the miniature electronic brain (The "Challenger"). We sat down to figure out how to beat the brain. In a shade over an hour, we came across the right combination. Provided that the machine goes first, we can beat it every time. For every single move that the machine makes, you make three; and for every two it makes, you make two; and for every three it makes, you make one. Needless to say, you would get beaten every time if you went first.

LARRY FEAZELL
DARYL GILMER

- Within 10 minutes time, I figured out how a person can beat the machine. In order to win, the person or the machine has to light the lamps in the following order: 4, 8, 12, 16, 20—thus leaving the 21st lamp for the loser. In order for the person to win—if the machine moves first, the machine will light lamp number 2; then the person should light lamp number 4 and light the remaining lamps in the order stated above in turn. If the person moves first, he should light lamp number 1, the machine will light lamp number 2, then he should light lamp number 4 and the remaining lamps in the orders stated.

KENNETH BELL
Portland, Oregon

The only winning combination is the one in which the player completes a sequence of four. If he misses one such sequence, the machine seizes on

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INSTRUCTION INCLUDED

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all these units

#tubes excluded

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Est. 1922

November, 1957

27

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NEW RECORD CHANGER ACHIEVES HIGH FIDELITY TURNTABLE PERFORMANCE

GLASER-STEERS

GS Seventy Seven

offers fully automatic operation and added record and stylus protection

At last, the quality performance of a turntable has been combined with flawless record handling convenience. The result is—the new Glaser-Steers GS Seventy Seven. Wow and flutter are virtually non-existent. Rumble, for all practical purposes, has been eliminated, and automatic features such as the amazing 'SPEEDMINDER' mark the GS-77 as the most advanced record changer of our time.

'SPEEDMINDER' does your thinking—prevents you from using the wrong stylus with your records; selects the correct turntable speed...and intermixes and plays 33 and 45 rpm records automatically, without regard to size or sequence.

Another important GS-77 feature is that the turntable pauses during change cycles and doesn't resume motion until next record has come into play position and stylus is in lead-in groove. This eliminates record surface wear caused by grinding action of record dropping on moving disc—a common drawback in other changers.

Other GS-77 features include—CHANGE CYCLE—only 5 seconds—fastest in the field. MOTOR—4-pole induction; dynamically balanced, hum shielded and shock suspended. ARM—acoustically isolated; has vernier adjustment for stylus pressure, and convenient finger lift for manual play, as well as indicator to facilitate location of stylus on groove; variation in stylus pressure between first and tenth record is less than 1 gram. MUTING SWITCH & R/C NETWORK—maintains silence except when record is being played. IDLER—automatically disengages in 'off' position to prevent flat spots. PRE-WIRED for easy installation, replaces most other changers.

The new GS-77 is absolutely jamproof. A single knob controls all automatic and manual speed operations. $59.50 less cartridge and base (base illustrated, $9.60). See and hear the new GS-77 at your local high fidelity dealer, or write for further information. Dept. PE 11

GLASER-STEERS CORPORATION 20 Main Street, Belleville 9, New Jersey

Letters (Continued from page 26)

it and will win. The winning sequences are as follows:

If the player starts first, he must take one jump. The machine then takes one, and the player must take the two, completing a sequence of four. The machine then takes one, and the player takes three, continuing on in the same sequence.

If the machine starts first, it is programmed to take two. The player then takes two, and the sequence of four is completed. Then the machine takes one, the player three, and the game continues on as before.

Pardon Our Slip

There is one error or misinterpretation in "Push-Button Weather Man," (September '57 issue). I refer to the sentence beginning, "For this reason, Dr. Krick and other meteorologists..." on page 46. This statement should read: "For this reason, Dr. Krick and other meteorologists conducted a two-million-dollar Air Force project to compile 15,000 maps, showing the weather in the northern half of the world for every day back to 1899. Incomplete parts of weather maps and the logs of whaling vessels had to be consulted in plotting these complete surface maps, as prior to that time meteorologists had not been thinking in terms of world weather patterns." I think you can see that there is a considerable difference between the two statements.

RICHARD D. SHINERS, Director
Weather Engineering Div.
Irving P. Krick Assoc., Inc.
Denver, Colorado

We regret the error. Thank you very much for calling this to our attention.

Pep Up Your TV

Here in Los Angeles we have the v.h.f. channels fairly well covered. But in a lot of places there are just one or two local TV stations with one or more stations that can just barely be seen or heard part of the time. In other words, how about an r.f. amplifier for our TV sets?

ALAN OGDEN
Sun Valley, Calif.

Commercial r.f. preamps are cheaper than building your own. You can get them in any radio supply house.

Out of Tune

Superregen Pocket Receiver (June, 1957, page 60): The coil used in this receiver is a Grayburn Vari-Loopstick Antenna, available from Radio Shack Corporation, 167 Washington St., Boston, Mass., for 60 cents. Modified trimmer capacitor C1 should have an approximate capacity of 50-380 µµfd. If C1 tunes too low on the band at full open, try a capacitor with a smaller minimum value.

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You do not need the slightest background in radio. Whether you are interested in Radio & Electronics because you want a hobby, a worthwhile business or a job with a future, you will find the "EDU-KIT" a worthwhile investment.

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The Progressive Radio "EDU-KIT" is the foremost educational radio kit in the world, and it is universally accepted as the standard in the field of electronic training. The "EDU-KIT" uses the modern educational principle of "Learn by Doing." Therefore you construct, learn by trial and error, theory and hands-on application - an integrated program designed to provide an easily-learned, thorough and interesting background in radio. You will learn theory and practice, not just the theory of the Printed Circuit Chassis. You learn "practical" theory as you go along, and you are always working with real equipment.

The "EDU-KIT" course is completed with the Printed Circuit Chassis. Therefore you learn everything necessary to build and operate a complete radio, from theory to practice. You will learn how to build radios using the Printed Circuit Chassis. You will learn the theory and practice of building and operating your own radio.

The "EDU-KIT" is COMPLETE

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

You will receive all Printed Circuit materials, including Printed Circuit Chassis, Printed Circuit Board, a professional electric soldering iron, and a self-powered Dynamic Radio and Electronics Tester. The "EDU-KIT" includes also Code Instruction Book and the Signal Tracer and the Signal Injector, a unique servicing instrument that can detect troubles in commercial radio and TV sets. This revolutionary new technique of radio servicing is now becoming popular in commercial radio and TV sets.

Printed Circuit is a special Insulated Circuit Board, on which has been deposited a conductive material which takes the place of wiring. The various parts are merely plugged in and soldered to terminals.

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At no Increase in price, the "EDU-KIT" now includes Printed Circuitry. You build and construct the Signal Injector, a unique servicing instrument that can detect troubles in commercial radio and TV sets. This revolutionary new technique of radio servicing is now becoming popular in commercial radio and TV sets.

Printed Circuitry enables you to build and construct the Signal Injector, a unique servicing instrument that can detect troubles in commercial radio and TV sets. This revolutionary new technique of radio servicing is now becoming popular in commercial radio and TV sets.

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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.

If you are learning in this practical way, you will be a professional Serviceman. You will be a professional Serviceman. You will be a professional Serviceman.

FROM OUR MAIL BAG

Ben Valerio, P. O. Box 21, Magna, Utah: "The Edu-Kits are wonderful. Here I have been sending your catalog and magazine to a good many members of the Radio and TV Club. We have been using your equipment. I received the "EDU-KIT" for the last seven years, and I now build Radio Testing Equipment. I find that every kit worked with the different jobs. The Signal Tracer works fine. Also help to let you know that I feel proud of becoming a member of your Radio-Television Club." Robert L. Shuff, 2394 Monday Ave., Huntington, W. Va.: "I thought I would stop you a few lines to say that I received my Edu-Kit, and was really amazed how good it was. I really enjoy working with it. I wish I could get one at a low price. I have already started gathering radio and electronics. My friends were really surprised to see me get into the swing of it as quick as I did. Trouble-shooting and servicing is first, if there is any to be found."

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It's fun to build this pocket-size two-transistor radio—enjoy loud, clear local broadcast-band reception wherever you go! Completely self-contained with built-in ferrite loopstick antenna—no external antenna needed. Extremely efficient reflex type 2-transistor circuit actually does the work of 3 transistors! Printed circuit board reduces building time to about one hour. Has air-dielectric variable capacitor for easy, accurate station tuning. Operates for months and months on long-life alkaline battery supplied. Sensitive miniature earpiece provides remarkably fine tone. Complete with all parts, including plastic-impregnated case, earpiece, battery and transistors. 4 3/4 x 3 1/2 x 1 3/4". Shpg. wt., 1 1/2 lbs.

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Sensational Hi-Fi design at new low cost! Features precise record equalization guaranteed within 1/2 db of recommended accuracy! Exclusive new printed-circuit switches and 2 printed-circuit boards for easy, error-free assembly, built-in power supply, response, +0.5 db, 10-50,000 cps; 8 inputs (including Tape Head); separate Bass and Treble controls; separate Level and Loudness controls; Rumble Filter switch; Don all tube filaments; cathode follower output. Beautiful custom-styled case, 4 x 13 x 8". Complete with case. Shpg. wt., 12½ lbs.
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Here's superb Hi-Fi performance at less than half the cost of a commercially assembled unit. Williams
son-type linear-deluxe circuit delivers full 25 watts of virtually undistorted reproduction; use with NIGHT-KIT preamp above. Printed circuit board. Response: +0.5 db, 10-120,000 cps at 20 watts. Distortion: 0.15% at 30 watts. Output Impedance: 4, 8, 16 ohms. Includes balance control, variable damping control. Chrome-plated chassis; 6½ x 14 x 9". Ready for easy assembly. Shpg. wt., 25 lbs.
Model Y-755. 25-Watt Amplifier Kit. Net only $44.50
Y-759. Metal cover for above. Wt., 3 lbs. $4.25

knight-kit Hi-Fi FM Tuner Kit
The last word in looks, quality, performance and low cost. Covers 88 to 108 mc; features Automatic Frequency Control (with special disabling circuit); fly-wheel tuning; pre-adjusted RF coils, pre-aligned IF's; cascode broad-band RF amplifier; drift-compensated oscillator; illuminated lucite pointer. Sensitivity is 5 microvolts for 20 db of quieting across entire band. Cathode follower output. Ideal for use with NIGHT-KIT amplifiers on opposite page, or any amplifier with phono-tuner switch. With custom-styled cabinet, 4 x 13 x 8". Shpg. wt., 12 lbs.
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November, 1957
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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 SW 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
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model SX-104, SX-105 $89.95
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THE NEW ONE THAT'S ON THE DRAWING BOARD TODAY!

where the best ideas in communications are born!

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

November, 1957
DO YOU WANT to take a trip around the world at the speed of light and never leave your comfortable armchair? The opportunity is yours with the aid of a short-wave radio receiver. Most countries broadcast on the short waves and many of them have English language programs that can be heard in North America. So just sit back and start tuning the dial of your receiver. You'll enjoy the interesting programs of news, music and entertainment from these far-off and fascinating lands.

Generally speaking, there are two types of listeners to short-wave broadcasts: (1) those relaxing after a hard day's work who want programs of entertainment and information; and (2) those listening for far-off stations so that they can send in a reception report and receive a QSI, or verification card for their collection. This article has been written with both groups in mind.

With the information contained on these pages, you will know when and where to listen for certain stations. Of course, it would take a book to list all the stations that can be heard, so I have tried to select a representative cross section. Best-heard stations for listeners in Eastern North America are listed on pages 42 to 44; those for listeners in Western North America will be found on pages 45 to 47. News and "Mailbag" programs are listed under each station for easy reference. And the following paragraphs will give you a sampling of the various programs and personalities that can be heard on the short waves.

THIRTY YEARS ON THE AIR

One of the most colorful personalities of the radio world, the originator and polyglot speaker-producer of the world-wide "Happy Station" program is Edward Startz of Radio Netherlands' Overseas Service. Startz
ENGLISH LANGUAGE SHORT-WAVE BROADCAST STATIONS BEST HEARD IN EASTERN NORTH AMERICA

Readers in the eastern part of the United States and Canada will find the following list of stations helpful in tuning the short-wave broadcast bands. The left-hand column lists the hour in Eastern Standard Time for broadcasts in English only; in the middle column, the city and country from which the broadcasts originate are listed with the name the station uses for identification in parentheses; and on the right are the frequencies and call letters for stations using them during their broadcasts. When an asterisk appears before the name of the city, it indicates transmissions specifically beamed to North America; generally these will be the best-heard stations, though the others are often very well heard.

<table>
<thead>
<tr>
<th>TIME (EST)</th>
<th>CITY, COUNTRY [NAME]</th>
<th>FREQUENCIES (kc.)</th>
</tr>
</thead>
<tbody>
<tr>
<td>4:45-5:45 a.m.</td>
<td>Georgetown, British Guiana (Radio Demerara)</td>
<td>5980</td>
</tr>
<tr>
<td>5:00-6:00 a.m.</td>
<td>Port-of-Spain, Trinidad (Radio Trinidad)</td>
<td>6085, 3275</td>
</tr>
<tr>
<td>5:00-6:00 a.m.</td>
<td>Cap-Haitien, Haiti (The Evangelistic Voice)</td>
<td>15400, 9630, 6105</td>
</tr>
<tr>
<td>5:50-7:30 a.m.</td>
<td>Kingston, Jamaica (Radio Jamaica); News—7:00 a.m.</td>
<td>4950</td>
</tr>
<tr>
<td>6:00-6:30 a.m.</td>
<td>Buenos Aires, Argentina (Radio El Mundo); News—6:25 a.m.</td>
<td>15290 (LRU)</td>
</tr>
<tr>
<td>6:00-7:00 a.m.</td>
<td>Djakarta, Indonesia (The Voice of Indonesia); News—6:15 a.m.</td>
<td>9710</td>
</tr>
<tr>
<td>6:00-1:00 p.m.</td>
<td>Johannesburg, South Africa (South African Broadcasting Corp.) English on Tuesday, Thursday, and Saturday only; News—11:00, 12:00 noon</td>
<td>25800</td>
</tr>
<tr>
<td>7:10-8:45 a.m.</td>
<td>*Melbourne, Australia (Radio Australia); News—7:15, 8:15 a.m.; Mailbag—8:00 a.m. Sunday</td>
<td>11810 (VLC11)</td>
</tr>
<tr>
<td>7:15-8:15 a.m.</td>
<td>*Warsaw, Poland (Radio Warsaw); News—7:15, 7:45 a.m.</td>
<td>15120, 11755, 11740</td>
</tr>
<tr>
<td>8:00-9:30 a.m.</td>
<td>*Cap-Haitien, Haiti (The Evangelistic Voice)</td>
<td>15400, 9630</td>
</tr>
<tr>
<td>8:30-9:00 a.m.</td>
<td>Lisbon, Portugal (Lisbon Calling); News—8:30 a.m.</td>
<td>21495, 17880</td>
</tr>
<tr>
<td>8:30-9:30 a.m.</td>
<td>Delhi, India (All India Radio); News—8:35 a.m.</td>
<td>21580, 17845</td>
</tr>
<tr>
<td>9:00-9:30 a.m.</td>
<td>*Stockholm, Sweden (Radio Sweden); News—9:00 a.m.</td>
<td>17840</td>
</tr>
<tr>
<td>Time</td>
<td>Country/Program</td>
<td></td>
</tr>
<tr>
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<td>-------------------------------------------------------------------------------</td>
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</tr>
<tr>
<td>7:30 a.m.</td>
<td>* Dissau, Switzerland (The Voice of Europe, Monday)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>* Prague, Czechoslovakia (Radio Prague, News)</td>
<td></td>
</tr>
<tr>
<td>8:00 a.m.</td>
<td>* Warsaw, Poland (Radio Warsaw, News)</td>
<td></td>
</tr>
<tr>
<td>8:30 a.m.</td>
<td>* Warsaw, Poland (Radio Warsaw, News)</td>
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<tr>
<td>9:00 a.m.</td>
<td>* Stockholm, Sweden (Radio Sweden, News)</td>
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</tr>
<tr>
<td>10:00 a.m.</td>
<td>* Brussels, Belgium (Radio B.B.C., News)</td>
<td></td>
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<tr>
<td>11:00 a.m.</td>
<td>* Brussels, Belgium (Radio B.B.C., News)</td>
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<tr>
<td>12:00 a.m.</td>
<td>* Brussels, Belgium (Radio B.B.C., News)</td>
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<tr>
<td>1:00 p.m.</td>
<td>* Brussels, Belgium (Radio B.B.C., News)</td>
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<tr>
<td>2:00 p.m.</td>
<td>* Brussels, Belgium (Radio B.B.C., News)</td>
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<tr>
<td>3:00 p.m.</td>
<td>* Brussels, Belgium (Radio B.B.C., News)</td>
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<tr>
<td>4:00 p.m.</td>
<td>* Brussels, Belgium (Radio B.B.C., News)</td>
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<tr>
<td>5:00 p.m.</td>
<td>* Brussels, Belgium (Radio B.B.C., News)</td>
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<tr>
<td>6:00 p.m.</td>
<td>* Brussels, Belgium (Radio B.B.C., News)</td>
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<td>7:00 p.m.</td>
<td>* Brussels, Belgium (Radio B.B.C., News)</td>
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<tr>
<td>8:00 p.m.</td>
<td>* Brussels, Belgium (Radio B.B.C., News)</td>
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<tr>
<td>9:00 p.m.</td>
<td>* Brussels, Belgium (Radio B.B.C., News)</td>
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<tr>
<td>10:00 p.m.</td>
<td>* Brussels, Belgium (Radio B.B.C., News)</td>
<td></td>
</tr>
<tr>
<td>11:00 p.m.</td>
<td>* Brussels, Belgium (Radio B.B.C., News)</td>
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</tr>
</tbody>
</table>

* denotes a repeat of the same time slot with the same programming.
<table>
<thead>
<tr>
<th>TIME (EST)</th>
<th>CITY, COUNTRY (NAME)</th>
<th>FREQUENCIES (kc.)</th>
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<tr>
<td>8:30-8:40 p.m.</td>
<td>Paramaribo, Surinam (AVROS)</td>
<td>15407, 4350</td>
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<tr>
<td>9:00-9:15 p.m.</td>
<td>*Port-au-Prince, Haiti (Radio Commerce)</td>
<td>5980 (4VB)</td>
</tr>
<tr>
<td>9:00-9:30 p.m.</td>
<td>*Copenhagen, Denmark (Voice of Denmark)</td>
<td>9520 (OZF)</td>
</tr>
<tr>
<td>9:00-12:00 p.m.</td>
<td>*Quito, Ecuador (The Voice of the Andes); News—10:15 p.m. Tuesday, Thursday, and Friday</td>
<td>15115, 11915, 9745 (HCJB)</td>
</tr>
<tr>
<td>9:25-9:45 p.m.</td>
<td>*Rome, Italy (Italian Broadcasting and Television System); News—9:25 p.m.</td>
<td>11905, 9575</td>
</tr>
<tr>
<td>9:30-9:40 p.m.</td>
<td>*Cologne, Germany (Voice of Germany); News—9:30 p.m.</td>
<td>11795, 9640</td>
</tr>
<tr>
<td>9:30-10:00 p.m.</td>
<td>*Port-au-Prince, Haiti (Radio Commerce)</td>
<td>5980 (4VB)</td>
</tr>
<tr>
<td>9:30-11:00 p.m.</td>
<td>Port-au-Prince, Haiti (Radio Haiti)</td>
<td>6195 (4VHW)</td>
</tr>
<tr>
<td>9:30-10:00 p.m.</td>
<td>*Warsaw, Poland (Radio Warsaw); News—9:30 p.m.</td>
<td>11740, 9525</td>
</tr>
<tr>
<td>9:30-10:15 p.m.</td>
<td>*Hilversum, Holland (Radio Netherlands); News—9:33 p.m. except Sunday</td>
<td>9590, 6025</td>
</tr>
<tr>
<td>9:30-11:00 p.m.</td>
<td>*Hilversum, Holland (The Happy Station)</td>
<td>9590, 6025</td>
</tr>
<tr>
<td>9:55-10:35 a.m.</td>
<td>*Montreal, Canada (Radio Canada); News—10:00 p.m.; The Northern Messenger—10:20-11:20 p.m. Sunday</td>
<td>15320 (CKCS), 9585 (OKLP)</td>
</tr>
<tr>
<td>10:00-10:30 p.m.</td>
<td>*Bucharest, Rumania (Bucharest Calling); News—10:00 p.m.</td>
<td>11937, 9570</td>
</tr>
<tr>
<td>10:00-11:45 p.m.</td>
<td>Guatemala City, Guatemala (TGNA)</td>
<td>9668, 5952</td>
</tr>
<tr>
<td>10:15-11:00 p.m.</td>
<td>*Madrid, Spain (Voice of Spain); News—10:15 p.m.; Mailbag—10:40 p.m. Thursday, Sunday</td>
<td>9585, 6130</td>
</tr>
<tr>
<td>10:30-11:00 p.m.</td>
<td>Copenhagen, Denmark (Voice of Denmark)</td>
<td>9520 (OZF)</td>
</tr>
<tr>
<td>11:00-11:15 p.m.</td>
<td>Forest Side, Mauritius (Mauritius Broadcasting Service)</td>
<td>15055</td>
</tr>
<tr>
<td>11:15-12:00 p.m.</td>
<td>*Madrid, Spain (Voice of Spain); News—11:15 p.m.; Mailbag—11:40 p.m. Thursday, Sunday</td>
<td>9585, 6130</td>
</tr>
<tr>
<td>11:15-12:00 p.m.</td>
<td>Berne, Switzerland (Switzerland Calling); News—11:20 p.m.</td>
<td>11865 (HERS), 9535 (HER4)</td>
</tr>
<tr>
<td>11:30-11:45 p.m.</td>
<td>Buenos Aires, Argentina (Radio Nacional); News only</td>
<td>9690 (LRA)</td>
</tr>
<tr>
<td>12:15-12:30 a.m.</td>
<td>*Brazzaville, French Equatorial Africa (Radio Brazzaville); News only</td>
<td>15440, 9730, 5970</td>
</tr>
<tr>
<td>1:00-2:00 a.m.</td>
<td>Accra, Ghana (Ghana Broadcasting Service); News—1:00 a.m.</td>
<td>4915, 3366</td>
</tr>
<tr>
<td>1:15-5:45 a.m.</td>
<td>Wellington, New Zealand (Radio New Zealand); News—3:30, 5:30 (except Sundays) a.m.</td>
<td>9540 (ZL2)</td>
</tr>
<tr>
<td>2:00-3:00 a.m.</td>
<td>Lagos, Nigeria (Nigerian Broadcasting Service)</td>
<td>4990</td>
</tr>
<tr>
<td>2:00-3:00 a.m.</td>
<td>Kaduna, Nigeria (Nigeria Broadcasting Service)</td>
<td>3326</td>
</tr>
<tr>
<td>2:30-2:45 a.m.</td>
<td>Papeete, Tahiti (Radio Tahiti; the Voice of France in the Pacific)</td>
<td>6135</td>
</tr>
<tr>
<td>4:00-4:15 a.m.</td>
<td>Manila, Philippines (The Call of the Orient)</td>
<td>15300, 11855, 9730</td>
</tr>
<tr>
<td>4:00-6:00 a.m.</td>
<td>Port Moresby, New Guinea (The A.B.C.); News—4:00 a.m.</td>
<td>6130 (VLT6)</td>
</tr>
<tr>
<td>4:30-5:00 a.m.</td>
<td>Hanoi, North Vietnam (Voice of Vietnam)</td>
<td>15020, 11895, 9465</td>
</tr>
</tbody>
</table>
ENGLISH LANGUAGE SHORT-WAVE BROADCAST STATIONS BEST HEARD IN WESTERN NORTH AMERICA

Readers in the western part of the United States and Canada will find the following list of stations helpful in tuning the short-wave broadcast bands. The left-hand column lists the hour in Pacific Standard Time for broadcasts in English only; in the middle column, the city and country from which the broadcasts originate are listed with the name the station uses for identification in parentheses; and on the right are the frequencies and call letters for stations using them during their broadcasts. When an asterisk appears before the name of the city, it indicates transmissions specifically beamed to North America; generally these will be the best-heard stations, though the others are often very well heard.

<table>
<thead>
<tr>
<th>TIME (PST)</th>
<th>CITY, COUNTRY (NAME)</th>
<th>FREQUENCIES (kc.)</th>
</tr>
</thead>
<tbody>
<tr>
<td>6:00-8:00 a.m.</td>
<td>Manila, Philippines (The Call of the Orient); News—7:00 a.m.; Mailbag—7:15 a.m. Wednesday</td>
<td>17805, 15300, 11855, 9730</td>
</tr>
<tr>
<td>6:00-10:00 a.m.</td>
<td>Johannesberg, South Africa (South African Broadcasting Corp.) Tuesday, Thursday, and Saturday only</td>
<td>25680</td>
</tr>
<tr>
<td>6:00-7:00 a.m.</td>
<td>Quito, Ecuador (The Voice of Andes)</td>
<td>17890, 15115, 11915 (HCJB)</td>
</tr>
<tr>
<td>6:15-7:15 a.m.</td>
<td>Rangoon, Burma (Burma Broadcasting Service); News—7:00 a.m.</td>
<td>11765</td>
</tr>
<tr>
<td>6:30-7:30 a.m.</td>
<td>*Djakarta, Indonesia (Voice of Indonesia); News—6:45 a.m.</td>
<td>9710, 4910</td>
</tr>
<tr>
<td>6:45-7:15 a.m.</td>
<td>Hanoi, North Vietnam (Voice of Vietnam)</td>
<td>15020, 11895, 9465</td>
</tr>
<tr>
<td>7:15-8:15 a.m.</td>
<td>*Melbourne, Australia (Radio Australia); News—7:30 a.m.; Mailbag—7:45 a.m. Sunday</td>
<td>11770 (VLC11)</td>
</tr>
<tr>
<td>7:30-8:30 a.m.</td>
<td>Peking, China (Radio Peking); Dictation News—7:30 a.m.</td>
<td>17860, 17680, 15095</td>
</tr>
<tr>
<td>7:40-8:20 a.m.</td>
<td>Tokyo, Japan (Radio Japan); News—7:50 a.m.</td>
<td>15325 (JOB21), 11705 (JOA4)</td>
</tr>
<tr>
<td>9:15-10:00 a.m.</td>
<td>Lisbon, Portugal (Lisbon Calling); News—9:15 a.m.</td>
<td>21690, 17895</td>
</tr>
<tr>
<td>12:00-1:00 p.m.</td>
<td>*London, England (North American Service)</td>
<td>17700</td>
</tr>
<tr>
<td>1:00-3:00 p.m.</td>
<td>*London, England (General Overseas Service)</td>
<td>17700, 15310</td>
</tr>
<tr>
<td>1:15-1:55 p.m.</td>
<td>*Hilversum, Holland (Radio Netherlands); News—1:18 p.m.</td>
<td>17775, 15425, 15220</td>
</tr>
</tbody>
</table>

TIME (PST) | CITY, COUNTRY (NAME) | FREQUENCIES (kc.) |
<table>
<thead>
<tr>
<th></th>
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</thead>
<tbody>
<tr>
<td>2:30-3:00 p.m.</td>
<td>*Brussels, Belgium (WFR—World's Fair Radio) Sunday, Tuesday, Thursday, Friday</td>
<td>15335, 11720, 11850 (ORU)</td>
</tr>
<tr>
<td>3:00-3:50 p.m.</td>
<td>*Tokyo, Japan (Radio Japan); News—3:00, 3:40 (Saturday) p.m.</td>
<td>17825 (JOA20), 15325 (JOB21)</td>
</tr>
<tr>
<td>3:00-7:03 p.m.</td>
<td>*London, England (General Overseas Service); News—3:00, 6:00, 7:00 p.m.</td>
<td>15310, 11930, 9825</td>
</tr>
<tr>
<td>3:00-12:00</td>
<td>*Moscow, U.S.S.R. (Radio Moscow); News—Every hour on the hour</td>
<td>17870, 17820, 15100, 11850</td>
</tr>
<tr>
<td>3:15-4:45 p.m.</td>
<td>*Monrovia, Liberia (Radio Station ELWA) Tuesday only; News—3:55 p.m.</td>
<td>21535, 15200</td>
</tr>
<tr>
<td>3:15-5:00 p.m.</td>
<td>*Brussels, Belgium (WFR—World's Fair Radio) Saturday only; Mailbag—4:00 p.m.</td>
<td>11850, 9705 (ORU), 9655 (OTC)</td>
</tr>
<tr>
<td>4:30-5:00 p.m.</td>
<td>*Brussels, Belgium (WFR—World's Fair Radio) Sunday, Monday, Tuesday, Thursday, Friday</td>
<td>11850, 9705 (ORU), 9655 (OTC)</td>
</tr>
<tr>
<td>4:55-5:45 p.m.</td>
<td>*Montreal, Canada (Radio Canada); News—5:00, 5:30 p.m.; Mailbag—5:35 p.m. Sunday</td>
<td>15190 (CKC), 11720 (CHOL)</td>
</tr>
<tr>
<td>5:00-5:15 p.m.</td>
<td>Karachi, Pakistan (Pakistan Calling); News—5:00 p.m.</td>
<td>15335, 11885</td>
</tr>
<tr>
<td>5:00-6:30 p.m.</td>
<td>*Monrovia, Liberia (Radio Station ELWA); News—5:40 p.m.</td>
<td>9650</td>
</tr>
<tr>
<td>5:00-7:30 p.m.</td>
<td>*Cap-Haitien, Haiti (The Evangelistic Voice), News—6:30 p.m. Saturday; Mailbag—6:30 p.m. Monday</td>
<td>15415 (4WV), 9602 (4VEH), 6105 (4VE)</td>
</tr>
<tr>
<td>5:00-9:20 p.m.</td>
<td>*Oslo, Norway (Radio Norway) Sunday only; Norway This Week—9:00 p.m.</td>
<td>15175, 11735, 9540</td>
</tr>
<tr>
<td>5:15-6:00 p.m.</td>
<td>*Brazzaville, French Equatorial Africa (Radio Brazzaville); News—5:15 p.m.</td>
<td>11975</td>
</tr>
<tr>
<td>5:30-7:15 p.m.</td>
<td>*Bern, Switzerland (Switzerland Calling); News—5:35 p.m. (Continued on page 46)</td>
<td>11865 (HER5), 9535 (HER4), 6165 (HER3)</td>
</tr>
<tr>
<td>TIME (PST)</td>
<td>CITY, COUNTRY [NAME]</td>
<td>FREQUENCIES (kc.)</td>
</tr>
<tr>
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</tr>
<tr>
<td>5:30- 8:30 p.m.</td>
<td>Colombo, Ceylon (Commercial Service); News—6:00 p.m.</td>
<td>15265</td>
</tr>
<tr>
<td>6:00- 6:15 p.m.</td>
<td>Port-au-Prince, Haiti (Radio Commerce) Tuesday, Thursday, and Friday</td>
<td>5980 (4VB)</td>
</tr>
<tr>
<td>6:00- 7:35 p.m.</td>
<td>Belize, British Honduras (B.H.B.S.); News—7:30 p.m.</td>
<td>3300</td>
</tr>
<tr>
<td>6:00- 9:00 p.m.</td>
<td>*Quito, Ecuador (The Voice of the Andes); News—7:15 p.m. Tuesday</td>
<td>15115, 11915, 9745 (HCJB)</td>
</tr>
<tr>
<td>6:25- 6:45 p.m.</td>
<td>Rome, Italy (Italian Broadcasting and Television System); News—6:25 p.m.</td>
<td>11905, 9575</td>
</tr>
<tr>
<td>6:30- 6:40 p.m.</td>
<td>*Cologne, Germany (Voice of Germany); News—6:30 p.m.</td>
<td>11795, 9640</td>
</tr>
<tr>
<td>6:30- 7:00 p.m.</td>
<td>Warsaw, Poland (Radio Warsaw); News—6:30 p.m.</td>
<td>15120, 11740, 9525</td>
</tr>
<tr>
<td>6:30- 7:00 p.m.</td>
<td>Port-au-Prince, Haiti (Radio Commerce) Wednesday only</td>
<td>5980 (4VB)</td>
</tr>
<tr>
<td>6:30- 7:10 p.m.</td>
<td>*Hilversum, Holland (Radio Netherlands); News—6:33 p.m. except Sunday</td>
<td>9590, 6025</td>
</tr>
<tr>
<td>6:30- 8:00 p.m.</td>
<td>*Hilversum, Holland (The Happy Station) Sunday only</td>
<td>9590, 6025</td>
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<tr>
<td>6:55- 7:35 p.m.</td>
<td>*Montreal, Canada (Radio Canada); News—7:00 p.m. The Northern Messenger—7:20-8:20 p.m. Sunday</td>
<td>15320 (CKCS), 9565 (CKLP)</td>
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<tr>
<td>7:00- 7:30 p.m.</td>
<td>*Bucharest, Romania (Bucharest Calling); News—7:00 p.m.</td>
<td>11937, 9570</td>
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<tr>
<td>7:00- 7:30 p.m.</td>
<td>Peking, China (Radio Peking); News—7:00 p.m.</td>
<td>17745, 15118</td>
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<tr>
<td>7:00- 7:30 p.m.</td>
<td>*Prague, Czechoslovakia (Radio Prague); News—7:00 p.m.</td>
<td>11935, 9550</td>
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<tr>
<td>7:00- 7:30 p.m.</td>
<td>*Stockholm, Sweden (Radio Sweden); News—7:00 p.m.</td>
<td>11810 (or 9820)</td>
</tr>
<tr>
<td>7:00- 8:45 p.m.</td>
<td>Guatemala City, Guatemala (TNGA)</td>
<td>9668, 5952</td>
</tr>
<tr>
<td>7:00-10:00 p.m.</td>
<td>Wellington, New Zealand (Radio New Zealand)</td>
<td>15280 (ZL4)</td>
</tr>
<tr>
<td>7:30- 8:00 p.m.</td>
<td>*Copenhagen, Denmark (Voice of Denmark); News—7:30 p.m. Monday, Wednesday, and Friday; Mailbag—7:30 p.m. Saturday; No English on Sunday</td>
<td>9520 (OZF)</td>
</tr>
<tr>
<td>8:00- 8:30 p.m.</td>
<td>*Budapest, Hungary (Radio Budapest); News—8:00 p.m.</td>
<td>11910, 9833</td>
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<tr>
<td>8:00- 8:30 p.m.</td>
<td>*Sofia, Bulgaria (Sofia Calling); News—8:00 p.m.</td>
<td>9700</td>
</tr>
<tr>
<td>8:00- 9:00 p.m.</td>
<td>San Jose, Costa Rica (Lighthouse of the Caribbean)</td>
<td>9645, 6037 (TIFO)</td>
</tr>
<tr>
<td>8:00- 9:20 p.m.</td>
<td>*Oslo, Norway (Radio Norway) Sunday only; Norway This Week—9:00 a.m.</td>
<td>11575, 11735, 9540</td>
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<tr>
<td>8:15- 9:00 p.m.</td>
<td>*Berne, Switzerland (Switzerland Calling); News—8:20 p.m.</td>
<td>11865 (HER5), 9535 (HER4)</td>
</tr>
<tr>
<td>8:15- 9:00 p.m.</td>
<td>*Madrid, Spain (Voice of Spain); News—8:15 p.m. Mailbag—8:40 p.m. Thursday</td>
<td>9585, 6130</td>
</tr>
<tr>
<td>8:30- 8:45 p.m.</td>
<td>Buenos Aires, Argentina (Radio Nacional); News only</td>
<td>9690 (LRA)</td>
</tr>
<tr>
<td>8:30- 9:00 p.m.</td>
<td>*Bucharest, Romania (Bucharest Calling); News—8:30 p.m.</td>
<td>11937, 9570</td>
</tr>
<tr>
<td>9:00- 9:30 p.m.</td>
<td>*Tokyo, Japan (Radio Japan); News—9:00 p.m.</td>
<td>17855 (J0A23), 15325 (J0B21)</td>
</tr>
<tr>
<td>9:00- 9:30 p.m.</td>
<td>Taipei, Taiwan; News—9:05 p.m.</td>
<td>15225, 11815</td>
</tr>
<tr>
<td>9:15- 9:30 p.m.</td>
<td>Brazzaville, French Equatorial Africa (Radio Brazzaville); News—9:15 p.m.</td>
<td>15440, 9730, 5970</td>
</tr>
<tr>
<td>9:15-10:00 p.m.</td>
<td>*Madrid, Spain (Voice of Spain); News—9:15 a.m. Mailbag—9:40 p.m. on Thursday, Sunday</td>
<td>9585, 6130</td>
</tr>
<tr>
<td>9:30-10:00 p.m.</td>
<td>*Warsaw, Poland (Radio Warsaw); News—9:30 p.m.</td>
<td>11740, 9550</td>
</tr>
<tr>
<td>10:15- 2:45 a.m.</td>
<td>Wellington, New Zealand (Radio New Zealand); News—12:30, 2:30 (except Sunday) a.m.</td>
<td>9540 (ZL2)</td>
</tr>
<tr>
<td>11:30-11:45 p.m.</td>
<td>Papeete, Tahiti (The Voice of France in the Pacific); News—11:30 p.m.</td>
<td>6135</td>
</tr>
</tbody>
</table>
is a Dutchman who, for nearly 30 years, has been closely linked with the "Peace, Cheer and Joy" station (international call letters PCJ), broadcasting from Holland on the short waves. Startz's mission in life is, and always was, to spread peace, cheer, and joy, and he has made his one-man music, information and contact show known all over the world.

His career, like his personality, is a most colorful one. As a young man, after completing his studies of the classical languages, he left his home in Holland and went to the United States. For the next few years he was a wanderer on the face of the earth, going through the "mill of life," making his living by taking on all kinds of odd jobs from dishwasher to interpreter and commercial traveler.

In 1928 Startz returned to Holland where preparations were being made for short-wave broadcasts—which at that time were still a novelty. Having a clear voice and speaking seven languages fluently, Startz was the ideal selection as announcer and commentator when Station PCJ, then owned by the famous firm of Philips, went on the air with an experimental international radio service, the first on the continent. Since then he has never left the microphone—except during World War II—and for over 29 years has been the magic attraction that has made Radio Netherlands so popular.

At the outbreak of war in 1940, Startz retired from radio for the duration and went "underground." How he squirmed through the intricate net of Nazi trickery during occupation time is a story in itself. In the Dutch starvation winter of '44-'45, the retreating enemy pillaged and looted everything they could lay their hands on. The station's ample file of fine recordings, collected from all over the globe for the benefit of an international audience, were carried away, never to be seen again.

After Holland's liberation a huge task lay ahead—rebuilding the transmitters and recapturing the audience that for over five years had searched in vain for the lost signals from Holland. When PCJ became the Netherlands' official voice over the world

Graham Hutchins has prepared Radio Australia's popular "DX'ers Calling" for the past 12 years.

air, operating under the auspices of the Netherlands Ministry of Education, Arts and Science, Startz resumed his work as "Good-Will Ambassador of the Air," to broadcast once more his message of peace, cheer, and joy to the world, with even more stress than before. He made many trips abroad, and told his listeners about his experiences each time he returned.

Startz took an active part in the inauguration broadcasts from Holland at the occasion of Queen Juliana's ascension to the throne, for the Columbia Broadcasting System in America, and was on the spot when Holland was struck with the tragic catastrophe of the flood. In 1953, upon completion of his 25th year in radio broadcasting, Juliana bestowed a Knighthood (in the Order of the Royal House of Orange-Nassau) upon him for his outstanding work of promoting good will and understanding among the peoples of the world.

"Keep in touch with the Dutch" has been Startz's well-known slogan since the "Happy Station" began broadcasting. He himself continues to keep in touch with his listeners by visiting their countries and learning their characteristics, customs, likes and dislikes, so as to keep his programs constantly tuned to the pulse of the world. A colorful calendar, pictures, and other materials are sent to listeners who write to the Happy Station, P. O. Box 137, Hilversum, Holland.

INVITE JACKO IN FOR BREAKFAST

At breakfast time each morning Jacko, the Kookaburra, is heard starting the Radio Australia programs for the day. These programs from "down under" have been favorite morning listening in many American homes for years.

"My Song Goes Round the World" is a very popular live-artist program presenting listeners' requests every Saturday at 7:25 a.m. EST. And on Sunday mornings the "North American Mailbag," conducted by Keith Glover, and the "DX'ers Calling," prepared by Graham Hutchins, are programs that most short-wave listeners don't want to miss.

Many of Radio Australia's transmissions are heard well in this part of the world, though only those beam to North America have been listed here. The latest program booklet, available from Radio Australia, Melbourne, Australia, has a colored photograph of Jacko on the cover.

ACROSS THE CONTINENTS

The following are some of the most popular short-wave broadcasts the world over

(Continued on page 110)

<table>
<thead>
<tr>
<th>DX PROGRAMS</th>
</tr>
</thead>
</table>
| Australia (Every Sunday) | 8:30 a.m. EST on 11,810 kc.  
8:00 a.m. PST on 11,770 kc. |
| Denmark (Every Tuesday) | 9:15 and 10:45 p.m. EST on 9520 kc.  
6:15 and 7:45 p.m. PST on 9520 kc. |
| Germany (Second Monday of each month) | 9:00 p.m. EST or 6:00 p.m. PST on 11,795, 9640 kc. |
| New Zealand (First Wednesday of each month) | 4:30 a.m. EST or 1:30 a.m. PST on 9540 and 6080 kc. |
| Sweden (Every Monday) | 9:25 a.m. EST on 17,840 kc.  
8:55 p.m. EST on 11,810 kc. (or 9620 kc.)  
7:25 p.m. PST on 11,810 kc. (or 9620 kc.) |
| Switzerland (First Thursday of each month) | 8:50 p.m. EST or 5:50 p.m. PST on 11,865, 9535, 6105 kc.  
11:35 p.m. EST or 8:35 p.m. PST on 11,865, 9535 kc. |
CHANCES ARE you don’t know it, but there’s a quiet revolution going on in the television industry. Its success, as a matter of strict fact, depends on your knowing nothing about it.

What’s been happening? The television networks have latched on to the video tape recorder. They are using it up to the hilt, and, while it’s not expected to replace film completely, it is proving to be a powerful adjunct to bringing realism back to television.

You might wonder how a picture can be put on tape and rebroadcast at a later time. In theory, that presents no problem. Essentially it works on the same principle as the audio tape recorder.

How It’s Done. The signal comes from the camera and is fed to the recording head of the video tape machine. It sets up a magnetic field in the head varying in proportion to the signal strength.

This in turn induces a magnetic pattern in the oxide coating of the tape which is a “replica” of the signal. In effect, this pattern is the picture, since, on playback, the differences in magnetic intensities are picked up and fed to the transmitter in exactly the same pattern as was originally sent by the camera. In other words, the tape takes the place of a reel of film, but instead of visual pictures, it carries “magnetic pictures” of the program.

The recorder puts both the video and audio portions of a transmission on the same tape, and rebroadcasts it when needed with close to the fidelity of live broadcasting. In that lies its tremendous advantage—it is said to be almost impossible for the home viewer to tell that he is not watching a live broadcast. As a matter of fact, it is sometimes impossible for a television technician to determine whether a program is taped or not.

Simultaneous or Delayed. Taping TV programs presents no

Bing Crosby financed some of the pioneer work on video tape recording machines in 1951. Since that time, the devices have made spectacular gains.

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great problem. It is just an added step in the ordinary course of broadcasting. It can be done in two ways, both of which are in use today:

(1) During the ordinary course of broadcasting a "TV" program, the engineer can feed the signal to the video tape machine as well as to the transmitter. This allows the broadcast, which is being seen "live" in some sections of the country (the West Coast, for example) to be held on tape for rebroadcast later to other sections.

(2) The signal may be fed to the tape machine only, without broadcasting the live program. Then, at some later time, the program can be rebroadcast with "live" quality. This has its advantages for those programs which can only be picked up at odd hours and are to be seen at another time. (For instance, "Wide, Wide World" tapes some portions of its program which are

HOW VIDEO TAPEING WORKS

Ampex faced a tough obstacle in designing the video tape recorder. In television, the signal must be at least 4000 kc. wide and better than 30 db "deep." A quarter-inch head gap, which will record a 15,000-cycle signal at 7½ ips, would need a tape speed of 2000 ips to reach a frequency of 4000 kc. At that speed, a tape reel 14 inches in diameter (4800 feet long) would last only about 30 seconds or less.

So the Ampex people did a revolutionary thing. Instead of recording along the length of the tape, as was customary, they recorded across the tape. And instead of using one head with the tape passing across it, they mounted a rotating drum with four heads on it so that the heads would pass the face of the tape in a crosswise direction, moving the tape only fast enough to avoid interference with each succeeding track. In this way, the tape speed was dropped to only 15 ips, and gave about an hour of recording on a 14" reel. Naturally, highly accurate synchronization is required since the head drum revolves at about 14,400 rpm. The net result was a speed of about 1500 ips.

At the same time, a small band on the upper part of the tape is used to record the audio portion of the program in the conventional manner, in a longitudinal direction rather than transverse, and an equal band at the bottom is used as a control track. The latter band carries cues or other instructions for later playback.

only available for recording in early morning hours, and transmits them during the regular afternoon program.)

"Impossible" Tape. There are other things about video taping which present difficulties, however. The tape itself has proved a top obstacle to the success of the system. Also, the only manufacturer of video tape machines, Ampex Corp., is forced to charge $45,000 for each machine. It must be able to pack ten times as much information on the tape as the ordinary sound-recording machine, and this presents enormous construction problems.

In the usual sound recording, a single inch of tape holds perhaps 2000 bits* of information—changes in the magnetic oxide induced by changes of signal strength from the recorder head. In video tape, however, each inch must carry about 20,000 bits of information. The bits are much smaller, too. Wavelengths only 30 ten-thousandths of an inch long must be recorded. Any dust particle or imperfection in the oxide coating which is only one-tenth that long will cause signal "drop-out." (Drop-out is momentary signal loss which appears as small white, gray or black dots or "pips" on the television screen. It results from the loss of close contact between the tape and the recording head.)

In sound recording, imperfections up to three-thousandths of an inch may be permissible and not cause drop-out. In instrumentation recording, such as guided missile work, imperfections as small as three ten-thousandths of an inch may be permissi-

ble. But in video taping, imperfections as small as three hundred-thousandths of an inch will cause signal drop-out.

Minnesota Mining and Manufacturing Co. has done pioneer work in making video tape. The finished product, called "a tape that was almost impossible to make," involves coating tolerances up to two hundred-thousandths of an inch. A 2"-wide roll, 4800 feet long, sells for $306 and has a useful life of about 200 playbacks.

"Head" Problems. Drop-out can also be caused by the recorder head. That's why a tape may work the first time through a machine but cause drop-outs thereafter. The head must be perfectly smooth. If it isn't, it gouges the tape and starts picking

(Continued on page 117)
First color video recorder (right) was demonstrated by RCA in 1953. Tape traveled at 240 ips, requiring a 19” reel to hold a 15-minute program. Below is an over-all view of video recording room at CBS Television City in Hollywood, showing five recorders together with associated equipment. Below, right, a special degaussing unit automatically erases a roll of video tape in a matter of seconds. The tape has a life of 200 plays and/or playbacks.

Key to video tape recording is the tape head, shown in front (A) and end (B) views above, left. The greatly simplified sketches indicate how the four tape heads mounted on a wheel pass over the tape to give the transverse picture track in (C). Note longitudinal sound and control tracks on top and bottom of tape. Diagram at right shows how signal is fed to tape recorder simply as an additional step in the usual transmission. Link stage has connections available for additional facilities.
Spreading the Stations with CSSB

Compatible single-sideband system may double available

AM broadcast band space

By PHILIP JAMES

THE HARRIED Federal Communications Commission is keeping its fingers crossed. One of these days it may get a totally unexpected bonus in the way of doubled broadcasting space. Tests are under way with a completely new method of broadcasting that promises to allow "space" for many new stations.

The FCC's big trouble up to now has been those tricky little devils called "sidebands." Stations allotted an AM broadcast (or carrier) frequency must also be given added room on each side of the assigned frequency. This is because the two sidebands take up that room.

What Sidebands Are. These side frequencies normally are inescapable. They are created when the carrier is modulated with voice or music. It's because of the sidebands that you can pick up a station even if your receiver isn't tuned on the nose. However, if you were able to eliminate one of these sidebands, you would automatically cut down on the bandwidth needed for the station. That's what the new compatible single-sideband system (CSSB) does.

Developed by Leonard Kahn, a young research engineer, the system essentially filters out one of the sidebands of the signal on transmission, theoretically doubling the bandspace available. Actually, because of technical complications, it would work out to only an 80% increase, which still would prove to be quite a help in relieving the overcrowded broadcast spectrum.

CSSB's most remarkable feature is that although it uses but one sideband, a broadcast will still sound the same to even the simplest home radio. It will be recalled that in standard single-sideband reception, receivers with a local oscillator to reinsert the carrier frequency must be used to receive an intelligible signal. Otherwise, you would get "Donald Duck" chatter.

Tested by VOA. One huge Voice of America station has been using CSSB in order to crack though Russian jamming. They found that it reduces interference and manages almost to double signal strength without increasing the size of the transmitter.

The American Broadcasting Company (ABC Radio Network) has been so impressed with the new system that it is planning a thorough tryout. Should the network consider the system a complete success, it would probably kick off the biggest race for new station permits since the inception of broadcasting. Areas now considered "full up" would no longer be so.

(Continued on page 121)
Personnel at the Voice of America installation in Munich, Germany (left), adjust their receiving equipment. VOA is now using the new compatible single-sideband technique. This is one of the few pictures ever released of an overseas Voice installation. Below is the adapter equipment developed by Leonard Kahn to transmit CSSB; it is located in the Kahn Research Labs test center, Freeport, N. Y.

**HOW CSSB WORKS**

In the compatible single-sideband system, conventional SSB is first generated without a carrier in the usual manner. From this point, the system follows a new path.

The carrier is reinserted and then, with an adapter unit, the distortion which this process has introduced is cut out. It's done by changing the shape of the wave which has amplitude and phase modulation (and a high degree of distortion) into a non-distorted AM wave. The final result is a single-sideband wave with carrier almost completely lacking in distortion. Thus, it can be picked up by the ordinary AM receiver.

By using a spectrum analyzer, we see the ordinary c.w. or code signal as a single carrier in A (above, right). In B, we see the ordinary double-sideband AM wave with carrier as the taller center line and the two shorter lines on each side as the sidebands. C is the compatible single-sideband analysis. Actually, you get a choice of cutting off either the right or left sideband.

In the conventional single-sideband analysis (not shown), the center (center line) would also be cut off; this, of course, requires a local oscillator to reintroduce the signal.

D shows a frequency-modulated wave analysis. Because of the constant change in frequency, however, these sidebands also change constantly, so that the picture is different at any given moment.

What is spectrum analysis? If a signal is examined using a relatively rare instrument known as a spectrum analyzer, we get a very different picture of what takes place during modulation, as seen in the scope traces above. Instead of the usual time-based trace, we get "spectra," in which the horizontal base line is a measure of increasing frequency rather than increasing time. A detailed description of the individual traces (A, B, C and D) is given in "How CSSB Works" at left.
Computer Translates Directly into Perfect Morse Code

Machine-perfect code with typewriter ease in sending is possible when you use the new low-cost Codetypers developed by Codetypers Laboratories, 1027 Casa Vista Drive, Pomona, Calif. This "miniature computer" will automatically key a radio transmitter as any of the keys of the typewriter-like keyboard are depressed. Speed is continually adjustable from 10 to 75 words per minute. The unit has 12 miniature tubes, printed circuits and switches, and an internal power supply and keying relay. Operation can be a.c. or d.c.

The Codetypers are easy to set up, since the only connections are two leads which can be clipped across the hand key or directly to the transmitter. In addition, no typing skill is needed— one-finger operation is enough for the most-used code speeds. A built-in monitor allows signals to be heard as the instrument is operated. Besides the standard alphabet and numbers, there are also keys for such combinations as BT, AR, AS, and SK, as well as for the comma, period, query and error.

Lightweight Traveling-Wave Tube to Be More Reliable

Operating reliability of microwave relay and radar equipment may get a boost through an RCA development. Their radically new traveling-wave tube, now in the experimental stage, is also expected to cut the weight of such devices substantially. It eliminates the bulky electromagnetic focusing equipment used with many types of traveling-wave tubes and points the way to compact and reliable systems of new design for airborne and other applications.

External focusing electromagnets have been discarded and a compact electrostatic element built right into the tube. Not only does this cut weight 30 pounds or so, but it eliminates the critical alignment necessary with previous types— because the element is given a permanent proper alignment during assembly. While other traveling-wave tubes can be affected by vibration, changes in temperature, or other variations in environment, making realignment necessary for effective functioning, the new one will operate under a wide range of conditions without further alignment.

Assembly Machine Takes Orders from Itself for Changes

IBM has a new machine which takes orders from itself. It's an automatic assembler that fastens resistors, capacitors, and other small parts to printed-circuit panels before they're put into computers and other equipment. But it goes a step further. When a change in circuitry is needed, instead of waiting to be reset manually, the machine gets instructions from an IBM card and resets itself for the new operation. The Programmed Component Assembly System is assembling wiring panels for data processing equipment.
By HOMER L. DAVIDSON

Low-power phonograph amplifier

uses all-purpose transistor

ONE

TRANSISTOR

RECORD PLAYER

PROBABLY the simplest phonograph amplifier ever designed, this one-transistor job serves to drive a full 6" x 9" oval speaker. It uses only six components in addition to a standard transistor. You should be able to complete construction in one evening, and there should still be time left over for a couple of hours of TV and a short beer (or long coke).

The changer used is the same compact RCA 45-rpm unit featured in previous construction articles. Costing little more than the price of a separate tone arm, turntable and base, its changing action is almost a free bonus.

The high output (at least two or three volts) of the original crystal in the tone arm serves to drive the CK722 to an output adequate for quiet listening, but it won’t shake the rafters. Don’t expect to blast the windows out with this little job.

No volume control is included or necessary in the amplifier shown here. The transistor used may be a CK722, 2N107 or equivalent. The shielded phono lead connected to C1 has its shield grounded to the speaker frame.

If more power is required, you can try the “Picnic PowerAmp” circuit in the June 1957 issue of POPULAR ELECTRONICS.

Any phono player can be used with this midget amplifier. However, the cartridge should be one of the high-output types, such as the Lafayette PK-80, Ronette TO-222, or Astatic L12, having at least a

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2-volt output. On the other hand, too high a voltage may overload the transistor. The amplifier chassis holds the output transformer and the battery clip. The other small components are wired by their leads into the circuit. As no socket is used for mounting the transistor, be very careful when soldering its terminals to the other components. The amplifier is mounted by the same bolts which hold the loudspeaker to the front panel.

A homemade cabinet houses the amplifier as shown. Common pine was used for the sides and cut to the correct dimensions. The oval speaker hole in the front panel was sawed with a jigsaw. One side of the base was designed as a record holder—a dozen records can be stored here.

The top panel or mounting board is constructed of ¼" tempered Masonite as is the bottom panel. Four small rubber feet attached by the same screws hold the bottom on the cabinet. A grille cloth with metal screen backing was placed over the oval hole before the speaker was mounted.

The screws which hold the plastic bottom on the 45-rpm changer can be used to mount it to the speaker assembly. It's a good idea to place an old tube carton over the crystal in the arm when working with the changer to prevent damage to the crystal.

Operation of the unit is simplicity itself. But check the wiring several times before throwing the toggle switch. Be sure that the small battery is placed into the holder with the correct polarity. Then throw the toggle switch and slowly rub your fingers over the needle. A scratching sound should be heard. Place a record on the turntable, and your player is ready to go.

**Push-Button Dialing for Rural Radiotelephones**

Radiotelephone users, who recently got a bonus in the way of dial systems in their cars, now have an extra added attraction in rural areas—push-button dialing. Developed by Motorola for the Rural Electrification Administration, the system is said to be ideally suited for sparsely populated areas. Tests in mountainous terrain showed reliable communication within a radius of 25 to 30 miles from the base station.

The new system is particularly attractive since it permits the use of automatic exchanges instead of operator-manned stations. As it employs specific tone sequences for dialing, it is practically impossible to receive a wrong number because of high ambient electrical noise levels. The equipment is designed to give no number rather than a wrong number in those rare instances when a tone is lost because of transmission difficulties.

As shown in the photo, the system is easy to operate. Lifting the handset and depressing the push-to-talk button automatically connects the phone to the base station. Then it is just a matter of pushing the buttons in the proper sequence to get the exchange and the party desired. A lock-out circuit insures complete privacy.

**PARTS LIST**

- BI—15-volt, miniature B battery
- CI—10-μfd., 15-volt electrolytic capacitor
- RI—220,000-ohm, ½-watt carbon resistor
- S1—S.p.s.t. toggle switch
- TI—Universal output transformer (Merit A 2900 or Stancor A 3622)
- TR1—CK722 transistor (Raytheon)
- SPKR—6" x 9" oval PM speaker

**HOW IT WORKS**

The high output of the crystal cartridge in the phonograph player is fed through the 10-μfd. capacitor (CI) to the base of the transistor. The universal output transformer is connected to the collector terminal with one side of its primary tied to the negative side of the battery supply. The secondary winding of the output transformer is tapped and the connection providing the best impedance match between the transistor and speaker should be used.

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SQUARE-WAVE TESTING can be called the "buckshot" approach. One shot covers a lot of territory, and can bring down a whole flock of fast clues.

In many kinds of testing, a single frequency or tone is put into the input of an amplifier or system and the output waveform is checked for distortion and level. But when an amplifier is to be checked over a wide band of frequencies, this method can be long and tedious. It would save considerable time and provide a better overall test if a number of the desired frequencies could be checked simultaneously.

That's just what actually happens in cases where we employ a square wave as a test signal. A quick look at the structure of a square wave shows why this is so.

**What Is In the Wave.** The oscilloscope pattern in Fig. 1 is an example of a sine wave. This is a simple sinusoidal waveform which we will call F1. The square shown in the broken line is the desired shape of a "square wave."

In Fig. 2, we still have F1 but the third harmonic F3 (or F1 times 3) has also been added. This combination provides the waveform labeled F1+F3, which fills out a little more of the square-wave box. By adding the fifth harmonic, we get the wave F1+F3+F5 as shown in Fig. 3.

Using our imagination, we can see what
The first four figures illustrate the relationship between the square wave and its constituent sine waves. Fig. 1 compares the sine wave and square wave. In Fig. 2 is a sine wave and its third harmonic. In Figure 3 is a sine wave plus its third and fifth harmonics, which together begin to fill out the shape of the square wave. Figure 4 shows an ideal square wave containing a large number of harmonics.

A low-capacity probe such as this one is needed for square-wave observation. Finished probe is shown in top photo; circuit and construction details in the two lower illustrations.

is happening to the original waveshape. With each harmonic added, the shape comes closer to that of the dotted line square. If the process of adding odd harmonics is continued, we finally arrive at a fairly acceptable square wave by the time about 10 harmonics are thrown in with the fundamental.

Yet, in many cases, 100 or more harmonics may be needed to produce the desired waveshape with the filled-out corners, as shown in Fig. 4. Suppose that a 1000-cps square wave which includes the 10th odd harmonic is used to test an amplifier. The amplifier must then be able to respond up to 21,000 cps or better to pass the waveshape without distortion.

By using a square wave as a test signal, it is not only possible to test the complete frequency response of an amplifier, but you can also show up troubles such as phase shift and instability resulting in oscillations and parasitics.

"Square Deal" Probe. When using a square-wave generator and oscilloscope in a test setup, keep these items in mind: (1) the generator must be properly matched to the input of the amplifier; (2) the amplifier output must be properly loaded; (3) the oscilloscope must be connected across the output of the amplifier under test in such a way that the 'scope leads themselves do not distort the waveshape of the signal. In most cases, simple leads to the 'scope are not adequate and will cause serious distortion. A simple probe, easy to make, is almost a necessity.

The circuit for such a probe is shown at left, and the photos will give a general idea of its construction. The low-capacity shielded line to the 'scope should be less
than two feet long and the entire probe must be kept well-shielded. The ceramic trimmer is adjusted by feeding a known square wave from a generator into the tip of the probe and tuning for the squarest wave possible on the 'scope. Once adjusted, this type of test lead is also excellent for use on video circuits. The probe, because of its method of operation, will normally attenuate the input signal somewhat, but you can compensate for this.

Connections of the square-wave generator and 'scope are very much like those suggested for testing with a sine-wave oscillator, but the interpretation of the pattern is very different.

**Which End Is Up?** When an amplifier is driven by a square-wave generator and the oscilloscope connected to its output displays a pattern like Fig. 4, the amplifier is probably passing up to the 25th or higher harmonic. However, if the trace more nearly resembles Fig. 5, the slope to the right indicates a loss at the lower frequencies while retaining good high-frequency response.

A slope in the reverse direction, as shown in Fig. 6, indicates just the opposite: good low-frequency response with a dropping off at the highs. Figure 7 is a curve indicating that an amplifier is lacking in both low and mid-range response.

The curve in Fig. 8 bears little resemblance to a square wave and shows an extreme case of high-frequency attenuation. When using square waves, it can be said in a generalized interpretation that the left-hand edge of each half-cycle indicates the high-frequency conditions existing in the tested amplifier while the right-hand edge of each half-cycle indicates the low-frequency conditions. Superimposed ripples on the leading (or high-frequency) edge as in Fig. 9 indicates the presence of oscillation or "ringing."

Complete books have been written about square-wave testing, and very limited ground can be covered in a few hundred words. However, even with the simplest kind of square-wave generator, such as the one shown, used only for the simple patterns given here, one can gain much experience and knowledge.

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**Square-wave patterns** indicate conditions within the amplifier under test. The waveform in Fig. 5 indicates good high-frequency response but poor lows, while the waveform in Fig. 6 indicates good low-frequency response but poor highs. Figure 7 illustrates a case of poor low- and medium-frequency response, and Fig. 8 indicates serious attenuation of high frequencies. The pattern in Fig. 9 betrays the presence of high-frequency instability or "ringing" in the system.
THE HI-FI SALESMAN who sold you your high-powered amplifier probably made a very good point. "Just think," he said, "with this one investment, you're on your way towards music in every room of your mansion. All you have to do is keep adding speakers. This twenty-watter will handle four and possibly more!"

"Good," you thought, "after I learn the quirks of all these watts and db's, I'm going to scrap all those 'kitchen model' four-tube midgets, mount a few speakers here and there, and pipe the classics around as they do in the elegant restaurants."

Well, perhaps the time has come. Perhaps your ears have become so attuned to clean and faithful reproduction that you just can't tolerate inferior radios in the bedroom or den. The problems confronting you at this point are twofold. First, how do you arrange your switching so that you can pipe the music where you want it. Second, what sort of speakers should you choose for those "secondary" outlets? Since the second problem is a bit more personal, let's deal with it first.

Outdoor Speakers. The first prerequisite for any outdoor speaker installation is that it be thoroughly waterproof. There is absolutely no way to protect a conventional paper-cone speaker from the elements and still have it couple sound to the air! The only solution, then, is to employ a good quality metal or plastic "trumpet" with a suitable driver system designed for outdoor use. Anyone who has

Fig. 1. A common but incorrect way of using two speakers separately or both together.

Fig. 2. This is the correct way to hook up two speakers which have different impedances.

Fig. 3. Correct hookup for two 16-ohm speakers.
ever seen an outdoor sporting event or concert will recall the type we mean. These systems are generally classified as Public Address speakers, but be careful. Most p.a. speakers do not have a frequency response even remotely consistent with hi-fi requirements. A typical p.a. speaker we found listed in the catalog has a response of only 300 to 10,000 cycles. Actually, it's a fine speaker for voice paging—not musical reproduction.

Two acceptable units manufactured by University Loudspeakers are: Model BLC, which claims response from 70 to 15,000 cycles and sells for around $50.00; and a much larger version of the same job, Model WLC, which sells for about three times that figure but goes down to 50 cycles. Electro-Voice's Model 848 claims good response from under 100 cycles to about 10,000 cycles, handles 25 watts and sells for under $50.00. Jensen's Model VH-24 is recommended for music, handles 25 watts and claims fairly uniform response from 110 cycles to over 6000 cycles; it can be purchased for a little more than $50.00.

Do not be alarmed at the seemingly conservative claims for bass frequency response of all these systems. Outside listening simply can't provide low bass, even if the speaker were capable of reproducing it, because of the missing room acoustics. There are no walls to bounce the bass around. The important things to listen for are "clean" reproduction and wide-angle coverage, so that you don't have to sit right in front of the speaker to get most of the music.

Kitchen Units. A lot depends here on just how far you want to go and how much room you have. Actually, a kitchen is seldom as large as a living room, and
If your den happens to be in the basement, you will generally find plenty of wall surface separating the den from the utility room or garage, and such wall surfaces are, again, ideal for speaker mounting. If the room is of generous proportions, a 12" or 15" woofer is recommended. However, if you must resort to the added expense of a furniture enclosure, be certain to hear the speaker in the particular enclosure before you make up your mind. This is an excellent rule to follow in choosing any speaker system and enclosure.

The Bedroom. Here, too, the requirement is mostly for background music rather than extended serious listening. Ideally suited to these requirements are the small, bookcase-type enclosure-speaker combinations which have become so popular. The Heath SS-1, the University "Companionette," the R-J SSU, the "Hartsdale," and many more of similar size, have found homes in headboards and night tables.

Incidentally, you can avoid jumping out of bed on wintry nights to turn off the hi-fi set by investing in one of the many types of appliance-timers available. They'll do the job at a preset time and spare you a set of frozen toes.

Speaker Volume Controls. Chances are you will end up with loudspeakers having different degrees of efficiency. That is, speaker A may sound quite loud with the volume control of your amplifier turned up halfway, while speaker B may be just above a whisper. There's nothing wrong with either of them—it's just a question of how they were designed. Then, (Continued on page 118)
DO YOU have to strain to hear that short-wave broadcast? Do you fret and fume because London fades, or Paris just never shows up? Calm down. The answer to your problem will cost you peanuts ($5 or less) and just a couple of hours of your time. It's called a Receiver Antenna Coupler, Low Cost, Mark I.

The device is the missing link between antenna and receiver. It will not only couple them together at the desired frequency, but it will automatically "uncouple" many types of interfering signals. It will be found particularly effective ahead of receivers which do not have a preselector stage ahead of the mixer tube, typical of many low-cost short-wave receivers.

Technically, it is a pi-section filter. There is no complicated switching involved from series resonance to parallel resonance, and it is simplicity itself to construct. Total cost will depend on how many parts you can salvage from your junk box.

Note that if your antenna, transmission line and receiver impedances are already closely matched, no antenna coupler will greatly increase the signal. But for the system which uses tuned feeders or an end-fed antenna, or a random-length antenna, this coupler will give surprising results.

Switching Operation. The values shown will provide good matching over a wide range of impedances from about 2 mc. to 30 mc. Taps on the coil enable you to peak on the 80-, 40-, 20- and 10-meter amateur bands by rotating switch S1 through its five positions. Position 1 is a bypass position which automatically removes the antenna coupler from the circuit and shorts the input to the output terminals. Position 2 is for the 80-meter band; 3 is for 40 meters; 4 for 20 meters, and 5 is for 10 meters.

Frequencies which lie between these amateur bands can easily be tuned with capacitors C1 and C2. Generally, as the frequency increases, the tuning becomes more critical; and on the 20- and 10-meter positions, care must be taken not to tune the coupler to the image frequency.

The tap switch is of phenolic material and the terminal block is of molded Bake-lite. They could be replaced with ceramic types, if desired. Mhiductor coil #3015.
was chosen because it is easily tapped, due to the spacing between the windings, and because of its rigidity, which contributes to the ruggedness of the unit.

Note that the windings adjacent to the windings on which the taps are made are slightly depressed, making it easier to solder the connection. You can make these depressions with a screwdriver, but be careful not to let the tool slip, or the coil may be damaged. It is recommended that the windings be depressed before mounting the coil. Because of the rigidity of the coil, no separate mounting is needed. It is connected directly to the stator terminals of capacitors C1 and C2 as shown above.

Tap the coil as follows: for 50 meters, the full 48 turns; for 40 meters, 24 turns; for 20 meters, 12 turns; 10 meters, 3 turns. Follow the switch wiring exactly as shown in the schematic diagram.

**Now To The Chassis.** The chassis may be of any type. The one illustrated was a can which contained a small reel of 16-mm. film; its shape and dimensions made it ideal for a lightweight chassis. (Even a coffee can may be used, if necessary.) Looking at the top of the chassis from the rear (photo at left), the input capacitor, C1, is at the right, and C2, the output capacitor, is at the left.

One note of caution: If the receiver is of the a.c./d.c. type, do not—repeat—do not connect the coupler chassis to the receiver chassis. Both your receiver and antenna coupler chassis would then be connected to one side of the a.c. line. In the case of a two-wire feeder, one side of the feeder and, therefore, one side of the antenna might be "hot" to your roof gutters or vent pipe. This could result either in a blown fuse or a severe jolt—depending on how lucky you were.

**HOW IT WORKS**

A maximum transfer of energy is made between the antenna and receiver at any given frequency if the impedances of antenna and receiver are matched. The coupler acts as a transformer and provides matching over a wide range of impedances, such as is the case when using one antenna for all-band coverage. It may be noted that at some frequencies the coupler will provide no apparent improvement; these are frequencies at which the antenna impedance comes close to matching the receiver's input impedance.

Another—perhaps more important—advantage of the coupler is in the additional selectivity gained, resulting in greater image and oscillator harmonics suppression. Since the r.f. stage is omitted in most inexpensive receivers, this leaves the path open for undesirable signals. Greater selectivity would cut down the interfering. The coupler acts as an additional tuned circuit ahead of the mixer grid, thus increasing the selectivity of the receiver.
Build Your Own
CROSSOVER
...with Brilliance

SPEAK to the average hi-finitic and he'll rattle off facts and figures about his amplifier and tuner, the unparalleled performance of his turntable, and the beautiful bass from his enclosure. He knows so much, it seems, that he's truly an expert. But if you want to be sure, give him the acid test.

"What," you should ask him, "about your crossover?"

Chances are, if he's Mr. Average, he'll respond with a blank look, and quickly change the subject to that new book he's reading.

While many aficionados have a good talking knowledge of high fidelity, they lack almost completely an understanding of how a crossover functions. This article may help the average hi-finer to understand it better, and give him a chance to build one tailored to his rig at very low cost. In addition, it will allow him to add two controls frequently lacking in commercial products—"brilliance" and "presence" controls.

Traffic Cop. Basically, the crossover, or frequency-dividing network, directs the highs into the tweeter and the lows into the woofer, where they can do their proper jobs. Otherwise, you'll get serious distortions as the frequencies ram into each other and clash. In a three-speaker system, an additional filter sends the proper frequencies to the mid-range speaker. Normally, this is what you have in that little black box.

The more elaborate kinds of crossover, however, have added controls for "brilliance" and sometimes "presence," two rather vague terms which actually refer

Addition of two controls which are frequently overlooked in making crossovers will contribute to your listening pleasure

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to emphasis on the upper frequency range (brilliance) and on the middle range (presence). If you accentuate the middle highs (say about 2000-4000 cps), you get the effect of bringing certain individual instruments right into the room with you; if you turn them down, the instruments recede into the background. Presence, therefore, adds an illusion of realism; it makes you feel as if you're listening to a "live" orchestra. The brilliance control determines the highs which add sparkle and shimmer.

Tackling the Job. Building the crossover is simple—just follow the schematics and pictorial. Costs are low: for about $3 or so, you can build a two-speaker network; for another $2.50, you can add a mid-range section.

The most difficult part is winding the coils, which are used to choke out the higher frequencies and pass the lows to the woofer and mid-range speaker. (Just the reverse is true in using the capacitors—they pass the higher frequencies to the tweeter.)

Use a cardboard bobbin from a roll of ribbon, or make one from a piece of dowel or broomstick. It should have a diameter of 1" and a length of about 1 1/2". The bobbin will have ready-made supporting flanges; but if you make your own of wood, use Masonite or some such non-

(Continued on page 102)
Curing AUTO RADIO Noises

By HERB CARRIER

Here's a step-by-step method to put back the pleasure in listening while you drive

WHEN YOU SETTLE BACK in your car for a comfortable drive accompanied by some sweet music, does your radio give out with squawks, squeals, rattles, howls or chatter? If so, friend, don't fret. A few hours of careful noise suppression will work wonders on that set and on your nerves.

Most car radios are well engineered and, when properly installed, give no trouble. Occasionally, however, excessive interference is encountered, usually in older cars or in cars where the radio was an afterthought and never installed properly.

Types of Interference. Noise troubles generally fall into four categories: chassis or ignition circuit pickup; antenna pickup; generator whine; wheel static.

To eliminate this interference, various suppressors, capacitors and static arresters have been strategically installed in cars. For example, to prevent excessive ignition circuit interference, a suppressor has been installed in—or built into—the distributor high-tension wire.

To reduce generator whine, a capacitor is mounted on the generator frame (one side of the circuit), and the center lead is connected to the armature terminal. A capacitor is occasionally used on the dash panel ammeter, connected to the same accessory terminal to which the radio battery supply lead is connected. Another capacitor is used on the voltage regulator, mounted on one of the regulator screws with the lead connected to the regulator armature terminal. (Note: these capacitors are generally about 0.5 μfd, 200 volt, with metal case negative, pigtail center lead ending in spade lug.)

Adequate common ground connections are usually installed during the manufacture of the auto. They include a cylinder head ground strap, transmission ground strap and hood ground strap.

Locate the Noise. If a quick check shows that all the basic suppressors, capacitors, static arresters, and ground

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straps are installed, yet excessive radio interference is present, you'll have to do some trouble-shooting in a step-by-step manner.

Most modern receivers are equipped with automatic volume control (a.v.c.). This increases the sensitivity of the receiver when weak signals or no signals are being received, and decreases it when strong signals are received. Therefore, maximum sensitivity is needed in conducting interference tests. So, when you tune the station selector between stations, turn the volume control on full.

**Chassis Pickup.** To test for chassis pickup, have a friend pull the antenna lead-in connection from the receiver while the engine is running and the car is in motion. If interference continues, it is an indication of chassis pickup.

To correct this condition, check for poor ground between receiver and instrument panel. Tighten all mounting bolts securely. Then check the ammeter capacitor and its connections—replace this capacitor if it is defective.

Bonding (grounding) is sometimes required to eliminate chassis pickup. In extreme cases, it may be necessary to bond all pipes, cables and rods which pass through the firewall. When bonding, use flexible copper braid. Solder one end of the braid to ground (dash panel, or firewall), and the other end to the pipes, rods, etc. Keep bonding material as short as possible.

**Antenna Pickup.** If, when making the above check, interference stops, or is greatly reduced, it is an indication of antenna pickup.

To correct this, be sure the cylinder-head ground strap connections are clean and tight. Paint sometimes insulates the ground strap. And be sure the strap actually has a metal-to-metal connection. Also, inspect the antenna lead-in shield ground. Paint, again, can cause trouble here, so make certain that the connections are clean and bright.

After making the above corrections, close the hood to prevent ignition system radiation. Plug the antenna lead-in terminal securely into its socket in the receiver. Then repeat the test.

**Generator Interference.** To test for generator interference, accelerate the engine and turn off the ignition switch. If a whine is heard, which decreases as the engine stops, the generator is causing interference. (Note: in some cars, the radio goes off when the ignition is off; connect fused power lead from the radio to the

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To prevent excessive ignition circuit interference, many cars have a built-in suppressor in high-tension lead from the coil to the distributor. You can see this at the arrow in photo at right.

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**other** ignition terminal for test purposes.)

To correct for such interference, clean and tighten all generator and generator-capacitor connections. Also clean and tighten all voltage regulator and regulator-capacitor connections. Replace either or both capacitors if they are defective. If noise persists, have your mechanic clean and undercut the generator commutator.

**Wheel Static.** Wheel static shows up most on a dry sunshiny day while traveling on an asphalt or concrete highway. It's seldom heard in damp weather, or when traveling on dirt or gravel roads. And, usually, wheel static (a continuous roar) increases as car speed increases.

To pinpoint wheel static further, accelerate to highway speed, and turn off the ignition (see note above). Depress the clutch pedal, or shift an automatic transmission into neutral. A continuous roar indicates wheel static. If static fades when the brakes are applied, the front wheels are causing the static. If the noise fades as power is intermittently applied, the rear wheels are at fault.

In either case, the trouble can be corrected by proper installation of static col-
M
lectors in the wheels. These collectors are usually small flat springs which conduct the static charge to the axles or the spindles. Occasionally, a special powder is blown into the inner tube along with the compressed air as a further aid in eliminating wheel static.

Normally, static collectors are installed on the front wheels only. However, in some cases where extremely sensitive receivers are used, it is necessary to install arresters on all four wheels.

**Microphonic or Loose Tubes.** If none of the above checks and corrections disclose or eliminate excessive interference, check all wires and connections. Tap each of the receiver's tubes with the end of a wooden-handled screwdriver. If a tube howls or chatters, or shows signs of being (Continued on page 110)
Two-Way Bus Radio

Ralph Kramden, the bus driver, is going modern up Rochester way. The transportation company there is testing a two-way radio system (left) which is expected to take out a lot of the headaches involved in jockeying the lumbering vehicles. If the test is successful, Stromberg-Carlson will equip the fleet of 300 buses with this equipment. When the dispatcher wants to call a specific driver, he broadcasts a call which will be heard over a tiny loudspeaker at the driver's ear in all buses. When the one who's called answers, the dispatcher switches over to communication with him only, cutting out the other buses. The driver responds using a regular telephone-type handset. Drivers will be able to report immediately any traffic delays, breakdowns, heavy passenger loads, accidents, or other things affecting the bus service.

D.C. for Your Shaver

Since it is a fact that most electric shavers work better on direct current, Wellsco Electronic Products of Van Nuys, Calif., has introduced an electric shaver wall outlet (below) designed to replace the regular convenience outlet in the bathroom. It uses a selenium rectifier in a fused circuit in case any other appliance is accidentally inserted into the socket. The price is $7.50 for the complete assembly.

Talent Scholarships

Westinghouse Educational Foundation has increased to $34,250—more than triple the amount formerly granted—the total value of 40 science scholarships and awards for which high-school seniors may compete in the coming school year. This is the organization's 17th annual nationwide Science Talent Search.

Computer Goes Boating

The Navy has put in an order for a UNIVAC-LARC, a three-and-a-half-million dollar computer designed to take the labor out of problems connected with nuclear reactors on ships. It will be installed at the Bureau of Ships' Model Basin (above) where testing of new ship designs takes place. Almost completely transistorized, the LARC is said to be able to do one man's mathematical work of a lifetime in only two minutes. It is actually two computers in one: the first does the arithmetic, the other controls the flow of data fed to the first. The Navy also plans to use the LARC in other fields, such as ship hull design, hydrodynamics, sonar and radar propagation and logistics planning.
WITH A BIT of judicious rewiring, you can change your mild-mannered little bedroom or kitchen radio into the commanding “master’s voice” of your household. What was once a quiet little stick-in-the-corner can become the transmitter of demands—summoning Dad from his workshop, the children from their TV, or even Rover from his bone. In addition, it will answer the door and question the salesman, all without Mom having to stir a step from her kitchen. This Jekyll-to-Hyde personality change can be simply accomplished by the technique described below.

A dual-purpose unit is not an original idea in itself as several intercom models of this type are commercially available. However, the commercial models usually feed the signal into the radio’s first audio stage. This works well enough for the high output of a crystal pickup of a record player, but it’s woefully weak for amplifying the output of a PM speaker used as a microphone. It’s especially unsatisfactory in the home where there’s a need to carry on a conversation with the “called” party some distance from the speaker.

What’s needed is a little more “soup.” This can be easily added by wiring the switching circuit so that a five-tube radio becomes a three-stage intercom amplifier instead of a two-stage one. The schematic shows a portion of a typical a.c./d.c. radio with the comparatively few alterations necessary to make the change.

**Assembly.** For ease of assembly, a 6-pole, 3-position, non-shorting (spring return to one side) rotary switch has been selected. It not only makes the conversion from radio to intercom, but switches the local and remote speakers back and forth.
The partial schematic above is of a common type of a.c./d.c. home receiver. The lettered terminals on switch shown beneath it should be connected to similarly lettered points in receiver.

for intercommunication. This switch occupies very little space, and it should be possible to find room for it, the input transformer and the intercom volume control (if one is used) in the radio's present cabinet.

You may, however, wish to design a special cabinet both reflecting the new character of your intercom-radio and providing plenty of space for the added components.

The conversion illustrated was made to an old chassis which had been resurrected from the junk box. It has the conventional a.c./d.c. circuit with a 12SK7 i.f. tube, a 12SQ7 detector/amplifier and a 50L6 power output tube. As can be seen, the function switch and new volume control are mounted on a piece of scrap aluminum which is bolted to the speaker frame. This results in a symmetrical arrangement of the controls and is quite attractive in the specially made cabinet.

One disadvantage of a switch with 24 contacts is the maze of wires serving it. However, by mounting the input transformer on the switch with an aluminum strap, we find that we can complete 90% of the wiring in the open before the switch assembly is installed. This pre-wiring may

PARTS LIST
C1—0.1-µfd. tubular capacitor
R1—3.5-megohm potentiometer
R2—20,000 to 40,000-ohm, 1/2-watt resistor (see text)
S1—6-pole, 3-pos. non-shorting switch, spring return to one side (Centralab 1449)
T1—Intercom input transformer, speaker voice coil to high impedance input (Standard Transformer Corp. A-4744)

HOW IT WORKS
The signal from the remote speaker, which can be a 4" or 5" unit like the one in the radio, is fed into an intercom input transformer. From here it passes through a capacitor to remove the d.c. and proceeds through the radio's unmodified first audio and output stages, then to the speaker.

The switch, in its first position, restores the original radio circuit. Positions 2 and 3 change the radio into a three-stage amplifier with position 2 for "listen" and 3 for "talk."

Gang A isolates the front end and feeds the intercom input to the control grid of the i.f. tube. Gang B breaks the voltage supply to the i.f. tube and, through load resistor R2 and interaction with Gang C, feeds this voltage directly to the plate of the i.f. tube. Gang C also isolates the radio's volume control and feeds the signal, through a capacitor, which removes the d.c., to the grid of the first audio tube.

Gangs D and E merely shift the local and remote speakers from the front to the rear of the amplifier, in the customary intercom manner. Gang F is used to isolate the remote speaker leads completely when the unit is being used as a radio.

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look pretty complicated, but the worst is over when you have finished it. At this point, it's only necessary to attach ten color-coded leads to the set and two to the binding posts for the remote speaker leads, and the job is done.

The radio's volume control is deactivated by this conversion; the separate intercom volume control is shown in the schematic.

**Precautions.** Adjustment of the intercom gain is made by using exactly the correct plate load resistance ($R_2$) for the preamp/i.f. tube. Because of the circuit employed, the tube manual cannot show the exact load value needed, so it is necessary to connect a potentiometer of at least 100,000 ohms in place of $R_2$ temporarily. Adjust it until maximum gain with minimum distortion is achieved. Check the pot with an ohmmeter and then replace it with a resistor of the nearest value.

This is a rather tricky conversion in some respects. Wiring the switch is tedious and can be downright confusing. The leads must be color-coded or you'll become hopelessly lost.

If the set's output transformer is mounted directly on the speaker frame, it would be well to move it. On the "talk" position, there might be some feedback between it and the speaker voice coil if they're too close together. Not all sets have one side of the speaker voice coil grounded, and this must be done.

The switch should be mounted as far as possible from the converter tube (which may be a 12SA7, 6SA7, or 12BA7) to reduce noise pickup. Leads from the switch to various parts of the set should be as short as possible. A few holes through the chassis may sometimes offer the shortest route.

Each conversion presents its own special problems. Because of common tie points, some care and thought must be exercised in selecting the right place to break the circuit. Sometimes leads will have to be relocated.

(Continued on page 124)
"POWER" is rapidly becoming the "key word" in transistor design. Does that sentence sound familiar? It should, for it was the opening sentence of our August column. And power transistors have continued to make news!

Sylvania has announced a new low-cost power transistor for experimenters, gadgeteers and hams—the 2N307. Netting "across the counter" for only a buck-fifty (that's right... only $1.50), this unit is rated to deliver 2 watts in single-ended Class A operation, with a pair delivering 8 watts in Class B push-pull.

But "top honors" as the lowest-priced power transistor still goes to the first of the low-cost power transistors—CBS-Hytron's popular 2N255. This transistor, featured in several POP'tronics articles in the past (see the June and October issues), now nets for only $1.35 (formerly $2.95). The higher voltage version, the 2N256, now nets for $1.50 (formerly $3.25).

From a military-industrial viewpoint, G.E. has the "hottest" power transistor of all. The 2N451 n-p-n silicon transistor, manufactured with the vapor diffusion technique developed at G.E.'s Advanced Semiconductor Laboratory in Syracuse, N. Y., has a collector dissipation rating of 85 watts at a temperature of 25°C, 35 watts at 100°C. A single 2N451 in a Class A circuit is capable of 25 watts output at temperatures up to 30°C, while a pair in Class B will deliver 50 watts, even at temperatures up to 100°C!!! With a frequency cutoff of 400 kc, the 2N451 can be used in common-emitter amplifier circuits at frequencies up to 500 kc. . . or as an oscillator at even higher frequencies.

Readers' Circuits. Although simple receivers continue to be the most popular projects with experimenters and home-builders, it is difficult to determine the second most popular project. On the basis of the letters and postcards received, I would guess that transistorized test equipment projects would be strong contenders for "place" position. This month we are fea-
This tiny six-transistor receiver was put together by reader John Jensen of Blair, Nebraska. Note the compact wiring in the interior view at left. The photo at right shows that the finished receiver in its case is not much larger than a pack of cigarettes. See page 125 for details.

Fitting one of each: a useful piece of test gear submitted by Ronald L. Ives of 251 Lincoln Ave., Palo Alto, Calif., and a transistorized short-wave receiver, developed by John L. Janning (WSQCN), of 1332 Central Park Ave., Dayton 9, Ohio.

Audio Tone Generator. A typical audio signal generator may require from 20 to 50 watts line power to deliver an audio signal of up to a few milliwatts, and may need a half-minute to five or ten minutes to reach a stable operating temperature. Ronald Ives set out to design a 1000-cycle audio tone generator which would: (a) require relatively little power and thus be economical to operate on batteries; (b) be "instant starting"; (c) be easy to build and to use; and (d) not "make like a cookstove" on the bench.

Referring to the schematic diagram (Fig. 1), we see that this tone generator consists of a modified LC multivibrator, TR1-TR3, followed by a transformer-coupled push-pull buffer amplifier, TR2-TR4. Power is supplied by a single six-volt battery, B1, with on-off switch S1.

In operation, transformer T1 acts both as the inductive collector loads of the multivibrator (by virtue of its center-tapped primary winding), and as impedance matcher for the multivibrator's output to the buffer amplifier's input. Cross-feed coupling capacitors C2 and C3 provide the feedback necessary to start and sustain oscillation. Base bias for the first stage is provided by resistors R1, R2 and R3, R4, bypassed by C1. The common-emitter configuration is used.

The push-pull output stage is conventional. Output transformer T2 matches the buffer amplifier stage to the load; like the first stage, the buffer is a common-emitter amplifier. Neither layout nor lead dress is critical and you have considerable freedom of choice in assembly.

Oscillator transformer T1 is a 500-ohm CT to 500-ohm CT unit. Either the Argonne AR-62 or Thordarson TR-1 is suitable. Output transformer T2 is rated at 500 ohms CT to 1500 ohms; Ronald suggests the use of a Thordarson TR-4 here. Power may be supplied by a single 6-volt battery, such as a Burgess Type Z4 or F4P1, or by four flashlight or penlite cells connected in series.

Operating frequency should fall between 800 and 1400 cycles. The final value (1000 cycles) is obtained by adjusting R4. If you wish to change the basic frequency to another range, you can do this by using other values for C2 and C3. Bias resistor R5, in the output stage, serves as a fine control over output amplitude; for most applications, where a fixed level signal is desired, this control may be left fixed in position.

(Continued on page 124)
LAST MONTH we told you about the origin, purpose, and aims of Radio Free Europe, in addition to various facts about the programming. This month we'll discuss RFE's monitoring stations, relay points, studios, transmitters, and antennas.

The Schleissheim monitoring station in Germany has often been called the "ears" of RFE, and it is from here that the programs are produced. Stations behind the Iron Curtain are monitored, as are the satellite stations, while the American stations provide up-to-the-minute news. The Schleissheim monitors use 50 communications receivers for general listening and triple-diversity receivers for picking up programs from Press Wireless in New York City. Teletype and telephone also play important parts in the functioning of the Schleissheim station. Antenna-wise, there are a number of rhombics (including reversible and inverted types), long-wave, open-V, Yagi, and Beverage antennas, and a cross-loop and goniometer arrangement.

Some 200 miles northwest of Munich and 50 miles south of Frankfurt, we find an abandoned airstrip that is now the home of the Biblis transmitting center. The transmitters include four 10-kw. units, one 20-kw. unit, and three 50-kw. units. Commercial power is brought in at 20,000 volts and reduced to 380 and 460 volts for operation of the transmitters and other equipment. In all, a total of 750 kw. is required at Biblis. Rhombic and curtain antennas are used here; the curtains consist of one, two, or four elements, each with a tuned parasitic reflector.

In Holzkirchen, Germany, is a relay sta-

(Continued on page 134)

Technicians check radio equipment in maintenance laboratory at Munich. The machine in the foreground is an Ampex tape recorder. RFE uses three Ampex machines in each of its 24 studios.

This giant tower is one of the four antennas of the powerful RFE short-wave transmitter at Holzkirchen, Germany.
BACK in the good old days of ham radio, one-tube radio receivers were affectionately referred to as "one-lungers." Although this phase in the development of amateur radio will never return as such, we are now at a similar point in time with respect to the development of transistors. So it seemed quite apropos that this high-frequency transistorized receiver be tagged a "two-lunger."

Some of you may recollect the year 1932 when the first screen grid tube—the revolutionary 24A tetrode—was announced. The tetrode transistor is just as spectacular today as the first screen grid tubes were in those bygone days.

The "Ten-Meter Two-Lunger" utilizes an amazing semiconductor, the RCA 2N247 drift transistor. All of the 2N247's that I tried worked well beyond 50 mc. By replacing $L_1$ (as will be described later), it is usually possible to receive signals as high as 40 or 45 mc. However, if your 2N247 doesn't "cut the mustard" near 40 mc., don't sue the company. Anything above 30 mc. is par for the course.

Putting It Together. Chassis layout is straightforward and the circuits are not critical. The chassis in the model was constructed from a sheet of 6" x 5 7/8" 18-gauge aluminum. This size is neatly accommodated by an LMB box, UC-972. The midget 15-volt battery ($B_3$) located on top of the chassis supplies power to the 2N44 audio amplifier stage.

Components are arranged so that there is only one terminal strip, located between the 2N247 and the battery holders. The primary and secondary leads of transformer $T_1$, the disc capacitors $C_2$ and $C_5$, and one end of $L_1$, $RFC_1$ and $C_6$ are all secured to this terminal strip. Note from the bottom view of the receiver that $T_1$ is held in place with an aluminum bracket and a single screw.

One word of caution regarding earphone jack $J_3$—be sure to use the insulating shoulder washers that are supplied with the jack and check to see that there are no burrs around the mounting hole that could short through to the jack frame.

In the photograph of the top of the chassis, you will see another aluminum bracket, fabricated to secure $B_3$. This photo also shows the "gimmick" capacitor ($C_1$) used to control antenna coupling. A 2" piece of busbar wire (stiff and tin-plated) was soldered to the left terminal of the capacitor and bent parallel to the chassis. Around this were wound approximately 13 turns of insulated wire, and the free end was soldered to the antenna binding post. The
HOW IT WORKS
The Ten-Meter Two-Lunger" uses two transistors to form a complete 10-meter receiver. A single p-n-p
RCA drift transistor Type 2N347 functions as a tunable superregenerative detector and the common
base configuration is employed. Incoming r.f. signals are applied to the collector and at the same time
coupled to the emitter through internal transistor capacity and capacitor C3. The signal is amplified in
the transistor and again appears in the collector circuit, this time highly amplified. With the 2N347 func-
tioning in this manner, a feedback loop is created and oscillation takes place.
In addition to the oscillation at the incoming signal frequency, another oscillation occurs at approximately
17 kc. due to the time constant of C3 and R1. This
secondary oscillation tends to raise the high-frequency oscil-
lations of and on at just the right instant to
maximum sensitivity. This type of circuit is also known
as a super-regenerative oscillating detector.
Transformer T1 is used to couple the audio and
match the impedance between TR1 and TR2. TR2
is wired as a high-gain class A amplifier and uses a
Type 2N44 p-n-p transistor. Resistor R3 provides base
bias for the transistor and, in effect, controls its oper-
ating point. The audio output is direct-coupled to the
headphones and provides more than adequate volume.

turns of wire are free to slide on the busbar,
and the amount of wire in proximity with
the busbar controls the degree of coupling
between the antenna and the receiver.
Firing It Up. If you follow the schematic
faithfully, the receiver will probably work
the first time around. However, if you're
like me, you may be too eager to hear it
perform and rush the job a wee bit. So it's
a good idea to make a few checks just to
protect the transistors and batteries.
There's nothing like a molten mass of ger-
manium to put a damper on one's spirits.
And that's just what will happen to the
transistors if you hook them up wrong.
First, insert the batteries but not the
transistors. Check with the schematic to
make sure that you get the polarities cor-
rect. Once you are sure they are right,
place some plus and minus marks on the
chassis for future reference. With the
switch off, measure the resistance between
the chassis and the frame of J8. It should
be extremely low. If the resistance is low,
the jack is shorted.
Next, couple the negative lead of the
voltmeter on coil L1 and the positive lead
on the chassis. With good batteries, the
meter should read 4.5 volts. If it does not,
see if the coil is shorted to the chassis, or
if the transformer leads are shorted. Then
place the positive lead of the voltmeter on
the emitter connection of TR1. Turn the
switch on and rotate R1. The meter should
read a little over a volt. Now, insert the
phones in the jack and again check from
the frame (negative meter lead) to the
chassis. With a fresh battery, the voltage
should be 15 volts. Then check the voltage
between the base terminal of the 2N44
socket (negative meter lead) and the chas-
sis. It should be below 15 volts.
If the meter reads down scale during any
of the above checks, it means that a bat-
tery is reversed. Assuming that all the
checks are satisfactory, turn off the power
switch and insert the transistors correctly.
It is possible to pop a transistor if it is in-
serted when the power is turned on.
With the headphones inserted in the jack
and the antenna disconnected, turn on the
power switch and slowly advance the re-
generation control, R1. You should hear a
scratchy sound as the control is turned, and
at about half rotation the 2N247 will start
to oscillate. The oscillations are heard as
a sizzling sound known as hiss. When you
hear this sound, you have arrived. It is
time to connect an antenna.
As you tune capacitor C3, you will prob-
bly hear stations across the dial. Their
strength can be increased by sliding more
turns of wire on the busbar. If you get too
much coupling between the two wires, the
detector will quit oscillating, or else it will
pop in and out of oscillation across the dial.
If it quits as soon as the antenna is con-
ected, you have too much coupling to start with.
Making Replacements. If you don't
like winding your own r.f. chokes, you can
purchase commercial units in the form of
television peaking coils. Any choke in the
vicinity of 70 microhenries will work. How-
ever, the handmade one wound on the 1-
megohm resistor will be more than satis-
factory, although not quite as pretty as a
commercial unit.
As mentioned earlier, replacing coil L1
with one containing less turns will usually
allow you to receive signals almost up to
the six-meter amateur band. The technique
goes something like this. With the plates

TRANISITOR RATINGS
Most transistor manufacturers rate the high-frequency
performance of their units in terms of "alpha cutoff"
and in megacycle units. As the transistor tries to
amplify higher and higher frequencies, efficiency starts
to fall off and the amplitude of the output signal
decreases. At some high frequency, the output signal
will be reduced to half the value of a low frequency
(fast 1000 cycles) which the transistor can easily am-
plify. This frequency is known as the alpha cutoff
frequency.
RCA, however, rates its units differently. As we
attempt to amplify beyond the alpha cutoff frequency,
the output drops even more. At another frequency,
considerably higher than alpha cutoff, a point will be
reached at which the output signal is of the same
dagnitude as the input signal. This is known as the
unity gain cutoff frequency, the frequency at which
the transistor has neither gain nor loss. (It should be
noted that these ratings are established using the
commercial emitter configuration rather than the base
configuration. Also, unless specified, the alpha cutoff
or unity gain frequency is an average figure and not
a guaranteed minimum.) The RCA 2N247 drift tran-
sistor has a unity gain cutoff frequency of 163 mc.,
and the alpha cutoff frequency is about 30 mc.

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POPULAR ELECTRONICS
PARTS LIST

B1—1½-volt penlite cell
B2—4½-volt battery, three penlite cells
B3—15-volt hearing-aid battery (Eveready 411)
C1—1 μfd. adjustable "gimmick" capacitor (see text)
C2—0.002 μfd. disc ceramic capacitor
C3—6.50 μfd. variable capacitor (Johnson 50R12)
C4—10 μfd. mica or disc capacitor
C5—0.01 μfd. disc ceramic capacitor
C6—10 μfd., 25-volt electrolytic capacitor
I1, I2—Binding posts (Johnson 111-102 red and 111-103 black)
J3—Open-circuit headphone jack
L1—14 turns #20 wire wound on ½" form spaced the diameter of the wire (14 turns of Air Dux #416 or B & W 3003 "Mini-ductor")
R1—25,000-ohm potentiometer, linear taper
R2—3300-ohm, ½-watt resistor
R3—100,000-ohm, ½-watt resistor
RFCI—Homemade choke consisting of 50 turns 34 wire scramble wound on a 1-megohm, 1-watt resistor (see text)
S1a/S1b—D.p.s.t. switch (part of R1)
T1—Transistor interstage transformer, 20,000 ohm to 1200 ohm (Triad TZ-15 or equivalent)
TR1—2N247 drift transistor (RCA)
TR2—2N44 transistor (General Electric)
I—Case (LMB = UC-972)
J—Vernier dial (National MCN)
K—Knob (National HRS-3)
L—3-pin transistor socket
M—4-pin transistor socket

Although the receiver is very sensitive, you'll find it simple to construct if you follow the schematic diagram above.

Top and bottom views of the "Two-Lunger." C1 is a "gimmick" capacitor which allows a wide range of frequencies to be received. Aluminum brackets hold T1 and B3 in place.

November, 1957
TV Does Office Work

Closed-circuit TV may become a form of standard office equipment if the Stanford Research Institute continues its development of a new type of electronic duplicating device. The diagram below shows the transition from the original document to be duplicated to the completed copies. One distinct advantage of the device is that it can, without any extra equipment, directly duplicate line drawings. It also eliminates the need for duplicating stencils and the labor involved in preparing them.

Cut Down on Soldering

The photo below shows a new system of breadboarding by Van-Dee which eliminates soldering of connections. Since circuits may be assembled without solder, clips, screw connections or specialized accessories, a number of developmental circuits can be checked in the time it would ordinarily take to assemble one circuit. The circuit board contains cells or "pockets" of conductive material, which automatically connect components inserted into them. Components may be replaced without damaging leads or loosening contacts. The grid lines do not enter the circuitry, but simply serve to locate the cells.

Boy-Power Robot

A six-foot robot capable of "seeing" an object and "sensing" the presence of a human was built by 13-year-old Donald Rich of Queens, New York. He gave "Robetron" the ability to move its arms, pick up objects magnetically, or manually, make decisions by use of a computer, roll forward or backward or turn in any direction by means of motorpower wheels. Some parts for the project were donated by Westinghouse Electric Corporation. A photocell is used for "seeing," a capacity-operated relay for "sensing," and a microphone in the nose is the communications system. The computer, which adds, subtracts, multiplies and divides, fits the robot like a vest. In the photo above, Donald is about to fit the computer on his friend, who seems a likeable, patient sort of fellow for a robot.

Servicemen's Awards

General Electric has instituted "All-American Awards" to honor the 11 television servicemen who have performed the most outstanding community service. Each will get a $500 check for his favorite charity or public service, plus a trophy.
I've begun to wonder where electron physics is going. There are so many different synchrotrons, betatrons, cosmotrons, etc., that the list seems endless. What are they all about and how do they work?

We'll begin with the cyclotron, not because it was the first atom-smasher but because it was the grand-daddy of all the modern particle "whirlers." The idea was to impart a very high velocity to an ion—to supply it with oodles of kinetic energy. Then it could be electrically directed to wallop an atom and blow it apart. Heavy positive particles like protons, deuterons (double protons), and alpha particles (two protons plus two neutrons) were selected as projectiles because their large masses help provide large impact energies.

The Cyclotron. Dr. E. O. Lawrence and Dr. M. S. Livingstone built the first cyclotron (Fig. 1) in 1931. Picture a flat circular pill-box cut vertically down the middle—separated into two "D"-shaped halves. The hollow half-boxes or dees are connected across a source of high-frequency voltage and enclosed in a gas-filled chamber. The whole assembly is then mounted between the poles of a powerful magnet. An electrically heated filament in the position shown provides an abundance of electrons which serve to ionize the gas in the chamber.

Suppose that at a given instant A1 is made positive with respect to A2 by the high-frequency voltage; a positive ion from the source F will be attracted toward A2, but instead of moving directly toward A2, it will move in a circular path due to the action of the uniform magnetic field pro-
duced by the pole pieces. As it reaches the gap between the two dees, it is accelerated by the strong electric field at this point and proceeds into the opposite box with increased velocity.

If you whirl a stone attached to the end of an elastic band around your head, the stone will gyrate in ever-widening circles as you make it go faster and faster. So it is with the speeding particle; each time it crosses the gap, it is given another violent kick which causes it to spiral outward with more and more speed until at last it emerges from the “window” endowed with tremendous kinetic energy. Its target may be a cloud chamber or a photographic emulsion in which the effect of its atom-disruption may be observed and measured.

The first cyclotron accelerated protons to a little over 1 million electron-volts (1 m.e.v.) of energy. (An electron-volt is the kinetic energy acquired by any particle carrying one unit of electric charge when it has been accelerated through one volt of potential.) As larger cyclotrons were built, the available particle energy rose steadily until, in 1946, the cyclotron peak of 40 m.e.v. for alpha particles was obtained.

The limit was achieved at 40 m.e.v. because one of the famous scientific principles finally proved by Dr. Albert Einstein began to push its insistent proboscis into the picture: as any body moves at increasing speed, its mass also increases. Up to about 40 m.e.v., this increase in mass is very slight and does not affect the cyclotron’s operation; beyond this energy value, however, the ions begin to gain mass. This slows them down enough so that their spiral paths fall out of synchronization with the high-frequency voltage on the dees and they no longer receive their accelerating shoves at the right instant.

**Synchrocyclotron.** To compensate for the increasing mass of the whirling protons or alpha particles, the frequency of the accelerator voltage can slowly be changed so that it keeps step with the diminishing speed increment of the ions. In 1950, the huge Columbia University synchrocyclotron went into operation using this synchronization principle. The most significant departure in construction from prior cyclotrons was the use of a single rather than a double dee.

In the synchrocyclotron, a grounded deflecting electrode of simpler construction serves as the second side of the applied high-frequency voltage. Recent reports in-

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**Fig. 3.** The betatron. Note how the pole pieces go into the center of a vacuum “doughnut.”

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**Columbia University’s huge synchrocyclotron produces alpha particle energies of over 400 million electron volts.**
MAGNETS (PLATES ABOUT 9FT. IN DIAMETER ARRANGED SIDE BY SIDE AROUND QUADRANTS)

A—PROTONS INJECTED HERE
B—DEFLECTOR FOR REMOVING ACCELERATED PROTONS
C—CAVITY RESONATOR

Fig. 4. Plan view of the Berkeley bevatron. Brookhaven's cosmotron follows a similar pattern.

Fig. 4. Plan view of the Berkeley bevatron. Brookhaven's cosmotron follows a similar pattern.

dicate that the Columbia synchrocyclotron produces alpha particle energies in excess of 400 m.e.v. An ion having this energy travels at approximately 93,000 miles per second or at a speed high enough to carry it to the sun in about 10 seconds flat!

Thus far, no mention has been made of electrons, since the cyclotron and synchrocyclotron are positive-charge accelerators. Why can't they be used for accelerating electrons? If we remember that an electron has a rest mass of about 1/1800th that of a proton, it is evident that we would have to speed it up far more than a proton to obtain the same kinetic energy from it. (Kinetic energy depends upon both mass and velocity. If we want a large k.e. in a body of small mass, the velocity must be made very much greater.)

To get an electron up to an energy level of only 1 m.e.v., we must make it travel at a speed more than nine-tenths that of light!

At this velocity, its mass increases 2.5 times over its rest mass, and even a modern synchrocyclotron cannot compensate for such a large increase. Hence, it became apparent that another type of machine was required.

The Betatron. The first successful betatron—the "beta" prefix comes from beta rays which are streams of electrons—was designed and built by D. W. Kerst in the United States in 1940. Its operation is similar to that of an ordinary step-up transformer.

As illustrated in Fig. 3, the major features of the betatron include a large electromagnet whose pole pieces protrude into the center of an evacuated glass-tube "doughnut." Electrons are produced outside the betatron by thermionic methods and are given a preliminary acceleration by an external electric field of about 50,000 volts potential. They are then fed or injected into the doughnut. The current through the electromagnet coils is alternating so that the magnetic field is a varying one; the injection process occurs at the precise time when the magnetic field is building up in the right direction. The effect of the field is to induce a voltage within the

(Continued on page 133)
Parasitic Transistor Power Supply Replaces Batteries

In mixed electronic equipment, employing both transistors and vacuum tubes, batteries are often installed when they are not needed. In many instances, the transistors can be "parasited" onto existing potential sources, eliminating the need for batteries and the ever-present threat of their going dead at inopportune times.

A convenient source of low voltage at low current is the cathode resistor of a power amplifier tube, such as the 6AQ5. The conventional cathode circuit of this tube is shown in (A) of the circuit diagram. Any voltage lower than the maximum can be tapped off by means of a voltage divider. The method of obtaining approximately 6.5 volts, d.c., at low current (a couple of milliamperes) is shown in (B).

If a very accurate voltage is required, this can be obtained by using a potentiometer, as in (C). The capacitor filters out small a.f. variations that may be present. Even better filtering can be produced if a series resistor is inserted between the potentiometer arm and the filter capacitor.

Use of a parasitic voltage supply for transistors not only eliminates the need for batteries but also makes power switching a single operation, as the transistor power is automatically turned on when the main power is on, and turned off when the vacuum-tube circuit is de-energized.

—Ronald L. Ives

CROSSWORD PUZZLE

By Arthur L. Branch

ACROSS
1 Impedance unit.
3 Snake.
6 Electrical conductor.
8 Conductance unit.
9 Number represented by brown in the color code.
10 Places.
12 Type of oven.
13 Frequency modulation.
14 Type of current used in a transformer.
15 Belonging to it.
17 Chemical symbol for tin.
18 Frequency in audio output transformer.
19 What a diode does.
21 Power formula: d.c.
23 Current unit: Abbr.
24 To terminate.
25 Part of a tube.
26 Color that represents a multiplier of 100 in color code.
28 Man's nickname.
30 Vapor used in tubes.

DOWN
1 Unrefined metal.
2 That man.
3 To increase power.
4 Type of circuit connection.
5 Cooking utensil.
6 Part of a hi-fi system.
7 Within.
11 Chemical symbol for a photosensitive element.
12 Broadcast frequency: Abbr.
14 Insect.
16 Black eye.
17 Look for.
18 At a later date.
20 To give off electrons.
22 Useless current in a transformer.
25 Greek letter used as a mathematics constant.
26 Prefix denoting restoration to a previous state.
27 Rectified current.

(See page 121 for solution)

POPULAR ELECTRONICS
Among the Novice Hams

By HERB S. BRIER, W9EGQ

In October we discussed some of the fundamental properties of current, voltage, and resistance, and how the relationship between them is expressed concisely by Ohm's law: \( E = IR, \frac{E}{I} = R, \) \( E = I/R \). We also talked about the formulas for calculating the power in electrical circuits, \( P = EI \) and \( P = I^2 R \), and how to use them in answering simple questions involving Ohm's law and power calculation that may be found in the Novice examination. Now, we'll go over the information necessary to understand and answer questions that might appear in the General/Technician/Conditional exam.

In the General Class examination, there are usually a couple of questions based on the diagram in Fig. 1 (see page 87), such as: "What is the bias voltage on the tube?" And: "What is the resistance of \( R_2 \)?" It is important to read each question separately and then study the diagram to determine which of the data given is pertinent to that question. Once this is done, the problem is half solved.

Fred Beyer, KN9HFP, made 200 contacts in 35 states in five months as a Novice. His transmitter is a DX-20 feeding a dipole; his receiver is an NC-98.

Ken Grimm, KN5K8H, works 16-meter c.w. with a DX-100 transmitter cranked down to 75 watts at Baylor University Radio Club.

For example, there is nothing difficult about determining the resistance of \( R_2 \). From Ohm’s law, \( R = \frac{E}{I} \); therefore, you simply divide the voltage across \( R_2 \) by the current flowing through it. Both of these quantities are given. Remembering to change milliamperes to amperes, the solu-

WHAT IT'S ALL ABOUT

"Among the Novice Hams" is devoted to the beginning radio amateur. If you are familiar with amateur radio, it speaks for itself. If not, the following may help you understand what it is all about.

Amateur radio is a hobby in which a quarter million people throughout the world, from grade school boys and girls to men and women, operate their own officially licensed radio stations. They communicate with each other over distances ranging from a few miles to 12,000 miles.

The simplest amateur license to obtain is the Novice license. It is issued by the Federal Communications Commission, Washington, D.C., to any citizen who has not previously held an amateur license and who can send and receive the International Morse code at a speed of five words a minute—actually a very slow speed. In addition, it is necessary to pass a simple written examination on elementary amateur radio theory and regulations. The license is valid for one year, during which time the licensee must qualify for a permanent license or leave the air.

Full information on how to obtain the various classes of amateur licenses may be found in a packet of booklets called "Gateway To Amateur Radio." The booklets are available for $1.50, postpaid, from the American Radio Relay League, Inc., West Hartford, Conn., or from any of the amateur supply houses that advertise each month in POPULAR ELECTRONICS.

Read "Among The Novice Hams" for up-to-date news and discussions of interest to all beginning amateurs.

November, 1957
HELP US OBTAIN OUR HAM LICENSES

Prospective amateurs requesting help and encouragement in obtaining their licenses are invited to have their names listed. Write to H. B. Brier, WEQG, % POPULAR ELECTRONICS, 366 Madison Ave., New York 17, N. Y. Please print your name and address clearly. Names are grouped geographically by amateur call areas.

K1/W1 CALL AREA

Bob Koval (16), 11 Jackson St., Northampton, Mass. (Code, theory and selection of equipment)
Don Randall (14), 169 Beverly Rd., Wethersfield, Conn. Phone: JA 9-4398. (Code and theory)
Ronald Simonot, 19 Leavitt St., Skowhegan, Me. (Code and theory)
Roger Tomes, 16 Belden Ave., Norwalk, Conn. Phone: VO 6-3214. (General Class theory)
William A. Dodge, Jr., P.O. Box 723, N. Attleboro, Mass.

K2/W2 CALL AREA

John Perx, 34 Arthur St., Brentwood, L. I., N. Y. Phone: BR 3-9085. (Code, theory and selection of equipment)
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John Maliakish, 166 Washington St., Freeport, N. Y. (Code and theory)
John Firth (16), 25 N. Harrison Ave., Blackwood, N. J. Phone: CNal 7-1655. (Code and theory)
David Griffiths, 38 Lowell Ave., Summit, N. J. Phone: CR 3-2289. (Code and theory)
Alvin Wolf, 521 Fifth Ave., New York 17, N. Y.
Douglas Waterman, 81 Greenway East, New Hyde Park, N. Y. Phone: PI 6-7725. (Code and theory)
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Joseph Shapira, 67-22 214th St., Bayside 64, N. J. (Code and theory)
Alan Luger (15), 33 Park West, New Hyde Park, L. I., N. Y. Phone: Pionever 2-6457. (Code and theory)
George Freed (15), 43 Greenway, New Hyde Park, N. Y. Phone: PI 6-6389. (Code and theory)
Robert F. Welch, 115 Arbour Lane, Buffalo, N. Y. Phone: TD 8-3006
Stephen Lyons, 59 Schubert St., Binghamton, N. Y. Phone: Binghamton 7-4879.
Roy Williams, 33 Robertson Rd., West Orange, N. J. (Code and theory)
Stephen, Pincus, 2191 Creston Ave., Bronx 56, N. Y. (Code, theory and selection of equipment)

K3/W3 CALL AREA

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Thomas Shelton, M.D., 3814 Hayes St., N.E., Washington, D. C.
Charles Callan, 415 Center St., Washington Grove, Md. (Code and theory)
Charles M. Griffin, 520 W. Grove St., Clark's Summit, Pa. Phone: 6-6167. (Code, theory and regulations)

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Martin Alfonsi, Rt. 885, Box 308, Clairton, Pa. (Code and theory)

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Marshall DeBruhl, Jr., 3333 Murray St., Columbia, S. C. Phone: ALpine 3-0133. (Code and theory)
V. Miller, Jr. (16), Rt. #4, Lafayette, Tenn. (Code)
Mickey Jackson, 635 Maple St., Mount Airy, N. C. (Code and theory)
Conley Ingle, 124 Ashington St., Rockingham, N. C. (Code and theory)
Dale Cochran (13), 3301 Lyles St., Columbia, S. C. (Code and theory)
Kenneth L. Coomes, 1100 Helm St., Henderson, Ky. (Code, theory and selection of equipment)
Donald Graham, P.O. Box 273, Bedford, Va. Phone: 3393. (Code and theory)
Athel Matthew Ballowe, P.O. Box 92, Scottsville, Va.
Robert Pittman (13), 11361 S.W. 49th St., Miami 55, Fla. (General Class code and theory)

K5/W5 CALL AREA

Jim Landureth (14), 1124 Third Ave. N., Texas City, Tex. (Code and theory)
Howard Hammons, Box 141, Kilbourne, La. (Code, theory and selection of equipment)
Russ W. Copping, 6425 Calbert St., New Orleans, La. (Code, theory and selection of equipment)
Donald C. Castle, 137 Anderson, W. Helena, Ark. (Theory)
Bill Deland, 511 E. Center, Searcy, Ark. Phone: 894. (Code, theory and regulations)
Ronnie Womack, 519 Watson, Fort Worth, Tex. Phone: JE 5-7643. (Code, theory and selection of equipment)
Randolph Lemelle, Jr. (17), 216 S. Olive St., San Antonio 3, Tex. Phone: CA 3-5913. (Code and theory)
Roy Weinedel, P.O. Box 52, Columbia, Miss.

K6/W6 CALL AREA

Larry Goldsmith (10), 6628 Ben Ave., N. Hollywood, Calif. Phone: PO 1-4288. (Code, theory and selection of equipment)
Gary Andersen (15), 936 Anza Dr., Pedro Valley, Calif.
Marcella P. Pettis, 11415 S. Starlight Ave., Whittier, Calif. (Code and theory)
Eileen K. McBreen, 11429 S. Breckinridge Dr., Whittier, Calif. (Code and theory)
Michael Young, 1336 Hermosa Ave., Pedro Valley, Calif. (Code)

K7/W7 CALL AREA

Neal Precht, Box 1068, Milton-Freeewater, Oregon. (Code and theory)
Jim Kendrick (15), Qtrs. # 2505-F, Fort Lewis, Wash. (Code)

K8/W8 CALL AREA

Bob Epstein (11), 16039 Curtis Ave., Detroit 35, Mich. (General code and theory)
Dick Graham, Jr., 3118 Bannbridge Rd., Toledo 13, Ohio. Phone: LU 2-5174. (Code and theory)
Paul Wolfe, Rt. 87, Noveltv. Ohio. Phone: ED 8-6334. (Code)
Robert Lewis, 36200 W. 8 Mile, Farmington, Mich. Phone: QR 4-4030. (Code and theory)
Maurice H. Davidson, 23521 Stuart, Southfield (Royal Oak), Mich. (Code and theory)
Michael Coleman (13), 1069 W. Woodruff, Toledo 6, Ohio. Phone: CH 4-1131. (Code and theory)
Leon Carter (13), 645 Woodland, Toledo 2, Ohio. Phone: CH 6-4965. (Code and theory)
Larry Goelz, 536 Hedgewood Ave., Zanesville, Ohio. Phone: GL 3-2268 (Code and selection of equipment)
Carl D. Avers (15), 121 Orchard St., Keyser, W. Va. Phone: 2-8491. (Code)
Robert B. Strang (15), 310 Manistique Ave., Detroit 15, Mich.
Donald Reed (16), R.R. #7, Chillicothe 3, Ohio. Phone: MOhawk 3-2258. (Code, theory and selection of equipment)
Don Fisher, Rt. 1, Carroll, Ohio. (Theory)
Pat Rankin, 22099 Kramer, St. Clair Shores, Mich. (Code, theory, regulations and selection of equipment)
Ronald Kendall, 1940 Manhattan Ave., Youngstown 9, Ohio. Phone: SW 9-6131. (Code and theory)
G. Scott Henninger (14), 7817 Long Lane, Parma 30, Ohio. Phone: VI 3-7899. (General code and theory)
Frank Pierce (15), 4122 17th, Ecorse 29, Mich. (Code and theory)

K9/W9 CALL AREA
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Reginald J. Lunsford, Box 11, Milton, Ind.
Hank Wolfra (13), 5333 Park Ave., Indianapolis 20, Ind. Phone: CL 5-9630. (Code and theory)
Bill Riley, 812 N. Ninth St., Mattoon, Ill. (Code, theory and regulations)
Richard Harmon, 1009 Third Ave., Mendota, Ill.
Bruce Stufflebeam (14), Box 56, St. David, Ill. (Code and theory)
Robert Zwick, P.O. Box 321, Beloit, Wis. (Code and theory)
Robert Smith, 1206 Kansas, Peoria, Ill. Phone: 5-9982. (Code and theory)
Buddy Carter, Box 117, Kewanee, Ind. (Code, theory and selection of equipment)
Dave Bunte, 507 S. Williston, Wheaton, Ill. (Code and theory)
Joe Kovarak (15), 2131 W. 56th Place, Chicago 9, Ill. (Code and selection of equipment)

K9/W0 CALL AREA
Daniel S. Shaffer, Hawkeye, Iowa. (Code, theory and regulations)
John Davis, 503 W. Main, Washington, Iowa.
Dell Random, Oakdale, N. Dak. (Code and theory)
Kirk Fitzer, Rt. # 3, Estherville, Iowa. (Code and theory)
K. A. Posthumus, 529 Ply St. N.W., Le Mars, Iowa. (Code and theory)
Lawrence J. Coen, P.O. Box 9003, Kansas City 18, Mo. (Code and theory)
Tom Braunger, 3241 Virginia, Sioux City, Iowa. Phone: 7-1882. (Code, theory and selection of equipment)
Gene Consovo, 1517 S. Pinecrest, Wichita 18, Kans. (Code and theory)

VE CALL AREA
Gordon Burleson (14), 1344 Thurlow Rd., Victoria, B. C., Canada. (Code and theory)
Lyn Irwin, 9216 146th St., Edmonton, Alberta, Canada. (Code, theory and regulations)

To help prospective amateurs obtain their Novice licenses, the Radio-Electronics-Television Manufacturers Association offers a set of code records (recorded at a speed of 33 1/3 rpm) and a Novice Theory Course for $10.00 postpaid. The complete course or more information on it is available from RETMA, 1721 DeSales St., N. W., Washington 6, D. C.

November, 1957

Fig. 1. This diagram, with different component values, is the basis for several questions on Ohm's law which appear in the General Class Amateur exam.

- Voltage: 250V
- Current: 200mA
- Resistance R1: 250/0.005 = 50,000 ohms

The bias voltage on a tube is the fixed voltage applied to its control grid with reference to its cathode. In this circuit, the voltage across the cathode resistor R1 establishes the bias voltage. The problem, therefore, is to determine what this voltage is. From Ohm's law, $E = IR1$. R1 is given as 200 ohms. I is the 20-ma. plate current of the tube, which flows from the negative battery terminal, through R1, through the tube, and back to the positive battery terminal through the milliammeter. Thus, $E = IR1 = 0.02 \times 200 = 4$ volts. The bias voltage is 4 volts.

Resistances in Series. Figure 2(A) shows three resistances connected in series. From it, it is obvious that for an electric current to travel from one end of the string

(Continued on page 128)

Fig. 2. How resistances connected in series (A) can be used as a voltage divider (B) to deliver several voltages from a single power supply (see text).
IRON HAS SOLDER RESERVOIR

A small shallow hole drilled in one face of the tip of your soldering iron makes a handy "reservoir" to hold a drop or two of solder. When you work in hard-to-get-at places, the solder will flow from the reservoir onto the part being soldered. It's also handy for tinning tips of wires. — J. A. C.

PHOTOELECTRIC STANDARD

You can calibrate your photoelectric devices using an ordinary frosted 40-watt light bulb. At 25 inches, the direct light of a new 40-watt bulb is 10 footcandles. The error due to line voltage will not exceed 10%. Be sure that the only light reaching the photoelectric cell is from the lamp—for accurate calibration. — J. M.

SMALL SPAGHETTI TUBING

You can use the plastic insulation of bell wire and solid hookup wire as small-diameter spaghetti tubing. It's fine for insulating wire leads on transistors, germanium diodes, and other components with thin connecting leads. — A. T.

DON'T FLIP YOUR LID!

Ever have somebody sit on the lid of your recorder while it's open but still on the machine? Hinges aren't made strong enough to take that kind of treatment. Try running a short length of sash-weight chain from the recorder case up to the lid, and fasten it at both ends with small screw eyes. Leave one screw open so that chain will unhook for cover removal. — R. A.

TUBE TESTER "LINE ADJUST"

Since line voltages vary widely in many parts of the United States, you may have difficulty setting the "line adjust" on your tube tester low enough. If you're troubled with high line voltage, try adding another line adjust control as shown. — E. H. J.

HOLDER FOR CELLULOSE TAPE

Cellulose tape will always be at hand if you use one of the lid-shaped spool ends as a bracket. Nail it to a convenient location, such as the edge of a shelf. The spool of tape can then be slipped on and off the bracket quite easily. — K. M.
New! A MACHINE THAT COMPOSES MUSIC

BUILD IT YOURSELF in a few hours!

Yes, you build any one of 33 exciting electric brain machines in just a few hours by following the clear-cut, step-by-step directions given in a thrilling booklet! No soldering required . . . no wiring beyond your skill! GENIAC is a genuine brain machine—not a toy. The only logic machine kit that not only adds, subtracts, etc., but presents the basic ideas of cybernetics, Boolean algebra, symbolic logic, automation, etc. So simple to construct that even a twelve-year-old can make a machine that will fascinate people with advanced scientific training! With the special circuitry of GENIAC, the Electric Brain Construction kit, you can compose tunes automatically. These new circuits were never available before!

OVER 400 COMPONENTS AND PARTS. Circuits operate on one flashlight battery, and the use of ingeniously designed parts makes building circuits one of the most fascinating things you've ever done! You set up problems in a variety of fields—and get your answers quicker than you can set them up! Play games with the machine—nim, tic-tac-toe, etc.—and pit your brain against its logic! Solve puzzles in a few seconds that would take you hours without the aid of the machine. You actually see how computing and problem-solving is analyzed with algebraic solutions transferred directly into circuit diagrams.

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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, 3/4" thick, and measures 11½" H x 23" W x 11¾" D. Freestanding and predrilled for quick assembly.

Shpg. Wt. 30 Lbs.

Model S5-1

$39.95

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 17⅛" D, and is constructed of 3/4" veneer-surfaced plywood.

Shpg. Wt. 80 lbs.

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$99.95

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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.

Shpg. Wt. 23 lbs.

Model A-9C

$35.50

HEATHKIT HIGH FIDELITY FM TUNER KIT

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!

Shpg. Wt. 8 lbs.

Model FM-3A

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(with cabinet)

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.

Shpg. Wt. 8 lbs.

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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.

Shpg. Wt. 7 lbs.

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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.

Shpg. Wt. 31 lbs.

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NEW

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.

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 6" H x 3½" 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 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.

HEATHKIT ENLARGER TIMER KIT
The dial of this handy timer covers 0 to one minute calibrated in five-second graduations, 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.

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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. $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-OHM 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 1 1/2" W x 3 1/4" H x 5 3/8" 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

NEW! Heathkits for the boating enthusiast

November, 1957
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.

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

HEATHKIT GRID DIP METER KIT
An instrument of many uses for the ham, experimenter, or service technician. Useful in locating parasites, 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.

Shpg. Wt. 4 lbs.
Model GD-18 $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, or modulated at 400 CPS, or audio at 400 CPS. Prealigned coils eliminate the need for calibration after completion.

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

Shpg. Wt. 3 lbs.
Model M-1 $14.95

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 rejection. Amateur bands clearly marked on the illuminated dial scale. Employ 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.

Shpg. Wt. 12 lbs.
Model AR-3 $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

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"TV CONSULTANT" written and published by Harry G. Cisin, Amagansett, N.Y. 69 pages. Soft cover. $2.00.

This book is an enlarged second edition and contains over three hundred classified TV troubles and solutions. In addition, streamlined alignment methods are included which permit TV sets to be aligned in the shortest possible time using a sweep generator and an oscilloscope.

Recommended: to the serviceman or part-time trouble-shooter for whom "time is money."


Each tube in a TV set has a certain job to do, and when the tube becomes faulty, the particular job remains undone. This recently published volume contains tube trouble location guides covering thousands of recent TV models from 1955 up to and including the newest 1957 sets. Each guide gives the location and type designation of every tube in the TV receiver, plus an explanation of each tube function. This volume is ideal for trouble-shooting from symptoms alone.

TV Trouble Tracer, (Vol. 6, 45 pages, soft cover, 50 cents), the sixth volume of the TV Trouble Tracer series is also available. It specializes in the new portable TV models and does the same job for them that Vol. 2 does for standard receivers.

Recommended: for fast trouble-shooting on current models.

"BASIC MATHEMATICS FOR RADIO AND ELECTRONICS" by F. M. Colebrook and J. W. Head. Published by Philosophical Library Inc., 15 East 40 St., New York 16, N.Y. 359 pages. Hard cover. $6.00.

Previously published under the title Basic Mathematics for Radio Students, the new edition is wider in scope and includes much new material. Written in an easy "talky" style, starting with elementary algebra, the reader is led step by step through indices and logarithms, series, limits, geometry, trigonometry, vectors and

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When you build your High Fidelity sound system, use THE VERY BEST LOUDSPEAKERS YOU CAN GET

You are planning to build, or improve, your high fidelity sound system. Unstintingly, you will pour out your enthusiasm, time, and energy to get the finest music reproduction you can bring into your home. Get a loudspeaker that will do full credit to your handiwork... Install a JBL Signature Extended Range Loudspeaker, or two-way speaker system, in your enclosure.

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MODEL D123-12" extended range loudspeaker With outstanding "presence" and clean response throughout the entire audio spectrum, the D123 features an unusual shallow construction. Only 2½" deep, it is designed to mount flush with the wall, between studs, in any standard wall or partition. Frequently the D123 is used in multiples in "infinite baffle" wall installations. In this case the JBL Signature D75 is a logical high frequency unit to add when you advance to a two-way system.

MODEL 1720LH high frequency assembly The acoustical lens is only available on JBL Signature high frequency units. The 14 element lens on the 1720LH disperses sound within the listening area over a 90° solid angle, smoothly, with equal intensity regardless of frequency. The acoustical lens is the greatest contribution to lifetime high frequency reproduction in 20 years, and it was developed for use with high fidelity equipment by James B. Lansing Sound, Inc. In addition to the lens, the 1720LH consists of a high precision driver with complex plussing plug and a machined aluminum exponential horn. Designed for crossover at 1200 cycles with the JBL Signature N1200 Network.

MODEL 086 Kit This two-way system is made up of units which have been acclaimed by impartial authorities as the finest available anywhere today. Included in the kit are the 1504C Low Frequency Driver, N500 Network, 375 High Frequency Driver, 537-90 Horn-Lens Assembly. These are the same units — which are used in The Hartfield units designed originally for installation in the most modern theaters in the world.

MODEL D086-8" extended range loudspeaker A precision transducer in every sense of the word, the famed JBL Signature 8" D086 is made with the same care and precision as the larger units in the James B. Lansing Sound, Inc., line. If space and cost are major considerations, the D086, properly encased, provides the most satisfyingly satisfactory sound you can get. It is widely used in top quality systems where extension speakers are desired for areas other than the main listening room.

JBL Signature two-way systems are available as kits

002 Kit Including some of the newest drivers made, the JBL Signature 002 Kit includes a D123 for low frequency reproduction, N2500 Network, 075 High Frequency Unit. The 002 Kit is moderately priced, yet gives the user all the advantages of a two-way system made with independent drivers.

001 Kit Probably the most popular high quality two-way system on the market, the JBL Signature 001 system consists of a 1200 Low Frequency Driver, N3020 Network, 1750LH High Frequency Assembly. The D123 may be substituted for the 130A without disturbing the balance or coverage of the system.

000 Kit Probably the most popular high quality twoway system on the market, the JBL Signature 000 system consists of a 1200 Low Frequency Driver, N3020 Network, 1750LH High Frequency Assembly. The D123 may be substituted for the 130A without disturbing the balance or coverage of the system.

There are many more kits and loudspeakers in the JBL Signature line. Whatever your needs, you will find exactly the right unit or system in the complete JBL Signature catalog. Send for your free copy. A limited number of technical bulletins are also available. Please ask only for those in which you are vitally interested.

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November, 1957

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into calculus. In chapter 7, "The Application of Mathematical Ideas to Radio," we come to the electronic application section where all our previous math study pays off.

**Recommended:** to those wanting to delve deeper into the mathematics of this fascinating field of electronics.

"ALL ABOUT FM ANTENNAE AND THEIR INSTALLATION" by L. F. B. Carini. Published by Apparatus Development Co., Inc., Wethersfield 9, Conn. 16 pages plus 8-page directory of FM stations. Soft cover. 25 cents.

This little, non-technical book was prepared especially for the FM listener. Aimed at providing a better understanding of the practices and problems of FM antenna installation, the topics covered include preamplifiers, FM-DX, impedance matching and antenna rotors. As an extra bonus, a list of commercial FM stations is included. This is a fine buy at its modest price.

**Recommended:** to the hi-fi'er with reception problems and to those who just want to know more about FM.

"AUDIO AMPLIFIERS AND ASSOCIATED EQUIPMENT" compiled and published by Howard W. Sams & Co., Inc., Indianapolis 5, Ind. 226 pages. Soft cover. $3.95.

Covering the 1956 models of preamplifiers, amplifiers, and AM-FM tuners, this new volume is the ninth of the specialized Howard W. Sams high-fidelity servicing manuals. The material is presented in a uniform manner and is based on the Sams company's own analysis of the equipment.

All information found necessary for servicing, including listings of recommended standard replacement components, is presented in an easy-to-use tabulated form. Also included in this volume is a cumulative index to all equipment listed in Sams' previous specialized hi-fi manuals.

**Recommended:** to anyone interested in the circuitry and servicing of the latest in high-fidelity audio equipment.

"TV ANTENNAS" by M. Schwartz. Published by American Electronics, 1230 Bryant Ave., New York. 28 pages. Soft cover. 50 cents.

Discussing TV antenna installation and repair, this non-theoretical volume is written for the do-it-yourselfer. The various types of antennas available are listed and discussed.

**Recommended:** to anyone considering a climb over the rooftops with his conical, folded dipole or stacked Yagi antenna in hand.

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Build Your Own Crossover

(Continued from page 66)

metallic material for the flanges. Attach them with brass screws, as steel might cause waveform distortion.

Drill a hole through one of the flanges, insert the wire, and start winding. When you have sufficient turns, drill another hole and bring the wire out. Use #18 enameled wire, and no insulation will be needed. Mount the coil on a piece of wood and hook it to terminal lugs. Then mount your capacitors, brilliance and presence controls, and you're in business.

Despite the warnings against using electrolytic capacitors, you can do so if you hook them back-to-back to make them non-polarized. You can splice negative to negative or positive to positive, then wire them as a single capacitor. When they're hooked this way, however, in order to get the single value you need, you'll have to use two capacitors, each of which has twice the value desired. For instance, if you want 8-µfd capacitance, use two 16-µfd units. Choose capacitors of a high enough voltage so that they will handle the peak output voltage of your amplifier. About 150 volts will do nicely.

For the control of presence and bril-
liance, you must then insert potentiometers. (The pictorial on page 66 shows the brilliance control placement, the schematic proper hookup.) The potentiometers should be at least five times the load impedance. With a 16-ohm speaker, you should use about 100-ohm potentiometers.

**Math Simplified.** Now you come to the problem of calculating values. This is simplified by the use of the table and the graph on page 66.

After you've determined your crossover point or points, follow the table for the correct values of capacitance (C) and inductance (L) for your speaker or speakers. The table gives values for 4-, 8- and 16-ohm speakers. C is read directly in microfarads, which gives the proper capacitance value; but since L is in millhenries, you must then determine the number of turns for your coil. You can do this by running a line on the graph from the L value up to the heavy black diagonal, then from that point across to the left edge, which will give you the number of turns.

Here are two examples, one for two speakers, the other for three.

Choosing 1000 as the cutoff point for the two-speaker system (16-ohm speakers), we find that the C value is 10 μfd, and the L value is 2.5 μh. Therefore the capacitor value is 10 μfd. But we still need the number of turns for our coil. Going to the graph, we find that we get a value of 400 turns (approximately).

For a three-speaker system (16 ohms each), with arbitrary cutoffs of 500 and 5000 cps, we find values of 20 μfd and 500 turns at the lower cutoff, and 2.2 μfd and 225 turns at the higher cutoff.

**Final Adjustment.** You'll have to phase your speakers before hooking them to the crossover. Do this by connecting a flashlight cell across the voice coil of one speaker, noting the direction the cone travels on the instant of contact, and marking the terminal to which the positive line was attached. Then follow the same procedure with the other speaker. In connecting the speakers to the crossover, make certain that these common terminals are hooked to the same line. (On horn tweeters, you'll have to check terminal coding for the proper terminal to use.)

After you've built and hooked up your system, you'll want to adjust for what you consider the best presence and brilliance values. These, of course, are arbitrary, and will depend only on how you like your hi-fi. Go ahead and play with them, and have fun.

—W. McCormick

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November, 1957

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November, 1957

107
LAFAYETTE'S Exclusive High-Fidelity Values

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- 25 WATT WOOFER
- CROSSOVER NETWORK
- IMPORTED HI-FI TWEETER
- LEVEL-BRILLIANCE CONTROL

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MSG-10 — Signal Generator..................22.50
You’ll enjoy... THE CHALLENGING NEW THEME OF THIS YEAR’S PHOTOGRAPHY ANNUAL!

Curing Auto Radio Noises
(Continued from page 69)

noisy, replacement will usually correct the trouble.

You might also check your vibrator and buffer capacitor. The buffer is wired across the secondary of the high-voltage winding, and usually has a 1600-volt rating. The vibrator points may be pitted and replacement may be necessary. (It’s good practice, whenever a vibrator is replaced, to change the buffer capacitor also.)

If, when “revving” up your motor in the generator noise check, you find that not only does the noise level increase, but your radio plays louder, check your rectifier tube (usually a 6X5 or 024).

A word of advice—when trouble-shooting radio interference, it’s best to be methodical. Eliminating possibilities one at a time is generally the fastest way to isolate the trouble.

........................................

Voices of the World
(Continued from page 46)

which you can tune in on your short-wave receiver.

Europe—Radio Sweden has three 30-minute transmissions beamed to North America over one of their powerful 100-kw. transmitters. These programs of news and weather, press comments and features, mirror daily life and developments in Sweden and acquainted listeners with Scandinavian music. Radio Sweden is always glad to hear from those who have heard the broadcast. They have an attractive QSL to send you for a correct reception report, and a colorful schedule pamphlet.

World’s Fair Radio (WFR), in conjunction with the 1958 Fair at Brussels, Belgium, can be heard nightly except Wednesday and has a nice variety of lively programs. They are on the order of those that made OTC, Leopoldville, Belgian Congo, famous several years ago. WFR has a special QSL card and wants reports. If you expect to be in Europe in 1958, plan to go to the Brussels World’s Fair.

Asia and Africa—Radio Japan now has two transmissions to North America. Varied and interesting programs such as “Glimpses of Japan,” “Tokyo Jockey,” “Japanese Classic Music Appreciation,” the “Japan Guidebook,” and “Singing Voices of Japan” can be heard when you tune to Radio Japan. This station also sends out several profusely illustrated publications and QSL cards of outstanding beauty. Radio Japan endeavors to make friends with as many listeners as possible and to acquaint

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Some Standard Brands—Others with Famous Video Tubes

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them with life in Japan. (While in the Navy in 1954, I had the opportunity to visit Radio Japan and spent a pleasant afternoon touring the six floors of the NHK Building. I was in the studio when the North American transmission was on the air.) Try to tune in Radio Japan and write them about your reception. You'll find it well worth your while.

Radio Station ELWA at Monrovia, Liberia, broadcasts primarily for listeners in Africa. This year they have inaugurated a special service to North America which can be heard twice on Tuesdays. At 6:30 and 8:15 p.m. EST (3:30 and 5:15 p.m. PST), you can "Meet The Staff" and hear of the different work each of the missionaries is doing. The happenings of the week are given on ELWA Time, for those who are interested in the operation of a missionary short-wave station (7:20 and 9:05 p.m. EST, 4:20 and 6:05 p.m. PST).

The South African Broadcasting Corporation is heard three mornings a week in the 11-meter band with an interesting variety of programs in the African Service. On the other days the programs are in Afrikaans.

Latin America—There are a few stations with programs in English in South and Central America. But very few of these stations are beamed to North America and thus reception is not always good. HCJB (The Voice of the Andes) Quito, Ecuador, is the strongest station with English in South America.

Radio Commerce, at Port-au-Prince, Haiti, has a program called "Glimpses of Haiti," which presents four different looks into various aspects of Haitian life each week. These are heard Sundays at 5:00 p.m. EST, and Tuesdays, Thursdays, and Fridays at 9:00 p.m. EST (6:00 p.m. PST).

The Evangelistic Voice of the West Indies presents English programs daily except Thursdays. Your author is on the staff of this station and answers the mail from SWL's on the "Listeners' Post" every Saturday at 5:00 and 9:30 a.m. EST (2:00 and 6:30 a.m. PST) and every Monday at 9:30 p.m. EST (6:30 p.m. PST).

North America—Canada has a program of news and features for listeners in the United States beginning at 7:55 p.m. EST, 4:55 p.m. PST. Later in the evening, The Northwest Territories Service is beamed to listeners in Northern Canada from 9:55 p.m. EST, 6:55 p.m. PST. This program is extended during the winter to include the "Northern Messenger," in which greetings are broadcast to the listeners in the north.

There are several low-powered short-wave stations in Canada which operate in parallel with the regular medium-wave
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stations. These are well heard in parts of the United States and Canada within 600 miles or so of their location. Some of them are: CBNX, St. Johns, Newfoundland, on 5970 kc.; CJX, Sydney, Nova Scotia, on 6010 kc.; CFY, Calgary, Alberta, on 6030 kc.; CFRX, Toronto, Ontario, on 6070 kc.; CKFX, Vancouver, British Columbia, on 6080 kc.; CHNX, Halifax, Nova Scotia, on 6130 kc.; CEUX, Vancouver, British Columbia, on 6160 kc.; and VE9AI, Edmonton, Alberta, on 9540 kc. For more distant listeners, reception may be good at times, but is not regular due to the low power of the stations.

In the United States, there are four organizations broadcasting on the short waves: The Voice of America, The United Nations, The Armed Forces Radio and Television Service, and The World Wide Broadcasting System (WRUL). Since most of our readers want to listen to short-wave stations in other countries, we will not include detailed information on these stations here.

With a short-wave receiver, the correct time can be obtained by tuning in either WWV of the National Bureau of Standards located near Washington, D. C., or CHU of the Dominion Observatory at Ottawa, Canada. WWV gives a voice announcement of the time in Eastern Standard Time every five minutes over 2500 kc., 5000 kc., 10,000 kc., 15,000 kc., and 20,000 kc. CHU has a voice announcement each minute in Eastern Standard Time on 3330 kc., 7335 kc., and 14,670 kc. Both of these stations operate 24 hours a day.

HELPFUL PUBLICATIONS FOR SWL'S

The World Radio Handbook is now considered a "must" by most short-wave listeners. It is published annually and contains a wealth of information on stations around the world. The 1958 edition is expected to be obtainable from Gilfer Associates, Box 239, Grand Central Station, New York 17, N. Y., on the first of January. The price is $2.00 plus postage and it is well worth it. World Radio Handbook also publishes a bulletin every two weeks and a booklet called "How to Listen to the World." In May/June, 1958, a small summer-supplement to the Handbook is to be published.

There also are several clubs which publish excellent bulletins to keep you informed of the latest short-wave information. Write to these clubs for further information, if you would like to become a member and receive their bulletins. The Newark News Radio Club, 215 Market St., Newark 1, N. J., covers every type of radio and television DX-listening in a monthly
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And don't forget the Short-Wave Report, which appears regularly in Popular Electronics with the latest news on the short-wave broadcasting bands. Read it each month . . . and "Listen to the Voices of the World."

They're Putting TV on Tape
(Continued from page 50)

up tiny particles of the coating. When this happens, the particles get between the tape and the head and drop-out occurs. The head is therefore ground and polished—the term is "lapped in"—before use.

In the Ampex video recorder, four heads are used, mounted on the outside of a wheel and projecting like the teeth of a rotary saw. The wheel rotates at a speed of 14,400 rpm, pressing against the tape in a crosswise manner and recording in a crosswise pattern to give the tremendous footage of tape that will take the wide video signal. The tape is pressed against the heads with a pressure of 20,000 pounds per square inch. This creates such friction that previously it softened the binder that held the oxide on the tape. Better binders have now been developed by Minnesota Mining and Manufacturing.

New Oxide Pattern. Another major change forced on the tape manufacturer was a special cross-orientation of the magnetic oxide particles. The particles are rod-shaped, and on ordinary tapes they run the long way. This results in improved magnetic characteristics. However, since the video recorder records crosswise on the tape, it was necessary to swing the particles 90° to bring them approximately parallel to the sweep the head makes across the tape.

The networks don't believe that the video tape recorder will completely supplant the use of film. The cost of the recorder is one major drawback; smaller stations just won't be able to afford it unless the price is reduced drastically. Despite all such problems, however, you can be sure that more and more programs will appear on tape, which may end viewer complaints on the quality of the picture, if not the quality of the program.

November, 1957
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Speaking of Extra Speakers

(Continued from page 62)

too, in different rooms, different levels of sound may be required.

It's a good idea to equip each speaker with a level control, located right at the speaker in question. These "pads" are available commercially either from Labtronics Corporation or P. R. Mallory Corporation. Be sure to specify 4·8- or 16-ohm types, depending upon the impedance of the speaker you wish to control.

Switching Choice. The biggest pitfall of all multiple speaker installations is found right at this point. Don't fall into it! A 16-ohm speaker belongs across the 16-ohm terminals of your amplifier. If the amplifier is to perform correctly, provide the most usable, undistorted power, proper damping, proper feedback and other criteria essential to hi-fi, there must be a correct impedance match between amplifier and speaker.

Yet, many multiple speaker fans think nothing of slapping a second or even a third 16-ohm speaker across the same terminals of the "amp" when they wish to have all three playing at the same time in different rooms. Two 16-ohm speakers in parallel look like an 8-ohm impedance to the amplifier (just as two 16-ohm resistors in parallel add up to 8 ohms). With only two speakers connected this way, a 2-to-1 mismatch exists between amplifier and speaker systems. Distortion occurs at much lower power levels and considerable power is wasted.

Okay, you say, hook the pair of speakers across the 8-ohm terminals of the amplifier and everything will be fine. It will, so long as you listen to both at once. But if you open one up in the course of your switching hookup, you'll now have a 16-ohm impedance across the 8 ohms, still a mismatch of 2 to 1. Figure 1 shows a typically incorrect switching arrangement.

Mixing Speakers. There is a way of switching two and even three speakers of different impedances in and out of a system and maintaining virtually perfect impedance match at all times. After all, your amplifier has several output impedance taps, and there's no reason why you can't use more than one in your proposed switching setup.

As one of the common "mixed setups" probably consists of one 16-ohm main speaker and one 8-ohm secondary system, let's consider this hookup first (Fig. 2). You'll notice that when speaker B is used, it's connected across the 8-ohm taps on the amplifier. When speaker A is used, it's connected across the 16-ohm terminals. And, finally, when both are in use, each is

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<tr>
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<tr>
<td>David Seigler, 216 Dowling, Waverlyboro, S. C.</td>
<td>1st 12</td>
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<tr>
<td>W.D. Mains, 333 S. Paramount, Rivera, Calif.</td>
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<tr>
<td>Paul Schuetz, 124 20th Ave., Longview, Wash.</td>
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<tr>
<td>Robert Todd, 216 West End Ave., Cambridge, Md.</td>
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<tr>
<td>Dan Breese, Station KOVE, Lander, Wyo.</td>
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<td>Joe C. Davis, Station WABO, Waynesboro, Miss.</td>
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<tr>
<td>Paul Chuckray, 7354 Weber Rd., Altion, Mo.</td>
<td>1st 12</td>
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<tr>
<td>W. Reynolds, 730 Washington Blvd., Venice Calif.</td>
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connected to its proper impedance. While it is true that the presence of a speaker across part of the output transformer secondary winding alters the total impedance of the winding slightly, the effect is much more negligible than would be the case when just paralleling the two speakers.

Figure 3 gives a correct hookup for two speakers having equal impedances of 16 ohms. It is similar to Fig. 1 in that each individual speaker, when used alone, is hooked up to the 16-ohm terminals of the amplifier. But in the third position of the switch, both speakers are hooked up in parallel and at the same time flipped over to the 8-ohm terminals of the amplifier, maintaining a perfect impedance match for every setting of the switch.

**Shall We Try For Three?** Having gone this far, we decided to do something about our own "spider web." You see, our hi-fi can be piped to any of three locations: the living room system (8-ohm impedance), the basement (16-ohm coax job) and the upstairs bedroom (8-ohm wall baffle system). Previous to this effort, our control panel resembled something out of a science-fiction rocket dispatching center, with knife-switches mounted in liberal profusion.

We decided right off that four switch settings (A, B, C and ABC) wouldn't do because there'd always be the friends in the living room and basement den, eager to partake of much fidelity, plus some "spoil-sport" in the upstairs bedroom trying to grab forty winks. A good switching system involving three speakers should, therefore, work as follows: A, B, C, AB, AC, BC, and ABC, or a total of seven positions.

The circuits of Figs. 5, 6 and 7 all utilize a special switch (Mallory, part number 1231L, or the equivalent) which consists of three sections, adjustable from two to eleven positions. The plate shown in the photograph on page 60 is nothing more than a regular home switchplate, available in all hardware stores in a variety of finishes. Mounted in a wall or in your equipment cabinet, the over-all effect is one of simplicity and professional "customized" wiring. The small knob supplied with the Mallory switch, though adequate for its intended purpose, was discarded in favor of a larger knob which requires less twisting torque and covers the rectangular wall-switch-slot in the switchplate.

A suggested wiring layout is shown in the photo on page 61 which corresponds to the circuit of Fig. 5. Since there are many non-used switch lugs, however, you...
may find any number of ways of conveniently wiring up any one of the three circuits just by following the schematics themselves.

The most practical place for mounting your new switch is probably at or near the equipment, but there is no reason why it cannot be mounted anywhere you find it convenient.

Spreading Stations with CSSB

(Continued from page 52)

Although the FCC could not permit too many new stations to go on the air, since that would defeat CSSB’s purpose of wiping out interference, it would probably allow quite a few new ones.

**Finer Tuning.** For the listener, CSSB would mean that much finer tuning of a receiver is necessary. Right now you can pick up most stations 2 or 3 kc. away from the station’s authorized frequency. That is, if a station is broadcasting at 1500 kc., you can get a pretty fair signal anywhere from 1498 to 1502 kc.—although the optimum signal is still at 1500 kc.

A station broadcasting with CSSB would use either the lower or upper of the two sidebands available to it. It could use either the area from 1490 to 1500 kc. or from 1500 to 1510 kc.—depending on which sideband it picks. If it picks the upper—1500 to 1510 kc.—the listener would get optimum signal strength at about 1502 or 1503 kc., thus detuning slightly from the station’s authorized frequency. However, if you should stay at 1500 kc., you would still get as good a signal as if the station were transmitting a standard double-sideband signal.

November, 1957
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Their Master's Voice

(Continued from page 73)

Their Master's Voice

(Continued from page 73)

to reduce hum pickup or feedback squeals. However, with an understanding of the principles involved, the conversion becomes an interesting and challenging project.

Remote Speaker. The remote unit consists of an ordinary PM speaker housed in any manner which suits the situation. Since the switching during conversations is done at the master station, and since the sensitivity is excellent, the remote speaker can be inconspicuously mounted high on a wall or on the ceiling.

One of the remote speaker leads may be "hot" in an a.c./d.c. transformerless set. It is important, therefore, to use insulated wire to connect the remote speaker. Shielding should not be necessary. Usually an ordinary twisted pair, such as telephone wire, is satisfactory for this purpose.

Transistor Topics

(Continued from page 75)

You’ll find that the output signal is not a sine-wave. The approximate waveform across a resistive load is given in Fig. 2. If you prefer a sine-wave for your tests, connect an additional capacitor across the primary of the output transformer (C5). One other optional component may be used in the circuit—power supply bypass capacitor C6; where good quality batteries in good condition are used, this anti-blocking capacitor is not necessary.

Short-Wave Receiver. We’ve received many, many requests for circuit data on simple transistorized short-wave receivers. Actually, almost any of the simpler detector-amplifier receiver circuits featured in past columns may be used as short-wave receivers if their tuned circuits are modified to resonate to higher input frequencies. John Janning (W8QCN) has submitted a basic circuit of this general type (Fig. 3). With it, using only a four-foot external antenna, John indicates that he has received DX of 3000 to 4000 miles.

W8QCN’s circuit includes antenna tuning capacitor C1, input r.f. transformer L1-L2, and main tuning capacitor C2. The signal picked up by the antenna and selected by the tuned circuit, L2-C2, is detected by a simple diode, then applied to a three-stage direct-coupled audio amplifier. A common-emitter complementary amplifier (using n-p-n and p-n-p transistors) is used for the first two stages, with its output driving the final stage, a common-base amplifier. Two batteries—a 6-volt unit (B1) and a 22 ½-volt unit (B2)—supply
operating power. A pair of standard magnetic headphones (2000 ohms impedance) serves as the output load.

Since the receiver is used at higher frequencies, some care in layout and wiring is necessary. Keep signal leads reasonably short and direct. All parts, with the exception of the input r.f. transformer L1-L2, are standard and readily available. According to John, you can have maximum fun with this circuit by experimenting with different coils. As a start, however, he suggests that L1 consist of 9 turns and L2 of 24 turns of No. 28 enameled wire on a 3/4" form. The two windings should be spaced about 3/4" apart.

If you duplicate W8QCN's circuit, don't install the batteries or turn the receiver "on" until after you've double-checked all connections for possible wiring errors. And pay particular attention to the polarity of battery connections. The length of the external antenna used with this receiver may be varied. In general, of course, the higher and the longer the antenna lead, the better your pickup.

In use, C1 is adjusted either for maximum pickup or to "tune out" any interfering local broadcast station. C2 is adjusted to tune in desired stations. If you assemble a similar receiver and pick up any unusual DX, drop a note to Transistor Topics. We'd like to hear about your results.

**Readers' Projects.** In our August column, we included photographs of an interesting project assembled by a POP'tronics reader—a transistor receiver in a handmade leather case submitted by J. E. Bassett of Wilmington, Calif. Since then we've received other reports—and photos.

John R. Jensen, of 60 West Grant, Blair, Neb., has sent in photos of one of the most compact receiver assemblies we've seen. Using a standard Lafayette six-transistor receiver circuit, John made a few minor modifications in the interests of more compact wiring. He used a small (1 1/2") Argonne loudspeaker in place of the slightly larger speaker specified in the original circuit, and a UTC S50-8 interstage coupling transformer. And he used RCA 2N140 and 2N139 transistors in the r.f. stages.

Using special care in wiring and, probably, a healthy dash of patience, John assembled his receiver in a case measuring only 4 1/4" x 2 5/8" x 1 1/4", or only slightly larger than a package of cigarettes! The completed receiver gives excellent performance . . . John says he can receive a broadcast station 70 miles away regularly and with good volume.

Another reader, Ian Cameron, of 318 Mel-
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rose Ave., Toronto 12, Ontario, reports an
unusual case of DX reception with a re-
ceiver he assembled from a circuit pub-
lished some time ago in Transistor Topics
—he picked up Moscow, Russia. Distance:
about 5000 miles.

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er connected for single-ended Class A or
Class B push-pull operation. Secondary
impedances of 4, 8, or 16 ohms are avail-
able. The unit will handle unbalanced d.c.
primary currents up to 500 ma. (1/2 am-
phere). Type number is TR-94. Net price,
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Both G.E. and Philco have announced
price cuts in several of their industrial and
military transistors. The biggest cut is a
68% drop in the cost of G.E.'s 4JD1B4 tran-
sistor. As time goes on, we can expect
even more "miniaturization" of prices.

RCA (Semiconductor Division, Somer-
ville, N. J.) has introduced quite a num-
ber of new transistors, including eight new p-n-p
junction types intended for compact enter-
tainment receivers (2N407, 2N408, 2N409,
2N410, 2N411, 2N412, 2N405 and 2N406)
... a new medium-speed switching transis-
tor (2N404) ... and three high-frequency
r.f. transistors for all-wave battery port-
able receivers (2N370 as an r.f. amplifier,
2N371 for the local oscillator, and 2N372
as a mixer).

Burstein-Applebee Co. (1012 McGee St.,
Kansas City, Mo.) is offering a pre-wired
three-transistor audio amplifier. Designed
originally for use as a phonograph ampli-
fier, the unit should have many general-
purpose applications in the home or shop.
The circuit appears similar to that em-
ployed in Philco's portable transistorized
phonograph, introduced some time back.
You'll find a description of this circuit, plus
a schematic and parts values, in the Octo-

Burstine-Applebee's transistorized audio amplifier.

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ber 1955 issue of Radio & TV News (see page 41).

Transistor Manual. The General Electric Company (Electronics Park, Syracuse, N. Y.) has released the Second Edition of its pocket-sized Transistor Manual. Still priced at only fifty cents a copy, the Second Edition is approximately 75% larger than the first. Be sure to pick up your copy of this valuable booklet... you'll find it chock full of useful technical data, circuits, and reference material.

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

Lou

Among the Novice Hams

1955 issue of Radio & TV News (see page 41).

Transistor Manual. The General Electric Company (Electronics Park, Syracuse, N.Y.) has released the Second Edition of its pocket-sized Transistor Manual. Still priced at only fifty cents a copy, the Second Edition is approximately 75% larger than the first. Be sure to pick up your copy of this valuable booklet... you'll find it chock full of useful technical data, circuits, and reference material.

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

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Among the Novice Hams

(Continued from page 87)

to the other, it must flow through each resistance in turn; therefore, the total resistance must be the sum of the individual resistances, or $R_{total} = R_1 + R_2 + R_3$, etc. For the values shown, the total resistance is 1000 ohms.

Resistances connected in series across a voltage source are usually called **voltage dividers** because, by proper choice of the individual resistances, any desired percentage of the total voltage can be obtained at the taps between them. A voltage divider is often used across the output terminals of a power supply; there it serves the dual purpose of keeping a minimum load on the supply and furnishing intermediate voltages to the associated equipment.

For practice, let's design a voltage divider to do a specific job. Assume that we have a transmitter requiring 500 volts at 100 milliamperes (0.1 ampere) for the final amplifier tube plate circuit, and 250 volts at 50 ma. (0.05 amp.) and 100 volts at 10 ma. (0.01 amp.) at other points. A power supply capable of delivering 500 volts at a maximum of 200 ma. is available.

Referring to Fig. 2(B), the first step in calculating the resistances in the voltage divider is to decide on how much "bleeder current" to allow to flow through it. Normally, about 10% of the current capacity of the power supply is allocated for the purpose. Ten percent of 200 ma. is 20 ma. When added to the 160 ma. drawn by the transmitter, this makes the total key-down current drain on the supply 180 ma.

Starting at the bottom of the divider, the only current that flows through $R_1$ is the bleeder current, while the voltage across it is obviously 100 volts. Substituting these values in the appropriate Ohm's law formula gives: $R_1 = 100/0.020 = 5000$ ohms.

Proceeding to $R_2$, the current through it is the 20-ma. bleeder current, plus the 10
ma. drawn from the 100-volt tap, or 30 ma. The voltage across it is the difference between the voltages at the two taps: 250 volts - 100 volts = 500 volts. Solving for the resistance of $R_2$ using these values gives: $R_2 = \frac{500}{0.030} = 16667$ ohms.

To calculate the value of $R_3$, we add the 50 ma. drawn from the 250-volt tap to the 30 ma. already accounted for, making the current through it 80 ma. The voltage across it is 250 volts (500 volts - 250 volts). Solving Ohm's law with these values gives: $R_3 = \frac{250}{0.08} = 3125$ ohms.

Then add the three resistance values together: $5000 + 5000 + 3125 = 13,125$ ohms. One large resistor (13,000 ohms would be close enough in an actual circuit) with adjustable taps or three separate resistors could be used.

To complete the calculations, determine the current that will flow through the divider with no connection to the taps by dividing the supply voltage by the resistance: $I = \frac{500}{13,125} = 0.038$ ma. Because the supply voltage will undoubtedly increase somewhat under no-load conditions, the actual current will probably be at least 40 ma. This is more current than flows through $R_1$ and $R_2$ when power is being delivered to the transmitter; therefore, $R_1$ and $R_2$ must be large enough to carry this current without overheating. Use either of the power formulas to determine the wattage rating of the resistors.

Under no-load conditions, the voltage at the divider taps will be higher than when they are under load. The main advantage of a voltage divider over series dropping resistors is that voltage variation between the load and no-load conditions is minimized.

** Resistances in Parallel. ** Figure 3 (page 130) shows three resistances in parallel. The formula for calculating the effective resistance of such a combination is:

$$R_{eff} = \frac{1}{\frac{1}{R_1} + \frac{1}{R_2} + \frac{1}{R_3}}$$

If you are a whiz at algebra, you know exactly how to solve this formula and need not worry that you may be asked about it in the examination. If not, you will probably say: "Fine, but what does it mean?" Fortunately, it's easy to understand with a bit of explanation.

Referring to Fig. 3 and taking each resistance in turn, we know from Ohm's law that the currents through them are: $I_1 = E/R_1$, $I_2 = E/R_2$, and $I_3 = E/R_3$. Furthermore, the total current is the sum...

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Fig. 3. How to calculate the effective resistance when three resistances are connected in parallel.

of the individual currents: \( I_{\text{total}} = I_1 + I_2 + I_3 \), or \( I_{\text{total}} = E/R_1 + E/R_2 + E/R_3 \).

Reverting to the fundamental Ohm's law again, the effective resistance of the three resistances in parallel is:

\[
R_{\text{eff}} = \frac{1}{\frac{1}{R_1} + \frac{1}{R_2} + \frac{1}{R_3}}
\]

Of course, we can make \( E \) any value we wish, as long as it is the same in each part of the equation. For convenience, \( E \) is usually made equal to one volt in parallel-resistance calculations, making the last equation the same as the first one given here.

The effective resistance of 2-, 4-, and 5-ohm resistors in parallel is 1.05 (to two decimal places). I suggest you verify this answer for practice and then make up a few practice problems of your own. In checking your answers, remember that the effective resistance is always less than that of any of the individual resistances.

News and Views

Ken, KN40KY/2, has installed a 10-position crystal selector and an antenna-changeover relay for his Heath DX-20 transmitter, and an 8-meter for reading the signal strength of incoming phone signals to his Heath AR-3 receiver. He uses the 8-meter circuit from the ARRL Radio Amateur's Handbook. Both transmitter and receiver modifications work fine. Ken also suggests that amateur clubs willing to help prospective amateurs should have their programs listed in our column.

Bob, KN1CVH, received help in getting his license from KN1BDC, who teaches electricity at his school. Bob, in turn, offers to help other beginners. In a week on the air, KN1CVH's WRL Globe of C7F and 66' antenna has made eight contacts in five states.

Jacob, WN6GCU, reports that his 15-meter "folded dipole" antenna gets out much better since he installed a set of balun coils between his Johnson Adventurer transmitter and the antenna feed line. It should. His receiver is an AR-3.

Bill, WB60QU, has been getting excellent results on 40 meters with his home-brew 20-watter feeding a dipole and receiving on a Heath AR-2. He is ready to give 80 meters a whirl after having put up a 30' steel-pipe
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November, 1957
pale to support it at a cost of $6.00. Bill offers to help prospective hams. Red, KN2ZSF (father) and Bob, KN2ZSQ (son) have been on the air for three months with the 2-meter phone rig described in the booklet, "How to Become a Radio Amateur." It runs 18 watts to a ZS26 and feeds a "ground plane" vertical antenna. DX on this band has been about 100 miles. Bob has also been on 80 meters with 36 watts and an antenna 15' high, working six states in 2½ weeks on the band. Red is still building his 75 watt 3-band c.w. (code) rig. ... Ted, VE5EH, reports from Moose Jaw, Sask., that he operates on 7154 kc. with a 6AG7-6L6 transmitter feeding a 132" antenna plus an Ocean Hopper receiver. He offers to listen for Novices. He also favors 2 meters and would like to hear from W7's who are interested in that band.

Lorry, K4LY, started as a Novice with a Heath AT-1 transmitter and an AR-3 receiver, and worked 29 states and Puerto Rico. Now, as a "General," he uses a Heath DX-35 and a Hallicrafters S-40 receiver with an added Q-Multiplier, which he recommends highly to all hams with inexpensive receivers for increased selectivity. ... Derry, K4KGW, who uses a converted ARC-5 transmitter at 75 watts into a Window antenna and receives on a Hallicrafters S-38D, Terry 130 contacts in 12 states on 80 meters. ... Terry, W6DPR, works 40 meters only running 35 watts to a home-built transmitter feeding a folded dipole antenna, 20' high. He receives on a Hallicrafters SX-90. His record is 41 states, Japan, Australia, New Zealand, Okinawa, Hawaii, Cuba, Canada, and Mexico in a year and a half on the air. Terry offers to help any prospective amateur obtain his license.

Ron, WN71YJ, doesn't think his record of 25 contacts in four weeks on the air is very good, but his six states worked are all confirmed. He uses a Globe Chief running 75 watts to a 75' wire on 80 meters and a folded dipole on 40 meters. Both antennas are 15'. He receives on an AR-3, plus Q-Multiplier, but he has his eyes on a new Hammerlund HQ-150 ... Stu, KN2ZYY, couldn't stay away from his rig in the four months he has had his license until he went to camp, probably to rest up. His Hallicrafters SX-20, a single-wire antenna, and a National NC-98 receiver have accounted for 25 states, 21 confirmed, and several Canadians. He QSL's (confirms contacts) 100% and has received 63 QSL cards. ... Jim, KOBYN, has been a General for four months and now habits the 19- band and 11-meter phone bands with his WRL Globe Scout, running 50 watts, and a Hallicrafters S-40A receiver. He uses a 10-meter doublet antenna, ten feet high. His best DX has been Puerto Rico, Uruguay, Haiti, Dutch West Indies and most sections of the United States. Not bad, especially considering that most of it was done during the "dead" summer months on "10." For those of you who would like a real DX pen pal who needs help with radio theory, try: Ho Ik Yum, #304-583 Sin Dang Dong, Sung Dong Ku, Seoul, Korea. ... Jim, KN3-ACM, has made 125 contacts from coast to coast—17 states—with his 6L6 transmitter running 30 watts, in three months on the air.

---

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His receiver is an NC-98. Jim and his brother, KN3ACM, are anxiously awaiting their General licenses. Their Dad, W3TKY, has been a ham for 25 years.

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Keep your letters, reports, and pictures coming. See you at this spot next month. 73.
Herb, W9EGQ

After Class (Continued from page 83)

doughnut which increases the energy of the electrons.

Although the electrons tend to spiral outward as their velocity increases, the magnetic field grows at exactly the right rate to counterbalance this tendency. It will be remembered that the field of the cyclotron is steady and that the spiral path is characteristic of such an unchanging magnetic flux. Thus, the electrons in the betatron follow essentially circular paths. The magnetic field around the doughnut is allowed to grow for only one-quarter of the a.c. cycle, but during this brief interval each injected electron makes over 275,000 turns around the circle!

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Where will it all end? The scientist has an insatiable thirst for knowledge and the boundless energy to see it through. Man, in his quest for the keys to the universe, has already duplicated the energy of cosmic rays in his new atom-smashers and has surpassed the heat of the sun in his nuclear bombs. Can we doubt that next will come the “trevatron,” and then the “quadrvatron,” and then—who knows?

Short-Wave Report

(Continued from page 76)

tion for program link to Portugal. There are six 10-kw. units for relaying programs from Munich to Portugal, and a 135-kw. medium-wave transmitter beamed to Hungary and Czechoslovakia. The usual array of rhombics and curtains is installed.

Maxoquiera, near Lisbon, Portugal, is the receiving point for programs being relayed from Holzkirchen. Triple-diversity receivers and three rhombic antennas make up the basic equipment, while three more rhombics are beamed to New York for picking up any “hot” items. From Maxoquiera, the signals are fed on 462, 463, 464, and 467.5 mc. to Lisbon. There is also a c.w. circuit to Holzkirchen for handling frequency changes. Incidentally, all operations in Portugal are conducted by the Sociedade Anonima de Radio Rertransmissao, called RARET for short.

The main studios for Portuguese operations are in Lisbon. Some 450 people are employed here. Full-time programming, from 0500 to 0000, is carried out in Polish, Hungarian, and Czechoslovakian. In addition, there is a saturation broadcast at 0000-0110, and another seven hours daily.

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American Radio History

November, 1957
is devoted to listeners in Bulgaria and Romania.

From the studios in Lisbon, we go to the main transmitting point at Gloria. Thirteen transmitters and 90 frequencies are used to beam programs to Iron Curtain countries. Not all channels are used at any one time although changes are made several times daily in order to achieve maximum propagation. The original 7.5-kw. transmitter, first used in Germany, is located here. Later eight RCA 50-kw. units were added, and still later four 100-kw. transmitters were installed.

All crystal oscillators at Gloria, designed by RFE engineers, are located on one central panel for convenience in frequency-shifting, which may be done as often as 80 times a day. There are numerous antenna arrays, totaling 18 curtains and 12 rhombics, designed for use from 6 to 17 mc. The average distance from transmitter to target is about 1400-1500 miles. Operations at Gloria are round-the-clock for either transmissions or maintenance, 21 hours daily for receiving.

It is believed that the people of the Iron Curtain countries are hopeful of eventual freedom. The RFE stations provide stimulation for those hopes by their broadcasts.

Current Station Reports

The following is a compilation of the latest reports received by your Editor. All times shown are Eastern Standard and the 24-hour system is used. If you have been sending in reports and fail to see them listed, please bear in mind that we receive hundreds of reports each month and that it is impossible to use all of them.

Aden—This rarely heard country can be tuned on 7170 kc, at fair level from 1030 with Arabic chanting. The schedule runs to around 1045-1115. (286)

Albania—Tirana has moved from 6818 kc. to 6900 kc. and carries Eng. at 1700-1730. The earlier Eng. xmsn, at 1530-1600, is parallel to 7848 kc. (27, 166)

Although many DX'ers report hearing Tirana on 9700 kc., your Editor is of the opinion that a verification from this station would not be a true Albanian confirmation. Evidently the program is being transmitted by Radio Sofia (Bulgaria) xmt and not by any within Albania proper.

Brazil—ZYR99, Emissoras Cacique, Sorocababa, is another tough one to locate. On 2460 kc. the schedule is 1200-2200, and there will be plenty of interference noted from other services. Reports should be sent to Radio Cacique de Sorocababa, Rua Miranda Azevedo 311, Sorocababa, S. P., Brazil. (91)

Agencia Nacional, Rio de Janeiro, is scheduled at 2150-1800 on 7935 and 10,220 kc. They QSL by letter. (27)

Cook Islands—Radio Ratutonga has shifted from 5050 kc. to 4965 kc. to avoid QRM from a Venezuelan that has extended its sked past 0000. It is being heard on the west coast at

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2330-0015 (Wednesdays only) with an Eng. and language session. (31)

Costa Rica—TIFC, The Lighthouse of the Caribbean, San Jose, operates a religious station with Eng. programs at 2300-0000 on 9645 and 6037 kc. For a good DX catch, try to log the parallel outlet on 995 kc., medium-wave. (JC, RM, 107)

Denmark—The Voice of Denmark, OZF, Copenhagen, 9520 kc., continues to be well heard in most areas of the USA. Widely reported is the N.A. xmsn at 2030-2130 (repeated at 2200-2300), the first 30 minutes of which is in Danish and the rest in English. This xmsn is noted daily except Sundays. (JB, SS, 277)

Ecuador—Another widely heard program is “Morning In The Mountains,” broadcast daily except Mondays over HCJB, Quito, on 17,889 kc. at 0900-1000. (JW, 282)

Egypt—Radio Cairo can be heard daily on 9740 kc. at 1830-1900 (Arabic), 1900-1930 (Spanish), and 1930-2000 (Czechoslovakian). There has been very little Eng. noted on this outlet. (NR)

Cairo has also been noted, very strongly, on 9890 kc. at 1515, 1627, and 2230 in Arabic. (59, 166)

An Associated Press dispatch reports delivery, by Communist Czechoslovakia, of a new 300-kw. xmtr to Egypt. There is no information available at this time as to the frequency or beam to be used. (226)

French Guinea—The latest sked for Radio Conakry reads: 0130-0230, 0800-1315, 1330-1630 (Saturdays to 1700), and Sundays at 2000-1315 on 3376, 4910, and 6155 kc. The 4910-kc. outlet is being noted in the eastern states. (27)

Germany—The East German Radio DDR, Berlin, can be heard daily in Eng. on 9730 kc. (dual with 7150 and 6115 kc. which are heard irregularly) at 1530 and 1730. The 1730 xmsn on 9730 kc. is received at excellent level. (104)

Greece—Radio Athens can be heard in Greek at 1700-1730 (repeated at 1800-1830) on 17,778 kc. The second xmsn is usually the best one. (23)

Greenland—Godthaab Radio is off the air due to a breakdown of the s.w. xmtr. (27)

Haiti—As of this report, 4VEH, Cape Haitien, is operating on the following sked: on 9642 kc. (daily except Thursdays) at 0500-0600 (Tuesdays at 0515-0600); on 9632 kc. (daily except Thursdays) at 0800-0930 (Saturdays to 1030), at 1500-1700 (Saturdays from 1530); on 9600 kc. (daily except Wednesdays and Thursdays) at 1830-1900, 2000-2230 (Saturdays from 2030). “Listener’s Corner” may be tuned Mondays at 2145-2215 with POPtronics Monitor #4, Stewart West, announcing. (CH, BW, 228)

Radio Commerce, Port-au-Prince, has moved from 6991 to 5980 kc. and from 9485 to 9545 kc. It operates weekdays at 0600-0930 on 5945 kc., and at 1700-2230 on 5980 kc. On Sundays the sked is 0600-1900 on 5945 kc. Eng. programs are at 1700-1730 on Sundays and at 2100-2115 on Tuesdays, Thursdays, and Fridays. (156)

Honduras—HRN, La Voz de Honduras, Tegucigalpa, has moved back to 5875 kc. from 5960 kc. HROW has left 5880 kc. and the new channel has not yet been located. (100)

Iceland—Ut Varp Reykjavik, 12,175 kc., has
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-reportedly moved the former Sunday xmsn of 1115-1130 to 1500-1600. This is beamed to Denmark and is in the Icelandic language. The station has also been noted at 0815-0835. (11, 61)

Italy—English xmsns from Radio Roma are as follows: at 0400-0430 on 21,560, 17,800, and 15,325 kc.; at 1035-1055 on 21,560 and 17,770 kc.; at 1915-1935 on 15,400 and 11,905 kc.; at 2125-2145 on 11,905 and 9575 kc. The 1915-1935 English/French xmn to the USA and Canada on 15,400 kc. is well heard. (61, 279)

Malaya—DX’ers needing this country should listen for Singapore on 7280 kc. around 0630-0700 for the best signal. Forty-meter ham radio QRM often mars reception after that time. (286)

Mauritius—V3USE, Forest Side, is noted on 15,037A kc. from 2220 with music, 2230 news in French, 2246 music, 2300 news in English, 2318 s/off. (275)

Mexico—A new station is XEQM, Merida, Yucatan. Operating on 6105 kc., it is heard at 1900-2300, relaying XEMQ. (100)

Mozambique—Radio Clube de Mozambique, 15,083 kc., is noted in Portuguese with excellent music from 0000 to 0100 s/off, at 0930-1000, and at 1430-1515. Frequent 1D finds a 4-note gong. (61)

The 11,762-kc. channel is noted with usual Eng. Commercial Service at 0915, with QRM from Burma on 11,764 kc. A new outlet has been noted on 4945 kc. at 0000 (formerly 4911 kc.), also in English. (31)

Nicaragua—Radio Atlantico, YNCA, Blue-fields, has been heard on 7753 kc. from 2145 to 2300 s/off with Latin-American music and anmt in Spanish. This one is often difficult to hear due to the weak signal and some QRM. (FC)

Nigeria—A most unusual IS is that of the “Talking Drums” which can be heard from Lagos on 4990 kc. at 0100. BBC news relay is noted to 0115; the station often fades out shortly after that time. (23)

Pakistan—Radio Pakistan, Karachi, is heard from 1430 to 1500 s/off on 11,670 and 15,230 kc. The 1430-1435 Eng. newscast is followed by music. (WA, 168)

Peru—Radio El Sol, Lima, has moved from 15,190 kc. to 15,403 kc. and is well heard at
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2230-2300 with pop music and from 2300 with news. (37)

Poland—The current sked for Radio Warsaw to N.A. is: 1930-2030 and 2130-2200 on 11,740, 15,120, and 17,800 kc.; 0300-0100 and 0600-0630 on 11,740 and 15,120 kc.; and 0715-0815 on 11,740, 11,755, 11,785, and 17,800 kc. (CK, 61)

Reunion—Another rarely heard station is believed to be St. Denis, Reunion, noted on 7170 kc. around 2350 in French or German. Heavy QRM prevented positive identification. (98)

Rumania—Bucharest operates to N.A. as follows: at 2200-2230 and 2330-0000 on 11,937, 9570, 9254, 6210, and 5980 kc. Programs are in English. They are asking for remarks and suggestions concerning their broadcasts. (182)

Sao Tome—The Radio Club de Sao Tome is reported to have ceased operations on s.w. Watch 7157 kc. for the opening of another station shortly. (27)

Sarawak—Radio Sarawak, Kuching, is noted on 5052 kc. at 0800 with a BBC relay and at 0000 with Radio Australia news in English. The IS is a simple guitar melody. (286)

South Korea—In addition to frequencies of 9640, 7935, 5980, 7180, and 3910 kc., HLKA, Seoul, also has 17,885, 15,255, and 11,925 kc. allotted for use. The 9640- and 7180-kc. outlets are scheduled as follows: 0000-0430 on 9640 kc. and 0700-1515 on 7180 kc. During the latter xmn there is an Eng. session at 0930-1000. (27, 206)

Spain—An experimental station is operating on 6850 kc. with a test broadcast at 2000-2200. (206) (Editor's Note: With no other details available at time of writing, it is possible that this station could be either Radio Juventud de Almeria, listed at 6945 kc., or Radio Alerta de Valencia, listed at 6960 kc.)

Sweden—Radio Sweden has a DX program to 2160 close. Reports go to DX Editor, Radio Sweden, Stockholm 7, Sweden. This was noted on 11,810 kc. (BU)

Tanganyika — Dar-Es-Salaam operates on 7167 kc., replacing 5050 kc., at 2215-2340, except Saturdays (100)

Tangier—WTAN, P. O. Box 2219, Tangier (Socco), Morocco, has been experiencing considerable QRM on 9485 kc. and lately has been noted on 9418 kc. at 1430-1715. They are asking for reports on the new frequency. (27, 280)

Trinidad—A not-too-distant but often difficult station to hear is VP4RD, Port-of-Spain, on 6085 kc. It has been heard in Ohio around 1600 with news in English. (98)

Turkey—Radio Ankara is well heard in the

SHORT-WAVE ABBREVIATIONS
A—Approximate frequency
amnt—Announcement
BBC—British Broadcasting Corporation
Eng.—English
ID—Identification
IS—Interval signal
kc.—Kilocycles
kw.—Kilowatts
L.A.—Latin America(n)
N.A.—North America(n)
QRM—Interference
sked—Schedule
s/m—Sign-on
s/o—Sign-off
xmn—Transmission from station
xmr—Transmitter used by station

0000 with Radio Australia news in English. The IS is a simple guitar melody. (286)
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in Spanish. Programs continue after 2200 but with QRM. This one presumably signs off at 2300. (PC)

Windward Islands—The Windward Islands B/C Service, Grenada, is using two new outlets as follows: 4760 kc. at 1600-1730 (then moving back to 3365 kc. for the 1730-2215 period); and 9550 kc. at 0815-0900 Tuesdays and Thursdays only, for school broadcasts. (100)

Clandestine—A station, presumably Clandestine Russian, signing as Goberit Batkat, has been noted on 17,815 kc. at 2200 s/on in Russian. Within a few seconds it is usually jammed and unreadable. This might be a Far East outlet operating from near the Mongolian border. Details requested. (31)

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west during the 1815-1900 xmsn on 9515 kc. News, a short talk, and music make up the format of the program. (61)

The outlet on 15,160 kc. has resumed the "Mailbag" program on Sundays during the 1600-1645 xmsn to England and Western Europe. Reports and questions about Turkey should be sent to Mailbag Program, S.W. Service, English Section, Ankara, Turkey. (SP, 226)

Uruguay—Radio Sarkanedi operates at 1000-2100 on 9515, 11,885, and 15,385 kc., three days to the USA and three to Europe. All xmsr are 10-kw. units. (27)

Venezuela—New stations announcing in Eng. as "This is Caracas" and using Government xmsr are being heard on 9366 kc. at 0725-0800 and on 11,800 kc. from 2100. No other details are available as yet. (CI, 27)

YVQL, El Tigre, 3255 kc., has been noted from 2120 to 2157/close with music, commercials, and ID as La Voz de El Tigre. QRM was noted from ZFY until s/off at 2145. (59)

YVXJ, Barquisimeto, 9510 kc., is well heard at 2000-2200 with pop L.A. music and annits

SHORT-WAVE CONTRIBUTORS

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This is for you... BC-114-C amplifier, the electronic heart of the famous SCR-955 wire detector. This unit is brand new with 2 1N5 and 1-1G6 vacuum tubes, in steel carrying case with handle; net weight with batteries is only 10 pounds. It incorporates numerous electronic refinements; is complete with schematic diagram of the whole SCR-955 detector set. Case measures 14" by 6" by 5" including hinged cover. Operating panel hinges out for easy access to interior slim mounted chassis. This is a 1600 cycle fixed frequency amplifier, brand new and unused in a lifetime box at $3.95. Net of $1.95 remittance to Springfield Enterprises, 1515 N.W., Washington, D.C.

Write for government surplus bargain bulletin
J oe PALMER, P. 0. Box 6188 CCC, Sacramento, California

FOR SALE
LIMITED supply tape wind bobbin cores; used in computers, electronic brains, etc., below mfg.'s. cost. $1.00 postpaid. Bobbins, 4660-11 Ave. So., St. Peters-
bas, Fla.

15 ONE-TUBE Circuits—25c. Laboratories, 328-L Fuller, Redwood City, California.


TUBES-TUBE, Radio, Transmitting And Industrial Types At Sensibly Low Prices. New, Guaranteed 1st Quality Top Name Brands Only. Write For Free Illustrated Catalog of Call Walker-57000. Barry Electronics Corp., 512 Broadway, New York 12, N.Y.

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DIAGRAMS! Service Data! Radios $1.00. Television $1.50. TV tube circuits books, $1.50. TV service tests. $1.00. For Free estimate of your set, write to: Barry Electronics Corp., 512 Broadway, New York 12, N.Y.

WALKIE-TALKIE chassis $6.50. See our display ad in this issue Springfield Enterprises.

WALKIE-TALKIE. Build wireless portable radiophone for less than $10.00. Plans for variable frequency and crystal control types, only 50c for both, including assembly photographs. Springfield Enterprises, Box 54-E11, Springfield Gardens 13, N.Y.

CITIZEN'S band radio plans for building your own receiver and information on transmitter design, FCC requirements, etc., plus special discount on approved transceivers. All for $1.00. Springfield Enterprises, Box 54-E11, Springfield Gardens 13, N.Y.

200 UNMARKED Ceramics—Mixed Value, $1.00. Schneider, 7170 New York Ave., Bethesda, N. Y.

COMPLETE Television sets $1.95. Jones TV, 1115 Rambler Avenue, Pottstown, Pa.

HAMS! Work-the-world Alcoa all-band vertical an-
tenna for 40, 20, 15, 10, 6 meters. $16.95 shipped collect. Guaranteed, made of best materials, no guy wires. Literature, Godham, 1605A Purdy Ave., Miami Beach, Fla.

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TELEPHONE Extension in your car. Answer your home telephone by radio from your car. Complete diagrams & instructions. $1.50. C. Carrier Co., 734 15th St., N.W., Washington 5, D.C.

COLOR TV, Portable, Projection, Transistorized. Complete diagrams & instructions. $2.75. C. Carrier Co., 39 N.W., Washington 1, D.C.

POLICE Radar Detector. Stop before those radar speed traps. Foolproof legal system. Complete diagrams & instructions. $3.75. C. Carrier Co., 734 15th St., N.W. Washington 5, D.C.


2 WAY Wrist Radio with auxiliary long distance booster. Complete diagrams and instructions. $1.25. C. Carrier Co., 734 15th St., N.W., Washington 5, D.C.


GRAMS for repairing radios $1.00. Television $2.00. Give make, model. Diagram Service, Box 672-PE, Hartford 1, Conn.

TRADE-IN sets ship anywhere in the U.S. $10, 12 in. $12, 16 in. $17, 19 in. $21. Justis Bros., Newport, Del.\n

HEARING aid cases. Suitable for shirt pocket radios. $1.00. Regent, 6521 Oleatha, St. Louis, Mo.

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TV-DRY Eliminates TV Burnout Repairs Caused By Humidity. Send $1.00 To TV Miltie, Box 101X, Hicksville, New York.

PRINTED Circuits. Design your own. Copper boards, etchant, and complete instructions $2.00. Davenport's, 1061 Lansing, Denver 8, Colorado.

BUILD-EXPERIMENTER subscribe to "Radio Workbench" magazine, Special transistor issue for 25c. Smith Electronics, Chad. New Mexico.


INTERNATIONAL ANTENNAS, NEW Mexico, Ft. Dodge, Iowa or 67-16 Ave. S.W., Cedar Rapids, Iowa.

Always say you saw it in POPULAR ELECTRONICS.
WANTED

CYLINDER and old disc phonographs. Edison, Conqueror, Idella, and Oratorio models. Berliner-gramophones and Zon-o-phones, Columbia cylinder Graphophones, and Coin-operated cylinder Phonos. Want old catalogues and literature on early phonos prior to 1900. Also cash or trade late hi-fi components. POPULAR ELECTRONICS, Box 50.

CASH Paid! Sell your surplus electronic tubes. Want unused, clean transmitting, special purpose, receiving, or electronic components. Also want military & commercial lab test and communications gear. We swap, too, for tubes or choice equipment. Send specific details in first letter. Fee for a fair deal write, wire or telephone: Barry, 512 Broadway, New York 12, N. Y. Walker S-7000.

AIRCRAFT and ground radios. Will better best offer. Damon, W9HCR, 2600 Broadway, Arlington, N. J.

CRYSTAL-Radio experimenters. Write to Hulet, 305 Hope, Lakewood, New Jersey.

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VENDING Machines—No Selling. Operate a route of coin machines and earn amazing profits. 32-page catalog free. Parkway Machine Corporation, Dept. 12, 715 Elsinor St., Baltimore 2, Md.


AMERICA's largest wholesale sources. Dealers, agents, salesmen write Associated Wholesalers, Box 52–GM, Burlington, Iowa.

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

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RECORDING Tape—1800' $1.84. 1200' $1.44. Guaranteed. Catalogue, Broadcast Tape, P. O. Box 231B, Wallingford, Conn.


RECORDS


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BECOME Tax Consultant. Graduates earn to $3,000 every tax season preparing returns evenings. State approved. Union Institute, Hoboken, 3E, N. J.

ENGINEERING Degrees, EE Option Electronics earned through home study. Residence classes also available. Pacific International University, 5719-D Santa Monica Boulevard, Hollywood 38, Calif.

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USED Correspondence Courses, Educational Books Bought, Sold. Rented. Catalog Free, Vernon's, 624 Mohawk, Rossville, Ga.

BUILD FM-TV Antenna. Plans 50¢. Hed, 6925 Janell, Minneapolis, Minn.

MATHEMATICS. All levels. Correspondence. UCSM, 6605 N. 13 St., Philadelphia 26, Pennsylvania.

COMPUTER plans $3.00. New transistor robot plans $1.00. Robot construction manual $3.00. Only complete course in electronics under $100.00. For complete information on automation computers robots write E. B. E., 1015 Atkin Ave., Salt Lake City 6, Utah.

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WATER Softener $29.50. Does job of $300 unit. Details. Myers, Box 671–PE, Indianapolis 6, Ind.

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

FREE literature on new low cost electrical devices for home and shop. Write Wells Co., Box 3055, North Hollywood, California.


FREE literature! Send 25¢ for up-to-date list of manufacturers offering free information. Gention, 7134 Peabody Street, Long Beach, California.

TRANSISTOR Kits, parts. Free information. Transit, Box 15–C10, Aiden Manor, N. Y.

MISCELLANEOUS

November, 1957
SHIPPED ON APPROVAL
NO MONEY WITH ORDER
NO C.O.D.

Superior's New Model TD-55

EMISSION TYPE

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.

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,
37, 59, etc.) and providing sockets and circuits for efficiently testing the new Noval
and Sub-Minor types.

You can't insert a tube in wrong socket.

You can't insert a tube in wrong socket. If inserted in the wrong socket, it can't
be removed. The socket is built-in.

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
developed element selector switch system which
reduces the possibility of absolu-
teness to an absolute minimum.

Checks for shorts and leakages between
all elements.

Model TD-55
Terms: $6.95 after 10 day
trial then $5.00 per month
for 4 months.

Model TW-11
Terms: $11.50 after 10 day
trial then $6.00 per month
for 6 months.

Model TV-12
Terms: $22.50 after 10 day
trial then $10.00 per month
for 3 months.

SUPERIOR TUBE TESTER

STANDARD PROFESSIONAL

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
tubes. Housed in hand-rubbed oak
$47.50 cabinet.

TRANS-CONDUCTANCE
TUBE TESTER

* 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 $72.50
cabinet.

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.
Superior's **New**

**UTILITY TESTER**®

**Model 70**

**AS AN ELECTRICAL TROUBLE SHOOTER**
- 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 a megohm (5,000,000 ohms).
- Will test Teasets, Irons, Broilers, Heating Pads, Clocks, Fans, Vacuum Cleaners, Refrigerators, Lamps, Fluorescents, Fans, Switches, Thermostats, etc.
- Will test all TV tubes for open elements, inter-element shorts, burned out tubes, etc.

**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.
- Condensers.
- Directional Signal Systems.
- All Lamps and Bulbs.
- Fans.
- 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.

**Superior's New**

**Model 670-A**

**SUPER-METER**

A Combination VOLT-Ohm MILLIAMMETER PLUS Capacity,
Reactance, Inductance and Decibel Measurements

| J.C. VOLTS: | 0 to 7.5/15/25/50/100/150 | 1,500/7,500 | 3,000 Volts | 0 to 15/30/150/300/1,500/3,000 Volts | 0 to 1.5/15/150 Ma. | 0 to 1,000/100,000 Ohms | 0 to 10 Megohms | **CAPACITY:** 0.001 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 5,000 Ohms | 10 to 75 Ohms | **INDUCTANCE:** 10 to 75 Henries, 75 to 7,000 Henries, 70 to 700 Henries, 700 to 70,000 Henries |
| **D.C. CURRENT:** | 0 to 1.5/15/150 Ma. | 0 to 1,000/100,000 Ohms | 0 to 10 Megohms | **CAPACITY:** 0.001 to 1 Mfd. 1 to 50 Mfd. (Good-Bad scale for checking quality of electrolytic condensers.) |
| **Resistance:** 0 to 1,000/100,000 Ohms | 0 to 10 Megohms | **CAPACITY:** 0.001 to 1 Mfd. 1 to 50 Mfd. (Good-Bad scale for checking quality of electrolytic condensers.) |

**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!!**

**EASY TO USE:** Simply insert line cord into any 110 volt A.C. outlet, then attach tester socket to tube case (for 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**

**NO INTEREST OR FINANCE CHARGES ADDED!**

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-389, 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 TV-11**, Total Price $47.50
  - $11.50 within 10 days, Balance $36.00 monthly for 6 months.
- **Model TV-75**, Total Price $26.95
  - $8.95 within 10 days, Balance $18.00 monthly for 4 months.
- **Model TD-55**, Total Price $35.00
  - $9.75 within 10 days, Balance $25.25 monthly for 4 months.
- **Model TV-40**, Total Price $72.50
  - $23.50 within 10 days, Balance $49.00 monthly for 6 months.
- **Model TV-12**, Total Price $72.50
  - $23.50 within 10 days, Balance $49.00 monthly for 6 months.
- **Model TV-60**, Total Price $72.50
  - $23.50 within 10 days, Balance $49.00 monthly for 6 months.

**Name**

**Address**

**City**

**State**

**Zone**

**F. O. B.**

**S. Y. C.**

www.americanradiohistory.com
SUPERIOR'S New Model 76

**CAPACITY BRIDGE SECTION**
- 4 Ranges: 0.0001 Microfarads to 0.005 Microfarads, 0.01 Microfarads to 0.5 Microfarads, 1 Microfarads 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
- 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

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**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**
- **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 0-300 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.)

**DOTTED PATTERN GENERATOR (FOR COLOR TV):** The Dotted 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

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**TRY FOR 10 DAYS**
BEFORE you buy! THEN if satisfactory pay in easy, interest free, monthly payments. See coupon inside.

We invite you to try before you buy any of the models described on this and the preceding 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. (See other side for time payment schedule details.)

NO INTEREST OR FINANCE CHARGES ADDED! 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!

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**BUSINESS REPLY CARD**
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POSTAGE WILL BE PAID BY — MOSS ELECTRONIC DIST. CO., INC. 3849 TENTH AVENUE NEW YORK 34, N.Y.

VIA AIR MAIL

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