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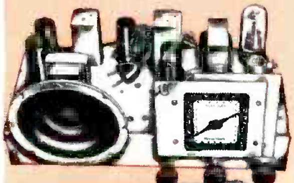

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Foreword

The continuous flow of new products and ideas from the laboratories of the world has always fascinated alert members of our society. We hope this issue of the ELECTRONIC EXPERIMENTER'S HANDBOOK will introduce some of these new products and ideas to you and serve as an inspiration for important work of your own. If you come up with anything interesting do not hesitate to write and tell us about it. The soil is fertile. To the inquiring spirit we dedicate this • • •

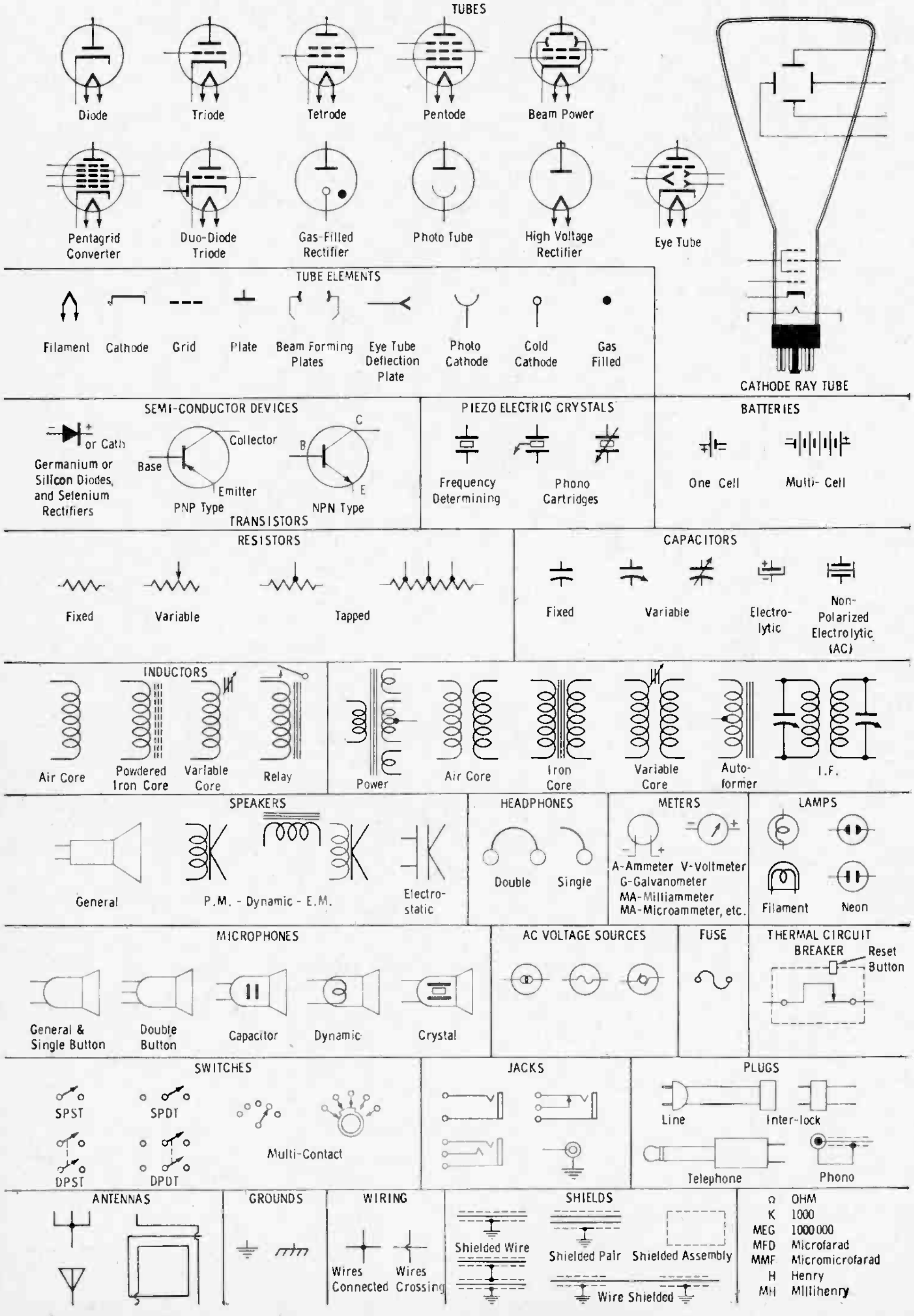
Popular Electronics' **ELECTRONIC EXPERIMENTER'S HANDBOOK**

FEATURING:

AND MUCH, MUCH MORE . . .

Turn to Page 7

Symbols for Electronic Circuits



1960 ELECTRONIC EXPERIMENTER'S HANDBOOK

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Contents

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Free Aids to Experimenters

By circling the numbers on the coupon below, the following manufacturers have a wealth of interesting information available: Simply clip and return to ELECTRONIC EXPERIMENTER'S HANDBOOK, Village Station, Box 182, New York 14, N. Y.

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Gyro will send you an interesting 16 page catalogue describing remote control radio equipment.

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Lafayette, long a source of supply for experimenters has an excellent catalogue of their own products and many others.

16. OLSON RADIO CORP.
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23. TRIAD TRANSFORMER CORP.
Manufacturers of transformers, Triad has a comprehensive catalogue ready for you.

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Information on Vaco's line of electronic tools including the new "Crimcut" tool is worthwhile.

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WHAT THE EDITORS ARE READING

Since most experimenters have an inventive turn of mind I am sure Matthew Josephson's biography **EDISON** ($6.95, McGraw-Hill) will provide genuinely inspirational reading. It is a treasured volume in this editor's library.

For those wishing they had a really solid theoretical background in electronics, mastery of J. R. Eaton's **BEGINNING ELECTRICITY** and then Daly and Greenfield's **BASIC ELECTRONICS** ($6.00 and $9.00 respectively, Macmillan) will provide just that. They are texts suitable for high schools and colleges, so a certain amount of mathematical knowledge is helpful. They fill a need very well.

THE CONCISE DICTIONARY OF SCIENCE by Frank Gaynor ($10.00, Philosophical Library) is a wonderful reference work for anyone with any interest in any of the sciences. Its 542 pages run the gamut from "A" for argon or Angstrom Unit to "Zwitterion," another name for dipole ion. You will like it.

In addition to the 5 volume **BASIC ELECTRICITY** and the now 6 volume **BASIC ELECTRONICS** Rider now has a 3 volume **BASIC AUDIO** ($2.90 per volume) by Norman Crowhurst. It uses the excellent cartoon style of the other two courses, and provides a real background for any hi-fi fan who would like to know the "why" of high fidelity.

From the same house comes a recorded **SIGHT 'N' SOUND** code course ($15.95 complete 0-20 wpm) that has been conceived by Lewis Robbins and Reed Harris. This is a real boon to those people who have always felt code to be a block to getting their Amateur License. The set uses the "reinforced learning" principle, and is very well laid out.

Rufus P. Turner's **BASIC ELECTRONIC TEST PROCEDURES** ($6.50, Rinehart) is a book every experimenter ought to own. Clearly illustrated, it is a real help toward checking home-built apparatus. It also will help the experimenter to learn a great deal about electronics he might otherwise miss.

For the beginning experimenter **THE ELECTRONIC EXPERIMENTER'S MANUAL** ($4.95, Ziff-Davis) written by a former editor of this publication, David A. Findlay, contains many useful tips on construction and details of building useful pieces of test equipment and electronic apparatus. The illustrations make things very plain for the beginner.

For the man who likes to design his own equipment **MODERN ELECTRONIC COMPONENTS** by G. W. A. Dummer ($15.00, Philosophical Library) will provide a reference so that you can get a component to do exactly what you want. This is not a catalogue, but rather an investigation into the various materials and modes of construction usually used by manufacturers. It is quite a valuable aid.

If you would like to go into the hi-fi-radio-TV service business, you really can if you master the six books put out on the subject by McGraw-Hill known collectively as THE McGRAW-HILL **TV-RADIO RECORD CHANGER REPAIR LIBRARY** ($29.95). It covers practically anything that the service man would run across. Six authors are represented: John Markus, Alex Levy, Eugene Ecklund, Eugene Anthony and William Markus. (See ad on page 155.) The whole package is tied together in a small book **THE HOME COURSE OUTLINE** prepared by John Markus, which brings out the fine points of really succeeding in the service field.

You might also look at GE's 4th edition of the **TRANSISTOR MANUAL** ($1.00), the **1960 A.R.R.L. HANDBOOK** ($3.50) and the offerings of our bingo coupon elsewhere in this book.

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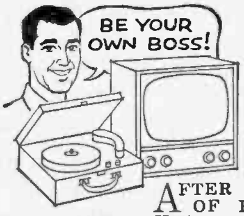

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4. **Profitable TV Troubleshooting**— Short-cuts to SPOT and FIX every trouble—fast, for big profits. By Eugene A. Anthony, Service Consultant, General Elec. Co.
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THE BOY'S BOOK OF SCIENCE AND CONSTRUCTION ($3.50) is another Morgan "oldtimer" which has proven itself over the years. Plastics, rockets, jet motors, sound and electricity come in for good writing, and the book has 300 illustrations.

Frank Ross, Jr. has written two books which will appear to old and young alike. One is called AUTOMATION, SERVANT TO MAN ($3.00), the other is called RADAR AND OTHER ELECTRONIC INVENTIONS ($3.00). Both are comprehensive and profusely illustrated and provided you have little knowledge of electronics, these serve as excellent introductory texts to these advanced fields.

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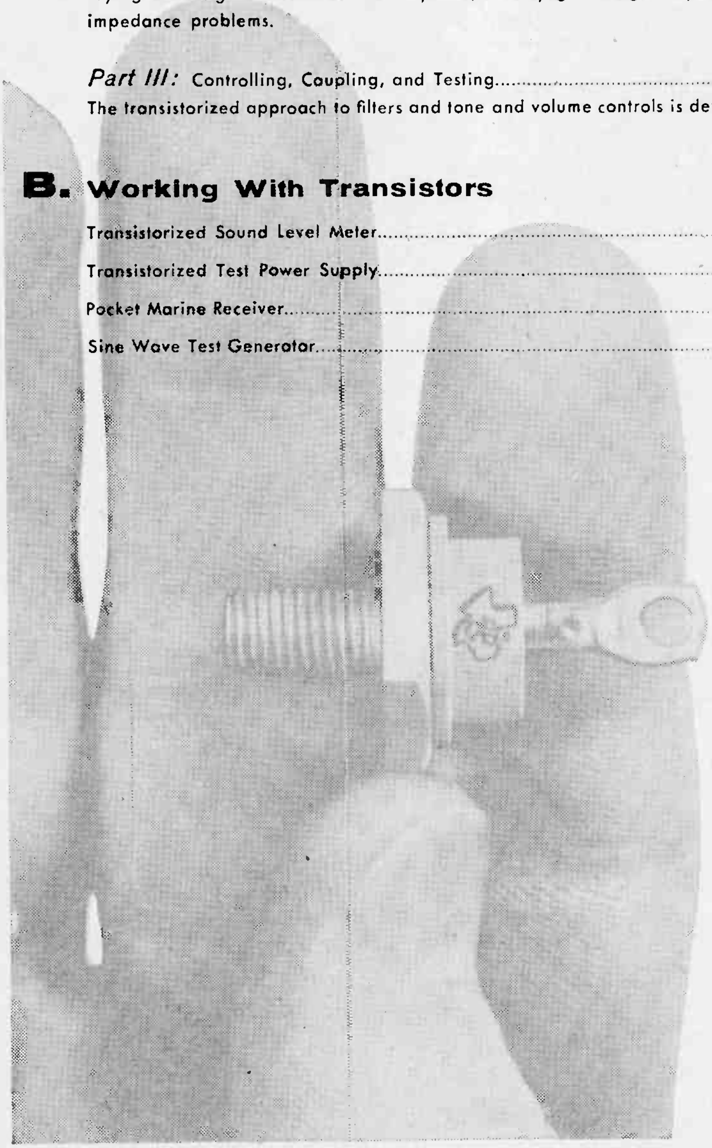
Full of various experimental things to do, Williard Doans EXPERIMENTAL ELECTRICITY FOR BOYS will challenge the alert boy for many pleasant hours. Involved are most of the basic electrical concepts.

SECTION I

A. Understanding Transistor Circuits

B. Working With Transistors



By James Butterfield
Canadian National Telegraphs

Part I

Ohm's Law and the Transistor

"This should do it," grunted Pete, as he soldered a final connection. "Now, let's try out the amp."

"*That's* an amplifier?" snorted Johnny. "You must have dreamed up that circuit during a fit of indigestion! Anybody knows even the simplest transistor amplifiers are bristling with resistors and oversize coupling capacitors. And where's the output transformer for the speaker?"

"Don't need any." Pete clipped on the ground lead from the audio generator and inserted a .1-μf. capacitor in series with the other lead. "Trouble with most of you experimenters is that you just copy diagrams—maybe change 'em a little here and there to see what happens—but you never bother to find out what really makes things tick." He touched the other end of the capacitor to his input lead, and the speaker sang with a clear tone.

"Pete, I've got six books on transistors, and I

still don't know what I'm doing," complained Johnny. "They are either so simplified that they don't say anything—or they're crammed with equations from stem to stern."

"Nothing wrong with equations." Pete was busy tidying up his workbench. "But you don't always need 'em. I threw this amplifier together without fancy calculations—just horse sense. Let's go into the kitchen for coffee, and I'll try to fill you in on the *practical* side of transistors."

Diodes Back to Back

"First off," said Pete settling in a chair, "You know that a transistor is sort of like a pair of diodes, back to back, like this." He sketched rapidly on a napkin.

"The way I've shown it here, the transistor is a *p-n-p* unit. To get an *n-p-n* job, you flip both diodes end-for-end. We'll dig deeper into this later—but for now, just remember when positive voltage is on the *p* section and negative voltage on the *n* section, the transistor conducts."

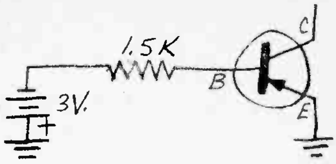
"I suppose the lead in the middle is the base," said Johnny. "But which is the collector and which is the emitter? Your diagram doesn't show any difference."

"Here's something that will probably surprise you, Johnny. The collector and the emitter could be changed around and the transistor would still work! But since the manufacturer normally builds the collector bigger and stronger than the emitter—take his advice and use the collector lead as the collector.

"The real difference between the collector and emitter is in the way we treat them. The emitter is biased to allow *maximum* current flow (forward bias) and the collector, on the other hand, is back-biased for *minimum* current."

"Hey," Johnny cut in. "Wouldn't a heavy current flow from the base through the emitter mean that there would be darn little voltage drop between the emitter and base?"

"Right, Johnny, there's seldom more than a quarter of a volt difference between emitter and base, which makes it easy to figure emitter current. Take this circuit for example:



"The collector isn't important just for the moment, so I won't show any wiring to it. Since the emitter is at ground, you can figure that the base is almost exactly at ground, too. This means . . ."

"I get it," cried Johnny. "The battery puts exactly three volts across the 1500-ohm resistor, so Ohm's law says that the current must be . . . ah . . . two milliamps!"

"Bravo!" chuckled Pete. "And since this part of the transistor is conducting in the forward direction, the current will not be affected by the collector. By the way, what type of transistor did I show in the diagram?"

"Negative voltage on the base, and positive on that emitter . . . so the transistor must be a *p-n-p!*" exclaimed Johnny triumphantly.

A Current Problem

"Now, here's point number two. The collector must be biased in the *non*conducting direction. How would you do that?"

"Put negative voltage on it, I suppose," said Johnny thoughtfully. "But, wouldn't that mean that no current would ever flow?"

"That would be true if the collector and base *only* were connected," replied Pete. "But when the emitter is in the circuit with positive bias, an interaction allows current to flow through the collector."

"Now you're getting complicated," complained Johnny. "You sound like a textbook."

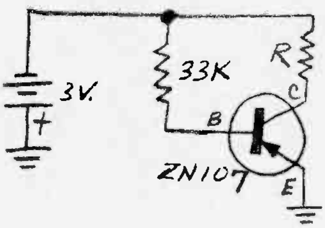
"Okay, let's put it this way. Whatever current flows through the base will produce an amplified current through the collector. You know how to find the base current—we just did it by Ohm's law. So you take the base current (I_b), multiply it by your amplification factor (H_{fe})—and there's I_c, your collector current."

$$I_c = I_b \times H_{fe}$$

"Just a minute," argued Johnny. "Suppose I put a higher voltage on the collector. Wouldn't that make more current flow?"

"Not at all! Ignoring the fine points, I_c will always equal I_b x H_{fe}. The latest G.E. transistor manual, by the way, lists H_{fe} for over four hundred transistors of all makes.

"The experimenters' transistors, such as the 2N107 and the CK722, have gains of about 20. Commercial grade transistors can run gains as high as 100 or more.



"Let's take a look at another circuit," Pete continued, sketching rapidly. "See what you make of this."

"Let me see," murmured Johnny. "With the emitter grounded, the base has to be at almost zero volts—which will cause the battery's three volts to drop across the 33,000-ohm resistor. That would give about 0.1 ma. flowing through the base. If the amplification of the transistor is 20, that means the collector will take almost two milliamps. But, doesn't the size of resistor *R* make any difference to the collector current at all?"

"Nope," said Pete cheerfully, "with one exception. What would happen if that resistor were, say, 2000 ohms?"

"Well . . . Ohm's law says that two milliamps times 2000 ohms makes a drop of four volts. Oh, I see what you're getting at. If your collector resistor is too big, it won't pass any voltage . . ."

"And once you lose the voltage, you lose your transistor action," finished Pete. "A resistance of about 800 ohms would be dandy for this circuit."

"That would give a collector voltage of—let's see—three volts minus a 1.6-volt drop across the resistor leaves a little under a volt and a half for the collector. Isn't that too low? You'd never be

able to put out a decent signal voltage with a supply like that."

"Depends on what you're using the amplifier for. Usually, you don't need voltage—all you want is current."

Beating the heat

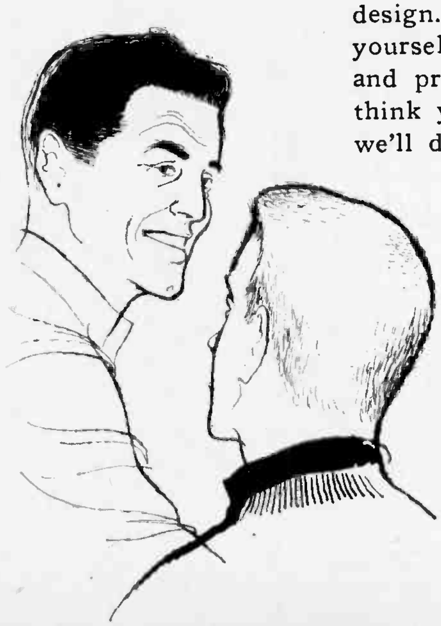
"Another thing, Pete, what about heat effects? Are transistors as heat-sensitive as some of my books say? Does the gain change, or what?"

"No, the gain of a transistor usually stays fairly steady; but when the thermometer is high, a little leakage current sneaks through. Don't worry about it, though. You'll seldom have trouble if you stay well within the maximum ratings of the transistor."

"These 'max' ratings—anything complicated about them?"

"Gosh, no! Maximum collector-to-base voltage, maximum collector current, and maximum collector dissipation—that's all you'll have to worry about. They mean just what they say. Don't put too much voltage across a transistor; don't put too much current through it; and don't heat it up too much with a combination of the two.

"Now—you've made a start on logical transistor design. The fine points will come later. Whomp yourself up a few circuits. You'll find that theory and practice go hand in hand. Then when you think you've got the basic idea under your hat, we'll dig into this thing a little deeper."



Part II

Design "Do's" and "Don'ts"

"Pete, I've been playing around with transistors like you told me, and I've got problems."

Pete carefully set down his soldering gun and turned toward his visitor. "What seems to be the trouble, Johnny?"

"Well . . . I wanted to boost the output of the radio I'm using as a tuner. I laid out a circuit the way you showed me, but it doesn't seem to work right. The volume is just as low as before—and what's worse, the tone is mushy and distorted. I tried a new transistor with no better results. Pete, tell me, where did I goof?"

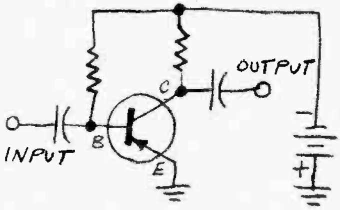
Pete grinned. "I think I know what the trouble is, Johnny. Your circuit is probably good for a vacuum tube. You'll have to learn to think in different terms for transistor amplifiers.

"First of all," said Pete, reaching for a pencil and scratch pad, "do you remember how I told you that a transistor was really a pair of diodes back to back?"

"Yes. I got that part okay."

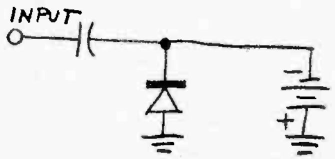
"Fine. Now let's go back to fundamentals again and attack the problem from a different position.

"Remember that the base-emitter 'diode' must be hooked up to conduct in the forward direction. Let's look at the circuit of an ordinary transistor amplifier.



"As I told you last time, in a *p-n-p* transistor negative voltage is applied to the base and positive voltage to the emitter, and conduction takes place in the diode formed by the base and emitter. I'll sketch this part of the circuit in detail for you.

"When a diode conducts, it's just as if a switch has been closed. Now, when this base-to-emitter diode is conducting, all your a.c. signal goes directly through the diode to ground. For most purposes, the input impedance is so low that you can consider it zero."



"Just a minute," interrupted Johnny. "If the input is a short circuit, how can you get any amplification? There won't be any voltage left at the input if you short it all out."

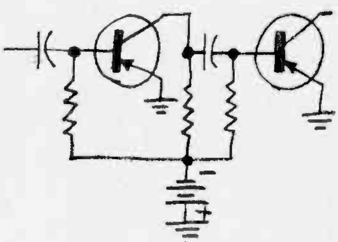
"Forget about voltages. Here's the important thing. Since the transistor has a 'short-circuit' input, it may not have much voltage at the input, but *current* flows *into* the transistor. Current is what a transistor amplifies.

"Suppose we have a transistor with a *beta*—that's current gain—of 20. Then if I put one milliampere of signal into the base, I'll get 20 ma. at the collector. Write this in your notebook in capital letters an inch high—A TRANSISTOR AMPLIFIES CURRENT."

"Pete, I notice you always put your signal into the base and take your amplified output from the other collector. It seems to me I've heard of other ways of connecting a transistor."

"Forget them, Johnny. There are very few jobs that can't be handled by the grounded emitter. We'll talk about the other circuits when an occasion arises that requires their use."

Cascaded Amplifiers



"Pete, how do I go about using an output that's rated in milliamps instead of volts? The current goes through the collector resistor, so it can't be used as it stands."

"That's not exactly true, Johnny. It depends on how you hook into the transistor output.

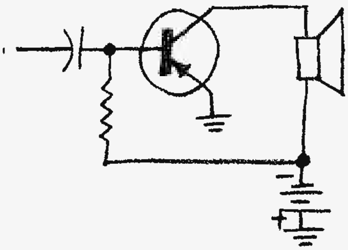
"Suppose we put the output directly into another transistor stage," continued Pete. "Since the input of this stage is a short circuit, all your signal will be 'shorted' directly to this stage through the coupling capacitor. In other words, all your output goes to the next stage.

"If both these transistors have a current amplification of 40, we can do some fairly accurate figuring. An input of 0.5 ma. will produce 20-ma. output. All of this goes to the second stage to be amplified, giving you a final output of 800 ma.—almost a full ampere."

"Wow!" Johnny exclaimed. "That's a lot of current!"

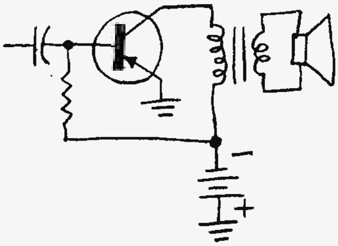
"A little too much current for comfort. To pass that amount of current, even in a power transistor, you'd have to be careful of heat effects.

This doesn't just mean mounting your transistors to dissipate heat—it means using special circuits to compensate for heat effects.



"For the time being, with the simple circuit we're using, it would be wise to keep your output signal to a quarter of an ampere or less. At this level, you can bring your d.c. bias down to about a third of an amp collector current, which is well within safety limits for a low collector voltage. If you use more than a couple of volts on the collector, keep an eye on your power ratings. And use a heat sink, of course."

"Pete, I still don't see how we're going to use that final output current. Do you connect a coupling capacitor to the speaker or what?"

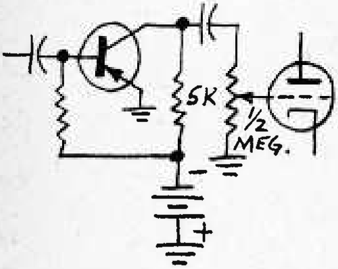


"You could do that, but you'd waste a lot of power. The easiest way to do it is to put the speaker directly in series with the collector, like this. But if the collector load is too *small*, there won't be enough voltage drop across it for appreciable power to be transferred to the speaker. Ohm's law, $W=I^2R$, (where W is the wattage delivered to the speaker, I is the collector current, and R is the speaker impedance) explains the problem.

"Get a transformer whose primary matches the collector load requirements and whose secondary fits the speaker, and you're in business."

Voltage Out

"Let's get back to your original question on figuring your output. If you're using a transistor as a preamplifier for a vacuum tube, you'll have to know your voltage out. This is really very easy when you think about it, because the input of the vacuum tube is usually high enough to ignore.



"In this diagram, the total transistor load is the 5000-ohm collector resistor shunted by a ½-megohm volume control. For all practical purposes, our output load is 5000 ohms. If our design shows we have a signal current of one milliampere on the collector, we use Ohm's law . . ."

"Don't tell me!" exclaimed Johnny. "That will be . . . ah . . . five volts!"

"You're sharp this morning. May I point out that if you want to use a transistor in this way—

and handle these levels—it would be common sense to put at least seven volts or so on the collector?"

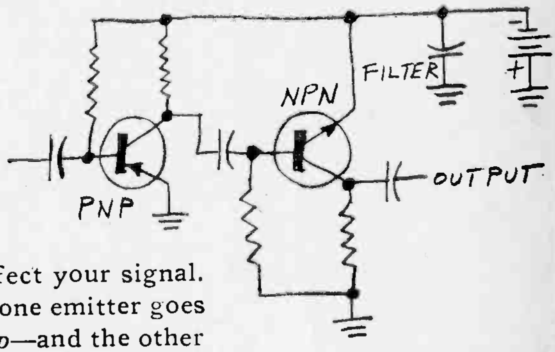
"I see what you mean, Pete. And I suppose it would also be a good idea to have at least one milliampere of d.c. current through the collector?"

"Right. Remember, of course, that a milliamp of a.c. will draw almost 1.5-ma. peak current, so you should allow a little extra. And that's just for pure sine waves—when you're figuring in terms of average music levels, leave lots of room for swing.

"Generally, it's best to choose your d.c. bias currents keeping in mind the a.c. signal voltages you want to handle," Pete went on. "And usually it's best to have at least 1 ma. of collector current, even at low levels. The reason for this is complex, having to do with impedances and distortion. We'll save this topic for another time."

N-P-N or P-N-P

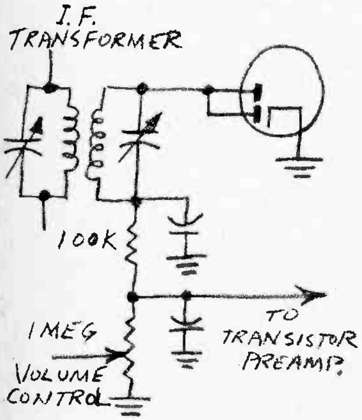
"You've probably noticed that all the transistors I've shown have been *p-n-p* types. As far as signal amplification goes, *n-p-n* transistors are exactly the same. Your signal goes into the base and comes out from the collector. Your connections for bias will be different, but that won't affect your signal.



"If you use both types together, one emitter goes to positive ground—that's the *p-n-p*—and the other emitter will go to your negative voltage supply. This is quite okay, since they are connected together signal-wise through the filter capacitor, making both emitters 'grounded.'

"Your bias currents are easy to set up on any of these stages. I've left the base and collector resistors unmarked, for two reasons. First, the size of these resistors depends on the battery voltage you are using. And, second, it will do you good to work out the values yourself using the techniques I showed you before."

Getting the Signal In



"Let's discuss the booster you tried your hand on, now. Where did you connect the transistor?"

"Across the volume control. I wanted to be able to turn the volume on the radio down and still feed my hi-fi."

"Well, let's sketch out a typical receiver circuit. Notice that the detector is designed to work into a very high resistance . . ."

"I see!" exclaimed Johnny. "The transistor booster would short out the volume control, and put a heavy load on the detector circuit. Well . . . how *can* I get the input impedance high enough so that it won't affect the circuit?"

"That's a story in itself, Johnny. The best way is usually to put a resistance in series with your input. But even though your radio isn't an a.c./d.c. job, you'll probably have hum problems if you try using a common ground. For the moment I'll say this: the best way will probably be to use an input transformer that matches from 500K down to about 100 ohms.

"In the meantime, dust off some of those old transistors and see if you can put them to work. A lot of design 'failures' result from the experimenter forgetting to take into account the very low impedance of transistors.

"Look me up when you've digested this session and I'll show you how to check out some of the transistor design parameters, and incidentally how to test the little gadgets."

Part III
Controlling, Coupling and Testing

It was a week later that Johnny once again sauntered down the stairs into Pete's basement workshop. Pete looked up from a small amplifier he was wiring. "How's tricks, Johnny?"

"I'm just a little confused, Pete. All this dope you've been giving me on transistors is hard to digest so fast. For example, you said that the input is a short circuit. Well, the *Radio Amateur's Handbook* has a table of specs for quite a few transistors, and for the 2N107 they say . . ."

"They told you the input impedance was around 600 ohms, I bet. Well, in a sense we're both correct. Here, Johnny, look at it this way—you've done a fair amount of wiring. How much resistance would you say there is in hookup wire?"

"I never thought about it. Oh . . . maybe a half an ohm a foot . . . but it doesn't make much difference to the circuit."

"Why not?" demanded Pete.

"Because even if the resistance were as high as an ohm or two, it's usually so much smaller than any other resistance in the circuit that you don't count it. Who cares about half an ohm or so when you're dealing with resistors of several thousand ohms?"

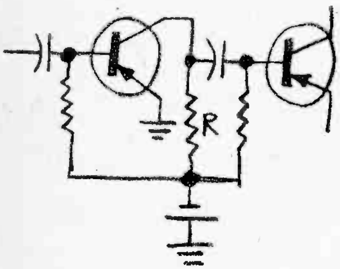
"Right you are, Johnny. And the same thing goes for your question about a transistor input impedance. Even at six hundred ohms, it's so much smaller than any other resistance in the circuit that you can count it as a short."

Short and Simple

"It's very simple to figure out a circuit this way, too. Using the short-circuit input approach, you eliminate most of the calculating."

"But wouldn't that make your calculations inaccurate? You couldn't get the exact values of gain. You'd have to be a few per cent off."

"Look at it this way, Johnny. To begin with, transistors are never rated exactly. A transistor with a rated gain of 20 might have an actual gain as low as 10 or as high as 40. So, fancy calculations usually aren't worth the trouble."



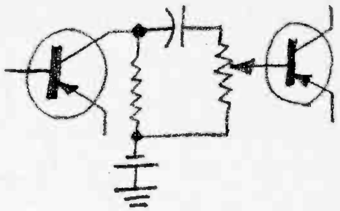
Johnny nodded. "True. But let *me* draw *you* a circuit. Now, if the voltage supply were very low —such as a single dry cell—then the collector resistor *R* would have to be small enough so that it didn't drop all the battery voltage. Wouldn't that mean . . . ?"

Pete chuckled. "Johnny, you're too sharp for me today. Yes, that would mean your small collector resistor would prevent some of the signal from getting to the next stage. Not only would amplification be poor, but the low resistance would call for some mighty hefty coupling capacitors. And to put another fly in the ointment, as soon as your signal began to get lost in the resistor, distortion would increase sharply. But don't worry—unusually low voltages are almost the only cause of such a situation."

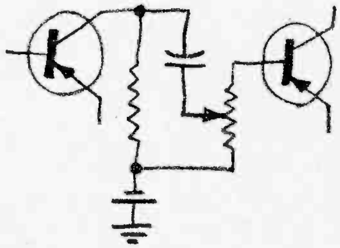
"Pete, you lost me. I guess I still don't dig this whole low impedance input idea."

"You've been brainwashed by vacuum-tube theory, Johnny—you've got to learn to rethink the problems. Let's look at some volume controls."

Volume Control

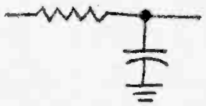


"A vacuum-tube circuit volume control transferred to a transistor circuit would look like this. Whereas a tube draws almost no grid current, the base input of the transistor does—and right through the control. You can see how moving the "pot" arm up and down is not only going to tap off a part of the signal current, which is what we want it to do, but unfortunately it's also going to change the value of the base bias resistor. A volume control with no problems looks like this.

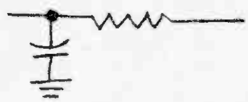


"If you run into volume control problems such as distortion at low volume, abrupt changes in volume as you move the control, or just excessive noise from the control, check to make sure that you're not goofing up the bias in some way and that there isn't too much current flowing through the control."

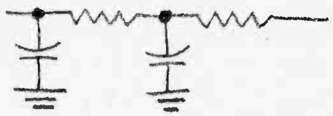
Capacitors—Filtering and Coupling



"You'll find that transistor filter circuits, too, have to be approached differently," Pete continued. "Here's a typical tube low-pass filter. A transistor input following the filter would short out the capacitor, making it useless.



"We'll redraw the circuit for transistor use like this. It could function as a scratch filter or a simple equalizer for a magnetic phonograph cartridge. The values, of course, depend on the use."



"Could I put two filter sections together, like this?" asked Johnny.

"You sure could. That will give you a sharper frequency cutoff."

"Looks like all you have to do to adapt a vacuum-tube circuit for transistors is turn it end for end."

"That's partly right, Johnny. But it applies only to coupling circuits between transistors, and it won't always work. Remember to make the resistances smaller and the capacitances larger than with tubes. And check out your circuit *practically* after you work up the design."

"Speaking of capacitors, Pete, I've been meaning to ask you: how do you figure the size of your blocking capacitor?"

COLLECTOR RESISTOR	BLOCKING CAPACITOR
2K	4 MFD.
4K	2
8K	1
10K	0.8
20K	0.4

"Match it to your collector resistor, usually. You know the formula—it goes, '*C* equals 1 over . . .' "

"Ouch! Spare me those formulas!"

"Tarnation!" grumbled Pete. "If you ever want to get anywhere in electronics, you'll have to start using formulas. Things are getting too complicated for anyone to get along with a wet finger and a screwdriver.

"This time I'll give you a break. Here's a table for you. I've rounded off the values for a frequency response down to about 20 cycles."

Test Techniques

Johnny looked at his watch. "Pete, I'll have to run soon. But first, you told me last time that you'd give me the low-down on how to test transistors."

"Well, it's fairly easy. A nice thing about transistors is that they usually *don't* gradually deteriorate—they burn out. And you can spot almost all faults real quick by two simple tests: leakage and again.

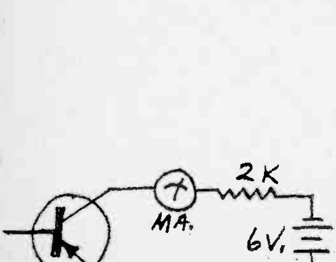
"This makes the transistor easy to check—no fancy testers needed. Just select *n-p-n* or *p-n-p,* check for leakage and current gain . . . and that's it!"

"Just how do you make these tests, Pete?"

"Easy. Let's take leakage. If I leave the base of a transistor disconnected, current can't flow through the other two leads. The transistor is just two diodes, back to back; so one of them will block the current flow.

"Practically, this isn't quite true. A small leakage current will flow—usually less than a tenth of a milliampere for most low and medium power transistors. A reading over 1 ma. means your transistor has 'had it'.

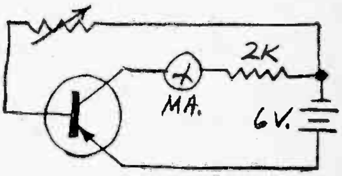
"So, to test for leakage, just place about six volts across the emitter and collector, using the normal polarity for the transistor type. A milliammeter with a range of anywhere from 1 - 10 ma. will do the trick. And for the protection of the meter, it's a good idea to add a 2000-ohm series resistor. This won't affect the accuracy of the test.



"Testing for gain is just as simple. Think back to our first talk. Whatever current is put into the base of a transistor appears multiplied by the amplification factor (*beta*) in the collector circuit."

"Of course," exclaimed Johnny. "All you have to do is put a milliammeter in the base circuit, another in the collector circuit—and you can see your amplification!"

"You can do it even easier than that," replied Pete. "With an exact known current in the base, you need only one meter in the collector, which you can calibrate to read directly in gain, if you wish. The ratio of the collector current to the base bias current gives you your gain figure. An open element, of course, gives you a zero-gain reading, as does a base-to-emitter short.



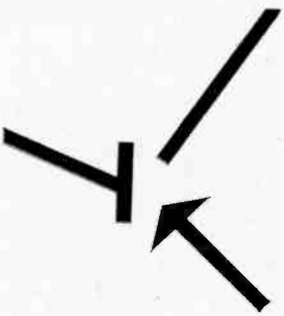
"If a transistor's *beta* reads low, don't throw it out. Remember, you're *not* working with vacuum tubes where low gain usually means that the tube is wearing out.

"Power transistors are checked in the same way —but you'll find much more leakage, sometimes as high as 10 ma. Because of this, it's easiest to check this type at much higher current levels.

"Transistor testers are quite inexpensive. Kit models are available, and it's a lot easier to build yourself a finished tester than it is to rig up a circuit every time you want to check a transistor.

"And another thing. You'd better learn how to use a little math! Those formulas are there to help you. Dust off an old textbook, and . . ."

"Yes, sir! Just as you say, sir! I'm on my way right now!" Johnny seized the pile of circuit sketches and ran up the stairs. He waved back. "Thanks, Pete. See you later!"



Working With Transistors

On the following 10 pages are transistorized construction projects. Pete and Johnny's previous discussion should help you understand what happens in these circuits.

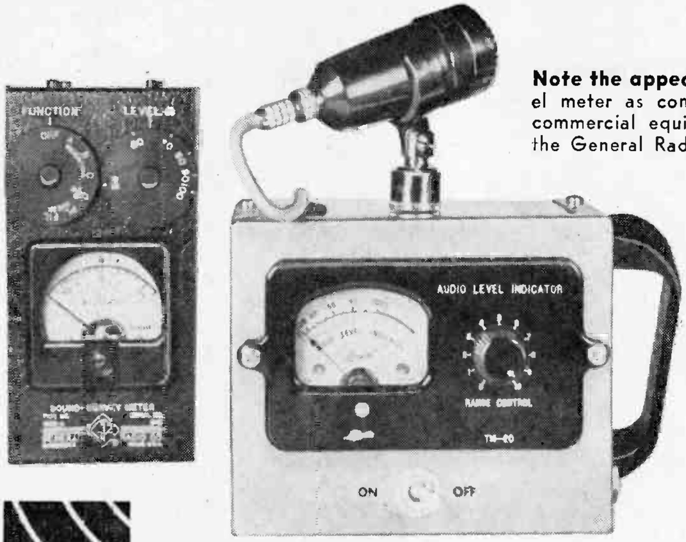
Build This Transistorized SOUND LEVEL METER

by
HARRY KALBE

The sound level meter is a device for measuring the intensity of sound. Typically, it consists of a microphone, a high-gain amplifier and an a.c. meter. The circuit is so designed that the deflection of the meter is proportional to the amount of sound reaching the microphone.

For the audiophile and experimenter, the sound level meter has innumerable applications. Here are just a few examples of the uses to which it may be put: (1) balancing the sound issuing from each speaker of a stereo system; (2) measuring the noise level in the listening room; (3) measuring the loudness of the hi-fi two rooms away; (4) determining the effectiveness of sound absorbent material on a wall; (5) measuring the noise output of a particular piece of machinery and determining how much lubrication decreases that noise output; (6) measuring the noise level inside the famliy car; (7) using it as an applause meter; and (8) determining the best speaker placement in the living room.

Commercial sound meters are high-precision, and therefore costly, instruments. Thus, their possession by an amateur is rare. However, the uses to which the average individual may put his sound meter will not demand the high precision of the professional instrument. It is not necessary for



Note the appearance of this sound level meter as compared to the precision commercial equivalent manufactured by the General Radio Co. shown at its left.

the non-professional to measure the absolute value of sound intensity; his concern is the measurement of relative differences between sound levels. In this area the inexpensive meter described here (total cost is about $17.00) is more than adequate.

Completely contained in a 5"x4"x3" Bud Minibox, and battery-powered, this sound meter is portable and easy to operate. Use of a commercially available audio level indicator eliminates a costly meter and meter rectifier, and has the added advantage of providing a built-in 20-db attenuation control. The cost is further reduced at the input end by using an inexpensive high-impedance dynamic type of microphone. Any one of a number of mikes can be tried.

Actually the only real construction involved in the assembly of the sound meter is the two-transistor amplifier strip. The two high-gain low-noise transistors provide enough output to peg the meter with a hoarse whisper two feet away from the microphone.

Construction is started by preparing the case. Placement of components is not critical and you can use the photographs as a guide in cutting the chassis.

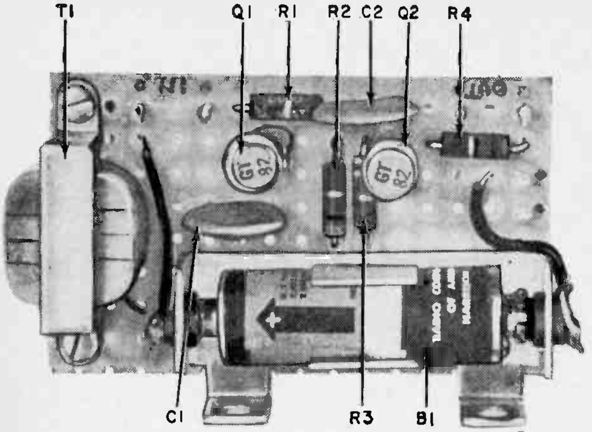
Lay out the 3⅞"x2" rectangular hole on the larger section of the Minibox with a scribe. Drill a ½" hole in each of the corners of the rectangle and use a hacksaw blade and file to cut out the rest of the rectangle. (Use of Greenlee rectangular chassis punches would greatly facilitate this job and make for neater holes.) Then drill a ⅛" hole on each side of the rectangle for the mounting screws of the audio level indicator. (The indicator front panel is removed from the plastic cabinet.)

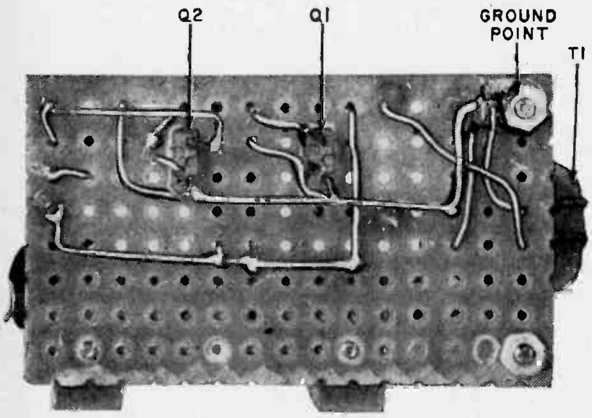
The on-off switch is mounted in a ½" hole centered directly beneath the audio level indicator hole. Provide two centerline ⅛" holes on one of the side panels for the mounting of the amplifier strip. On the other side panel drill a ⅜" hole for the phone jack and two ⅛" holes for the handle. Only two holes are drilled in the second section of the case: a centered ½" hole for the microphone and a ⅜" hole for the microphone cable.

For that professional look, we painted the case and applied Walsco decals.

The transistor amplifier construction is clearly shown in the photographs. The base for the amplifier is a 2⅞"x1⅞" piece of perforated phenolic board. Simply mount the parts by running their leads through the perforations and solder the necessary connnections on the reverse side.

We mounted sockets for the transistors





Front and back views of transistor amplifier board. The small brackets are used to mount it to the side of the cabinet. Parts placement is not critical but should follow a logical order from input to output. Certain microphones may not require transformer T1 for proper match to the input impedance of transistor Q1.

PARTS LIST

B1—9-volt battery (RCA VS309)
C1, C2—0.1-µfd., 60-volt ceramic disc capacitor
J1—Phone jack
R1, R4—1 megohm
R2—5600 ohms
R3—6800 ohms
All resistors ½-watt composition
Q1, Q2—GT-82 transistor
S1—S.p.s.t. toggle or slide switch
T1—Input transformer (Argonne AR-141)
MIC.—High-impedance dynamic microphone (Lafayette PA-48 or equivalent)
1—Audio level indicator (Lafayette TM-20 or equivalent)
1—5" x 4" x 3" chassis (Bud Minibox)
1—2⅞" x 1⅞" perforated phenolic board
2—Transistor sockets
1—Battery bracket for B1

but they are not necessary. The leads of the transistors may be run through the holes in the board and connections soldered directly to them. Be sure to use a heat sink and solder as quickly as possible, since transistors are very easily damaged by excessive heat.

If transistor sockets are used, enlarge two adjacent board holes with a ⅛" drill and cut the proper size rectangle with a small file (a nail file will serve nicely). The two small mounting brackets are mounted with the same bolts used to hold the battery holder.

Be careful to observe the polarity of the battery to avoid damaging the transistors. Flea clips used at the amplifier input and output make for neater construction and facilitate connections to the microphone and audio indicator.

Using the meter is a simple operation. Just flip the switch to the *"on"* position and point the microphone toward the sound source.

For example, to use it as an applause meter, point the microphone toward the audience and have everybody applaud as loudly and evenly as possible. Now adjust attenuation for full scale deflection, which corresponds to 100% audience response. Subsequent applause will correspond to meter deflection.

To balance a stereo system, feed a constant signal into one channel and note meter deflection at the desired listening level. Then feed the same signal into the

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0Z4	.45	6AL5	.43	6DE6	.43	12BE6	.46
1B3GT	.62	6AM8	.59	6DG6GT	.50	12BH7	.61
1R5	.51	6AN8	.64	6DQ6	.89	12BQ6	.63
1S5	.43	6AQ5	.48	6H6	.47	12BY7	.65
1T4	.51	6AS5	.52	6J5	.49	12CR6	.43
1U4	.51	6AU4GT	.50	6J6	.61	12CU6	.63
1U5	.43	6AU5GT	.60	6K6GT	.39	12DB5	.59
1X2	.62	6AU6	.43	6S4	.41	12DQ6	.63
2AF4	1.02	6AV6	.37	6SA7	.45	12K5	.44
2BN4	.55	6AW8	.50	6SC7	.54	12SA7	.45
3AU6	.43	6AX4GT	.60	6SK7	.45	12SK7	.45
3BC5	.58	6BA6	.56	6SL7GT	.60	12SN7GT	.56
3BN6	.90	6BA8	.49	6SN7GT	.60	12SQ7	.38
3BZ6	.45	6BC5	.48	6SQ7	.38	12V6GT	.43
3CB6	.51	6BC8	.59	6T8	.71	12L6GT	.43
3DT6	.51	6BE6	.46	6U8	.76	12W6GT	.43
3V4	.48	6BF5	.48	6V6GT	.48	17DQ6	.68
4BC8	.69	6BG6G	1.18	6W4GT	.43	19AU4	.60
4BQ7	.75	6BH6	.51	6W6GT	.53	19BG6G	1.48
4CB6	.51	6BJ6	.51	6X4	.37	25BQ6GT	.82
5AM8	.59	6BK5	.75	6X8	.75	25CD6G	1.19
5AN8	.64	6BK7	.78	7AU7	.53	25CU6	.82
5AT8	.54	6BL7GT	.78	8CG7	.54	25L6GT	.41
5AV8	.54	6BN4	.44	8CM7	.54	25W4GT	.43
5BK7	.68	6BN6	.90	9U8	.79	25Z6GT	.36
5J6	.61	6BQ6GT	.83	10DE7	.49	35B5	.48
5T8	.59	6BQ7A	.85	12AB5	.44	35C5	.48
5U4G	.43	6BY5G	.75	12AF6	.44	35L6GT	.41
5U4GA	.45	6BZ6	.45	12AT6	.37	35W4	.33
5U4GB	.45	6BZ7	.95	12AT7	.71	35Z5GT	.33
5U8	.59	6C4	.41	12AU6	.43	50B5	.48
5V4G	.49	6CB6	.51	12AU7	.58	50C5	.48
5X8	.55	6CG6G	1.63	12AV6	.42	50L6GT	.50
5Y3GT	.30	6CF6	.45	12AV7	.73	117Z3	.33
6AB4	.43	6CG7	.44	12AX4GT	.60	117Z6GT	.65
6AC7	.65	6CH8	.54	12AX7	.61		
6AF4	1.02	6CM7	.44	12AZ7	.65		
6AG5	.52	6CS6	.45	12B4	.52		
6AH6	.47	6CU6	.95	12BA6	.46		

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6BQ5	.74
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6CX8	.64
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1H4G	.39	7C5	.44
1LA6	.66	7F8	.77
1LB4	.69	7H7	.51
1LH4	.66	7N7	.52
1LN5	.66	7V7	.82
3LF4	.66	7Y4	.35
5T4	.59	7Z4	.40
6A6	1.00	12A8GT	.45
6A7	.59	12K7GT	.40
6A8	.40	12Q7GT	.48
6AB7/1853	.60	12SR7	.57
6AQ7GT	.60	14A7	.43
6AS7G	1.50	14B6	.36
6D6	.59	14Q7	.52
6F5GT	.44	27	.45
6F6	.42	35A5	.48
6S7G	.89	35Y4	.35
6SB7Y	.50	37	.59
6SR7	.43	39/44	.39
6U5	.54	45	.55
6U7G	.40	50A5	.48
7A4/XXL	.47	50X6	.53
7A6	.47	56	.48
7A8	.46	71A	.65
		75	.44
		77	.55
		80	.40

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6J4	1.25	5675	12.25
12A6	.60	5879	1.10
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16DP4	11.99	19AP4	18.25	24ADP4	*
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16KP4	11.95	21ACP4	21.95	24TP4	*
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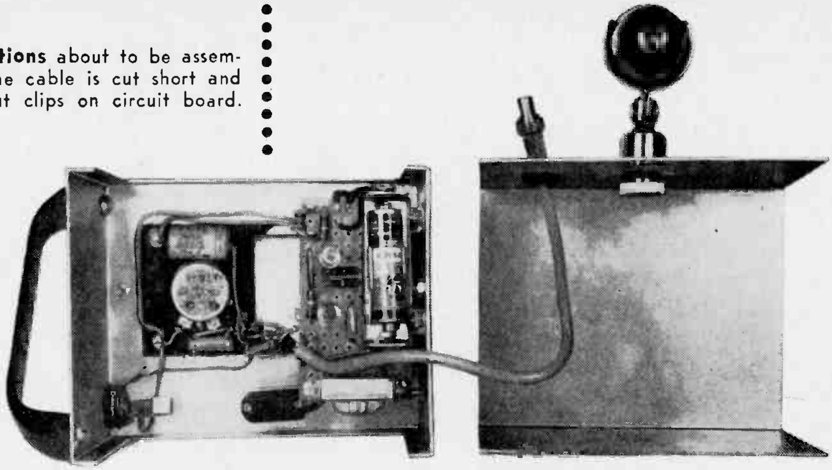
DEPT. EH-2

Completed sections about to be assembled. Microphone cable is cut short and soldered to input clips on circuit board.

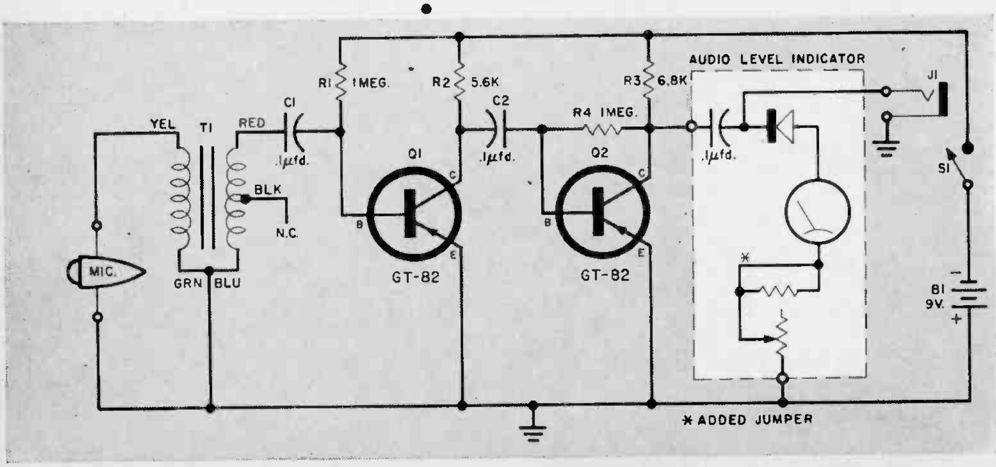


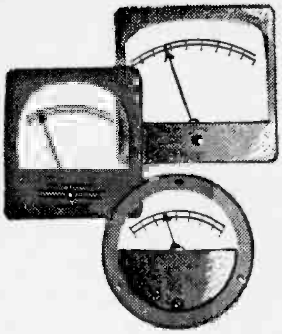
other channel and adjust the second channel gain to give the same meter deflection as the first.

To measure decibels, the sound meter must be calibrated against another previously calibrated sound level meter (such as General Radio Type 1551-A). Place the two instruments as close together as possible with both microphones pointing toward an adjustable sound source. Set the standard meter to its lowest range and adjust the sound source for full scale deflection. Now adjust the attenuator of the second meter for full scale deflection, noting the attenuator setting and the db reading on the standard meter to which it corresponds. The same procedure is repeated for the higher ranges of the standard meter.

As we mentioned earlier, calibration is not necessary for most applications. The meter's greatest value is realized in making comparative measurements. In order to do this, simply note meter deflection for each of the sound sources being compared. If you want to express the sound intensity of one source in terms of another, use the formula: $D1/D2 \times 100$ = the percentage $D1$ is of $D2$; where $D1$ and $D2$ are the meter deflections given by two different sound sources.

Part of schematic shown in white is audio level indicator described in text. Output jack J1 is optional; if used, connect it between the built-in 0.1-μfd. capacitor and the rectifier.





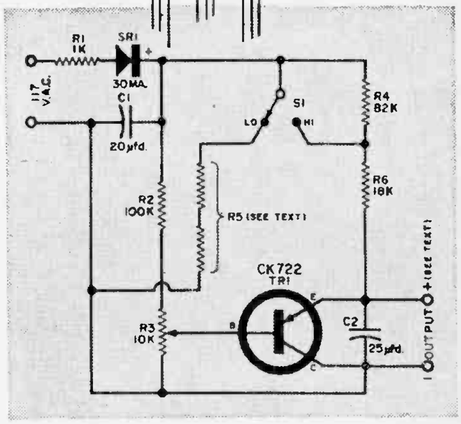
Transistor Test Power Supply

One of the handiest little units around the shop when you are working on or designing new transistor circuits is a variable low-voltage, low-current power supply. This unit supplies 0-9 volts in two current ranges, 0-0.8 and 0-4 ma. With current drain above these values (0.83 ma. on low and 4.15 ma. on high), the voltage drops to zero. An accidental short circuit across the output terminals does no damage and the voltage can be varied at will.

Standard components are employed and their arrangement is not critical. A pointer knob is used on voltage control potentiometer *R3* and the panel is marked from 0 to 9 volts in 1.5-volt steps. Calibration is accomplished by connecting a VTVM or other *high*-input-resistance voltmeter across the output terminals. *R5* serves as a shunt on the low range so that the voltage scale for both current ranges will coincide.

Resistor *R5* should be the last part wired in. Its operation is checked by connecting a voltmeter across *C1* with the output terminals shorted. *R5* is then selected using two 1-watt resistors whose combined value achieves the smallest shift in output voltage when the current range is switched.

Set *S1* for desired current range, set *R3* to zero, and connect the device to be powered. *R3* is then reset to the desired voltage value. The voltage knob should never be turned quickly to zero as the charge on capacitor *C2* could overload the transistor.



This circuit can be constructed on any type of chassis. Built-in current limiting factor prevents transistor burn out. C1 is a 150-volt unit; C2, 25 volts.

This instrument is used only to find the voltage required to operate the circuit under test correctly and not damage it with excess voltage or current. An isolation transformer, such as the Lafayette TR-91, could be added for safety. If a transformer is used, omit *R1*.

CONTROL SETTING	OUTPUT VOLTAGE							
9.0	8.95	8.90	8.80	8.25	8.85	8.70	8.50	8.20
7.5	7.45	7.40	7.35	7.20	7.40	7.25	7.10	6.90
6.0	5.95	5.90	5.85	5.80	5.90	5.75	5.55	5.40
4.5	4.47	4.43	4.40	4.30	4.40	4.30	4.20	4.05
3.0	2.97	2.94	2.90	2.80	2.93	2.86	2.80	2.70
1.5	1.48	1.46	1.43	1.38	1.45	1.40	1.35	1.25
CURRENT DRAIN (ma.)	0.2	0.4	0.6	0.8	1	2	3	4

By

R. B. DODSON

Pocket Marine Receiver

Monitor the marine communications band with this three-transistor midget

By
J. E. PUGH, Jr.

For you experimenters with salt in your veins, here's a pocket receiver to cover the 2.0 to 3.0 mc. marine communications band. And if you happen to be a "landlubber," this three-transistor regen job can easily be converted into a good broadcast receiver.

A small plastic case serves to house the receiver, with the detector and battery in one cover and the audio section in the other. Besides keeping the antenna away from large metal parts and arranging the various components for minimum crowding, there is nothing critical about the layout.

Locate all mounting hole positions and punch carefully with a sharp-pointed scribe. Drilling should be done very slowly to avoid chipping the plastic. The holes for the tuning capacitor shaft and phone jack (*J1*) are carefully enlarged with a tapered reamer or a jeweler's file. The large hole for the volume control knob is made the same way.

Before mounting the tuning capacitor, cut the shaft off to a convenient length; but don't make it too short.

The earphone jack shown (*J1*) is an RCA

PARTS LIST

B1—1.5-volt battery (Burgess Type 7) and bracket
C1—50-μμf. silver mica capacitor
C2—10-365 μμf. miniature tuning capacitor (Lafayette MS-274 or equivalent)
C3—8-60 μμf. miniature trimmer capacitor (El Menco 404 or equivalent)
C4—.05-μf. miniature capacitor
C5, C6—2.0-μf., 6-volt electrolytic capacitor
J1—Phone jack
L1—Ferrite loop antenna (Miller 2004, modified as stated in text)
Q1—2N274 transistor
Q2, Q3—2N406 transistor
R1—1200 ohms
R2, R4—1800 ohms
R3—12,000 ohms
All resistors ½-watt
R5—10,000-ohm miniature volume control with s.p.s.t. switch (Lafayette VC-43 or equivalent)
R6, R9—220,000 ohms
R7—22 ohms
R8—4700 ohms
S1—S.p.s.t. switch (part of R5)
T1—20,000 to 1000 ohm interstage transistor transformer (Argonne AR-104 or equivalent)
Phones—High-impedance magnetic type (Trimm, 24,000 ohms, or Lafayette MS-260)
1—2⅞" x 2" x 1" plastic box
1—Tuning dial to fit C2
1—⅜" o.d. x 5/32" i.d. shouldered fiber washer
Misc. screws, washers, nuts, wire, rosin-core solder

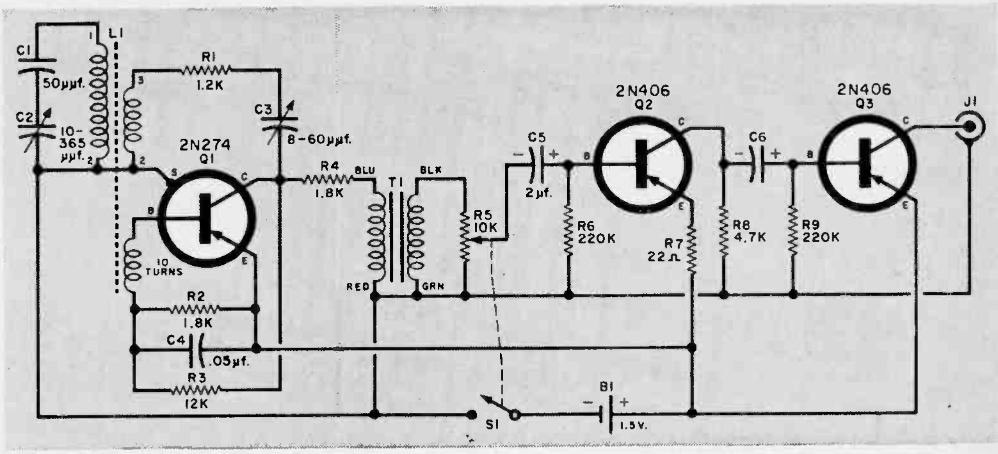
the other components) can be assembled on the plastic terminal strip before being mounted in the case. Most of the detector can also be preassembled.

The antenna (*L1*) is a flat ferrite loop that fits in the case nicely. It is modified by carefully removing all of the original winding between terminals 1 and 2 and then rewinding 48 turns of the same wire spread evenly over 1⁵⁄₁₆". The section between terminals 2 and 3 remains untouched.

Now wind 10 turns of #30 or #32 wire over the section between terminals 2 and 3, and fasten everything down securely with a

HOW IT WORKS

This simple regenerative detector, which tunes over the 2.0 to 3.0 mc. marine communications band, is compensated for nearly constant regeneration by *R1* and *R4*. Chance of over-driving the detector by strong local signals is minimized by a small amount of automatic gain control. Transformer *T1* gives good coupling between *Q1* and *Q2* with minimum loss of signal strength. High-impedance magnetic headphones load the output stage properly for maximum output.

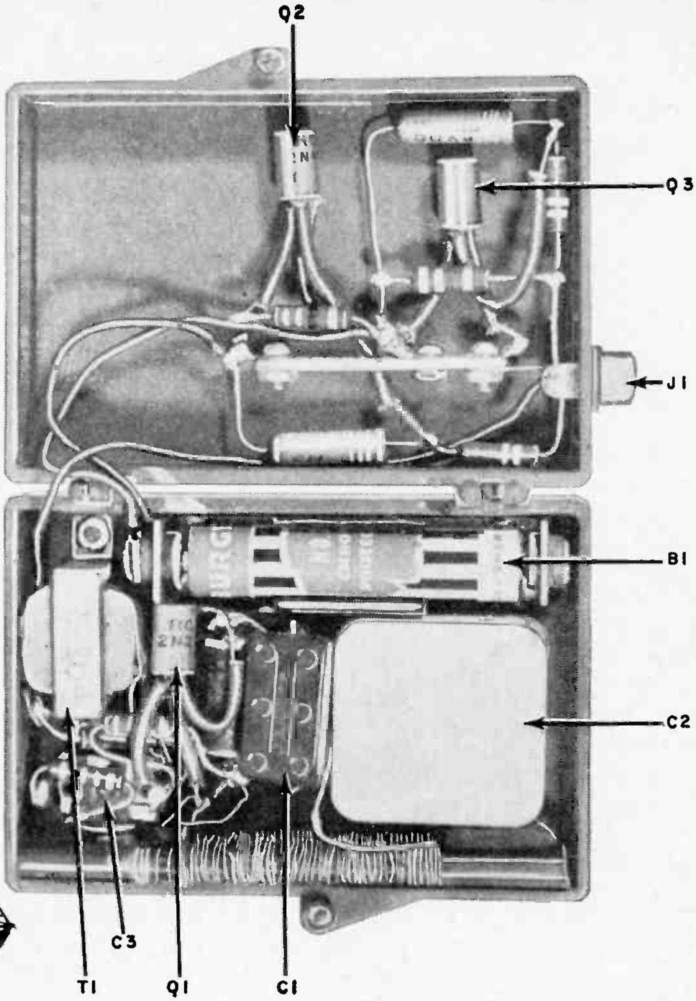


type phono jack, but it could be one of the miniature phone jacks. A thin strip of plastic is mounted on the solder lug of *J1* for use as a tie strip for the audio amplifier section.

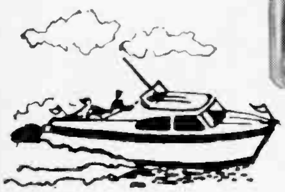
In cases where the outside noise level is high (the usual case in most motorboats), ordinary padded headphones will be best, as both ears will be covered and used. Otherwise one of the small single earphones will be suitable.

Most of the wiring should be done outside the case to avoid melting the plastic with your soldering iron. For example, the entire audio amplifier section (*Q2*, *Q3* and thin coat of coil dope or wax. When you are soldering this added 10-turn winding into the circuit, reverse the two leads if regeneration is not obtained.

The original antenna winding is litz wire and the ends are pretinned. Where the leads need to be shortened, the ends must be cleaned and carefully retinned. The easiest way is to remove the cotton covering and dip the wire in solder paste. Heat thoroughly with the soldering iron, using plenty of solder and paste. This will remove the enamel very effectively and tin the wire ends. After tinning, wash all traces of the paste off with alcohol to prevent corrosion.



The receiver's detector stage, battery and interstage transformer are mounted in one cover of plastic case (bottom) and the amplifier stages in the other cover.



(For any soldering other than this tinning operation, never use solder paste. *Always* use a good grade of rosin-core solder.)

If you want to build the receiver for the broadcast band, simply wind the 10 turns on the antenna as above but leave the original windings untouched. Eliminate capacitor *C1* and that's all there is to it, except for possibly changing *R4* for best regeneration balance.

The antenna is held in the case with small rolls of rubber tape placed between it and the case and the tuning capacitor. Adjust the tension by adding more turns to each roll of tape.

Mount regeneration capacitor *C3* in the case by removing its adjustment screw and inserting it through a hole provided in the case. A small flat washer is placed between the screw head and the plastic case to reduce friction. Put a drop of light machine oil between the screw head and the washer and another on the screw threads. After *C3* is fastened into position, a small, snug-fitting shouldered fiber washer cemented to the screw head serves as a knob for dial tuning.

Calibration and adjustment of the tuning dial is accomplished by covering the original BC band markings with white tape and using an r.f. signal generator (2 to 3 mc. range) to establish the new scale markings. Keep the regeneration control of the receiver just below the oscillation point for the greatest accuracy.

Include any special frequencies that you want but be sure to mark the international calling and distress frequency at 2.182 mc.

If desired, the tuning range can be widened by increasing *C1* slightly and spreading the end windings on *L1* slightly. To narrow the range, decrease *C1* and compress the *L1* windings.

After the correct tuning range is obtained, check that regeneration is balanced on both ends of the tuning range. It will normally rise near the center of the band and drop off slightly on the ends. If the high end drops off too much, increase *R4*; decrease it if the regeneration at the high end is greater than at the low end.

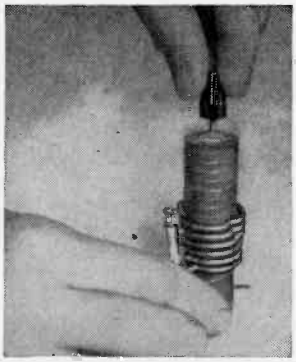
Both phone and code stations can be heard on the marine communications band, the c.w. stations being received with the regeneration control turned up to the oscillation point.

In most cases the reception ranges will be good, but not great, because most marine transmitters have fairly low power and low antennas. However, where the transmitter power is high, very good results can be obtained. For example, at night WWV at 2.5 mc. is easily received at a distance of 1000 miles.

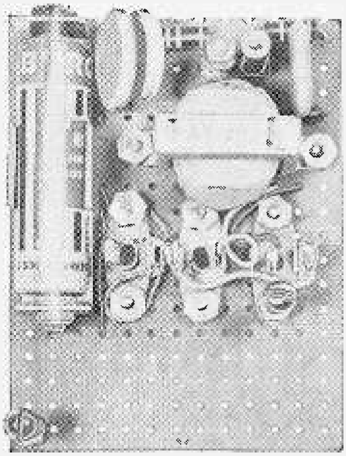
If the receiver is built for the broadcast band, its sensitivity will be about the same as that of any other regenerator. Its chief advantage lies in its being usable with a minimum of regeneration adjustment. So far as local broadcasts are concerned, the regeneration control should need no adjustment for good reception over the entire band.

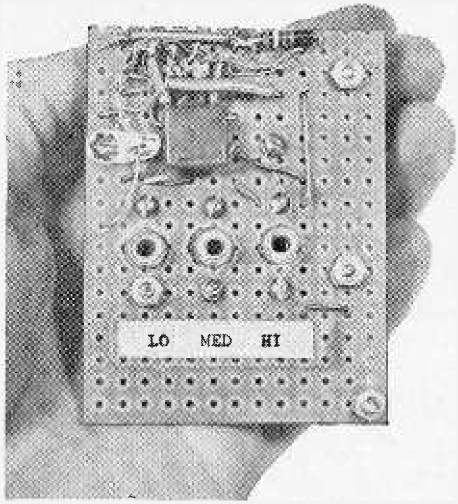
KNOBS FOR SLUG-TUNED COILS

Solderless connectors make neat miniature knobs for the threaded shafts of slug-tuned coils. Experimenters and builders who use slug-tuned coils and transformers in miniaturized transistor radios for tuning and station selection will find these solderless connector knobs very helpful, since ordinary knobs won't fit the threaded shafts.—*Joseph A. Carroll, Brooklyn, N. Y.*

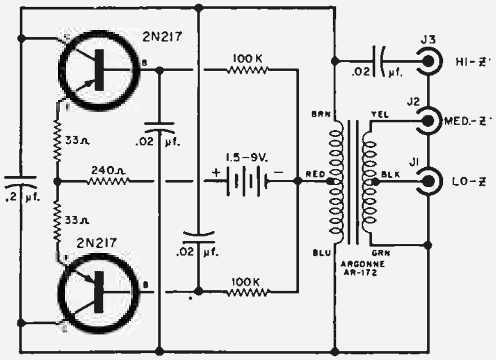


Sine-Wave Test Generator





By
R. ZARR



	1.5V.	9V	Z
J1	.1	6	20
J2	.35	2.0	200
J3	1.00	6.0	2000

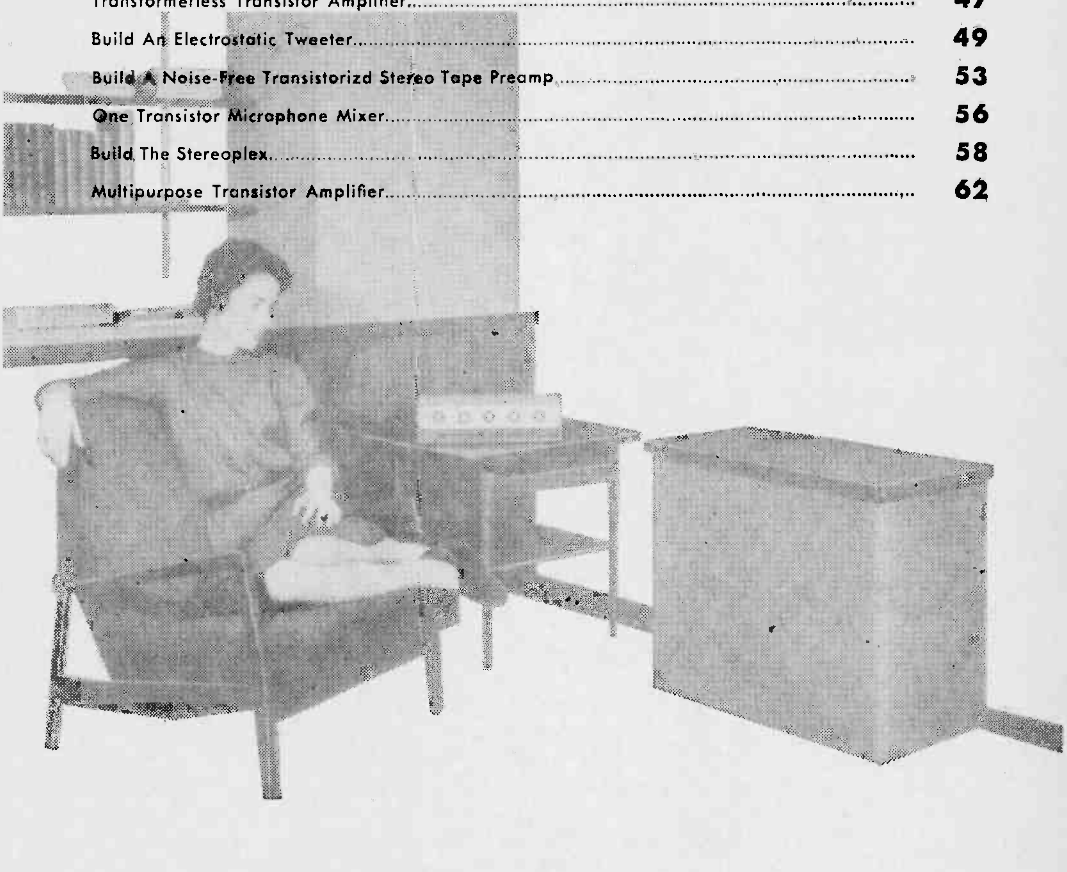
Many transistorized audio oscillators have been built and described, but few can boast a really pure sine wave. This Hartley oscillator circuit generates an undistorted 2-kc. signal suitable for operating bridges, hi-fi testing, filter experiments, etc. The push-pull feature eliminates even harmonics, increases the output to 5 mw., and reduces distortion. A choice of three distinct output impedances and voltages are available.

Listed below the schematic diagram are the approximate no-load voltages and output impedances for a 1.5-volt and a 9-volt battery supply. The drain is only 1.5 ma. with a penlight cell supply; it is 9 ma. with a 9-volt battery. Note the very low impedance at *J1*—nearly any low value of load can be connected here without appreciable voltage loss.

Components are not critical as to layout or value. Only the 240-ohm resistor may need adjustment; if it is too low for the transistors the waveform may suffer somewhat, and if it is too high the output will fall off. Frequency of operation can be lowered if desired by adding capacitance across the .2-μf. capacitor.

The two RCA 2N217 transistors have flexible leads and fit into adjacent pins of a 7-pin in-line socket—each transistor uses three pins with the center pin unoccupied. For the battery supply, the author employs a holder into which a "Z" penlight cell can be slipped for low power or an RCA VS309 (9 volts) for high power.

SECTION II: Component Hi-Fi Projects



Build the Reflex 12

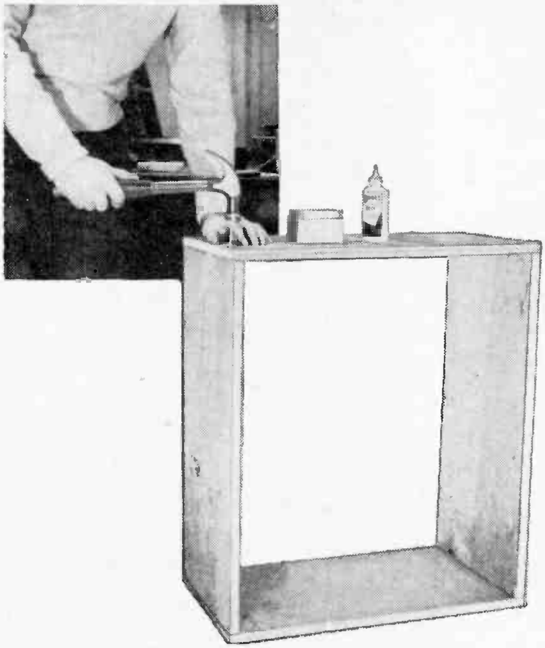
Friction-loaded enclosure provides excellent performance with low-resonance speakers

By DAVE GORDON

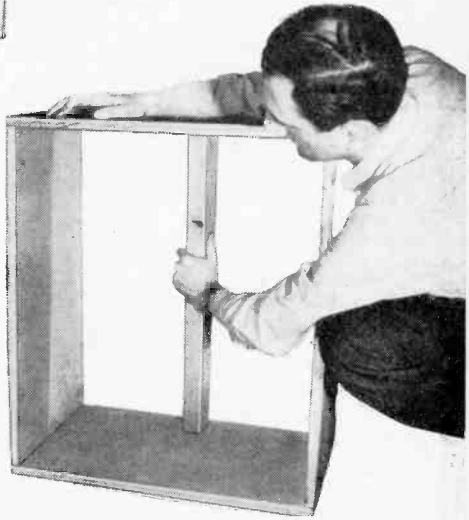
A well-designed bass reflex speaker system is constructed in such a way that the Helmholtz resonance of the air within the cabinet cancels out the electro-acoustic resonance of the loudspeaker. However, resonance caused by panel vibration is another question altogether. A great deal of the "muddy" bass response characteristic of the lower priced or homemade speaker systems which is usually blamed on the speaker is actually due to the panel resonance of the cabinet.

There are various techniques of minimizing panel vibration. One authority advocates solid brick enclosures or, if that proves unfeasible, sand-filled panels. Others suggest the use of 1¼" plywood construction—liberally screwed, glued, and cleated. All these ideas work well but their sheer weight eliminates them from the living rooms of most households.

Luckily for those of us with thin "modern" floors in our homes, very good vibration reduction can be achieved by the use of well-arranged internal bracing—at a considerable



1 Sides, top and bottom of enclosure are assembled using a good wood glue and 8d (penny) finishing nails. All joints are butted with five or six nails per joint. Design of cabinet makes use of cleats unnecessary.

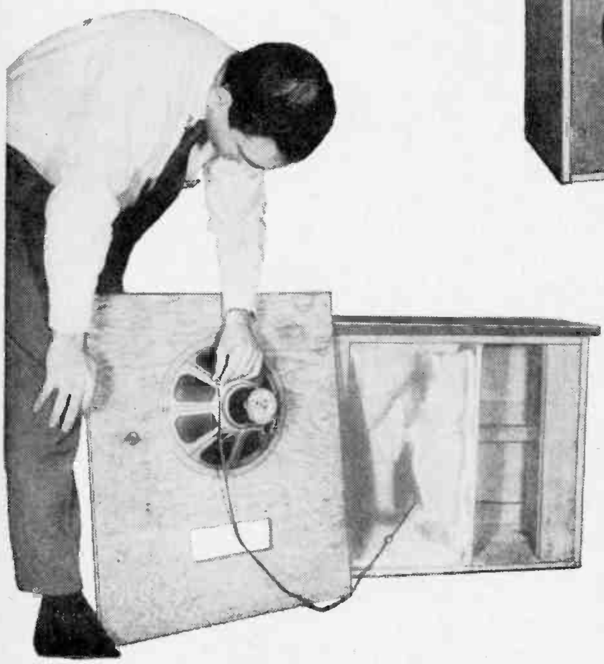


2 Rear 2" x 4" brace is placed with narrow side flush with rear edge of top and bottom panels. Two #8 flat-head wood screws and glue should be used at each end to hold 2" x 4" brace in position.

3 After back panel is glued and nailed in place, 2" x 4" cross-braces are installed. Wood screws and glue are used to tighten rear panel to the 2" x 4" rear brace and to secure cross-braces. Cracks should be calked with wood putty to prevent air leaks.

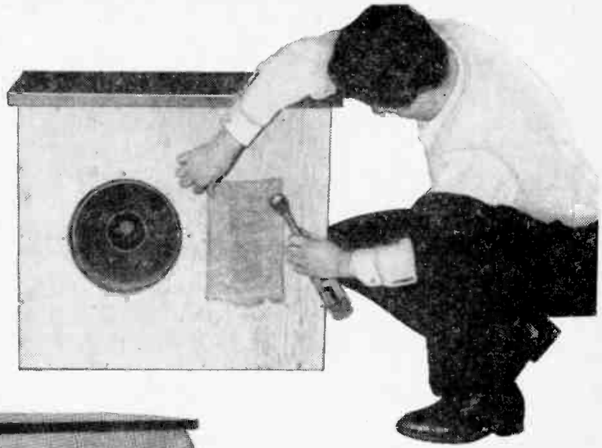
4 Cabinet divider is fitted next. Exact angle is unimportant, but it should not be mounted parallel with top panel. Glue and two wood screws at each end hold it in place. Slight arc cut out of the top brace enables speaker to mount properly. Front edge of shelf should be flush with front edges of enclosure.

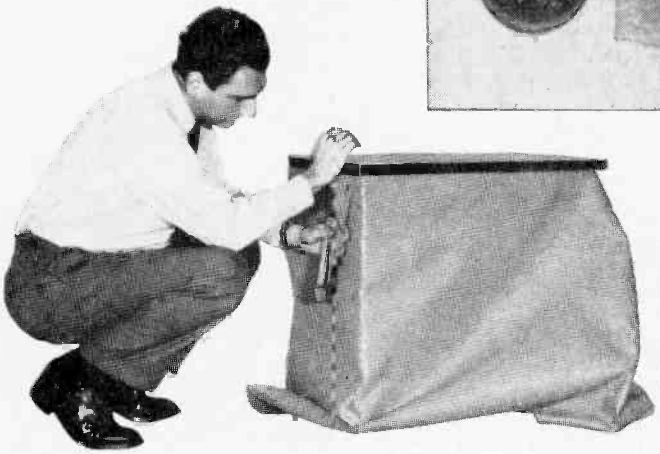
5 Finishing panel, although not necessary, may be added for the sake of appearance. Four wood screws through cabinet hold 30" x 16" panel in place. Interior of top compartment should be loosely lined with Fiberglas, rock wool, or other acoustical damping material. Cabinet may be used upright as lowboy, finished or unfinished, as desired.



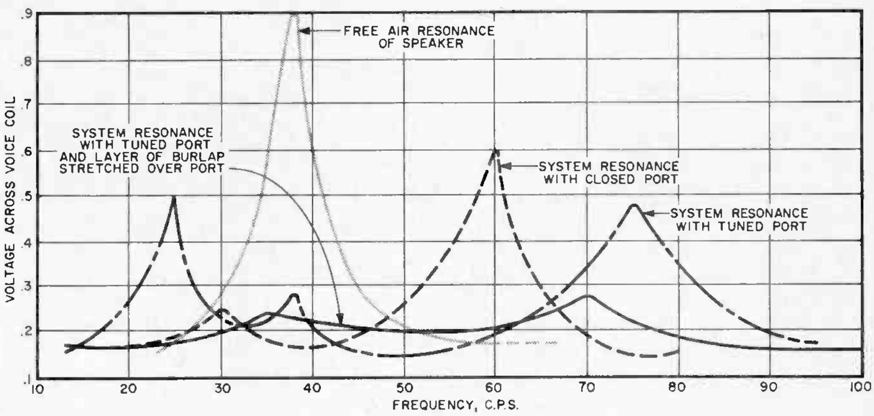
6 Speaker is mounted on front panel with four 1½" bolts and nuts. Speaker cable is attached to the binding posts on the speaker frame and comes out through a small hole drilled in the back panel of the enclosure.

7 One layer of ordinary burlap is stapled tightly over the port to provide "friction loading" of the speaker. See graph for effect of adding burlap. If more "resonant" bass is desired, omit the burlap strip.





8 Plastic hi-fi grille cloth made by Mellotone is wrapped around cabinet and stapled into place. This material is recommended for speaker enclosures because it is strong, good-looking, and acoustically transparent. After the grille cloth is stapled, legs or a base can also be installed.

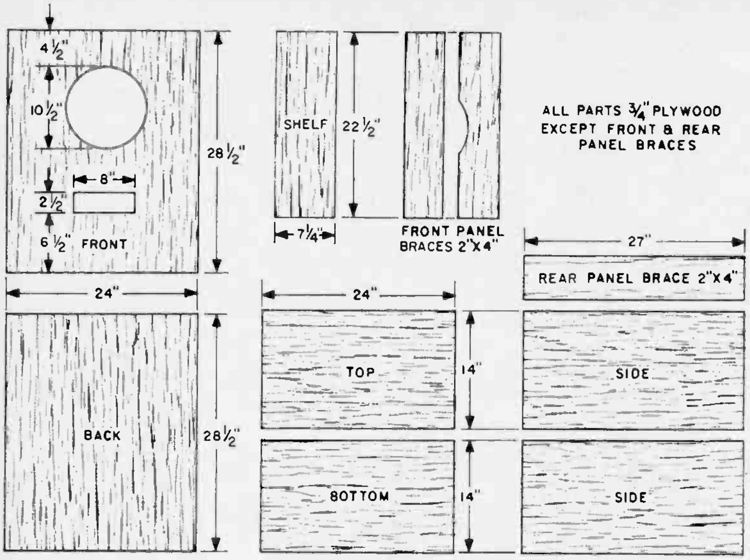


Impedance curves indicate performance. Free-air resonance of Norelco 4277 is 38 cycles (gray line). Installation of speaker in sealed cabinet causes the resonant peak to move up in frequency but down in amplitude (dashed line). Cutting a $2\frac{1}{2}'' \times 8''$ port tunes the cabinet properly, as shown by the two peaks of approximately equal amplitude (dot-dash line). The smaller peak at 37 cycles is apparently caused by a "subharmonic" of the 74-cycle peak. The final curve (solid line) is the result of stapling a layer of burlap over the port. Completed system has a very smooth bass response down to about 35 cycles. The treble end extends to 18,000 cps and is relatively uninfluenced by cabinet design.

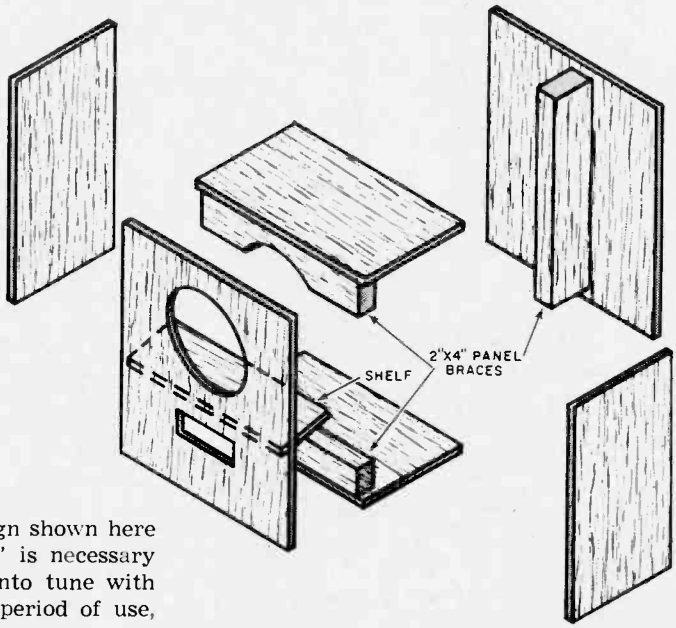
saving in weight. In addition, if the bracing is part of the internal design, two acoustic birds can be killed with one stone.

Practical Design. In response to requests from readers for the construction details of an enclosure which would accommodate a 12″ speaker, a "rattle-proof" tuned enclosure for a typical 12″ speaker—the Norelco 4277 has been designed.

The enclosure is basically a bass-reflex design employing a friction-loaded port tuned to the electro-acoustic resonance of the speaker. Any 12″ speaker with a fundamental resonance about the same as the



Construction of the Reflex 12 is simple since all joints are butted. At left, wooden parts are shown cut to required dimensions. Below is an exploded view of the enclosure's construction.

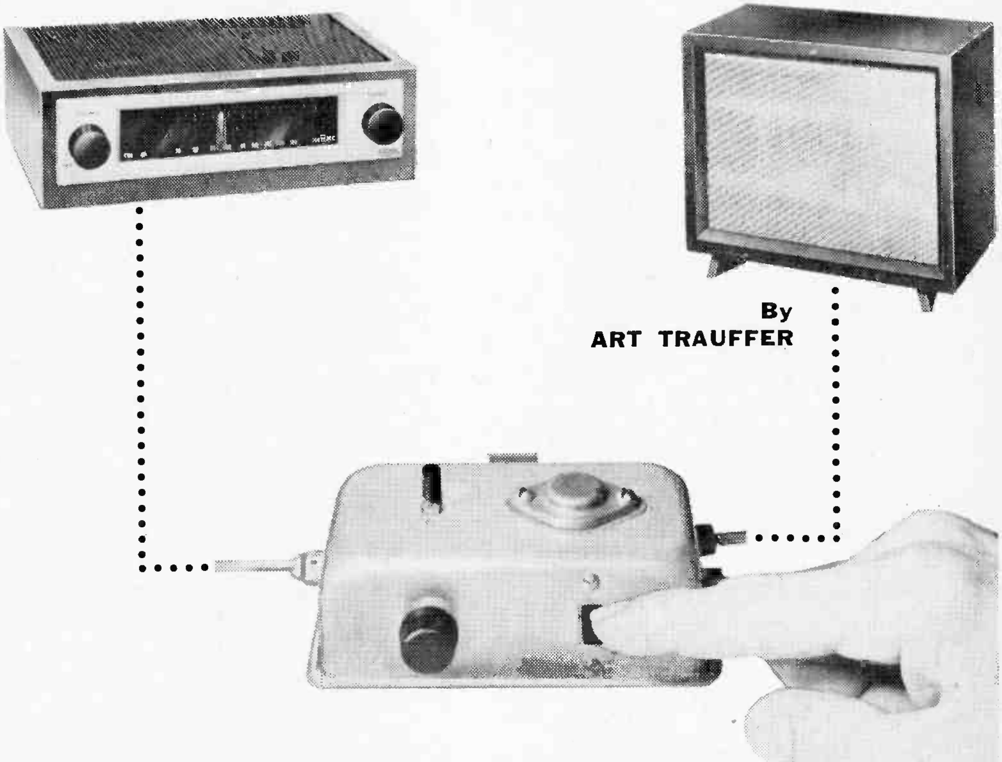


Norelco can be used successfully in this enclosure. The 4277 resonates at 38 cps, and speakers with resonances from 35 to 40 cps should be quite satisfactory.

It's a good idea to play new loudspeakers at a fairly loud volume for a day or so before attempting to tune a cabinet to them. A number of speakers, including the Norelco, require a workout period before their fundamental resonance settles down. However, if the cabinet design shown here is followed, no "pre-playing" is necessary and the Norelco will slide into tune with the enclosure after a short period of use, generally within an hour or two.

Simple Construction. Woodworking is simplified by the use of butt joints throughout. Plenty of glue and 8d finishing nails insure tight joints. Screws are used to fix the panels to the 2" x 4" braces and for mounting the removable front panel. The cabinet divider serves in both an acoustic role and as a brace for the side and front panels, all three of which should be screwed securely to it. Construction is simple, but the reader should follow the plans closely to avoid mistuning.

The performance of the system with the Norelco 4277 was extremely gratifying. In fact, when it was compared with one of the most acclaimed "book-shelf" type systems, the general opinion of the listeners favored this home-built job. The roughest test of all—the reproduction of the male voice with natural bass but no boom—was passed with flying colors. Since the response of the 4277 extends to about 18,000 cps, the response of the entire system covers the range smoothly from 35 to 18,000 cps without the use of a separate tweeter for the high frequencies.



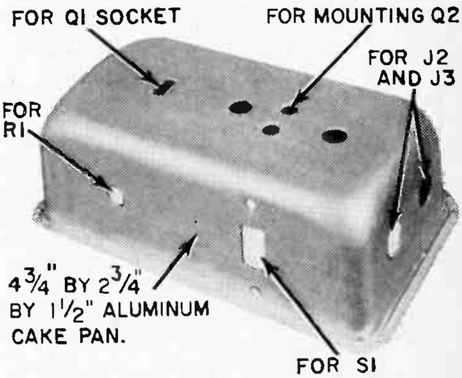
By
ART TRAUFFER

Transformerless Transistor Amplifier

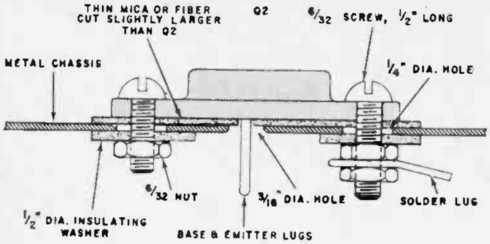
Here is a low-power amplifier with good fidelity. Used with your AM-FM tuner, it will drive a 12" extended-range speaker to a good volume. At a cost of about $8.50 for materials, you get an undistorted power output of about 200 mw. with excellent frequency response (±2 db from 12 to 12,000 cps).

The unit is compact and easily built. Follow the schematic on next page. The two transistor stages are direct-coupled and the power transistor drives the speaker without the need of an output transformer.

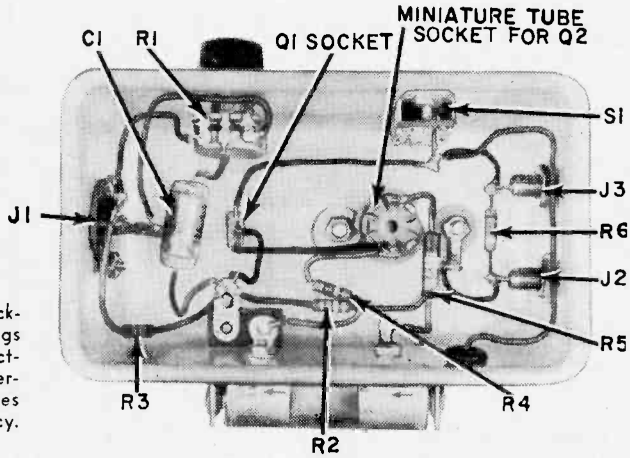
An efficient 16-ohm or 8-ohm speaker is recommended, but a 4-ohm speaker will give satisfactory results. The 560-ohm resistor, *R6*, across the speaker protects the transistors if the speaker is disconnected when the amplifier is on.



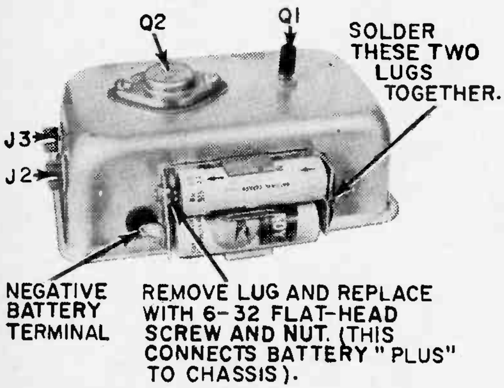
1 A small toy aluminum pan is used as the chassis. The holes can be cut to size with a pen knife and a few small files. Schematic and parts list are on next page.



2 Prior to mounting power transistor Q2, cement two ½" fiber washers to the chassis as shown. If done correctly, the mounting screws and lugs of Q2 will be insulated from chassis ground.



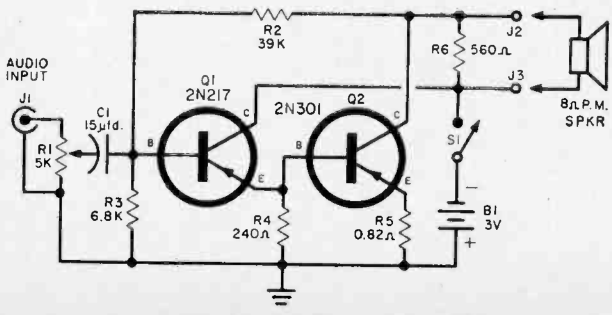
3 Use a 7-pin or 9-pin socket to connect to prongs on Q2. Do not solder directly to prongs. After soldering all components and wires in place, check for accuracy.



4 Rear view of completed chassis. Insulated phone tip jacks are used for J2 and J3. The battery holder terminals are connected so the two cells are in series with the positive end grounded.

PARTS LIST

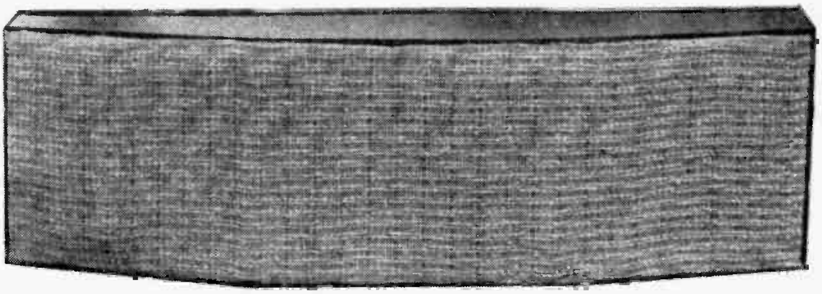
B1—Two size "AA" penlight cells
C1—15-μfd., 25-volt miniature electrolytic capacitor
J1—Phono jack
J2, J3—Insulated phone tip jack
Q1—Transistor (RCA 2N217)
Q2—Power transistor (RCA 2N301)
R1—5,000-ohm miniature volume control
R2—39,000 ohms
R3—6800 ohms
R4—240 ohms
R5—0.82 ohm
All resistors ½-watt composition, 10%, unless otherwise indicated
R6—560 ohms
S1—S.p.s.t. slide or toggle switch
1—Transistor socket
1—7-pin or 9-pin tube socket
1—Acme battery holder, No. 6
2—½"-o.d. fiber insulating washers
1—One-lug terminal strip
1—4¾x2¾x1½" aluminum cake pan



5 Check your wiring with the schematic of the amplifier. If the tuner has a volume control, set R1 fully clockwise for maximum gain. Connect a good quality 8-ohm speaker to J2 and J3.

By
PAUL SILVERSTEIN

Build an Electrostatic



Tweeter

An experimental speaker you can make for only three dollars

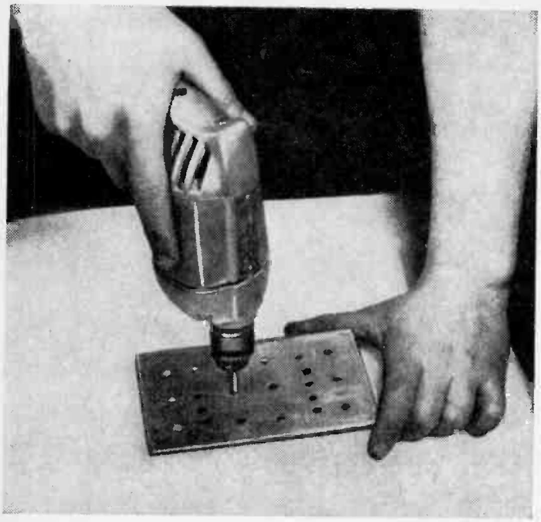
Since loudspeaker design is generally acknowledged to be one of the toughest jobs around, the average person seldom dreams that he can build his own. But it *is* entirely possible for the home experimenter to make a satisfactory speaker—and an electrostatic one at that!

And best of all: the electrostatic tweeter system described in this article can be built for a total cost of about three dollars! While this tweeter is presented basically as an experimental project, its performance will meet the minimum high-fidelity standards.

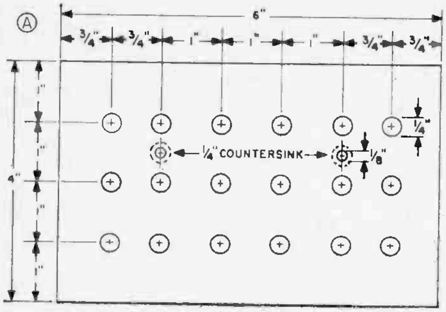
Special Materials. The theory of the electrostatic tweeter is quite simple if we think of it as a talking capacitor. If we can make a capacitor with a flexible plate that will move in accordance with variations of an applied audio signal, we will have an electrostatic tweeter.

In this case we use a piece of steel for the fixed plate of the capacitor (see A); for the moving plate we use a diaphragm of —you'll never guess—Saran Wrap! The Saran Wrap is painted with a thin coat of silver conductive paint (General Cement Silver Print). When a polarizing or bias voltage is applied to the two plates, an audio signal of sufficient amplitude impressed onto the polarizing voltage will cause the Saran Wrap diaphragm to move in accordance with the audio signal.

A connection from the plate of the output tube of an audio amplifier (see B and C) will provide the necessary polarizing volt-



Template for making the fixed plate of the tweeter. Use a 1/4" bit to drill the 1/8" steel plate. Two holes must be countersunk for heads of bolts to fit flush.



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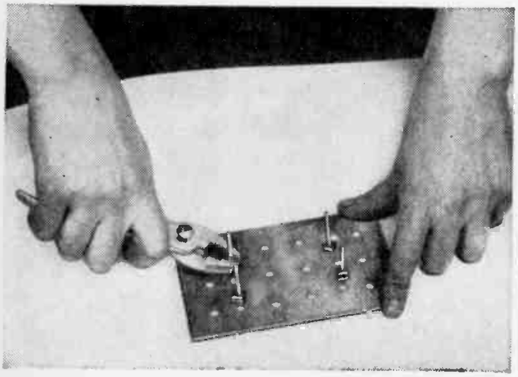

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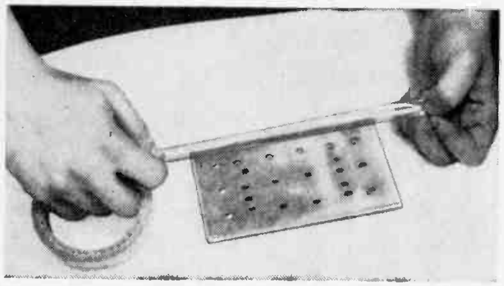


3.

age (350 volts is about right, but experimentation may prove that either a higher or lower voltage will work better) and the a.c. signal voltage.

The direct-to-plate hookup will work well if your speakers are near your amplifier. If your speakers are located some distance from your amplifier, the length of the plate leads may cause the amplifier to oscillate. Should this occur, the alternate hookup shown in Ⓓ should be used.

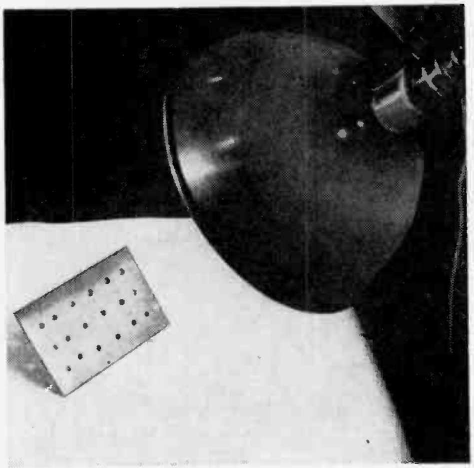
In Ⓓ, an inexpensive single-ended output transformer (Stancor A-3879 or equivalent) is *hooked up in reverse* to the secondary of the amplifier's output transformer. Polarizing voltage can be furnished either from the amplifier or from a separate power supply. Any standard supply that provides

1 Drill holes in 1/8" steel plate as indicated in Ⓐ. Use a 1/4"-high speed drill. One-eighth-inch holes are drilled and countersunk to receive the 6-32 x 1 1/4" flat-head mounting bolts. File off all burrs and make sure plate is smooth.

2 The flat-head bolts and nuts are screwed through the plate to serve as mountings for the tweeter when installed in an enclosure. Heads of the bolts must be flush with or below plate surface.

3 Scotch cellophane tape, 3/4" wide, is applied to the four edges of the steel plate. The tape will act as the spacer between steel plate and the Saran Wrap.

4.



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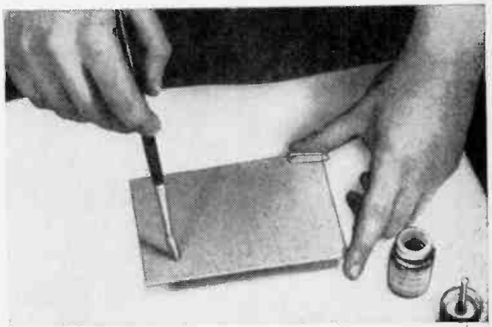

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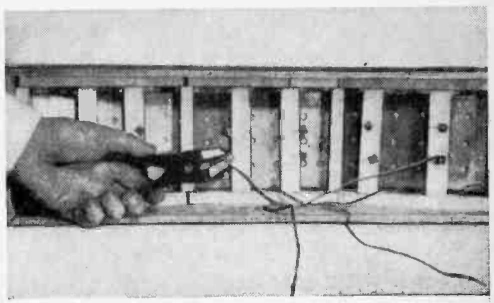


7.

4 Saran Wrap is cut to overlap the steel plate slightly on all edges. Tape is applied first to the Saran Wrap "diaphragm" and then is used to fasten the Saran Wrap to the back of the steel plate. Another layer of tape is applied on all the edges of the Saran Wrap overlap as additional insulation to prevent the silver paint from shorting out at back of the steel plate.

5 The diaphragm is heated with a sun lamp or 150-200 watt light bulb until all wrinkles are flattened and the Saran Wrap begins to smoke slightly. (Five to 10 minutes at a distance of about 12".)

6 Silver conductive paint is lightly brushed onto the diaphragm after a paper clip has been fastened to one corner of the tweeter. The paper clip is used as the contact point to the diaphragm. One of the mounting bolts serves as the contact to the steel plate. Paint is applied sparingly.

from 250 to 350 volts d.c. can be used.

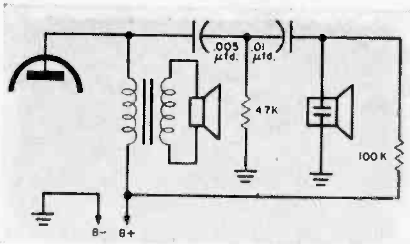
Since electrostatic speakers, by their nature, tend to be low-efficiency devices, it may be necessary to "pad down" your woofer to the efficiency level of the electrostatic tweeter. An 8- or 16-ohm L-pad is recommended for this purpose.

Try and Try Again. The amount of undistorted output available from the system depends to a great extent on the relationship between the polarizing voltage and the audio voltage. If the audio voltage is too

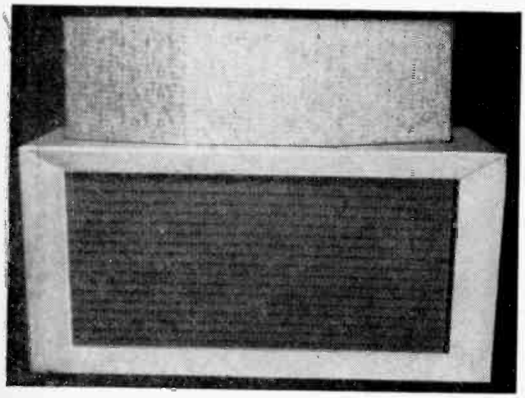
7 The three radiators are mounted in any sort of framework or cabinet desired. Your skill in woodworking will determine the design, but be sure not to obstruct front radiation of the tweeters. If desired, up to six plates can be used to eliminate any tendency toward point source effect.

8 Completed tweeter assembly cannot be effectively tested by playing unless connected to another speaker. Because of the high crossover point, the tweeter will sound thin and weak if operated by itself. It works best with a full-range speaker or woofer.

Ⓑ

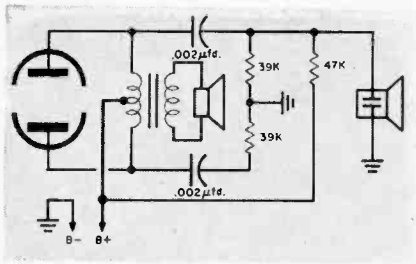


Hookup for connecting the electrostatic tweeter directly to output tubes of a single-ended amplifier.



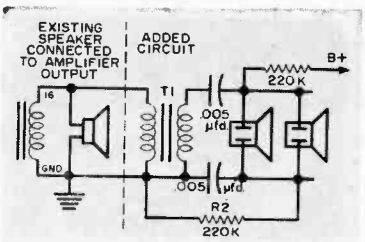
8.

Ⓒ



Direct connection of the electrostatic tweeter to the output tubes of an amplifier with push-pull output.

Ⓓ



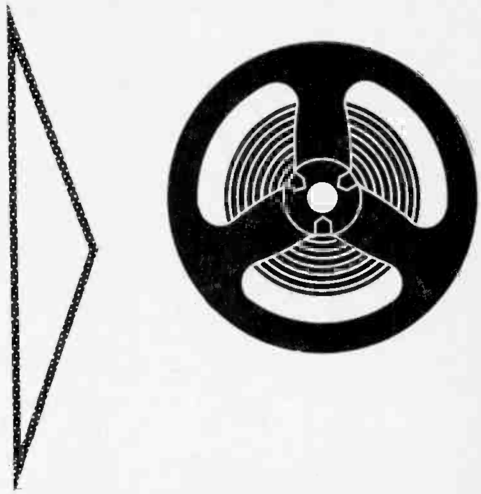
Alternate circuit to be used if the circuits of Ⓑ and Ⓒ cause the amplifier to oscillate. Voice-coil leads of T1 are connected to amplifier output terminals.

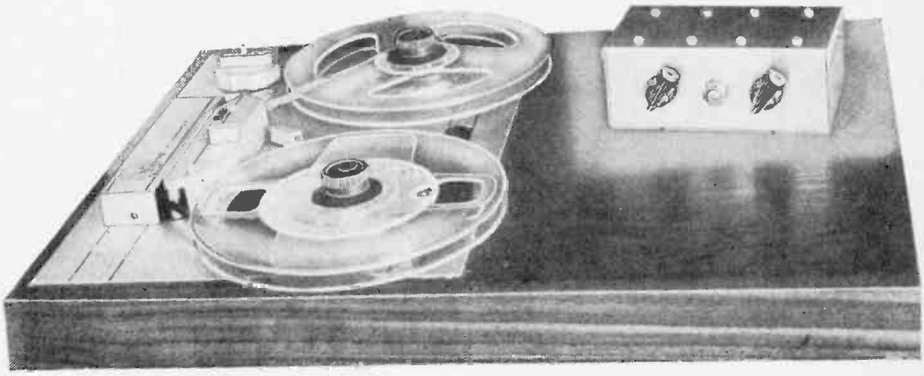
high in relation to the polarizing voltage, the tweeter will overload and distortion will occur. On the other hand, if the polarizing voltage is made too high, the moving diaphragm will arc out to the fixed plate. The experimenter may burn out several diaphragms before coming up with the optimum arrangement. Luckily, Saran Wrap is not expensive.

The author made three radiating elements at a cost of about $1.00 each, and mounted them in an enclosure as shown. Multiple radiators connected in parallel help reduce the point source effect inherent in flatplate electrostatic tweeters and give better results.

Remember that individual problems of matching impedances from amplifier to speaker must be solved by the person who builds the system. Experimentation is necessary to get optimum results. When the system is working at its best, however, it can be compared with commercial tweeters costing considerably more.

By
DONALD L. STONER
W6TNS





Build a Noise-Free Transistorized Stereo Tape Preamp

Designed for the stereo tape fan, this fully transistorized preamplifier can be used directly between a stereo tape deck and two basic or integrated amplifiers to form a complete professional-quality NARTB-equalized playback system. As for noise and hum pickup, it will outperform any vacuum-tube device anywhere near its price range.

Hum is inaudible, even with the gain full up. With no "moving parts" in the transistor, microphonics are nonexistent. At 2.5-millivolts tape head input, "hiss" is about 68 db below full output (1.5 volts or higher), barely audible with the volume control(s) wide open.

Construction. The two identical amplifier circuits are contained in a 2" x 3" x 5" aluminum chassis box. Most of the components are secured on lug-type terminal strips mounted on the bottom of the chassis. Two volume controls and a voltage adjustment potentiometer are mounted on the front apron. The input jacks, output leads, and battery are installed on the rear apron. Since parts layout is not too critical, the preamp can be built in a larger box, for example, a 5" x 7" x 2" box.

PARTS LIST

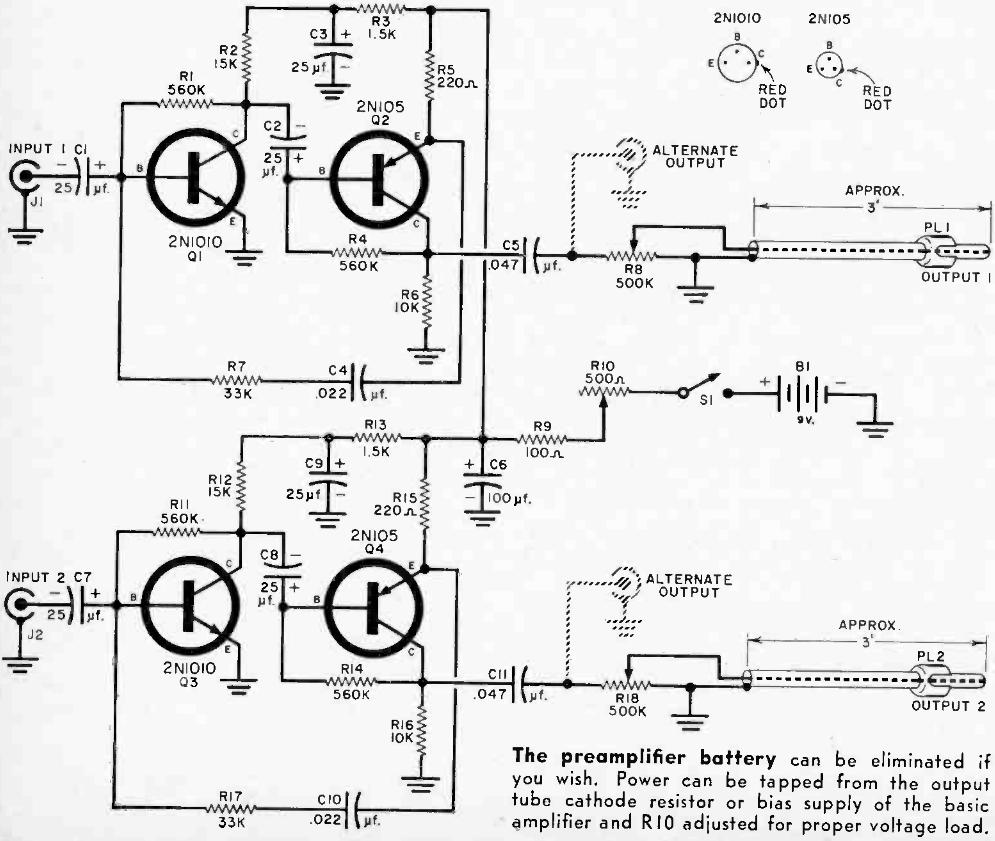
B1—9-volt battery (RCA VS309)
C1, C2, C3, C7, C8, C9—25-µf., 25-volt capacitor
C4, C10—.022-µf., 200-volt paper capacitor
C5, C11—.047-µf., 200-volt paper capacitor
C6—100-µf., 15-volt miniature electrolytic capacitor
J1, J2—Phono jack (RCA type)
PL1, PL2—Phone plug (RCA type)
Q1, Q3—2N1010 transistor (RCA—new type available at most supply houses)
Q2, Q4—2N105 transistor (RCA)
R1, R4, R11, R14—560,000 ohms
R2, R12—15,000 ohms
R3, R13—1500 ohms
R5, R15—220 ohms
R6, R16—10,000 ohms
R7, R17—33,000 ohms
All resistors ½-watt
R8, R18—500,000-ohm audio taper potentiometer (one with s.p.d.t. switch S1)
R9—100 ohms
R10—500-ohm linear taper potentiometer
S1—See text
1—2"x3"x5" chassis box (L. M. Bender #136)
Misc. knobs, hardware, terminal strips, grommet, and shielded wire

Drill the chassis as shown in the photographs. Note that one end lug is cut from each terminal strip so that it will fit between the edges of the chassis box. Mount the four strips so the lugs "face" the nearest open end of the chassis. The mounting feet of the tie lugs should "face" toward the center of the chassis.

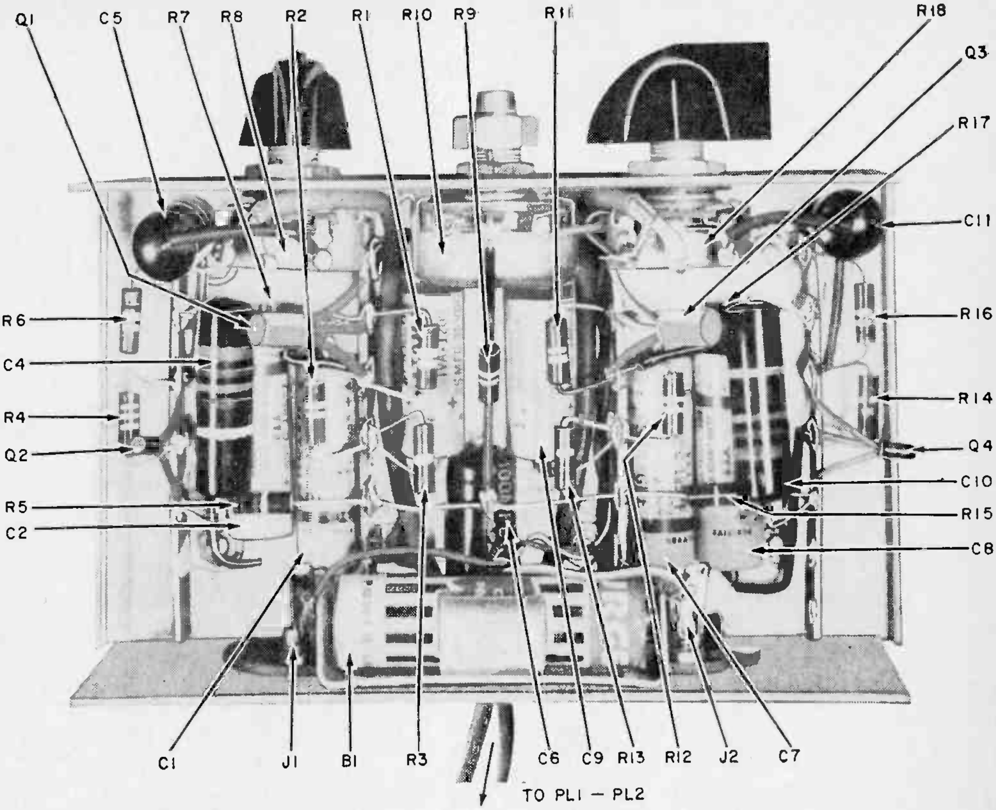
Following the photos, install the capacitors first and then the resistors. Components *R7, R17, C4,* and *C10* control equalization and their leads should not be wrapped around the terminal lugs if equalization adjustment is desired. Note also that a common tie-point is made at the junction of *R5, R9, R15,* and *C6,* halfway between the amplifier channels.

The jacks and potentiometers should be mounted and wired next. Pots *R8* and *R18* can be omitted if volume can be controlled at the amplifiers. In this case, output phono jacks (similar to *J1* and *J2*) can be used with *C5* and *C11* connected directly to the "hot" terminals of the jacks. Output lead length is not critical.

Install a 9-volt battery (*B1*) and holder



The preamplifier battery can be eliminated if you wish. Power can be tapped from the output tube cathode resistor or bias supply of the basic amplifier and R10 adjusted for proper voltage load.



on the rear apron of the box. Include a power switch in series with the battery. If the potentiometer-mounting switch is used, mark the panel so the control knob can be reset easily when preamp is switched on.

Testing. Wire a 0-10 ma. d.c. meter in series with the negative battery lead to chassis ground. When the preamp is turned on, the meter should "pop up" (as the capacitors charge) and then drop to about 2 ma. (between 1.5 and 2.5 ma. is okay). If the meter reads higher or lower, there is probably something wrong—you can tell which half of the preamp is at fault by separating the circuits at *R5* and *R15*.

If the test circuit reading is correct, disconnect the meter. Set pot *R10* to maximum resistance. With a VTVM or 20,000 ohms/voltmeter connected across *C6*, adjust *R10* for an 8-volt reading (± ½ volt). Testing is now complete.

Setting Equalization. The values shown for *R7* and *C4*, and *R17* and *C10* provide NARTB equalization for the Viking Model "85" tape deck. If you use the preamp with a different tape head or prefer more bass or treble, you may want to change these values. Do not change values more than 200% because the interaction will affect the gain.

If the preamp is not grounded properly, it is possible to get hum. To remedy this, run ground wires from tape deck to preamp and main amplifier.

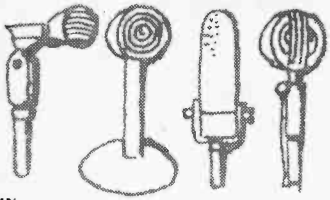
For monaural use, build only half the circuit and double the size of *R9* and *R10*.

HOW IT WORKS

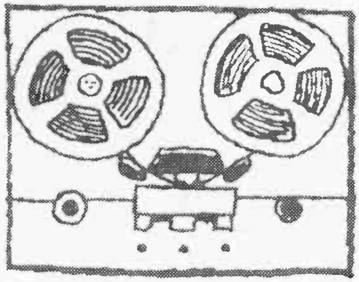
The transistor stereo tape preamplifier has two channels, each with a two-stage amplifier. Since the two sections of the preamp are identical, only one channel will be discussed. The two transistors in each section are resistance-coupled.

Input transistor *Q1* is connected in a common emitter circuit, with bias obtained through *R1*. Capacitor *C1* blocks the bias voltage from the tape head. The amplified signal appears across *R2* and is coupled through *C2* to transistor *Q2*, which is in a modified common emitter circuit. Bias for this stage is provided through *R4* as in the first stage, with additional stabilization obtained by *R5* in the emitter circuit. The highly amplified signal voltage appears across *R6* and is coupled to the power amplifier through *C5* and volume control *R8*.

Frequency response of the preamp is equalized to correspond to the NARTB playback curve. This is accomplished by applying negative feedback through *RC* network *C4* and *R7* from the emitter of *Q2* to the base of *Q1*.



One-Transistor Microphone Mixer

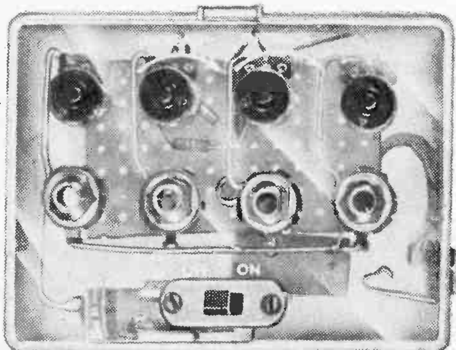


By
HERB COHEN

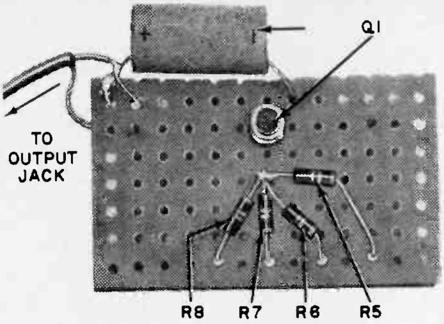
For tape recording fans—
this simple mixer provides multiple
inputs and wide frequency response

The tape recording fan and hobbyist is often at a loss when he wants to feed more than one microphone into his recorder. Recording a small choral group or a guitarist who sings along with an instrument, for example, makes the use of two or more microphones mandatory. Professional microphone mixers, even for inexpensive recorders, sell for about $30 and up, and are sometimes hard to justify costwise because they are only used occasionally.

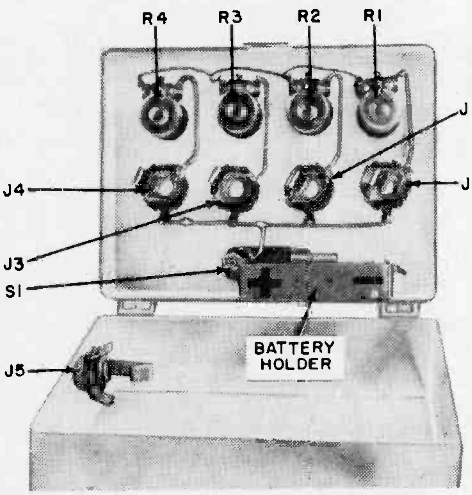
Problems encountered in designing a mike mixer are mostly ones of noise and control interaction. Both of these problems can be easily solved through the use of our old friend, the transistor. By employing a transistor with a low input impedance and having a very high resistance in series with each microphone input, almost perfect isolation between the input lev-



Rear view of completed mixer shown mounted in plastic case.



Phenolic board with Q1, C1 and series resistors ready for installation in cabinet.



Jacks and controls are mounted before installation of perforated circuit board.

HOW IT WORKS

Each microphone "sees" its potentiometer, the 82,000-ohm series resistor, and the 1000-ohm input impedance of the transistor (*Q1*). Since the major voltage drop takes place across the 82,000-ohm resistor, the level at the input at the base of *Q1* is very small and interaction between the microphones is minimized.

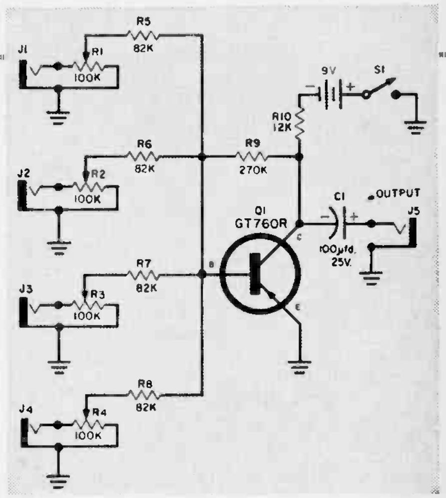
Input signal mixing takes place in the base element of *Q1*. The transistor itself is used in the grounded emitter arrangement which provides the necessary low input impedance. *R9* is the base-biasing resistor.

Since a transistor in the grounded emitter mode provides a 180° phase shift between base and emitter, negative feedback occurs which enables a frequency response from 20 to 15 kc. ± 1 db. The 12,000-ohm collector load resistor is low enough to match to the input of any amplifier, yet large enough to give the over-all 5-db circuit gain.

Q1 is a *p-n-p* r.f. type with alpha cutoff of 3 mc. and very good noise characteristics.

PARTS LIST

B1—9-volt battery (RCA VS309 or equivalent)
C1—100-µfd., 25-volt tubular electrolytic capacitor
J1, J2, J3, J4, J5—Phone jack
Q1—GT760R transistor (General Transistor)
R1, R2, R3, R4—100,000-ohm miniature potentiometer
R5, R6, R7, R8—82,000-ohm, ½-watt resistor
R9—270,000-ohm, ½-watt resistor
R10—12,000-ohm, ½-watt resistor
Misc. transistor socket, cabinet, knobs, phenolic board



el controls on the mixers can be obtained.

A moderately high input impedance suitable for most mikes is obtained by using an 82,000-ohm isolating resistor in series with each mike. This drops down the voltage appearing at the base element of the transistor (*Q1*), but no circuit problems are introduced. Because of the order of impedances involved and the characteristics of *Q1*, little noise or hum is encountered.

Although a small plastic case was chosen as the container for this mixer, almost any material could be employed. If you do use plastic, the mounting holes can be "drilled" very easily with a pencil-type soldering iron.

The circuit board layout is made with flea clips inserted into the phenolic board holes. Glue holds the transistor socket in place. The author's parts arrangement can be followed, or you can adapt the layout for your particular requirements.

Almost any number of inputs can be added by connecting a potentiometer and isolating resistor in the same manner that the present four inputs are connected.

Build the Stereoplex

By HARRY KOLBE

The amplifier to be described here was designed and built as a practical application of stereo simplex principles. High quality stereo at maximum economy was the goal, and anyone who has been reluctant to shell out the money for two amplifiers, or who would like a second stereo system for his playroom or summer house, will find that the "Stereoplex" is an excellent choice.

The Stereoplex consists of a simplex-connected push-pull feedback amplifier plus a power supply on a 5" x 7" x 3" chassis. It employs only three tubes: two 6BM8/ECL82 voltage amplifier-output tubes, and one 6X4 rectifier.

The compactness and low cost of the Stereoplex is made possible through the recent introduction of a new audio tube by Amperex and a recent modification of the simplex circuit by CBS. The new tube—the 6BM8/ECL82—is a 9-pin miniature tube combining a high-mu triode and a power output pentode in the same envelope. These combined characteristics of the 6BM8/-ECL82 allow the design of a medium-power amplifier with but two tubes plus rectifier. The further advantages of simplex operation permit this amplifier to serve as a complete two-channel stereo amplifier.

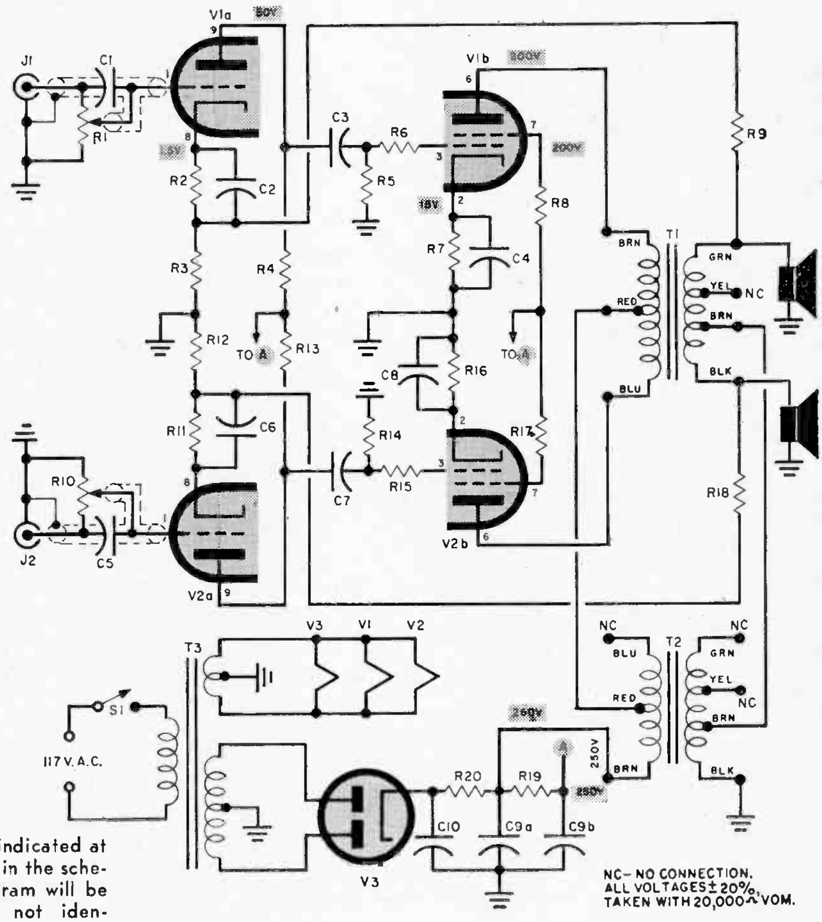
Features. Despite its compactness and simplicity of construction, the Stereoplex boasts an effective output of 10 watts from each channel. At an output level of one watt, the frequency response is flat within ±1 db from 30 cps to 20,000 cps and is down only 1.8 db at 2 cps. Use of negative feedback results in a total harmonic distortion of only 1.5% at full output.

Channel separation is 25 db at 1000 cps; hum and noise is down 70 db. Each channel is equipped with its own volume control, and a power take-off socket may be added to provide power for auxiliary equipment.

The input sensitivity is high enough so that most ceramic or crystal stereo cartridges may be plugged in directly, thus eliminating the need for a preamplifier. These stereo cartridges usually have .25 to 0.5 volt output, and are relatively inexpensive. The author has had excellent results with the Sonotone 8T, the CBS-Hytron SC-2, and the Ronnette BF-40 stereo cartridges.

Construction. The first step in construction is the preparation of the chassis. A light aluminum chassis is recommended since it is easily worked and helps minimize stray hum paths. Lay out the chassis as shown. If you have a set of chassis punches, the task will be greatly facilitated. For a professional-looking job the drilled and punched chassis may be rubbed with fine steel wool, then sprayed with clear Krylon

stereo with one output transformer



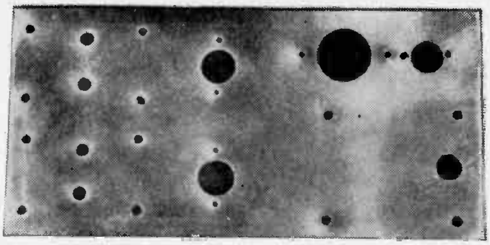
Voltages indicated at V1's socket in the schematic diagram will be close but not identical to those of V2.

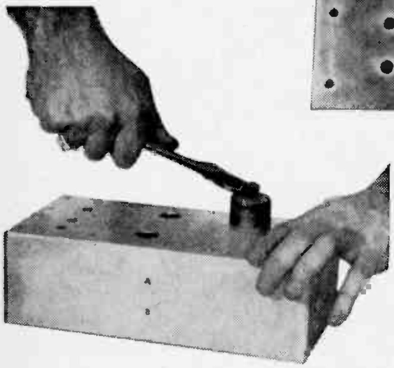
PARTS LIST

C1, C5—30-μμfd. disc capacitor
C2, C6—50-μfd., 15-volt electrolytic capacitor
C3, C7—.05-μfd., 400-volt tubular capacitor
C4, C8—50-μfd., 50-volt electrolytic capacitor
C9a/C9b—50-50 μfd., 450-volt dual electrolytic can-type capacitor
C10—10-μfd., 450-volt capacitor
J1, J2—Phono input jack (RCA type)
R1, R10—3-megohm potentiometer
R2, R11—2200 ohms
R3, R12—47 ohms
R4, R13—220,000 ohms
R5, R14—680,000 ohms
R6, R15—10,000 ohms
R7, R16—330 ohms, 2 watts

All resistors ½-watt composition unless otherwise indicated

R8, R17—56 ohms, 1 watt
R9—470 ohms
R18—1600 ohms
R19—470 ohms, 2 watts
R20—1500 ohms, 25 watts, wire-wound
S1—S.p.s.t. slide or toggle switch
T1, T2—Output transformer (Stancor A-3872)
T3—Power transformer 540-volt C.T., 6.3-volt C.T., 5-volt winding unused (Stancor-PC8405 or equivalent)
2—9-pin sockets
1—7-pin socket
1—Octal socket (for power takeoff if required)
1—5" x 7" x 3" aluminum chassis
2—3-lug terminal boards





The chassis as it appears after drilling and punching. Use of Greenlee punches greatly facilitates chassis preparation.

lacquer to preserve the luster. Application of Walsco audio decals will add the finishing touch.

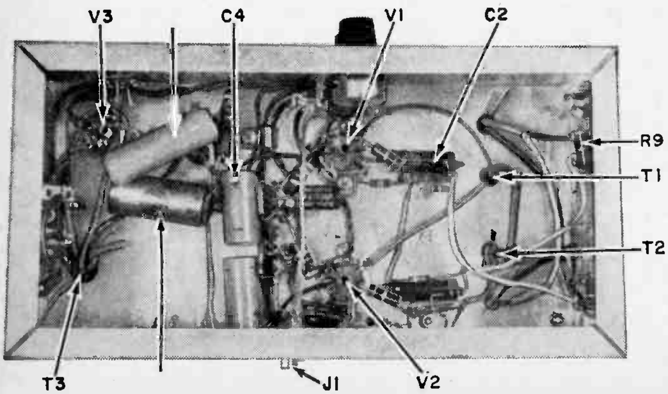
Mount the tie points first since it may be awkward to do so later. No difficulty in wiring should be encountered if the usual wiring practices are followed. Be sure to twist all filament leads together tightly and keep the input and output wiring as far apart as possible. Use shielded wire between the input jacks and the volume controls and between the volume controls and the tube input grids.

Use three-lug screw-type terminal boards at the speaker outputs; only two lugs are required for each speaker, but the third provides a handy spot to mount the feedback resistor. It is of the utmost importance to follow the color coding and connection of the output transformers as indicated on the schematic.

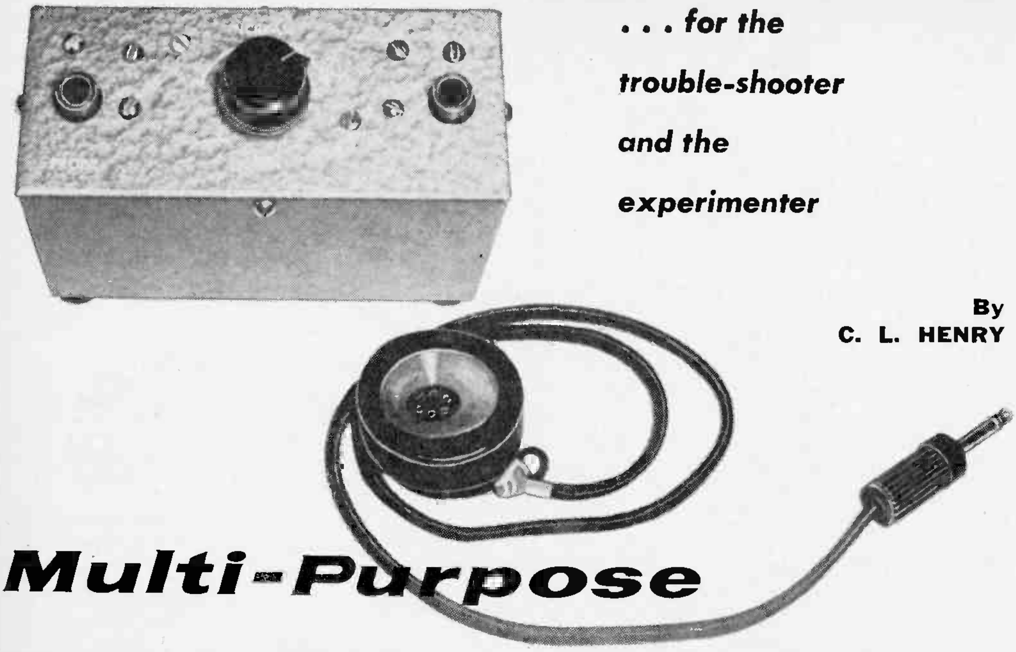
Operation. Proper operation of a simplex-connected amplifier is dependent on the phase relationships between the two input signals. A standard 45-45 stereo cartridge is capable of presenting this relationship to the amplifier if properly connected. Proper connection of the four-terminal stereo cartridges requires only the reversal of one set of leads. In any case, to return the amplified signals to their proper phase relationship, simply change the phasing of one of the speakers.

This amplifier has been used with two Lafayette SK-97 6½" coaxial speakers and the over-all quality from this small and inexpensive system is quite good. The highs are crisp and clean while the bass is present in ample quantity. And with more expensive speaker systems, results are excellent.

The sound output is more than adequate for the average living room. With the level controls cranked up only halfway, the room is filled with sufficient sound to drown out all conversation. Anyone who constructs the Stereoplex will be rewarded with many hours of pleasant listening.



Underchassis view of completed amplifier. The high-voltage secondary winding of T3 may vary in value from the one specified. Also adjust R20 for about 250 volts at point A in the schematic.



. . . for the trouble-shooter and the experimenter

By
C. L. HENRY

Multi-Purpose Transistor Amplifier

Have you ever tried to find a short in a cable by the "cut and try" method and finished with no cable at all? Could you use a vibration analyzer, a preamplifier, a monitor amplifier, etc? If so, this general-purpose transistorized amplifier may be just what you need for your tool kit.

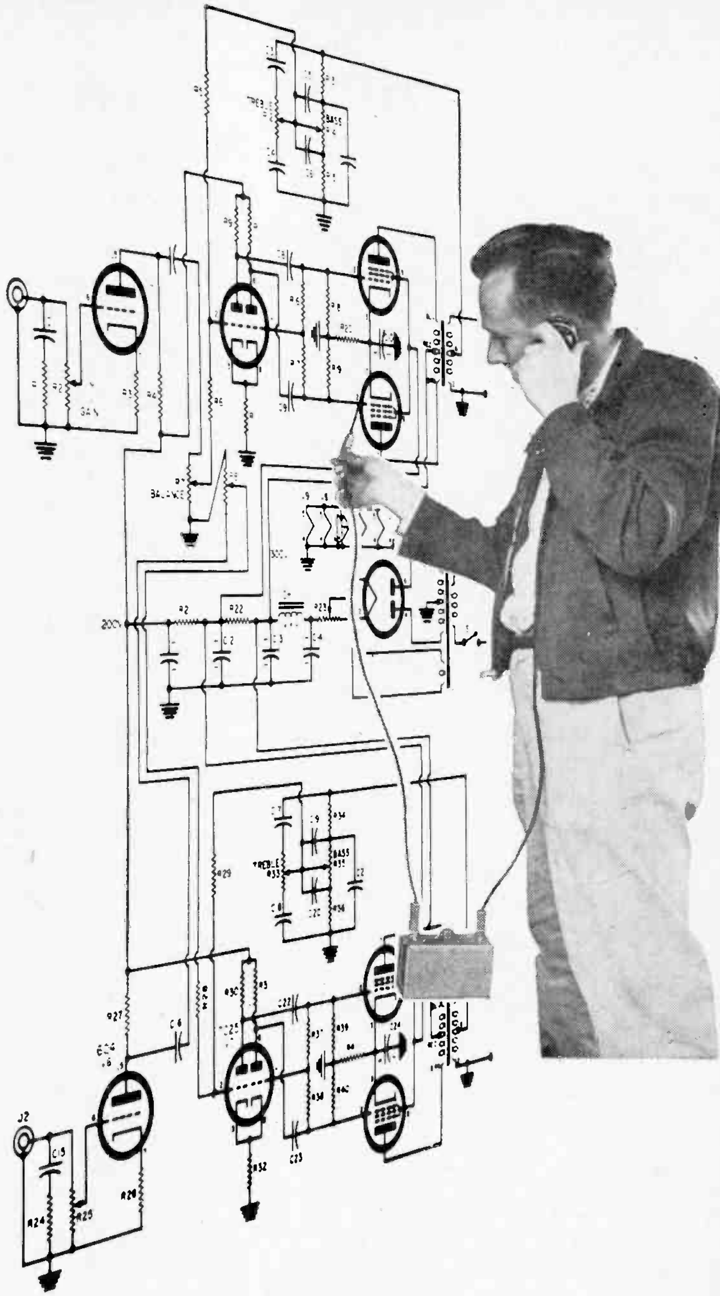
With the addition of accessory probes, this pocket unit will do all the above jobs—and more! A probe using an iron-core coil will enable you to locate shorted wires in any size cable. And a crystal-diode probe can be used for tracing signals in all r.f., i.f. and a.f. circuits.

Operated from a long-lived battery, the amplifier is independent of power lines, and is built in a small case which is convenient to carry and use. Since the total cost of constructing this unit is less than $15.00, it is a project well worth considering.

Mount all circuit components, with the exception of the jacks, gain control, and battery, on a small piece of perforated phenolic board. Flea-type lugs can be inserted in the holes to simplify the wiring. The board assembly is mounted on the front panel of a 3¼"x5¼"x2". Jacks *J1* and J2 are of the long frame telephone type; they cost more initially, but will give longer trouble-free service.

Optimum values of *R1* and *R4* are determined experimentally. These resistors, after selection for maximum stage gain, will fall between 10,000 and 20,000 ohms. Make sure that a maximum of 5 ma. flows in each stage. If everything works out as it should, total gain should be close to 60 db with the gain control at maximum. Transistor *Q2* can be driven to overload with 10 millivolts of signal at *J1*.

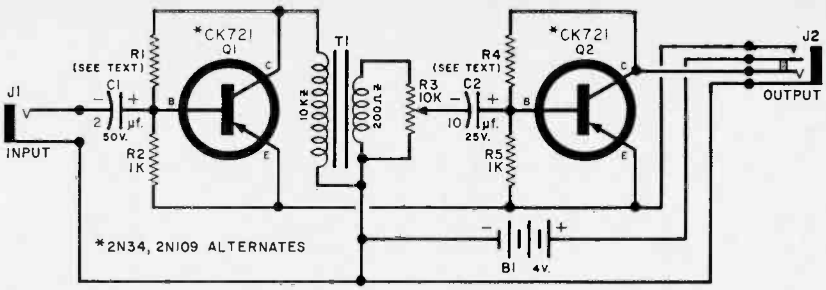
The battery and spring mounting clip are mounted on the bottom of the box and the amplifier's power leads are soldered directly to the battery since frequent replacements will not be needed. When all soldering is complete, the wires can be



laced. The component board is mounted between jacks *J1* and *J2*, with two 1½" long *6-32* machine screws and bolts arranged as stand-offs.

Next, the front panel should be fastened in place and decals applied. Rubber feet and a shoulder strap can be installed if you desire to carry the amplifier to jobs.

Applications for this gadget are plentiful. Possibly the most useful accessory is a pickup coil constructed by winding 500 or more turns of thin wire on a laminated iron core. (An old transformer or choke will provide the laminations.) The coil is



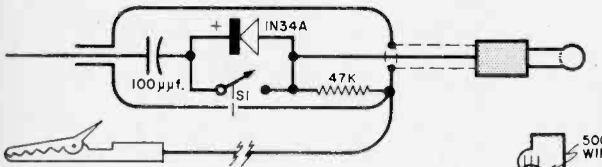
PARTS LIST

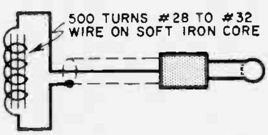
B1—4.0-volt mercury battery (Eveready type E-233 or equivalent)
C1—2-μf., low-voltage electrolytic capacitor
C2—10-μf., low-voltage electrolytic capacitor
J1—Telephone type jack, (Switchcraft type MT-331 or equivalent)
J2—Telephone type jack, (Switchcraft type MT-333 or equivalent)
Q1, Q2—2N109, 2N34 or CK721 transistor
R1—See text
R2—1000-ohm, ½-watt carbon resistor
R3—10,000-ohm potentiometer
R4—See text
R5—1000-ohm, ½-watt carbon resistor
T1—Interstage transformer, 10,000-ohm primary to 200-ohm secondary (Stancor TA-34 or equivalent)
1—3¼" x 5¼" x 2" steel box (ICA 3797 or equivalent)
1—Small perforated phenolic board

Select transistors that will provide the greatest gain for the amplifier. You can either solder the transistors in place or use sockets for convenience of replacement and testing, as you wish.

insulated with tape and connected to a 4′ cable terminated in a telephone plug.

In use, the pickup coil is held close to the point to be monitored. With it, you can trace trouble in an audio amplifier by picking up the signal at the transformers. You can also monitor a telephone and follow the signal in any equipment using transformer coupling.





Two probes for the amplifier: the one above, for a.f. and r.f. signal tracing, is built in a small shielded container; the induction probe at right has an unshielded winding.

HOW IT WORKS

This utility amplifier has two stages, each a common emitter type. The input goes directly to the base of the first CK721, through a 2-μf. electrolytic capacitor. Base bias is determined by a voltage divider (*R1* and *R2*) connected from the collector to the emitter. Transistor *Q1* amplifies the signal 40 times and the collector output feeds the primary of *T1*, the secondary of which is connected to the gain control, *R3*. The second stage is identical to the first, except that the output of the CK721 goes to a high-impedance headphone instead of to a transformer.

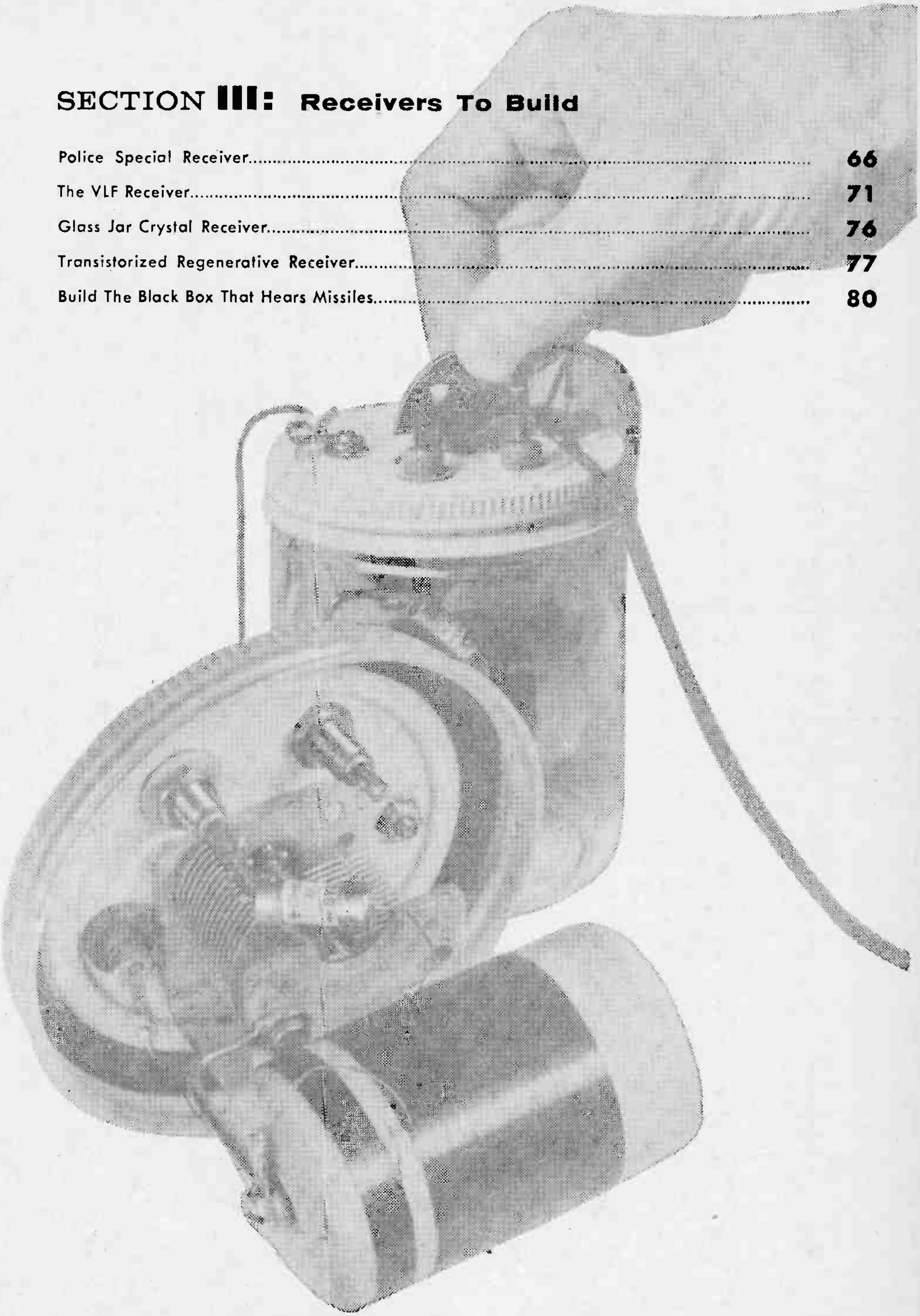
When the induction pickup-coil probe is used, it intercepts the magnetic lines of force surrounding a coil or wire carrying an alternating current. In the r.f. probe, the applied signal is coupled to the diode which demodulates the signal and applies it across the 47,000-ohm load resistor. The output voltage obtained from either probe is applied to the amplifier.

To find the exact location of a short in a cable, connect an audio oscillator to ends of the shorted pair in the cable. Move the pickup coil along the cable, starting at the oscillator end. The short will be found near the point where the signal stops.

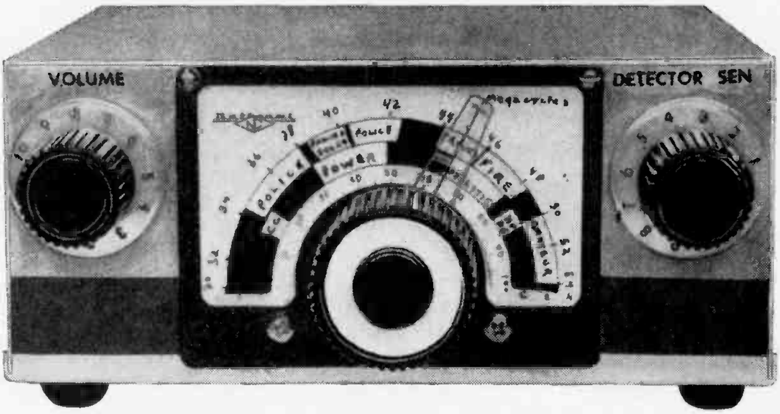
Another handy accessory is a signal-tracing probe. Using this probe, trouble may be traced in a radio receiver, and the defect easily found. The probe is constructed in a shielded can as shown in the diagram.

A vibration pickup may be constructed using a crystal phonograph cartridge. And with a little thought, you will probably be able to find many other uses for this truly versatile transistor amplifier.

SECTION III: Receivers To Build



Police Special



Compact 30-50 mc. tuner picks up public service bands

Some of the most thrilling radio listening to be found today is in the 30-50 mc. v.h.f. Public Service Band. You can join police and fire department emergency crews at the scene of a crime or disaster, ride with the driver of a truck carrying high explosives, or speed through the streets with an ambulance driver as he races against time and death. These vital emergency broadcasts and the communications of other services spaced throughout these frequencies generate high-voltage excitement and a feeling of participation on the part of the listener that no other band can match.

Unfortunately, commercially manufactured receivers for this band are very costly, and are generally priced out of the reach of most experimenters. However, the "Police Special" offers the constructor a simple, low-cost means of hearing these vital services in action. The entire project should cost no more than $15 to $20, and an adequately stocked junk box will bring the cost down even further.

Superior Performance. Amazing as it may seem, the two-tube Police Special will give many a factory-made superhet a run for its money in the sensitivity, stability, versatility and frequency-coverage departments. The high gain of the receiver is produced by mating two well-known and respected circuits—the cascode r.f. amplifier and the superregenerative detector. Together, they develop as much gain as the "front-end" and i.f. strip of many conventional 30-50 mc. superhet receivers.

As a measure of the sensitivity of these stages, a 1-microvolt signal at the grid of the r.f. amplifier will produce a 30-db quieting in the normal "rush" of the superregenerator. In order to test its stability, the model was tuned to the local police communications channel, and left in operation for 18 hours; at the end of this time, the total measured frequency drift of the oscillating detector was *less* than 1500 cycles.

These features, coupled with the inherent automatic volume control and impulse noise-suppression characteristics, plus the detector's versatility in demodulating either FM or AM signals, make the Police Special suitable for dependable monitoring work by the SWL, experimenter and amateur.

Construction. Over-all construction of the receiver is straightforward. Some slight modification of the National vernier dial is necessary to allow proper mounting on the front wall of the LMB chassis box. However, this only amounts to trimming 1/16" from the bottom of the drive-assembly, and does not affect the smooth operation of the dial at all.

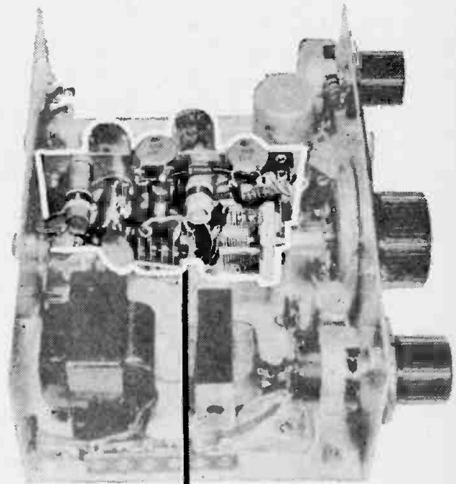
Receiver By GEORGE J. WHALEN K2BIE

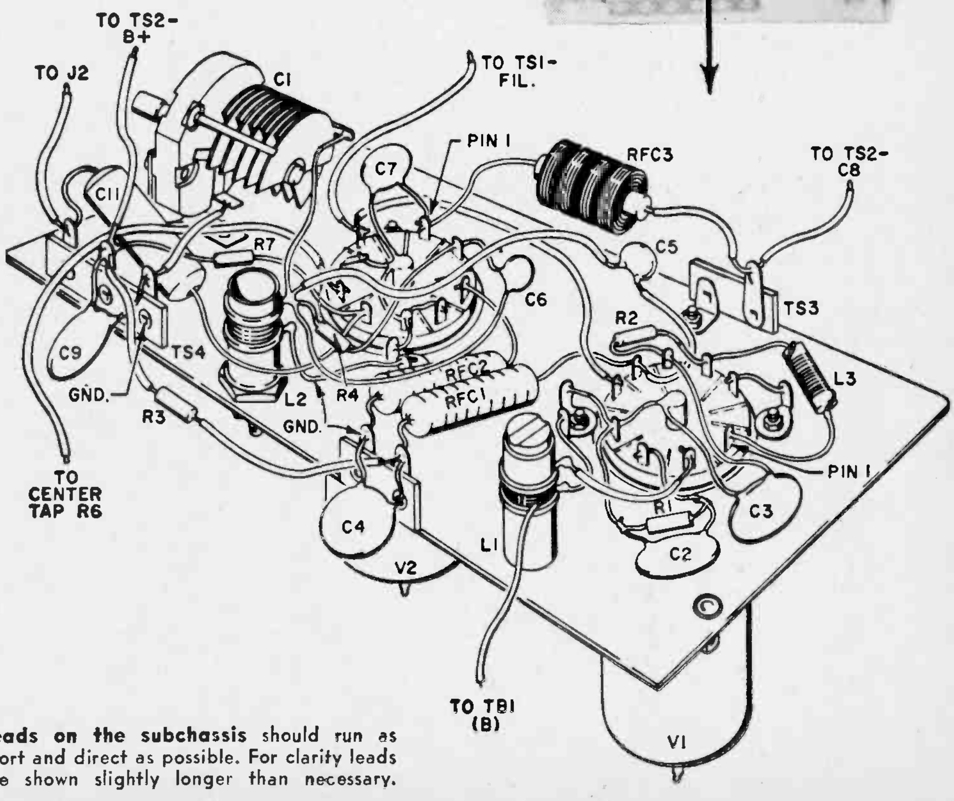
Using the pictorials and photographs as a guide, lay out the mounting holes for the *Main-Tuning* dial, *Volume*, and *Sensitivity* controls on the front wall of the chassis box, and the antenna terminal strip (*TB1*), audio output connector (*J1*), and headphone jack (*J2*) on the rear wall.

Next, mount all power supply components in the bottom section of the chassis box. Power transformer *T1*, filter choke *CH1*, and selenium rectifier *SR1* are all mounted at the left rear of the box. Filter capacitor *C12* is located at the right front, next to the receiver subchassis. Use ½" stand-offs and a *metal* mounting plate so as to ground the can properly. The power supply should then be wired as shown.

Length of leads in this section of the receiver is not critical, but they should be dressed carefully to prevent r.f. pickup. B-plus and filament power supply leads are brought out to a terminal strip near choke *CH1*, for easy connection to the subchassis.

Subchassis. The major circuitry of the Police Receiver is contained on a 2⅝" x 4¾" sub-chassis, cut from thin sheet aluminum. It is prewired, then mounted vertically in-



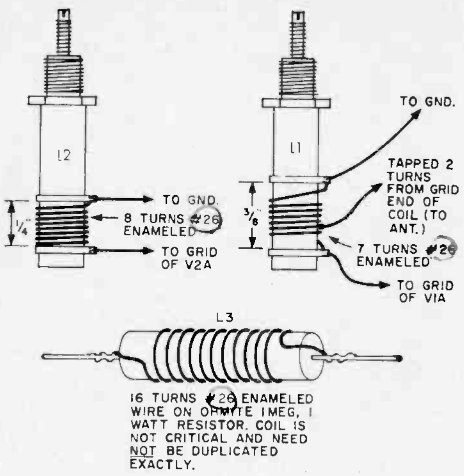


Leads on the subchassis should run as short and direct as possible. For clarity leads are shown slightly longer than necessary.

side the box by three small right-angle brackets. This type of construction was chosen to give the receiver a "streamlined" modern appearance, so popular in the design of hi-fi equipment. Whether it is used by itself or as a tuner alongside your living-room hi-fi gear, the unit will not look out of place.

PARTS LIST

C1—3.3-17 μμfd. variable capacitor (Hammarlund HF-15 or E. F. Johnson 15J12)
C2, C3, C4, C9—.005-μfd. disc capacitor
C5—3.3-μμfd. ceramic capacitor
C6—22-μμfd. silver mica capacitor
C7—.001-μfd. disc capacitor
C8—.005-μfd. disc capacitor
C10—.05-μfd., 200-volt paper capacitor
C11—.02-μfd., 200-volt paper capacitor
C12a/C12b—20/20-μfd., 150-volt dual electrolytic capacitor
CH1—8-henry, 40-ma. choke
J1—Panel-mounting microphone connector (Amphenol 75-PC1M)
J2—Open-circuit phone jack
L1, L2, L3—See text and coil winding diagram
R1—30-ohm, ½-watt resistor
R2—470,000-ohm, ½-watt resistor
R3—220-ohm, ½-watt resistor
R4—2-megohm, ½-watt resistor
R5—100,000-ohm potentiometer (Sensitivity)
R6—500,000-ohm potentiometer (with s.p.s.t. switch S1) (Volume)
R7—5600-ohm, ½-watt resistor
R8—18,000-ohm, 1-watt resistor
RFC1, RFC2—R.F. choke (Ohmite Z-50)
RFC3—2.5-mh. choke (National R-50)
S1—S.p.s.t. switch (on R6)
SR1—65-ma. selenium rectifier
T1—Power transformer; secondary 120 volts, 20-ma., 6.3 volts, .6 amp. (Thordarson 26R32 or Stancor PS-8415)
TB1—Two-screw terminal tie strip
TS1-4—Tie strips (see pictorials)
V1—6BZ7 tube
V2—12BZ7 tube
1—7" x 5" x 3" chassis box (LMB 145)
1—Vernier dial (National MCN)
2—Knobs (National HRS-3)
1—2⅝" x 4¾" aluminum plate for subchassis

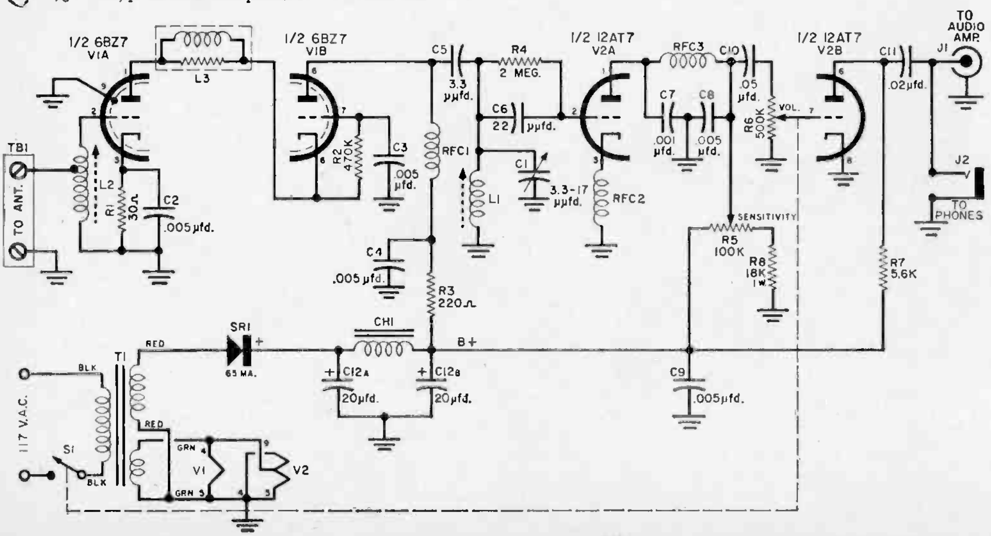


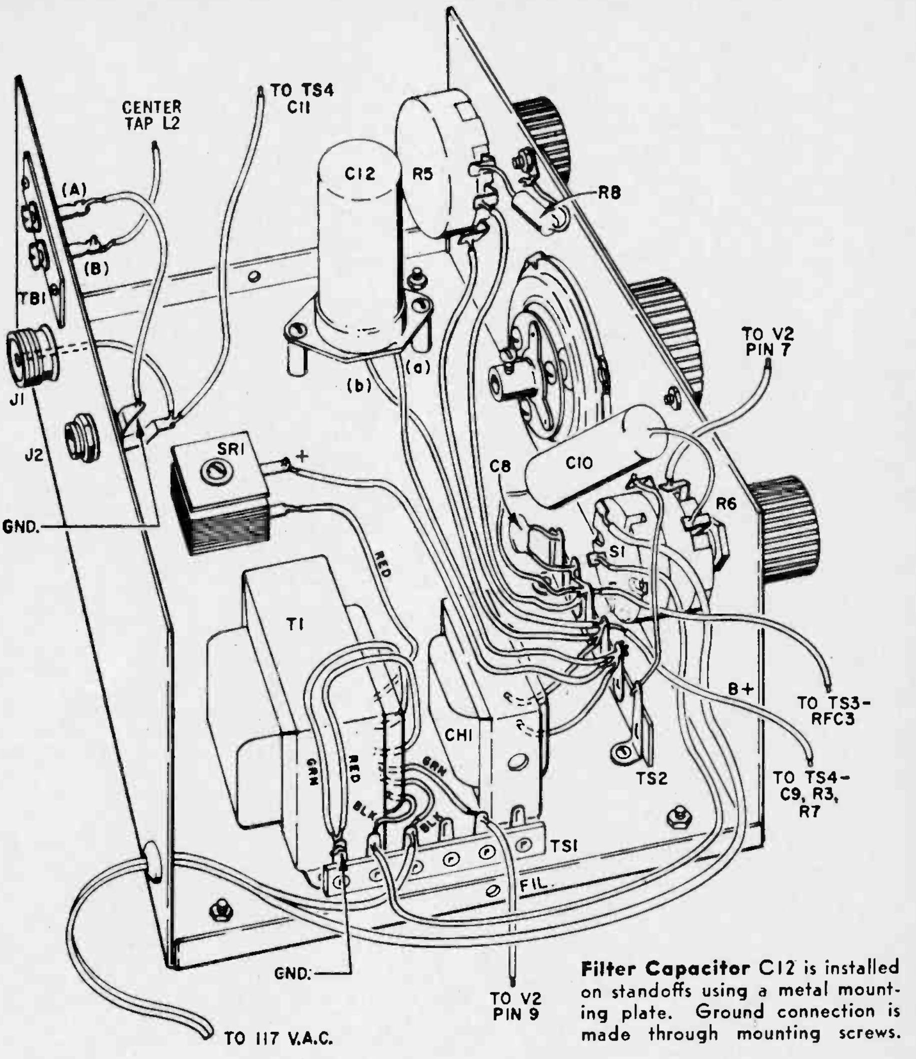
The coil forms used for L1 and L2 are Cambridge Thermionic ⅜" ceramic slug-tuned units (Type LS-3).

Sockets for the 6BZ7 (*V1*) and 12AT7 (*V2*) tubes are mounted on the same center, spaced about 1½" apart. The sockets should be positioned as shown so that short leads may be used for all connections.

Coils *L1* and *L2* are wound as shown on the coil diagram above. Coat the windings with Duco cement or a good-quality coil dope, and allow them to dry thoroughly before mounting. The ¼" mounting holes for the coils are positioned adjacent to the sockets for *V1* and *V2*.

Next, attach *C1* to the mounting bracket sold with it, and mark the position it will occupy on the subchassis with a grease





Filter Capacitor C12 is installed on standoffs using a metal mounting plate. Ground connection is made through mounting screws.

pencil or scribing tool. Do not mount *C1* until the other wiring has been completed.

To prevent interaction between the r.f. amplifier and detector, a separate ground point should be established for each stage. Ground the center post of each tube socket, and return all leads to be grounded within that stage to the center post. This results in shorter leads, and prevents r.f. "ground-loops," which could cause annoying squeals and heterodynes on the received signal.

When all wiring has been completed, mount and connect *C1*. Then slip the subchassis into place within the box and mount it by the three right-angle brackets mentioned previously. Connect the subchassis to the B-plus and filament tie points, sensitivity and volume controls, output jacks, and antenna terminal strip.

Checkout and Operation. If all wiring checks, plug a pair of high-impedance phones into *J2*, and apply power. As the receiver warms up, you should hear a loud hissing noise or "rush" in the headphones. This is known as "thermal-agitation noise," and is the product of the remarkable gain of the detector stage. Attach a 30" length of hookup wire to the "hot" terminal of *TB1*, and slowly tune *C1* across the band.

As you encounter a signal, the hissing

noise in the phones will drop to a level dependent on the strength of the received carrier. A fairly strong signal will cause the hiss to drop out completely. As you tune past the signal, or if it leaves the air, the hiss will return. The sensitivity control shown on the front panel is not critical in its setting; it can be adjusted once for best response and then forgotten. Proper setting depends on your location.

HOW IT WORKS

The "Police Special" is made up of two well-known circuits—the cascode r.f. amplifier and superregenerative detector. A 6BZ7(*V1*) serves to amplify all incoming signals while isolating the detector from the antenna. The amplified signal is coupled *loosely* to the detector grid-coil (*L1*) by capacitor *C5*.

One-half of a 12AT7 dual-triode (*V2*) acts as a superregenerative detector, and is connected as a modified Hartley grounded-plate oscillator. The oscillator is brought in and out of oscillation at a low frequency rate determined by *R4*, *C6*, and *C8*. This "quench-frequency" allows tremendous gain by the detector, without instability due to excessive feedback.

Audio recovered from the AM or FM carrier is coupled to the other half of the 12AT7, which serves as a conventional audio amplifier, delivering output to headphones or an external amplifier. The receiver power supply is transformer-operated to prevent any shock hazard. Choke filtering of the B-plus supply is used to provide a pure d.c. output and higher voltage under load.

Alignment and Calibration. If either a signal generator or grid-dip meter is handy, alignment and calibration of the receiver is quite simple. If you cannot beg, borrow, or otherwise appropriate one of these, you can do a surprisingly good job of alignment in the following manner.

If there is a television station operating in your area on Channel 2, the upper tuning limit of the receiver can be set by using the station's video carrier as a marker. With the receiver in operation, tune *C1* to its minimum (full open) capacity position. Next, adjust the slug in detector coil *L1* with an insulated, non-metallic alignment tool, until the video carrier (a loud 60-cycle buzz) is heard in the headphones.

The upper frequency limit of the receiver is now 54 mc. If specifications were followed in winding coil *L1*, the receiver will automatically fall into alignment at the low end of the band. The alignment of *L2* is not critical, and its slug may be peaked on any signal in the middle of the band (approximately 42 mc.).

The dial can then be calibrated by listening for the various services and determining their frequencies from the allocations chart.

SERVICE ALLOCATIONS CHART*

Service	Frequencies (mc.)
Automotive Emergency	35.7 — 36
Highway Trucks	35.78 — 35.94
Power Companies	37.5 — 37.86
Police (local)	38 — 41
Motor Carrier	44.1 — 44.42
Fire Department	47.2 — 47.9
Public Utility	47.7 — 48.5
Highway Patrol (State Police)	48 — 49.5
Radio Amateur	50 — 54 (six meters)

** A more complete listing of services operating in the 30-50 mc. band may be found in the "Registry of Police Radio Systems" or "Registry of Industrial Radio Services," both published by the Communications Engineering Book Company, Monterey, Mass.*

If you wish, the Police Special can be connected to an outdoor TV antenna. However, the receiver may be overloaded by the excessive signal input, and the 30" lead will provide more than enough signal pickup in any but the most remote locations. Suffice it to say that radio amateur signals from California have been heard "5 by 7" in New York City on the six-meter section of the receiver, with nothing more than the 30" "long-wire" antenna.

STATE REGULATIONS

Many states, such as those noted below, have ordinances pertaining to the installation and operation of short-wave receiving equipment on the 30-50 mc. band. If you have any question as to your state's requirements, check with the local Police Department.

California. Los Angeles has a city ordinance prohibiting the installation in a motor vehicle of receiving equipment which can tune to municipal (fire and police) frequencies.

Florida. The law prohibits the use in a motor vehicle of equipment capable of receiving on police frequencies; however, amateurs are specifically exempted.

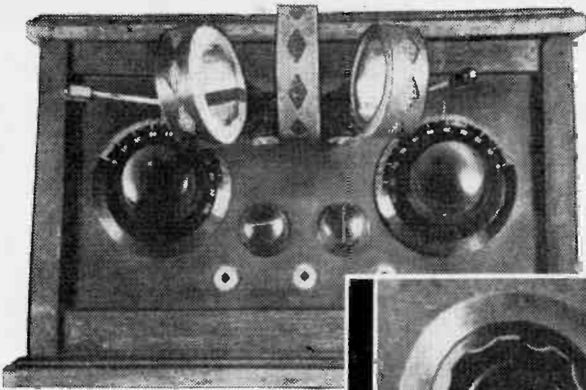
Indiana. Use in motor vehicles of equipment capable of receiving on police frequencies is prohibited.

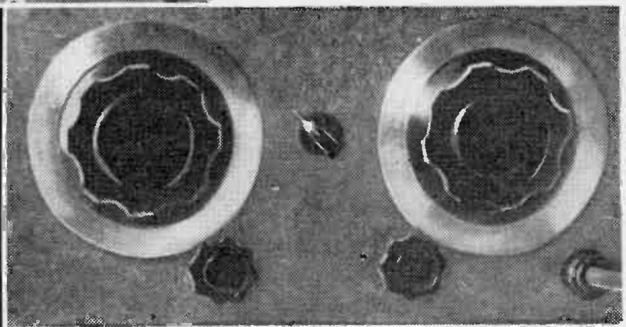
New Jersey. Use in motor vehicles of equipment capable of receiving on police frequencies is prohibited, unless user has a permit from the local chief of police.

New York. Same as New Jersey.

North Dakota. Installation and use of mobile short-wave receivers without a permit is prohibited.

South Dakota. Same as North Dakota.





Modern version of the old "honeycomb" type receiver (above) utilizes r.f. chokes as tuning coils.

The VLF Long Wave Receiver

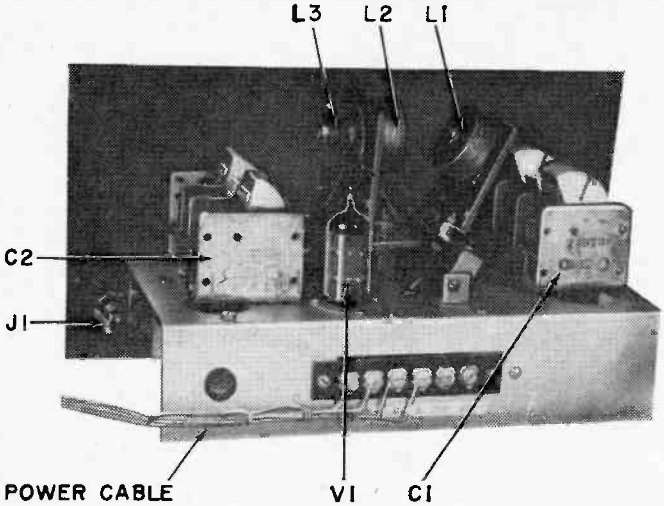
Explore the long waves . . . listen to marine transmissions on the very low frequency band

By F. J. BAUER, Jr., W6FPO

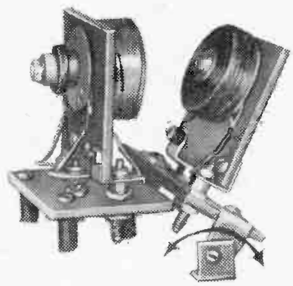
To most experimenters, the radio-frequency spectrum below 100 kc. is an unexplored mystery. In the old days, plug-in "honeycomb" coils were used in receivers tuning up to 30,000 meters (10 kc.). Such a receiver with a set of coils is shown above—it is over thirty years old and is a collector's item.

Although honeycomb coils are no longer available, a modern version of this receiver can be built using readily available r.f. chokes. Their *Q* is not as high as that of the older honeycomb coils, but the chokes work well and enable the construction of a v.l.f. receiver at moderate cost.

Stations NSS, Washington, D. C. (15.5 kc.), NPM, Honolulu (17 kc.) and NPG, San Francisco (19 kc.), were picked up in Los Angeles without difficulty using a low 50′ antenna. These "old reliables" in the v.l.f. band transmit weather and traffic data



Placement of major parts of the v.l.f. receiver is shown in the top chassis view at left. Below is a detailed view of the adjustable coil assembly.



to vessels at sea and are excellent for code practice purposes. Other broadcasts have been picked up including an occasional European station DX'ing through.

The coil socket assembly sketch (see p. 74) is used as a guide for the coil assembly banana jack mounting. Exact spacing is not critical, but make sure that all coils can plug in without binding.

It's best to mount the socket assembly *before* the other top chassis components and panel to allow room for adjustment. Don't forget to put the fiber washers between the mounting brackets. When properly adjusted, they provide the right amount of friction for convenient variation of the antenna coil coupling. (Antenna coupling is varied only occasionally during receiver operation.)

The secondary coil (*L2, L3*) socket is mounted on ⅝" spacers to raise it to the same level as the antenna coil (*L1*) socket. Orient it as shown and position the grid coil lugs for ease of soldering.

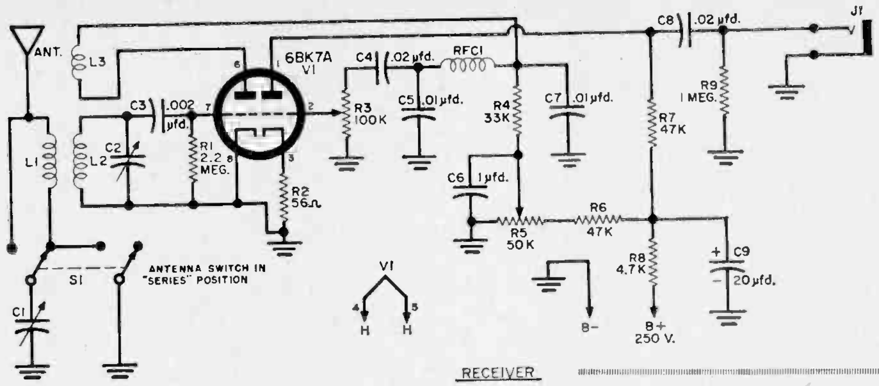
Solder short lengths of hookup wire to the *L3* jacks before mounting since they will not be accessible after installation of the assembly. Run the antenna and plate coil leads through holes in the chassis protected by rubber grommets.

Assembly and wiring of the rest of the receiver is simple, once the coil sockets have been mounted. Be sure that the series-parallel switch (*S1*) is wired correctly; otherwise, it will be impossible to tune the antenna circuit.

Standard three-gang capacitors with all sections connected in parallel are used to obtain the necessary 1000 $\mu\mu$fd. Either a t.r.f. or a superhet type provides sufficient capacitance. Remove all trimmers to enable the minimum capacitance to be as low as possible.

The 150-mh. r.f. filter choke (*RFC1*) underneath the chassis is mounted with a *brass* bolt and a short (¼") spacer. Do not use a steel bolt for any of the coils or performance will be impaired. No other special precautions are needed in mounting the parts.

No power supply is built in since many experimenters may want to use an audio amplifier for loudspeaker operation and



RECEIVER

power can be tapped from the amplifier. If a separate power supply is preferred, the one shown works well and decoupling filter *C9* and *R8* may be omitted in the receiver proper. Neither side of the tube filament is grounded at the receiver chassis. Ground is made at the amplifier or power supply used with the receiver.

Connect the receiver to a power supply or amplifier, and start with the lowest frequency coil set first. Mount a 150-mh. and 0.75-mh. coil on one of the coil plates as shown using a brass nut and bolt. The 150-mh. coil is mounted on the side of the coil plate with the widely spaced plugs. Connect the coil terminals to the corresponding plug terminals with short pieces of hookup wire and plug in the assembly.

If the coil socket wiring is correct, the

RECEIVER PARTS

C1, C2—3-gang tuning capacitor (all sections wired in parallel)
C3—0.002 µfd.
C4—0.02 µfd.
C5—0.01 µfd.
C6—1-µfd., 600-volt tubular
C7—0.01 µfd.
C8—0.02 µfd.

All capacitors are ceramic types, 400-volt or higher rating, unless otherwise noted.

C9—20-µfd., 450-volt electrolytic
J1—Open-circuit phone jack
L1, L2, L3—See text
R1—2.2 megohms
R2—56 ohms
R3—100,000-ohm potentiometer (audio taper)
R4—33,000 ohms
R5—50,000-ohm wire-wound potentiometer
R6—47,000 ohms, 1 watt
R7—47,000 ohms
R8—4700 ohms, 1 watt
R9—1 megohm
RFC1—150-mh. r.f. choke (Miller #961 or equivalent)

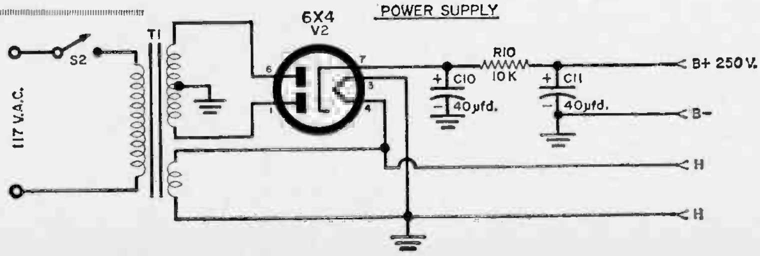
All resistors are ½-watt composition unless otherwise noted.

S1—D.p.d.t. rotary switch
V1—6BK7A tube
1—9" x 4½" x 2" chassis
2—Shaft couplings, ⅜" to ¼" shaft reduction
6—Banana jacks (Johnson 108-740 or equivalent)
20—Banana plugs (Johnson 108-750 or equivalent)
20—Small angle brackets (American Radio Hardware #1 or equivalent)
2—3" or 4" dials
3—Knobs
1—5½" x 11" panel
1—6-lug terminal strip
1—Tube socket for V1
1—Phenolic or Bakelite sheet, approx. 6" x 9", ⅛" thick

POWER SUPPLY PARTS

C10, C11—40-µfd., 450-volt electrolytic capacitor
R10—10,000-ohm, 2-watt resistor
S2—S.p.s.t. toggle switch
T1—Power transformer; primary 117 volts; secondary 250-0-250 volts @ 10 ma., 6.3 volts @ 1.2 amp. (Chicago Transformer PV10S, Triad R-3A, or equivalent)
V2—6X4 tube
1—7-pin miniature tube socket
1—Small chassis

POWER SUPPLY



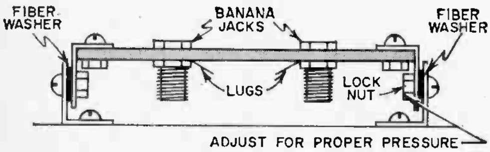
ANTENNA COILS

Frequency Range (kc.)	L1* (mh.)	Switch Setting Ser.	Par.
13–30	150 (#961)		X
34–70	150 (#961)	X	
25–65	30 (#692)		X
80–150	30 (#692)	X	
45–120	10 (#670 or 956)		X
140–280	10 (#670 or 956)	X	
100–240	2.5 (#640 or 953)		X
270–550	2.5 (#640 or 953)	X	

GRID AND PLATE COILS

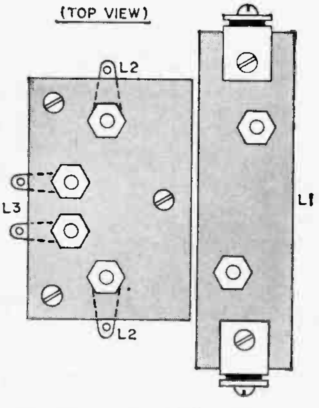
Frequency Range (kc.)	L2	L3
13–56	150 mh. (#961)	0.75 mh. (#620)
40–180	15 mh. (#690)	0.25 mh. (#610)
140–550	1.5 mh. (#630)	8 turns (see text)

** Four antenna coils are used to tune the antenna properly with no gaps in the tuning range; this listing can be used as a guide for selecting the proper coil. All coil numbers given here are J. W. Miller (5917 S. Main St., Los Angeles 3, Calif.).*



ADJUSTABLE ANTENNA COIL SOCKET MOUNTING DETAIL (SIDE VIEW)

(TOP VIEW)



COMPLETE COIL SOCKET ASSEMBLY

detector will oscillate as evidenced by a short "plop" when the regeneration control is advanced rapidly. Make up a 150-mh. antenna coil as shown, plug it in, and check the receiver for operation.

Adjust the coupling with the antenna switch in "parallel" position and the antenna coil tilted about 30°. Advance the regeneration control (*R5*) until the detector is oscillating weakly and set the antenna tuning capacitor for maximum background noise, readjusting *R5* as required. Some signals should be heard at this point.

"Touch up" the tuning capacitors for maximum strength. Experiment with the coupling and tuning adjustments until you

HOW IT WORKS

This is a regenerative receiver with positive feedback in the detector obtained through plate tickler coil *L3*. Regeneration is controlled by variation of the detector plate voltage with potentiometer *R5*.

One half of the 6BK7A twin triode (*V1*) functions as a detector and the other half as an audio amplifier. Choke *RFC1* and capacitors *C5* and *C7* supply the carrier frequency filtering required.

Both the antenna and grid circuits are tuned to the incoming signal to obtain maximum signal pickup and selectivity. Coupling is varied by changing the position of the antenna coil with respect to the grid coil.

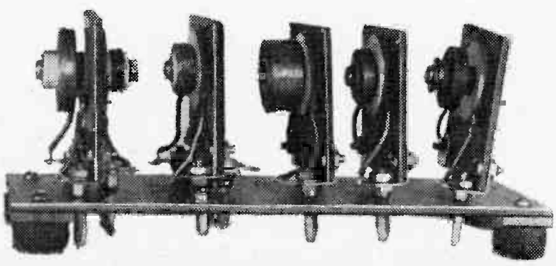
An audio amplifier will provide loudspeaker operation and the amplifier's power supply may also be used to supply the 5 ma. drawn by *V1*.

are familiar with the operation of the receiver and then make up the rest of the coils in accordance with the coil table.

The plate coil winding for the 140-kc. to 550-kc. band consists of eight turns of wire (salvaged from any r.f. coil) wound in the slot between the choke coil baseplate and the coil proper. Be sure to wind the eight turns in a direction *opposite* to that of the grid coil winding; otherwise the detector will not oscillate. If the tube does not oscillate, simply reverse the winding direction.

Coil connections are specified on the as-

A rack on which to store the coils when they are not in use can be made of scrap Masonite or Bakelite.



sumption that the manufacturer wound all the coils in the same direction. However, if a coil set refuses to oscillate, reverse the plate coil leads and try again.

With stations in the v.l.f. band only two or three kc. apart, it is necessary for the operator to separate c.w. stations "by ear." If the builder wishes to add a refinement to the receiver, a Type FL-8-A (B) filter may be obtained through surplus dealers.

In the *Range* setting of this filter's 3-position switch, a sharp 1000-cycle peak is obtained, which enables complete separation of stations in the v.l.f. band.

In the *Voice* position, the 1000-cycle peak is attenuated so that aircraft radio range-voice transmissions may be received with minimum interference from the 1000-cycle modulation present on these stations.

In the position marked *Both*, the filter is out of the circuit. The filter input is plugged into the receiver headphone jack and the filter output into the amplifier input.

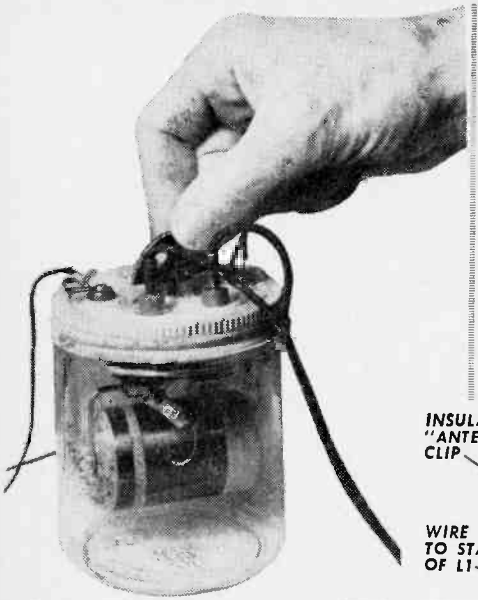
Short lengths of microphone cable fitted with phone plugs serve as connecting cable.

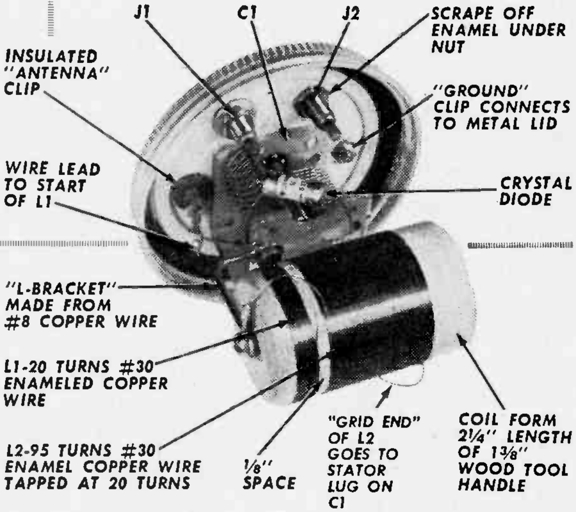
Operating this v.l.f. job, while not difficult, is much different from operating a superheterodyne type of receiver. Precise adjustment of the regeneration control and careful tuning of the antenna and grid circuits is necessary to bring in those elusive stations. You'll discover that considerable skill is required to get the best from this rig; but as your proficiency grows, so will your DX log.

JAR HOLD-ALL

Discarded jars which are fitted with spade lug bolts used to hold "cans" to a chassis make dandy containers for spare parts. When they are hung on the wall with "L" hooks, the contents are instantly visible. Cost is low and jars of any size can be used.—*A. P. Zanelli, Tampa, Fla.*

Glass-Jar Crystal Receiver





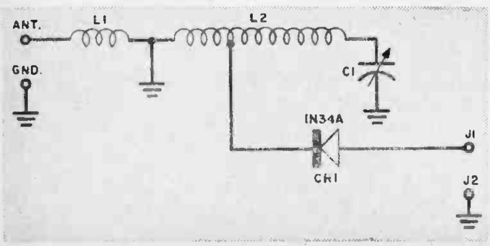
The next time you finish a jar of peanut butter, don't throw away the empty jar. Put a crystal receiver in it! A few inexpensive parts will transform that old dispenser of sandwich filling into a dispenser of local radio broadcasts.

You can use the metal lid of the jar as a ground. The only precaution to be observed is in scraping away the enamel on the lid at the points where you want to wire directly to the "chassis."

The coil is a homemade affair and can be made easily as shown above. Duco cement placed in strategic places is useful in winding the coil. After the coil is completed, a coat of shellac will hold the windings secure.

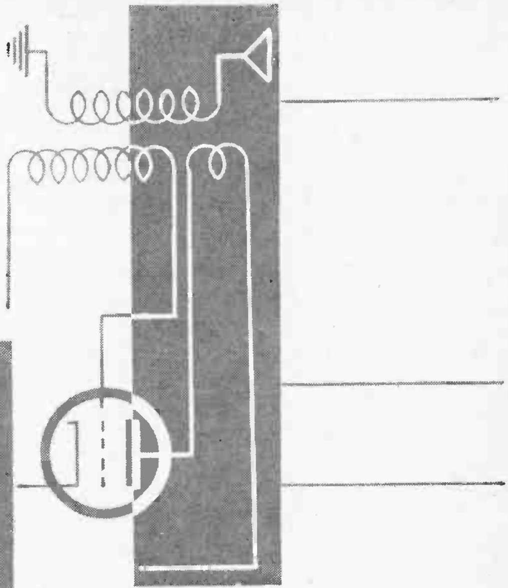
Selectivity is good with the crystal diode (*CR1*) connected to the tap on the secondary coil, but should you want to sacrifice a little selectivity for additional sensitivity, try connecting the crystal diode to the junction of *C1* and *L2*. *CR1* can be a 1N34A or CK705, and *C1* is a 15-400 μμfd. variable capacitor (Allied Radio 61H009 or Lafayette Radio MS-214).

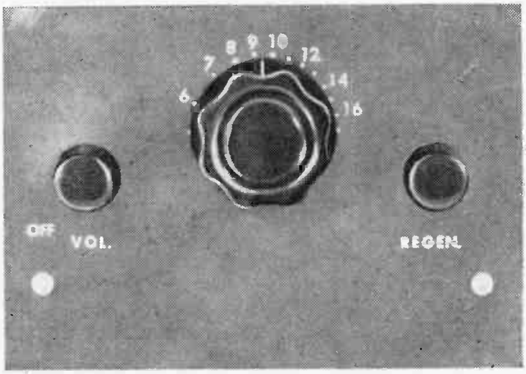
An outdoor antenna at least 75 feet long should be used for best results. Earphones with an impedance of 3000 ohms or more are preferable, but 500-ohm dynamic phones have proven satisfactory with this set.



By ART TRAUFFER

This two-transistor receiver features a.v.c. and tuning compensation





Transistorized Regenerative Receiver

By
JAMES E. PUGH, JR.

The regenerative circuit is one of the simplest and most sensitive receiver circuits available. But, as you probably know if you've had any experience with these "squealers," it is necessary to re-adjust the regeneration control constantly over a fairly wide range when tuning from one end of the band to the other. The two-transistor receiver described below uses a very simple compensation circuit to overcome this weakness and provides nearly constant regeneration over the entire broadcast band.

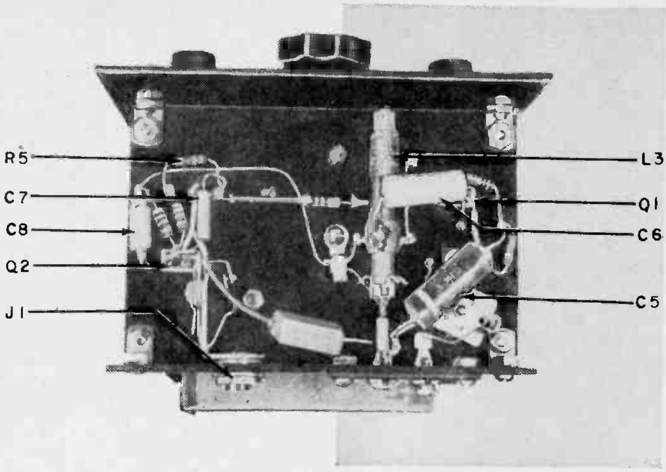
The chassis and front panel can be aluminum or Bakelite, with aluminum preferred to eliminate hand capacity effects. A 3¼" x 5" plastic chassis was used in the author's model with turret terminal lugs installed for parts mounting.

Various sections of the chassis are fastened together with small angle brackets, and the tuning capacitor is mounted to both the front and chassis panels for maximum panel rigidity. If a non-metallic front panel is used, ground the shaft of *C3* to the frame of *C4* with a flat metal grounding strip.

A built-in ferrite rod antenna (*L1*) provides good reception for portable use;

PARTS LIST

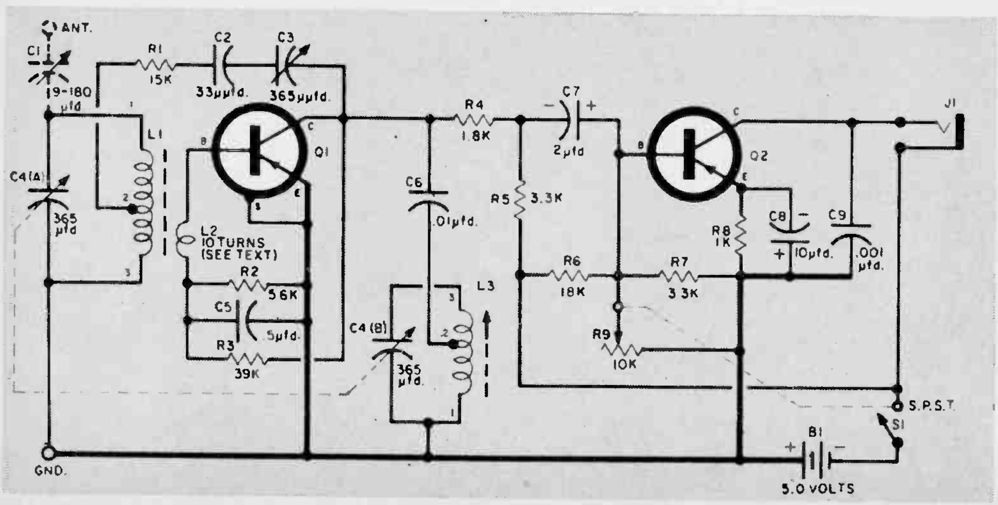
B1—5.0-volt mercury battery (Mallory TR-134R or equivalent)
C1—9-180 μμfd. trimmer capacitor (optional)
C2—33-μμfd. ceramic or mica capacitor
C3—10-365 μμfd. miniature variable capacitor (Lafayette MS-215 or equivalent)
C4a/C4b—Two-gang variable capacitor, 365-μμfd. each section (Miller 2112 or equivalent)
C5—0.5-μfd. tubular capacitor
C6—.01-μfd. tubular capacitor
C7—2-μfd., 6-volt electrolytic capacitor
C8—10-μfd., 6-volt electrolytic capacitor
C9—.001-μfd. ceramic or mica capacitor
J1—Phone jack
L1—Ferrite core antenna (Lafayette MS-166 or equivalent)
L2—10 turns of #30 enameled wire added to bottom end of L1
L3—Adjustable ferrite core coil (Miller 2002 or equivalent)
Q1—2N247 (or 2N274) transistor
Q2—2N109 (or 2N217) transistor
R1—15,000 ohms
R2—5600 ohms
R3—39,000 ohms
R4—1800 ohms
R5, R7—3300 ohms
R6—18,000 ohms
R8—1000 ohms
All resistors ½-watt composition
R9—10,000-ohm potentiometer (logarithmic taper) with S1
S1—S.p.s.t. switch (part of R9)
1—5-pin transistor socket
1—3-pin transistor socket
1—Chassis and panel
1—Battery holder (Acme #69 or equivalent)
Misc. screws, nuts, lugs, washers, wire, terminal strip, knobs, etc.



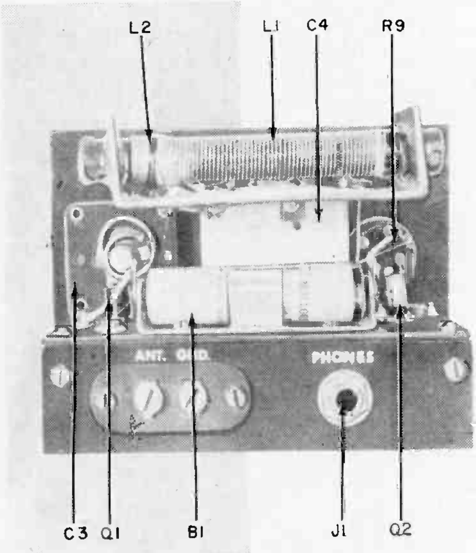
use the largest antenna that your chassis will accommodate (4" or more) and mount it as far away from any metal as possible. An external antenna and ground can be hooked up for peak performance.

Before mounting *L1*, wind 10 turns of #30 or #32 wire around the lower end of the present winding and fasten it with coil dope or wax. Leave the leads of the new winding (*L2*) about 6" long. They can be clipped to the correct length after you check to see which way they need to be connected in order to obtain regeneration.

Antenna *L1* can be mounted at the rear of the tuning capacitor (*C4*) with a small angle bracket and further supported with heavy (about #16) bus wire connections to *C4*. *L3* should be mounted at right angles



Major parts placement is shown in bottom and rear views of chassis. Phone jack J1 should be insulated if metal chassis is used. Note use of two-gang tuning capacitor (C4) and one-gang regeneration control (C3).



to and as far as possible from *L1*. Place *L3* so that you will have easy access to its adjustment screw. Other than this, parts layout is not critical.

A large tuning dial should be used, since the high selectivity makes tuning somewhat critical on weak stations, and 20,000-ohm headphones present the best match to *Q2's* output impedance.

Receiver alignment is achieved by varying the spacing of the *L1* primary windings (near the #1 terminal end) at the low end of the broadcast band (530 kc.) and the setting of the trimmer on *C4a* at the high end of the band (1620 kc.) until the complete broadcast band can be tuned in.

Next, tune in a station at about 600 kc., and adjust the *L3* core for maximum output. Adjust the *C4b* trimmer for maximum broadcast signal output at about 1500 kc. Repeat these two adjustments until maximum output is obtained at both frequencies. *C3* should be set near optimum regeneration point for the adjustments.

Now, with the dial set at 600 kc., make sure that *C3* is set just below the oscillation point. Reset the dial to 1500 kc. and note whether the regeneration control must be changed to obtain the same condition as at 600 kc. If not, you're ready to go.

If *C3* must be increased to obtain optimum regeneration at 1500 kc., a higher value should be used for *R4*. If *C3* must be backed off, reduce *R4* slightly. The proper condition is obtained when the two ends of the band are balanced. A slight rise in regeneration will probably be noted as you turn toward the center of the band, as it is not possible to get perfect compensation.

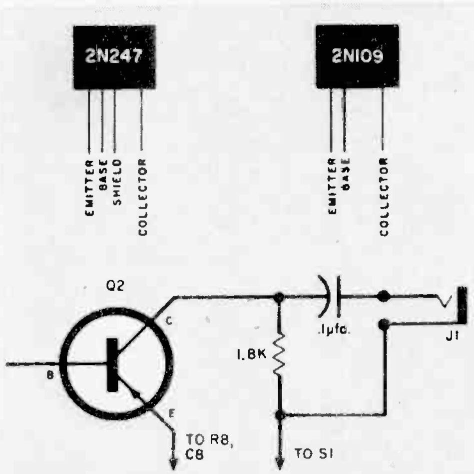
The receiver is tuned the same way as any other regenerator except that the regeneration control can be operated slightly above the oscillation point for maximum output.

HOW IT WORKS

This receiver uses a modified class B detector (*Q1*), followed by a single-stage audio amplifier (*Q2*). Regenerative feedback variation is minimized by resistor *R1* in series with *C2* and regeneration control *C3*.

Resistor *R4* is connected in series with *R5* and the audio amplifier stage to reduce the effects of load variation with frequency. *R4* reduces the signal fed to the audio stage but the improved performance more than compensates for the loss in gain.

The second tuned circuit (*C4b* and *L3*), ganged with the tuned-input circuit (*L1* and *C4a*), is used to give an increase in selectivity. A small amount of automatic gain control has been provided by returning *R3* to the collector of *Q1*.



Complete schematic is at far left. Alternate output circuit for use with crystal earphone is at left. A matching transformer can also be used with original circuit to match transistor to earphone.

Build The Black Box That Hears Missiles

By CHARLES H. WELCH

Missilemen, in the jargon of their trade, refer to a missile's guidance system as a "black box." This particular "black box" is really a very low frequency radio—it won't let you tell a missile where to go . . . but it will tell you when one went. Relying on ionization noise for its information, this little transistorized tuned preamplifier will not only indicate when one of the larger rockets takes off, but it will permit you to eavesdrop on the normal clicks, shrieks and whistles of the upper atmosphere's "dawn chorus."

The output of the black box is fed into an audio amplifier or a high-gain oscilloscope. Your tape recorder will serve nicely to give you a permanent record of upper atmosphere events, man-made—or otherwise.

The signals shown in the chart at right were detected with the black box during the firing of the lunar probe rocket "Pioneer" on October 11, 1958, at 3.42 a.m., EST. The monitoring site was at Orlando, Florida, and the time of the firing was confirmed by radio reports and by visual sighting of the rocket's exhaust flare as it neared the top of the first stage of flight. Though Orlando is only 50 airline miles from Cape Canaveral, the excellent propagation conditions in the very low frequency band would have made these signals detectable over distances many times that great.

One of the big difficulties in missile monitoring is knowing when to listen, since the Defense Department is not prone to advertise its firings in advance. However, accurate advance information is frequently given out on firings of test vehicles such as the "Pioneer" and the "Vanguard." Even with military missiles, it is usually possible to confirm observations afterwards since the time of firing is often announced shortly after the test.

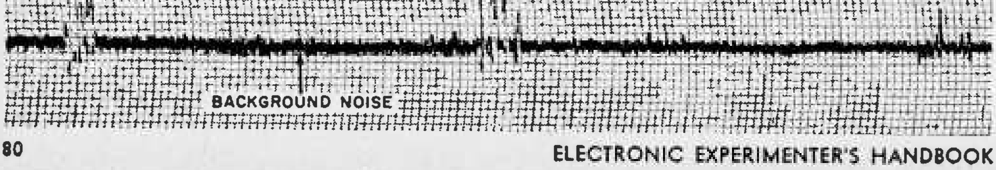
The loop-preamplifier combination has a frequency range between 4 and 16 kc. This response is a compromise between good sensitivity and wide coverage of the v.l.f. spectrum.

The loop antenna is 200 turns of #25 enamel-covered wire wound into a square loop on a wooden frame measuring 48" diagonally. The ends of the winding are brought up on two binding posts, and lamp cord is used to connect these terminals to the input jacks (*J1* and *J2*) of the preamplifier. Capacitor *C1* may be mounted on the terminals of the loop or within the preamplifier cabinet.

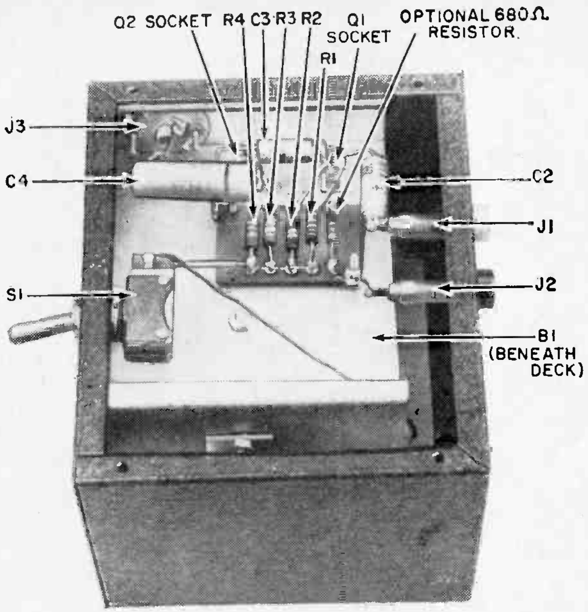
Since one of the big problems of this type of rig is power-line frequency hum, a battery-powered transistor amplifier was chosen. The two-stage resistance-coupled circuit used has a measured voltage gain of 1330 at 10 kc. and construction is straightforward. Parts layout is not critical. The original unit was built on a 1" x 3" x 4" chassis and enclosed in a 3" x 4" x 5" steel utility box. Any small 6-volt battery can be used, as current drain is very low.

Sensitivity of the completed unit may be tested by listening in on thunderstorms. If you can hear "whistlers" with the unit, or if chirps and clicks from a thunderstorm which is miles away are loud and clear, then the sensitivity is adequate.

Of course, the best way to determine the exact bandpass of the unit is to run a curve with an audio oscillator and a VTVM, but a rough estimate of correct bandpass can

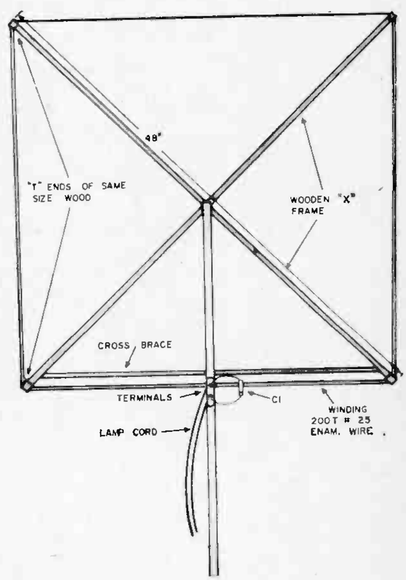


Oscillogram recording shows clearly difference between atmospheric and missile noise.



Bottom view of black box with cover removed. The two transistors and the battery are on the other side of the deck. A 680-ohm resistor can be wired across J1 and J2 to widen bandwidth, but sensitivity will be lost.

C1 is mounted on the loop antenna. A line cord connects them to the black box through pin jacks J1 and J2. The output from J3 can plug into any good audio amplifier.



Extra-large loop antenna and capacitor C1 form a tuned circuit covering the very low frequency band. The antenna should be positioned for best sensitivity and least noise.

be made. The higher frequency harmonics of the 60-cycle power line will make a steady whine which is overridden by the pops and clicks of atmospherics from distant ligntning. These clicks should be sharp, clear and unmuffled.

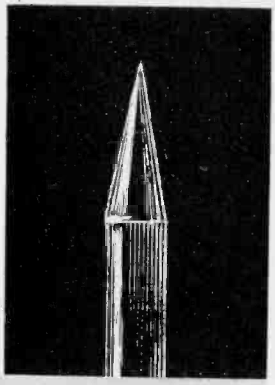
Remember that the characteristics of the v.l.f. band vary from one time of day to another and several tests should be made before any definite conclusion is reached.

The audio amplifier should be adjusted for flat response when the missile detection system is operating. The output of the audio amplifier may be fed into a speaker or viewed on a scope. If you have a tape recorder, it is a good idea to record the entire monitoring period, as this will enable you to reproduce any desired portion of the received signals later for detailed study.

The loop antenna should be rotated slowly until a sharp null in the hum level is apparent. When it is located, the antenna should be left in that position. However, if the antenna is not broadside to the noise source, there will be a large drop in gain. To prevent this, try a new site.

Missile noise and transient noise impulse interpretation is a study in itself, and a great deal of elaborate and expensive equipment is involved. However, the experimenter with limited equipment can recognize the noise of a missile when he knows what he is looking for.

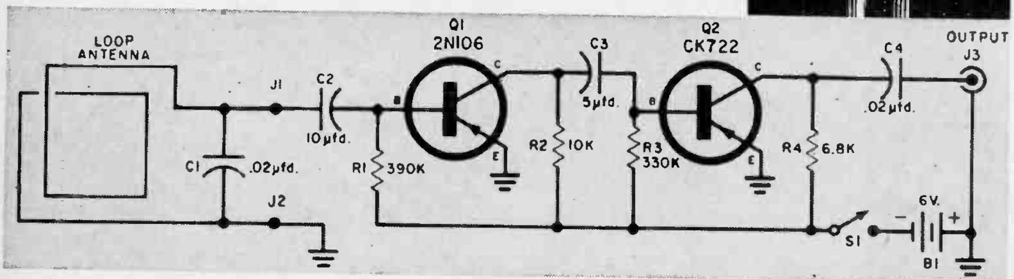
Unfortunately, describing the differences between noise produced by a missile and atmospheric noise is a little like trying to explain the differences between a Rebel yell and a Comanche warwhoop to someone who

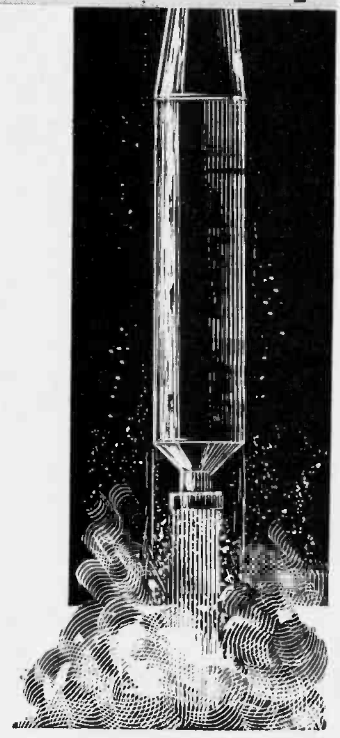


PARTS LIST

B1—6-volt battery
C1, C4—.02-µfd. low-voltage paper or disc capacitor
C2—10-µfd., 25-volt electrolytic capacitor
C3—5-µfd., 25-volt electrolytic capacitor
J1, J2—Insulated pin tip jacks
J3—Phono jack
Q1—2N106 transistor
Q2—CK722 transistor
R1—390,000 ohms
R2—10,000 ohms
R3—330,000 ohms
R4—6800 ohms
S1—S.p.s.t. switch

All resistors ½-watt composition





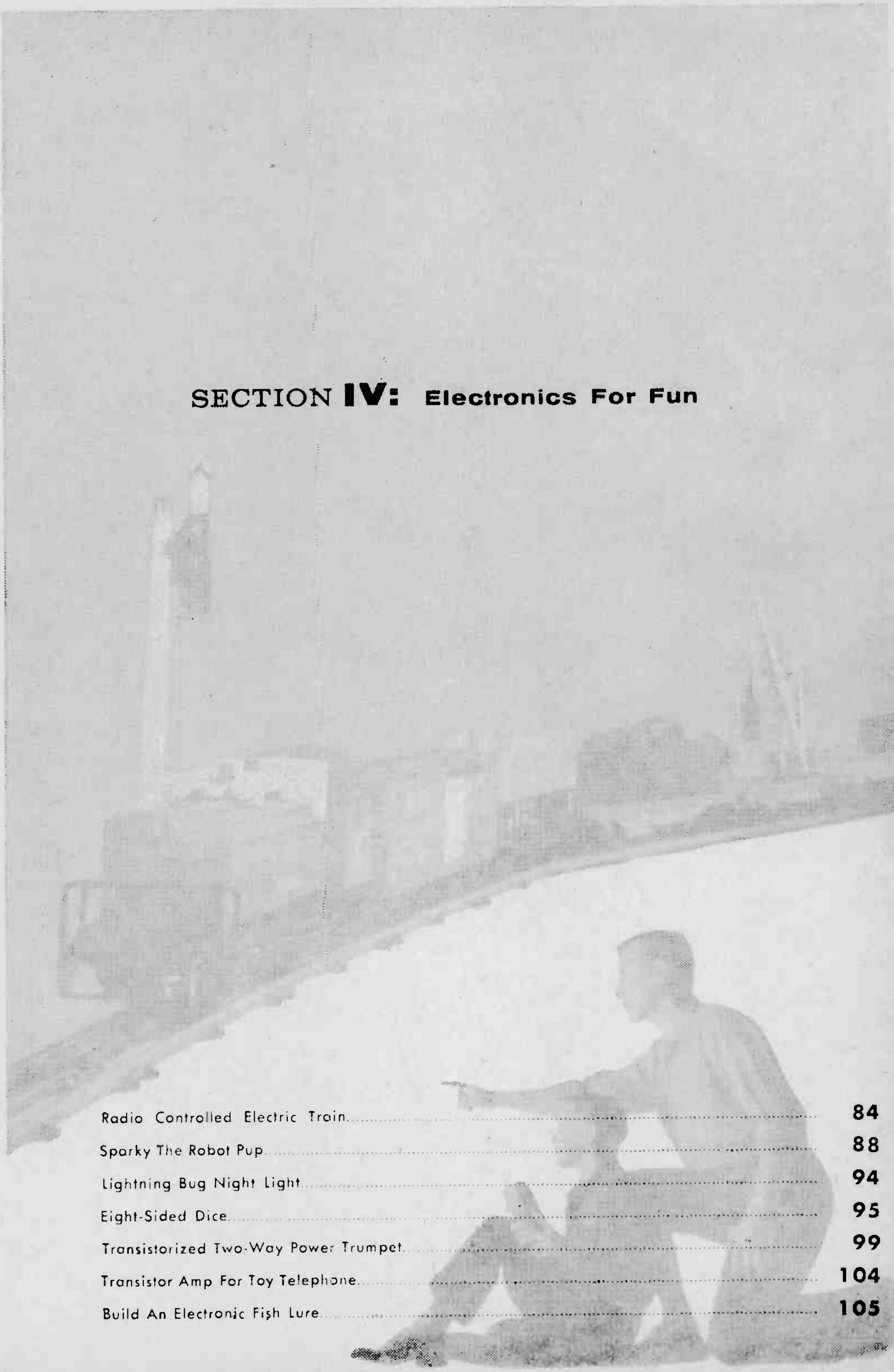
HOW IT WORKS

The loop antenna, with capacitor *C1*, makes a parallel-tuned circuit, which is resonant at 4.85 kc. The impedance of this tuned circuit is considerably higher than the input impedance of low-noise transistor *Q1* to which is it coupled. This deliberate mismatch loads the loop antenna and broadens its response to cover the desired portion of the v.l.f. band.

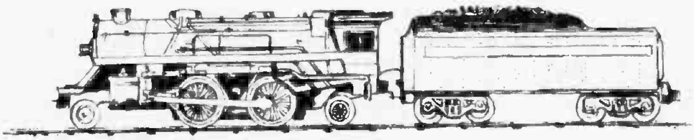
Transistors *Q1* and *Q2* make up a two-stage resistance-coupled preamplifier with a voltage gain of 1330 in normal operation, and with an over-all frequency response from 4 to 15 kc. The output of the unit may be plugged into the high-impedance input of a normal high-fidelity amplifier for further amplification to display, recording, or listening levels.

has heard neither. The key lies in the difference between the two. Become familiar with the sound of normal atmospherics, and their appearance on a scope, and the slightly different sounds of a missile will be easy to spot.

At the time of the "Pioneer" shot, oscillograph recordings of random noise taken just before the firing and about an hour afterwards showed spikes rising 3 db above the background, about one during each second. When the missile was under first-stage power, however, the noise peaks were 16 db above the background noise and occurred in bursts instead of at random. In addition, analysis of the individual noise peaks shows that they changed in character from the single spike of distant atmospherics to multiple oscillations several cycles in length. Such changes are easily detected when the signal is displayed on an oscilloscope.



SECTION IV: Electronics For Fun



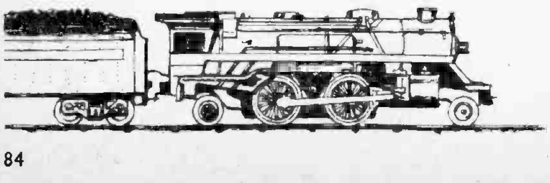
by *julian m. sienkiewicz*
managing editor of popular electronics

RADIO-CONTROLLED ELECTRIC TRAIN

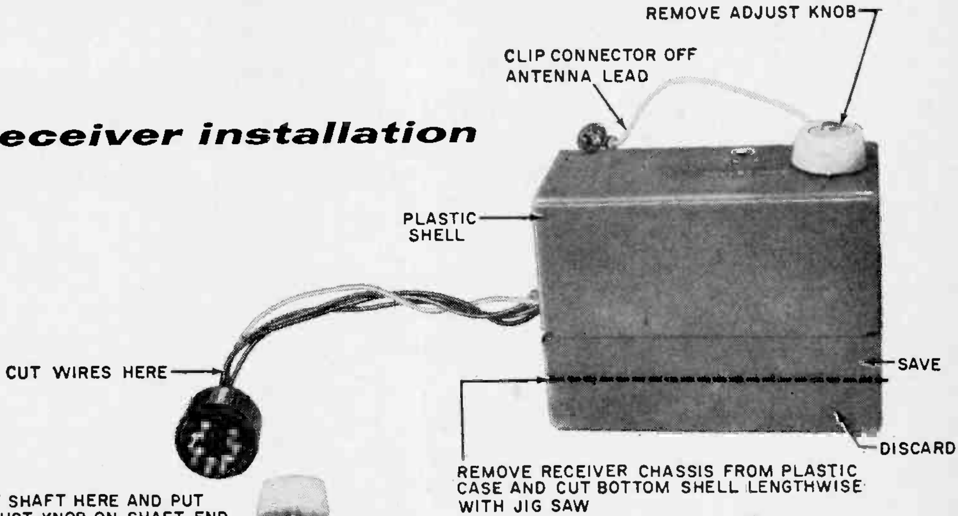
With the coming of winter, radio control hobbyists usually gather their planes and boats together and head indoors—to wait for spring. Instead of a long wait we went ahead and dreamed up a novel indoor use for R/C equipment—radio-controlled electric trains. Together or separately both Junior and Dad will get a big thrill out of this newborn hobby.

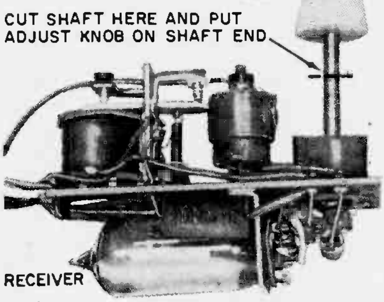
If you are not yet an R/C fan, you can get started with a completely wired radio control transmitter and receiver for less than $30.00. If you are an R/C fan now, you can use your present transmitter, and chances are your R/C receiver will be suitable for the job.

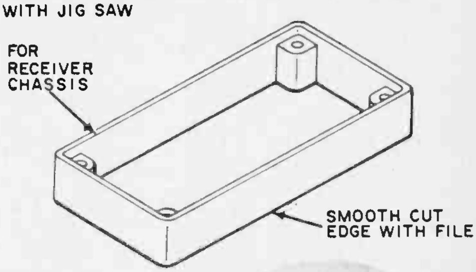
Our R/C "O" gauge electric train was built around a Lionel Model 614 Diesel locomotive with a Model 6434 poultry dispatch boxcar housing the receiver. A Lafayette Model F-208 receiver was disassembled and modified to fit into the boxcar as shown on the following pages. Operating details are given on page 87.

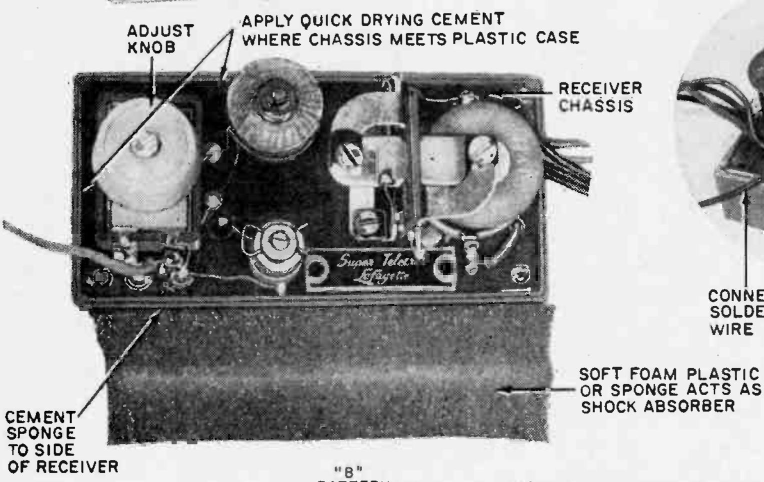


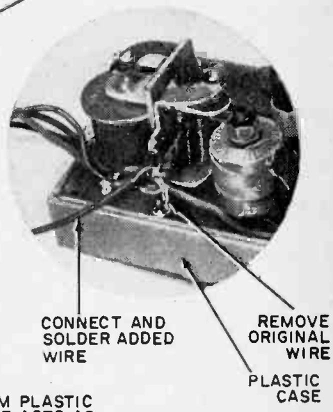
Receiver installation

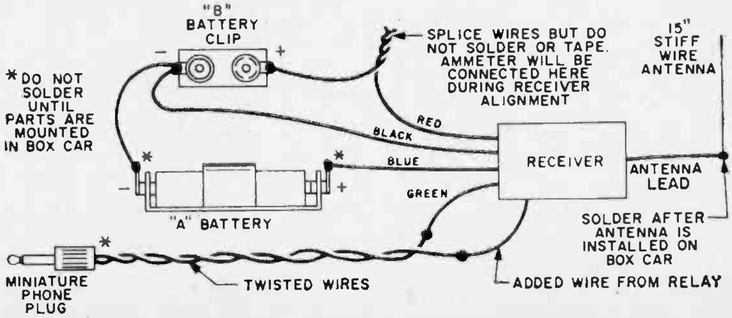


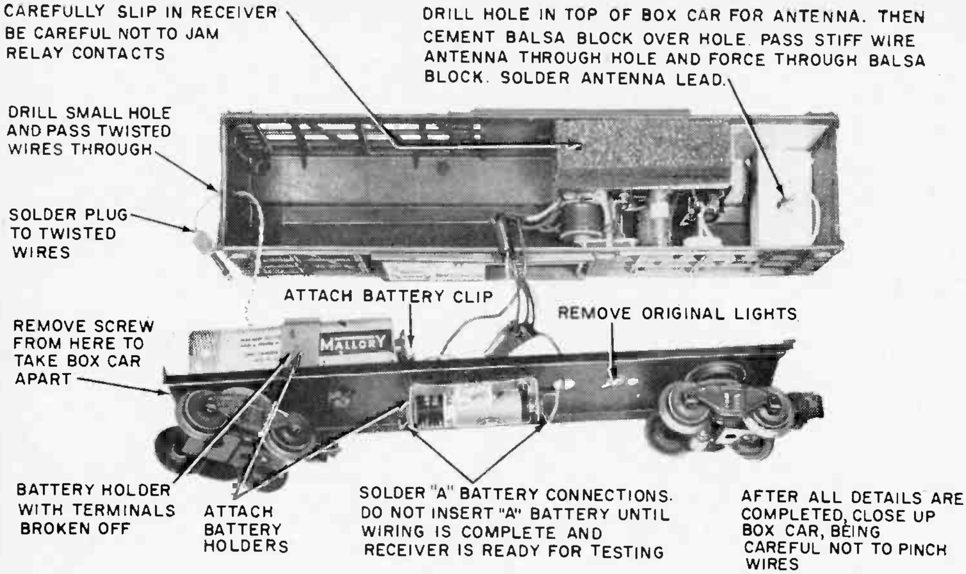


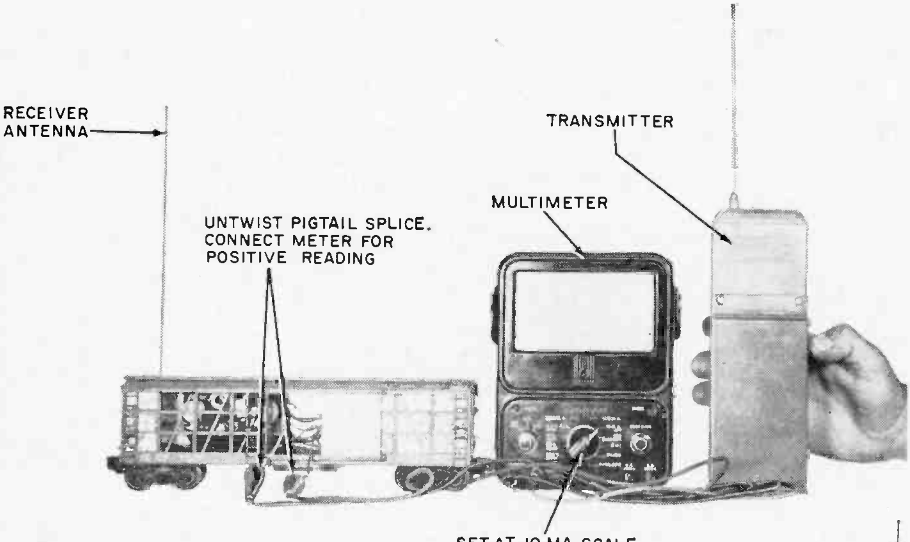












Receiver Adjustment

1 Connect a multimeter set to the 5-10 ma. range into the B-battery positive wire at the unspliced pigtail.

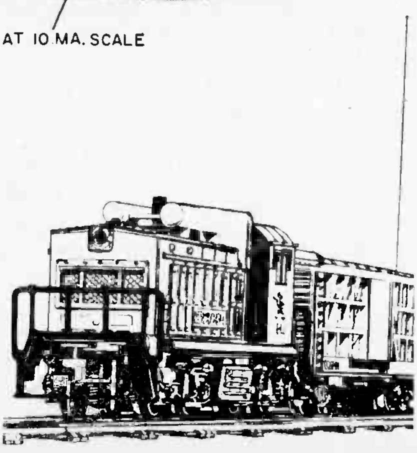
2 When you insert the A battery into holder under car to turn on receiver (the B battery is connected during receiver installation), the meter should read approximately 2.5 ma.

3 Turn *Adjust* knob all the way in (clockwise) as far as it will go, and then back it off *slowly*, watching the meter. Adjust knob for maximum meter reading. (Lift your hand from knob before taking meter readings, to avoid effects of hand capacity.) Note that the maximum point is quite critical and can easily be bypassed; you may have to repeat this operation before you find the maximum reading point.

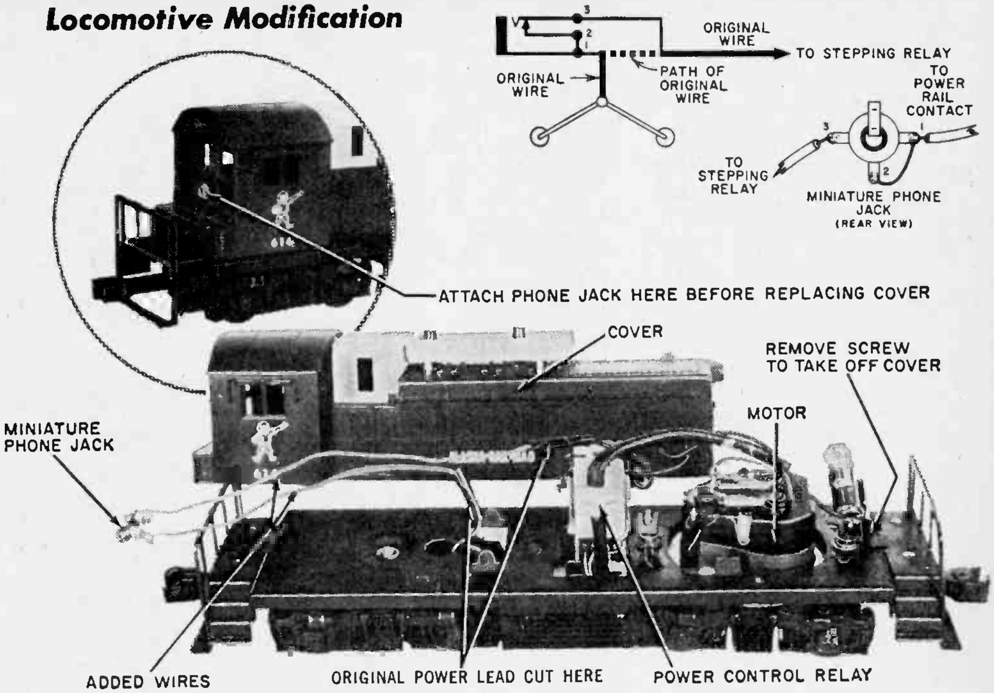
4 When you turn on and operate the R/C transmitter, the receiver's meter reading should dip to about 1.4 ma. Repeat several times to make sure receiver holds its adjustment.

5 Remove meter, splice and tape the bare leads and tuck them into the boxcar. Check receiver operation by listening for relay clicks as the transmitter button is depressed.

6 Remove A battery from under boxcar to turn off receiver.



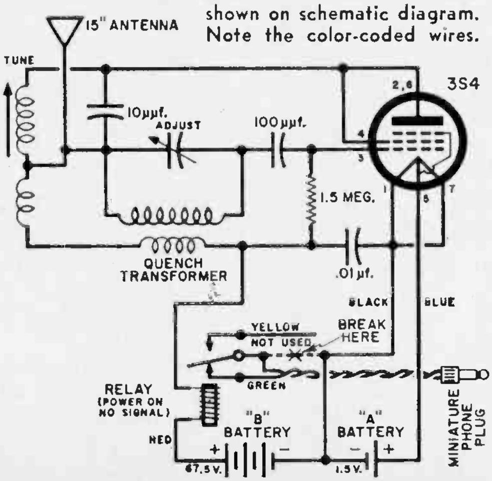
Locomotive Modification



R/C SYSTEM PARTS LIST

1—Diesel locomotive (Lionel Model 614)
1—Poultry dispatch boxcar (Lionel Model 6434)
1—Radio control receiver (Lafayette F-208)
1—Radio control transmitter (Lafayette F-249)
1—67.5-volt battery (Mallory M217)
1—1.5-volt penlight cell
1—Battery holder (Acme #52—terminals are broken off)
1—Battery holder (Acme #5)
1—Battery connector (H. H. Smith Type 1205)
1—Miniature phone jack (H. H. Smith Type 9245)
1—Miniature phone plug (H. H. Smith Type 9231)

Receiver modifications are shown on schematic diagram. Note the color-coded wires.

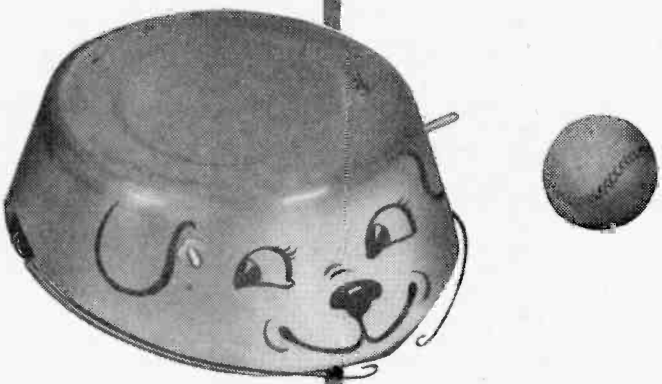


The construction details given here for the R/C train are intended as a guide—your exact setup will depend on the components you use. There are many other possible installation techniques. The locomotive modification shown above permits normal operation when the miniature phone plug is removed.

Running the train is simple. Be sure the receiver is adjusted and the batteries are in place. Set the cars up with the track power off, and plug the boxcar control plug into the receptacle on the locomotive. Then turn on the track power. You'll find that for each press of the button the power control relay in the locomotive will cycle the drive motor to *Forward, Stop, Reverse, Stop,* and then back to *Forward* for a new cycle.

You will need an FCC Class C Citizens Band license to operate the transmitter. If your youngster is over twelve and a citizen of the United States, he can apply along with Dad for a Class C Citizens Band station license. No exams are necessary. All that needs to be done is to read Part 19 of the FCC rules and fill out Form 505 obtained from the FCC. Have the form notarized, and mail it. To rush your license through the FCC, enclose a self-addressed and stamped envelope.

By
GAYLORD WELKER



Sparky is an interesting project for the experienced and well-versed experimenter. The kids should find the pup an obedient and exciting pet.

SPARKY the Robot Pup

"Robot" is still something of a catchword in this age of technology, carrying with it a hint of terrible power and a suggestion of the implacable machine. Yet robots are already with us, doing their jobs quietly and efficiently in our factories and homes.

Not everyone agrees on what a robot "is," but a good idea is given in Edmund C. Berkeley's definition: "A robot is a machine made out of hardware, wire, etc., which can receive or 'sense' information from its environment using its sense organs, perform actions or display behavior using its acting organs, and perform

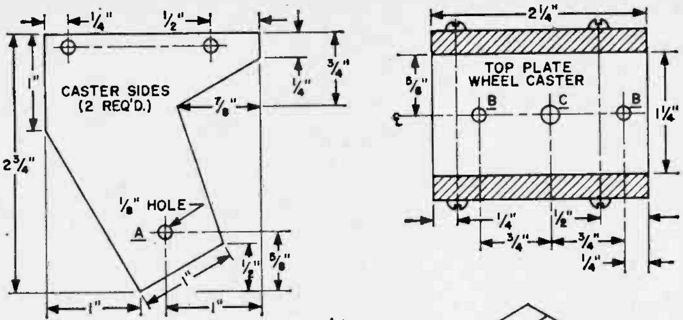


Fig. 1. Caster sides and top should be screwed together. Resultant caster assembly should be rigged.

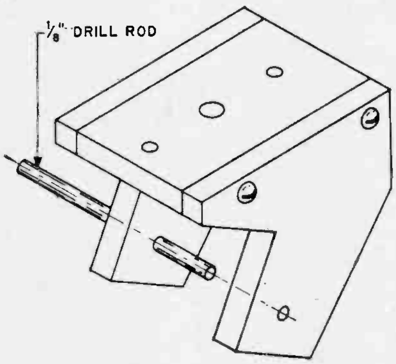
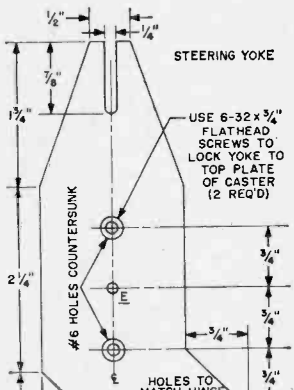
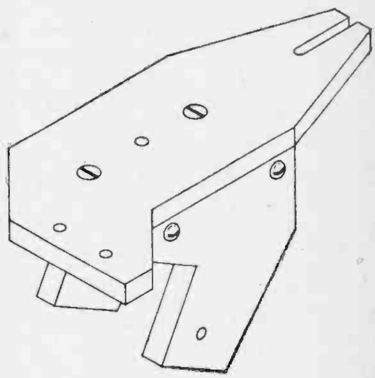


Fig. 2. Carefully cut steering yoke to exact size (below, left). Secure the finished piece to the caster assembly top (below).





logical or arithmetical operations correlating the sense impressions and action, using its thinking organs for a brain."

This article tells how to construct a simple robot. Since Sparky only has three brain cells to think with, he isn't very bright. But there are other things to recommend him, aside from his good disposition. He is the "gadgeteer's dream." And when he's running busily around the floor, he may remind you of an inquisitive puppy, skittering from one attraction to the next. That's the only thing he's been "trained" to do . . . so far.

Platform Details. Basically, the robot pup is composed of a 10"x12" tricycle platform of an approximately oval shape. The platform should be fairly rigid and built of 1/4" Plexiglas, Masonite, plywood or heavy sheet metal.

The hole for the drive unit should be cut so that the wheel and motor will have room to turn. Supporting members for the various components are fabricated of Plexiglas or aluminum and can be mounted on the platform with sheet metal screws or nuts and bolts.

Drive Motor Assembly. After shaping the platform, start construction of the drive motor assembly. This installation will determine the position of the other components.

Cut out three rear-wheel caster pieces as per Fig. 1, clamp the two side pieces together in a vise, and drill a 1/8" axle hole at "A." Assemble the caster unit, using washers to space the rear drive wheel in the center of the shaft. The wheel should

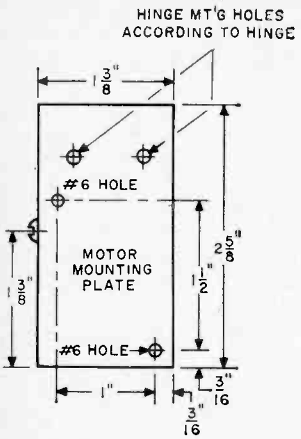


Fig. 3. Mount motor to motor mounting plate. Then attach assembly to steering yoke by means of a hinge.

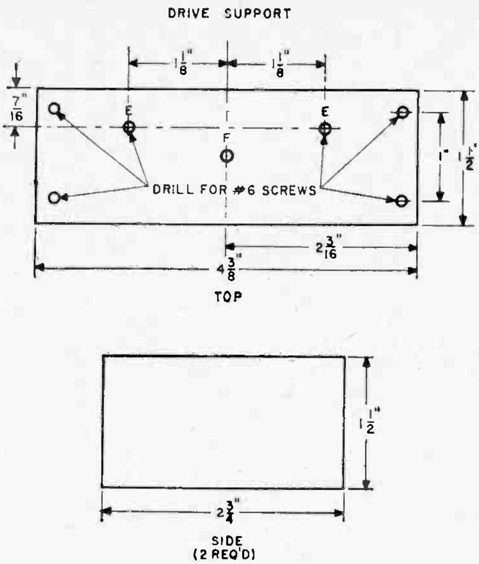
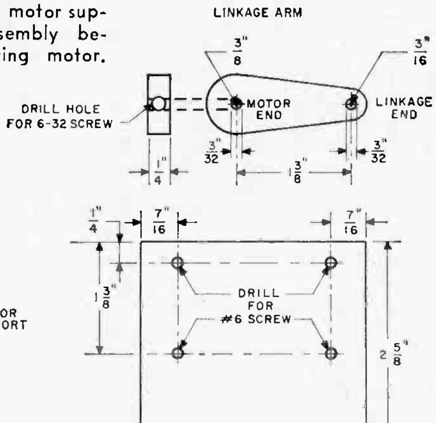
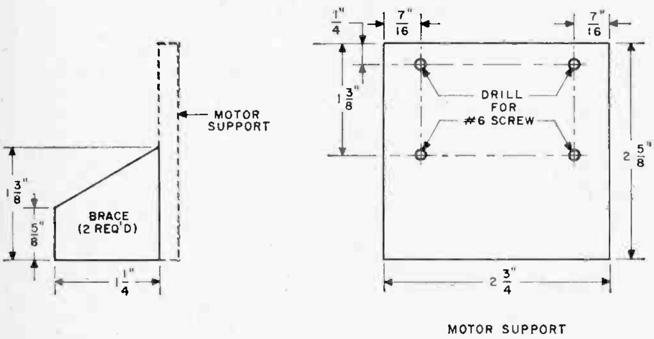


Fig. 4. Drill drive support holes at their exact locations.

Fig. 5. Secure braces and motor support into one rigid assembly before attaching the steering motor.





turn freely on ⅛" axle rod but should not "walk" from side to side.

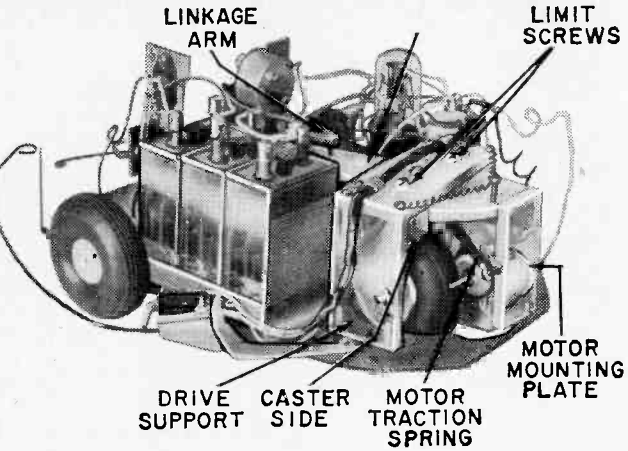
Cut out the steering yoke as per Fig. 2. Place flat-head screws through holes *D* in the steering yoke, and bolt it to the top of the caster assembly through holes *B*. Now drill the pivot bolt hole (*E* in yoke and *C* in caster) and tap for the *10-32* pivot bolt.

Next, install the Aristo #4 permanent magnet motor on the motor mounting plate (Fig. 3) so that the long shaft of the motor will bear against the rear wheel tread. Suspend this motor assembly on the rear of the steering yoke with a small hinge, taking care that the wheel does not rub against the motor body.

The motor mount should be loaded with a small coil spring so that the motor shaft bears against the wheel firmly. Assemble the U-shaped drive support bracket (Fig. 4), and install "limit" screws in top plate holes *E*.

Mount the previously assembled drive unit within the drive support with the *10-32* pivot bolt through *F* and into tapped hole *C* (Fig. 1) and *E* (Fig. 2). Tighten screw, then back it off to allow free swiveling. Place nut on screw end and tighten to lock it. Then mount this whole assembly on the platform so that the wheel assembly can swivel freely between limit screws.

A centering device for the steering yoke



Here is a picture of Sparky upon completion. The constructed assemblies are shown in their required locations.

PARTS LIST

B1—Three 2-volt wet cells (Aristo 23)
C1—50-µfd., 25-volt d.c. electrolytic capacitor
L1, L2, L3—6-8 volt blinker light
M1—Steering motor (Aristo No. 5 PM motor)
M2—Drive motor (Aristo No. 4 PM motor)
RL1, RL2—4-p., d.t., 6-volt d.c. relay
RL3—Thermal delay relay (Amperite 6C2 or 6C3)
S1—S.p.s.t. toggle switch
S2, S3—S.p.d.t. feeler switch (V3 Microswitch)
3—3" wheels with 1" aluminum hub, 1/8" bore (Perfect)
1—12" length of 1/8" drill rod (axles)
1—1" cabinet hinge
1—Shell (any container which conforms to robot shape—author used 14" thin aluminum dishpan)
1—Electric horn (Aristo Edu-Kit B 1-35)
3—Dial light sockets
1—Octal socket
1—5-pin male and female socket for interconnection of shell and robot's innards
Misc. 1/4"-thick Plexiglas scraps; screws; springs; washers; hardware; and plastic metal or cement

Part can be supplied by:
Berton Plastics, 79 5th Ave., New York, N. Y.
Gyro Electronics Co., 36 Walker St., N. Y., N. Y.
Microswitch Div., Minneapolis-Honeywell, 24-30 Skilman Ave., Long Island City, N. Y.
Polk Hobbies, 314 5th Ave., N. Y., N. Y.

must be made with two opposing low-tension coil springs which will act to re-center the caster assembly when the steering motor is off. Otherwise, the rear wheel will continue to steer in the same direction given it by the last impulse of the steering motor.

Steering Construction. Cut out the steering motor support, support braces and linkage arm from 1/4" Plexiglas as per Fig. 5. Install a 1"-long #4 screw in hole *G*, and mount the linkage arm on the long shaft of the motor with a setscrew. The #4 screw should project down towards the motor body. This steering motor, incidentally, will not be free to rotate fully as it is being used as a "torque motor" to turn the steering yoke.

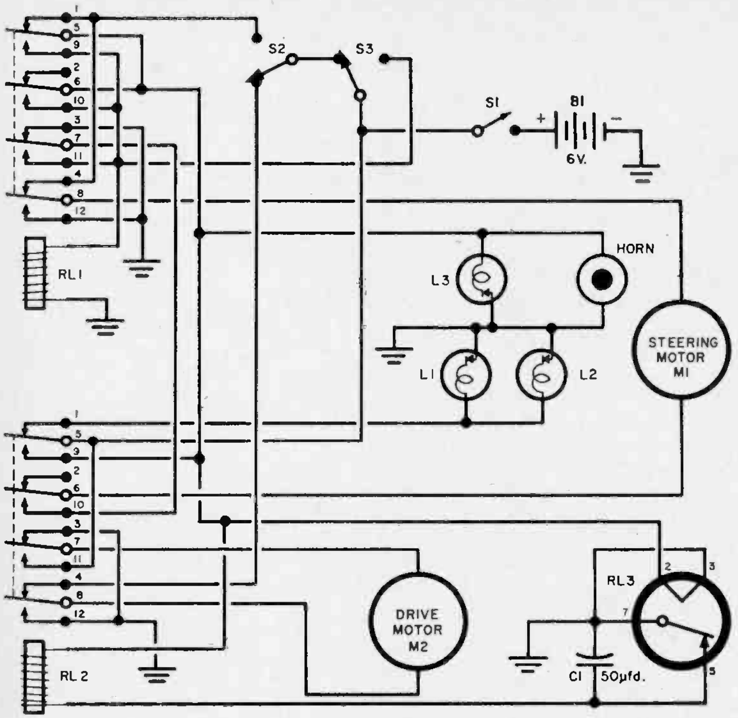
Mount the steering motor on the steering motor support with the long shaft up. Install the whole assembly in the center of the platform in such a way that the #4 screw in hole *G* seats loosely in the inner end of the steering yoke slot. The yoke and the linkage arm should both be lined up on the center line of the platform; otherwise the camming action will not be able to function correctly.

Front Wheels. The front wheels are mounted on separate 1/8" axles and are locked to the axles by a setscrew or a blob of plastic metal. The platform is hung from these axles by either Plexiglas or metal bearings.

A sufficient number of washers to keep the wheels from rubbing the side of the platform are installed between the wheel and the bearing. Two washers and a blob of plastic metal are used to anchor the inner end of the axle.

Batteries. Power is furnished by three 2-volt wet coils in series which are rated for 3 ampere-hours. The cells are clamped together and mounted firmly to the platform with a metal strap.

There is a certain amount of bumping around as the little fellow goes his way, and we don't want his power supply tearing loose. The batteries can be connected directly to the drive motor leads for testing



The coding of brain relays RL1 and RL2 correspond to the relay contact pictorial shown on next page. Note that RL3 may not operate unless batteries are at full charge.

purposes. Switch leads to reverse motor.

Thinking Mechanism. The chassis for Sparky's brain-works is shown in the overall view of Sparky's innards. A 3"x3¼" piece of aluminum will serve or you may wish to leave extra space for additional "brain cells."

The two 4-p.d.t., 6-volt d.c. relays (*RL1, RL2*) have two mounting screws on ⅝" centers, and are 1¼" high. The Amperite relay tube (*RL*3) uses a standard octal socket, or if a miniature relay is used, a noval is mounted on the brain chassis.

Mount the chassis on 1" standoffs to leave room for miscellaneous connections and parts. Be sure to allow adequate slack in the drive motor leads so it can swivel freely.

Body Shell. The robot's shell can be constructed of practically any material that can be shaped to fit. A large aluminum pan was warped into shape for Sparky. Holes for his "eyes" (*L1, L2*) and tail light (*L3*) were drilled oversize and fitted with grommets.

The dial lamp sockets with leads soldered to them were then inserted in the grommets. The screw thread contacts of the sockets are connected to a common ground. Center contacts of *L1* and *L2* are connected to contact 1 of *RL2*. The remaining lug of *L3* is connected to contact 9 of *RL2*.

Main switch *S1* is installed on the top for easy access. The shell can now be

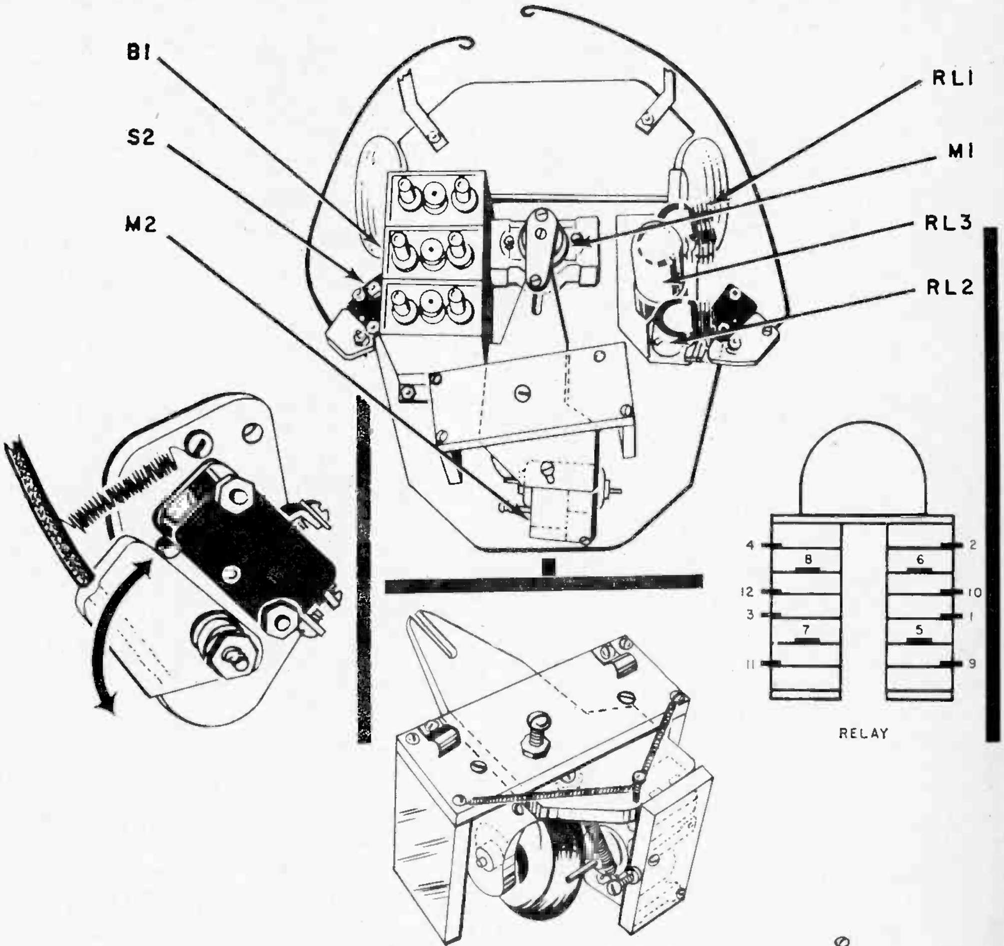
HOW IT WORKS

When main switch *S1* is closed, all relays stay in their unactivated position and power is supplied only to the drive motor *(M2)* and "eye" lights. The robot moves forward until one of the feelers contacts something with enough pressure to close switch *S2* or *S3*.

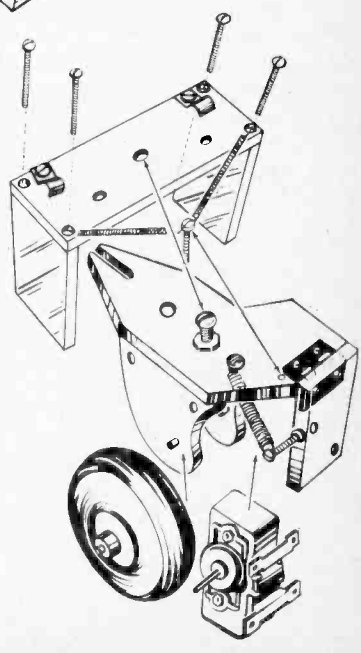
When the left feeler closes *S2*, the following sequence is initiated. *RL2* is energized and electrically locks in. Contacts 7 and 8 of *RL2* reverse drive motor *M2* and energize steering motor *M1*. The latter is polarized to turn *away* from direction of contact as Sparky rolls backward. *RL2* also disconnects *L1* and *L2*, turns on *L3*, and supplies heater current to *RL3*.

The other pole of *M1* is supplied from contact 4 of *RL1*. After three seconds, *RL3* opens, releasing *RL2*, so that the circuit reverts to the normal forward running condition.

When the other feeler arm closes *S3*, *both* relays are energized, causing *M1* to swing in a direction opposite to that of the *S2* closed condition. All of the other reversing operations are similar. Movement of the robot is really a random path determined by the heating time of *RL3*. If *RL3* is warm, turns and backing cycles are of shorter duration.



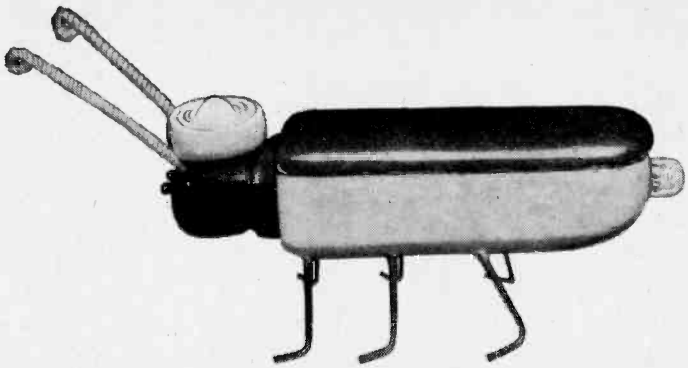
mounted to the platform by three angle brackets.



Sparky Takes Off. With everything connected up properly, and the batteries fully charged, flip *S1* on. If drive motor polarity is correct, Sparky should take off for the nearest table leg.

Arriving at full tilt, one of his feelers will close Microswitch *S2* or *S3* and Sparky will immediately go into reverse, honking like a small bullfrog. His tail (*L3*) lights up and filament current is sent to *RL3*. When *RL3* opens, Sparky immediately goes about his business in some other direction, until he hits something else.

One of the fascinating aspects of building this small robotic unit is the consideration of all the many ways that it can be put to use—both practically and for sheer fun. Body styles can be altered to fit the need, decoration can suit any fancy, and structural material can be anything at all.



LIGHTNING BUG NIGHT LIGHT

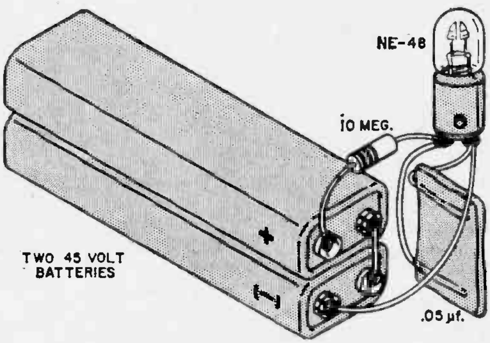
By CHARLES H. WELCH

While this dependable blinking "bug" furnishes no actual illumination, it is a friendly and reassuring sign in the night to the small fry. It was originally built to serve as "evidence" proving the existence of huge lightning bugs in Central America; now the outsized "insect" acts as a night light in a child's bedroom.

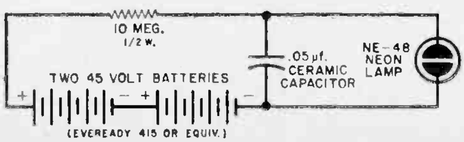
The flasher unit is a conventional neon-bulb relaxation oscillator which is completely self-contained inside the bug. All the components are supported by their own leads and are soldered in place. The batteries are soldered, too, since they shouldn't require replacement very often; however, be very careful when you solder because it is quite easy to damage the batteries with too much heat. The NE-48 neon lamp was chosen because its large size suits the proportions of the bug.

Build the bug itself from a ½"-thick sheet of balsa wood. The body is a box, with inside dimensions just large enough to accommodate the flasher unit and leave room at the neck opening for the head to plug in. Make a hole at the tail to fit the neon lamp. The thickness of the balsa permits rounding the body and shaping the wing covers. Shape the head from a block of balsa. The sombrero (necessary on the original to "certify" its Central American origin) is a plastic bottle cap.

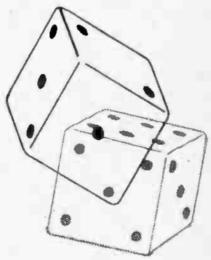
All the balsa parts are finished with sander-sealer and model airplane dope. The legs are made of wire and the feelers are pipe cleaners. You can use India ink for the face markings and red map pins for the eyes.



The "bug's" battery terminals should be insulated carefully to prevent the kiddies from getting a 90-volt "tickle" from the battery.



Eight-Sided Dice



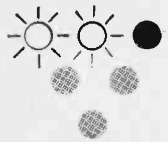
By
IRA GLICKSTEIN

Electronic "DICE" teaches binary arithmetic and tests for supernatural powers

This multi-purpose project can be used as eight-sided dice, or as a tester of extrasensory perception. As an added bonus, it will give you a chance to learn simple binary arithmetic as used in digital computers.

In a game of chance, you refer only to the top three flashing lamps of the BINARY DICE. At any instant some will be "on" and some "off." When the push-button switch is pressed, the lamps that were on at the instant of switching remain on, those that were off remain off. A little figuring will show that there are eight possible com-

EXAMPLE



(top line) 110 or 6

BINARY-DECIMAL	BINARY-DECIMAL
001—1	101—5
010—2	110—6
011—3	111—7
100—4	000—8*

**8 is actually 1000 but for BINARY DICE use 000 as 8*

How to convert binary numbers to the decimal system. Only the top line of bulbs is read, giving eight possible "on-off" combinations.

binations of the three lamps being on or off, and the lamps will indicate from 1 to 8 in the code of binary arithmetic.

Binary Arithmetic. Digital computers use a calculating system based on the number 2. This system is called "binary." Our ordinary number system is called a "decimal" system because it is based on 10.

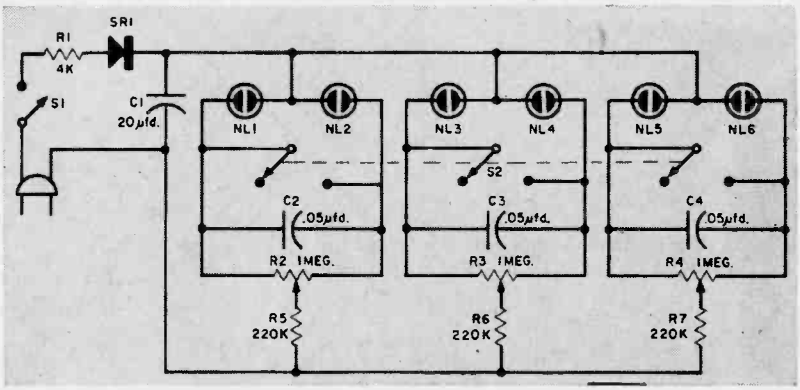
In the BINARY DICE, a lamp that is "on" represents the binary digit "1," a lamp that is "off" represents "0." Using the binary notations 1 and 0, read the top three lamps; then look up the resulting binary number in the chart shown above. After you use the device for a short time, you will be able to recognize 101 as 5 and 110 as 6.

Construction. The BINARY DICE is built in a 5" x 7" x 3" aluminum box. For ease of wiring, a subchassis for the three calibrating potentiometers and associated capacitors and resistors is used. This small 4½" x 3" aluminum panel should be wired first; see the photo for details.

When constructing the main cabinet, the neon lamps are press-fit into rubber grommets and leads are soldered directly to them. The remainder of the construction is self-explanatory. Be careful *not* to ground any part of the circuit to the metal box.

Plug in the BINARY DICE to the 117-volt line with the on-off switch to *"on."* All six lamps should start flashing at a rapid rate. Press the button and three lamps should remain on and three lamps should be off. If this doesn't happen, adjust each potentiometer to its approximate center position and /or change the value of *R1*. This resistor may be safely made as small as 100 ohms or as large as 6000 ohms. The optimum value is that at which the lamps flash so rapidly that you can just see the flicker.

Calibration. Because of inevitable differences between individual components, a

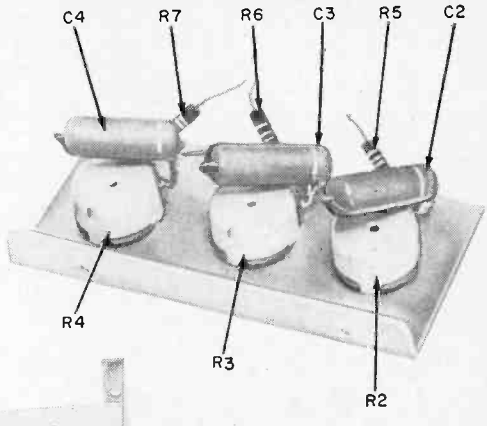


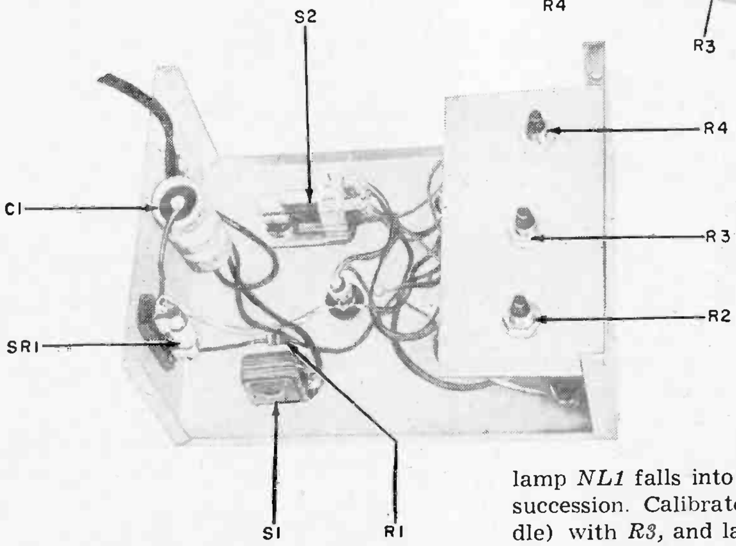
PARTS LIST

C1—20-μfd., 250-volt d.c. electrolytic capacitor
C2, C3, C4—0.05-μfd., 400-volt d.c. molded tubular capacitor
NL1-NL6—NE-51 neon lamp
R1—4000-ohm, ½-watt resistor (see text)
R2, R3, R4—1-megohm linear taper potentiometer with slotted shaft (Mallory SU-54 or equivalent)
R5, R6, R7—220,000-ohm, ½-watt, 10% resistor
S1—S.p.s.t. toggle switch
S2—3p.s.t. push-button switch (Switchcraft 9001 or equivalent)
SR1—150-ma. silicon rectifier (Sarkes Tarzian M-150)
1—4½" x 3" aluminum subchassis
1—3" x 5" x 7" metal box (Bud Minibox CU-2108)
6—⅜"-i.d. rubber grommets for ½" mtg. hole
Misc. mounting clip for silicon rectifier, insulated lug, wire and hardware

HOW IT WORKS

The BINARY DICE is made up of three separate indicator circuits using a common d.c. power supply. Each circuit has a capacitor, a potentiometer and two neon lamps, which form a relaxation-type oscillator circuit. As one lamp of each pair goes on, the other goes off, and vice versa. When switch *S2* is pressed, the two neon lamps are connected in parallel, and the one which was on at the instant of switching will remain on, while the other remains off.





Subchassis holds the calibrating potentiometers. Three holes in the back panel provide access for screwdriver calibration.

calibrating potentiometer has been built into each of the three random indicators.

Set each potentiometer to approximate center position. Observe neon lamp *NL1* (top row, far left). Press the button (*S2*) 30 times and record how many times *NL1* stays lit. Twelve to 17 out of 30 is good—don't touch *R2*. If *NL1* stays on more often, turn *R2* (directly behind *NL1*) slightly counterclockwise. If it stays on less than 12 times, turn *R2* slightly clockwise.

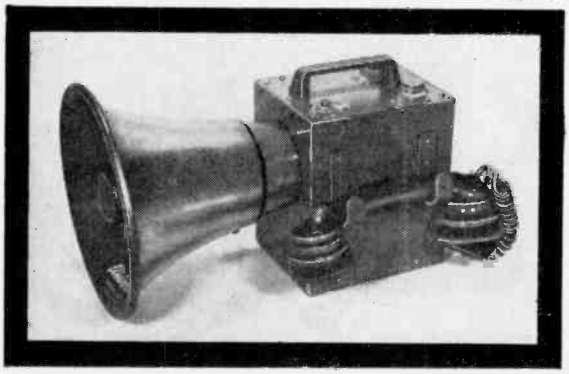
Repeat this procedure. Don't stop until lamp *NL1* falls into the safe zone twice in succession. Calibrate *NL3* (top row, middle) with *R3*, and lamp *NL5* (top row, far right) with *R4*.

The second row of BINARY DICE is used for ESP testing. There are two lamps and the four possible combinations are: 00, 11, 10, 01. Blindfold your subject, ask him to pick one of the four combinations and concentrate on it. Press the button to see if he "guessed" right. Do not tell the subject if he was right or wrong. If your subject does better than 5 out of 20, he may have extrasensory powers . . . or he may be plain lucky!

Transistorized Two-Way Power Trumpet

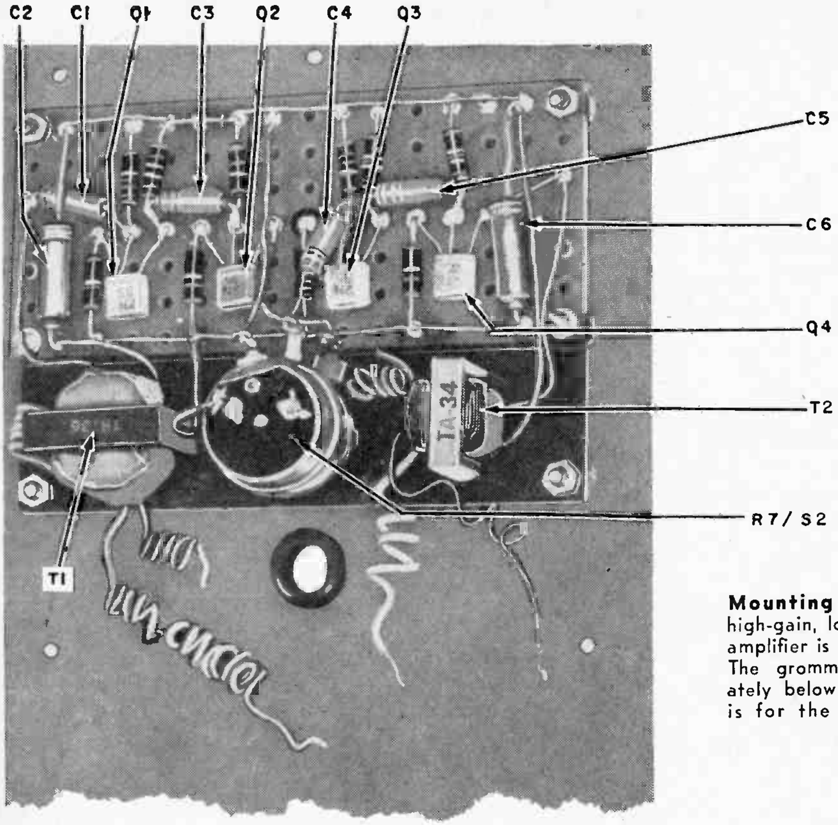
Special "talk-back" feature enables two-way communication for p.a. or boating use

By R. L. WINKLEPLECK

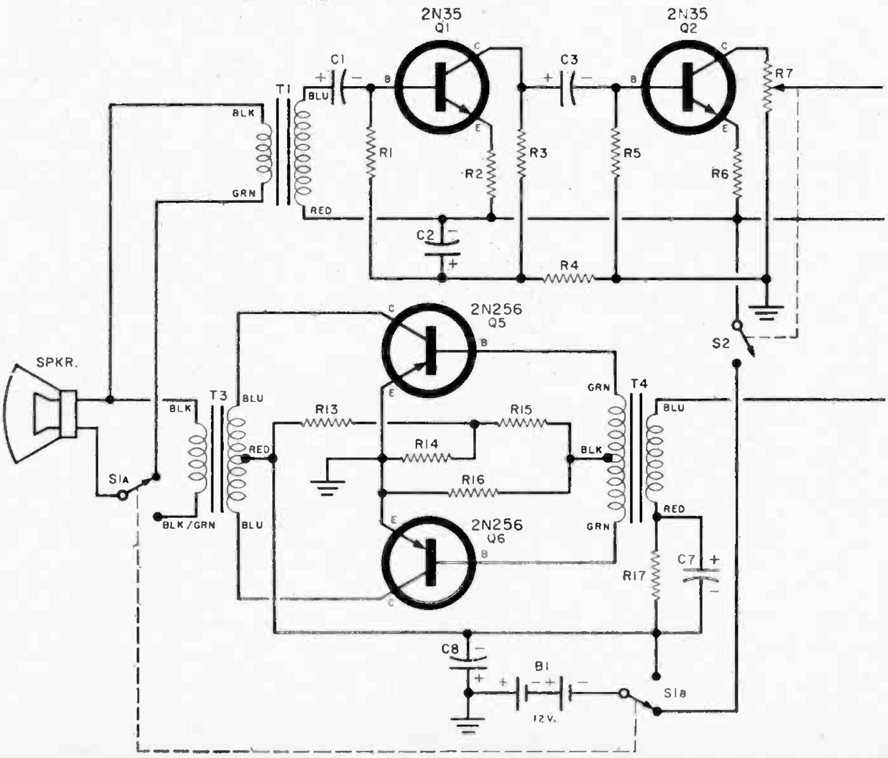


Portable voice amplifiers of the type used to direct crowds, instruct groups of workers and supervise games are a real convenience, and more and more are being used. The advent of power transistors has made possible size reductions and economical battery operation not previously attainable.

After using one of these handy devices for a while, you recognize that they have one weakness: the man with the horn can make his wishes known over a large area, but it's seldom that a reply is loud enough to be intelligible. What's needed is a "talk-back" or intercom type of power trumpet so that you can hear as well as talk. Relatively inexpensive and



Mounting plate of the high-gain, low-power "listen" amplifier is box's back panel. The grommet hole immediately below gain control R7 is for the handset cable.



compact, the unit presented here combines a ten-watt power trumpet with a second high-gain amplifier that can convert the sound of an approaching automobile into that of a roaring avalanche. It's completely transistorized and, except for the flaring horn and the telephone handset, is contained complete with batteries in a 5" x 6" x 7" aluminum cabinet.

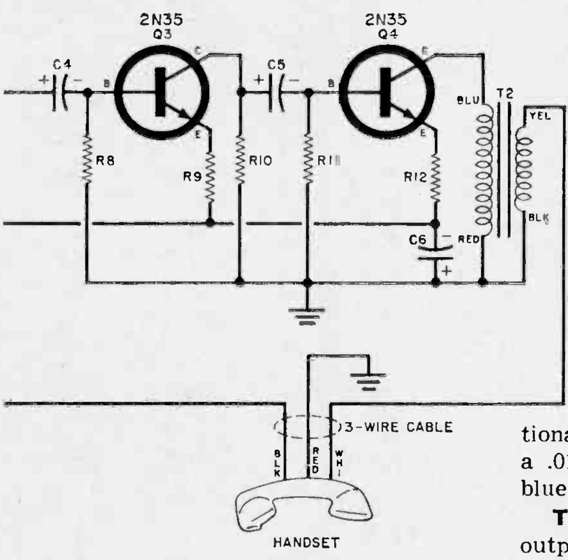
To use the trumpet, simply turn on the "listen" amplifier and adjust the volume knob at the back of the case. Pick up the handset and hear everything going on around you, with special emphasis on sounds originating in the 90° pickup and dispersion angle of the trumpet. When you want to talk, push the button on the top of the box next to the handle. This disconnects the "listen" amplifier from the trumpet, and turns on and connects the "talk" amplifier.

The box can be constructed of sheet aluminum, aluminum angle stock and self-tapping screws, or a commercial cabinet can be used. The entire circuit is wired and mounted to the box panels before the box is assembled. In this way you avoid the problem of working in tight corners.

The "talk" amplifier mounts on the underside of the top panel and the "listen" amplifier is fastened to the inside of the back panel. Two six-volt batteries are housed in the bottom of the box. All interconnecting wires terminate at a tie strip mounted near the battery.

The "talk" amplifier parts placement and lead dress are not critical. But it's impossible with the arrangement illustrated to keep the input and output well separated; so transformers *T3* and *T4* must be placed at right angles to each other. This reduces the possibility of magnetic coupling and feedback.

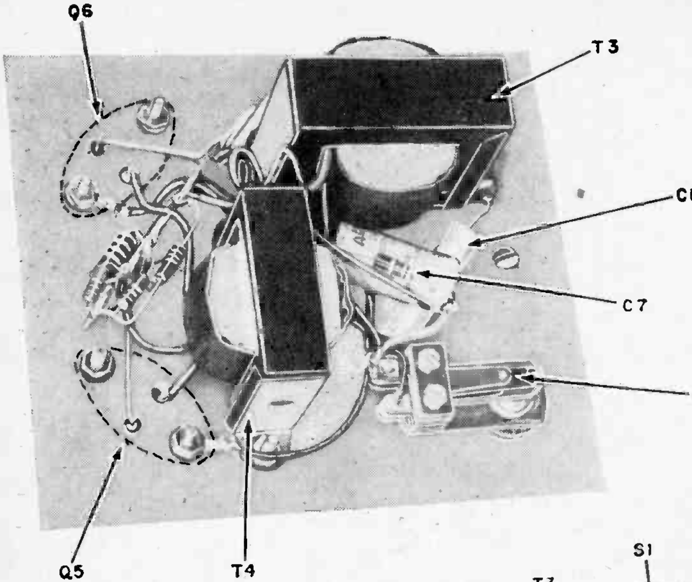
The shells of the power transistors *Q5* and *Q6* are their collector connections and must be insulated when they are mounted on the top panel. Thin fiberglass, mica or composition sheets provide good electrical insulation and still let the heat generated flow into the chassis. Be very careful to remove all burrs from around holes in the insulation before mounting the transistors. With the new fiberglass insulation, even a small projection may punch through when the power transistor is tightened in place.



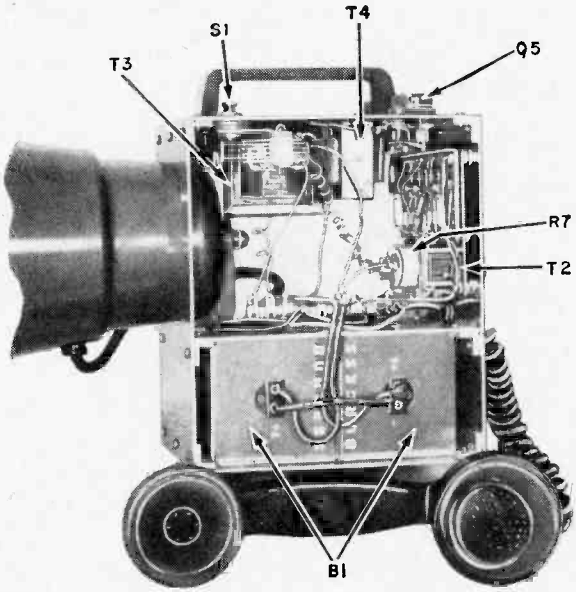
Output volume may be fairly well controlled by varying the level of the speaking voice. If a volume control is desired, and one will be necessary if the unit is used in a restricted area, current limiting resistor *R17* can be replaced with a 1000-1500 ohm pot hooked up as a rheostat. If the unit will be exposed for hours to the hot summer sun, resistor *R14* should be replaced by a Veco 21W1 thermistor to prevent thermal runaway.

Some of the older carbon buttons tend to develop quite a bit of hiss. If this is loud enough to be objectionable, it can be eliminated by connecting a .01-.04 μf. capacitor across the red and blue leads of transformer *T4*.

The "listen" amplifier, its input and output transformers, and the volume control may be assembled on a 3" x 4" phenolic board with metal clips at the points where the components are interconnected. The circuit board is then mounted on the rear panel of the aluminum box with the shaft of the volume control protruding through the back.



Top panel, at left, is the mounting base for the two power transistors and the transformers of the "talk-back" section. Assembled unit, below, shows relative placement of panels. "Listen" amplifier is mounted on panel opposite rear of horn.



PARTS LIST

B1—Two 6-volt batteries (Burgess F4P1)
C1, C3, C4, C5—1 µf.; C2, C6, C7—10 µf.; C8—100 µf. — *All capacitors 12-volt electrolytics*
Q1, Q2, Q3, Q4—2N35 transistor (Sylvania)
Q5, Q6—2N256 power transistor (CBS)
R1, R5, R8, R11—1 megohm; R2, R6, R9, R12—1000 ohms; R3, R10—10,000 ohms — *All resistors ½-watt composition*
R4—22,000 ohms
R7—10,000-ohm audio taper potentiometer
R13—150 ohms
R14—100-ohm resistor or Veco 21W1 thermistor (see text)
R15—100 ohms
R16—3.3 ohms
R17—470 ohms (see text)
S1—D.p.d.t. push-button switch
S2—S.p.s.t. switch (on R7)
T1—Thordarson TR-36 transformer (or equivalent)
T2—Stancor TA-34 transformer (or equivalent)
T3—Triad TY-64x transformer (or equivalent)
T4—Triad TY-61x transformer (or equivalent)
Spkr.—University Model 1B-8 trumpet
1—Western Electric E-1 handset (or equivalent)

When you wire the "listen" amplifier, save the transistors for last since they are easily damaged by heat. Be careful to hold each transistor lead with long-nose pliers while it is being soldered, and for a moment afterward, until the lead has cooled.

Final assembly of the box is done after the "talk" and "listen" amplifiers and batteries are wired and assembled on their respective panels. Leave one side of the box off while attaching trumpet, handset, and amplifier leads to the terminal tie strip

HOW IT WORKS

The "talk" amplifier employs two CBS 2N256 power transistors in a class "B" push-pull circuit using the common-emitter configuration. These are driven, through driver transformer *T4*, by the F-1 carbon button microphone in the Western Electric E-1 handset. The output rating of the amplifier is a powerful ten audio watts—adequate for virtually every need.

The driver and output transformers specified in the parts list provide good impedance matching. Note that the d.p.d.t. push-button switch *S1*, when depressed, both supplies the power to the amplifier and connects the trumpet to the amplifier output. Thus, this amplifier, which may draw an ampere or a bit more when hard-driven, consumes battery current only when the "push-to-talk" switch is actuated.

The "listen" amplifier is a four-stage *RC*-coupled transistor unit using 2N35 *n-p-n* transistors. With a maximum over-all voltage gain of approximately 2500, current drain from the battery is about 5 ma. Potentiometer *R7* adjusts sensitivity for good intelligibility and a low level of background noise. Degeneration, provided by the 1000-ohm resistors in the emitter circuits, produces an input impedance of approximately 40,000 ohms and increases stability.

The input transformer specified offers a good impedance match between the amplifier input and the 8-ohm trumpet which substitutes as a dynamic microphone for "talk-back." The output transformer *T2* closely matches the receiver in the E-1 handset. If some other handset is used, another transformer may be required for good matching.

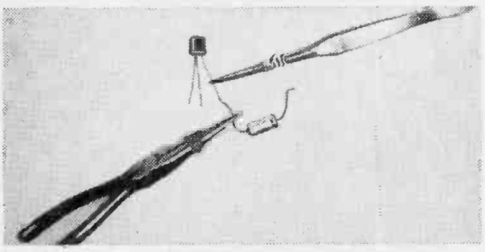
just above the batteries.

The batteries can be secured in place with cardboard if desired since they last for an unbelievably long time. When necessary, they may be quickly and easily replaced by removing a side or bottom panel.

Aside from the very practical advantages of a two-way power trumpet, it has side benefits which may be amusing or confusing. Many people in the crowd you're addressing simply never realize that you can listen in on their private comments.

HEAT SINK SOLDERING

When soldering transistors and associated miniature components, it is desirable to place a heat sink between *all* parts and the soldering iron. Most people, having only two hands, find this difficult, since the



soldering iron and solder must also be held. The solution to this problem is simply to wrap a small rubber band around long-nosed pliers or long tweezers and clip them onto the leads as shown. —*N. E. P.*

Transistor Amplifier for Toy Telephones

By

J. E. PUGH, Jr.

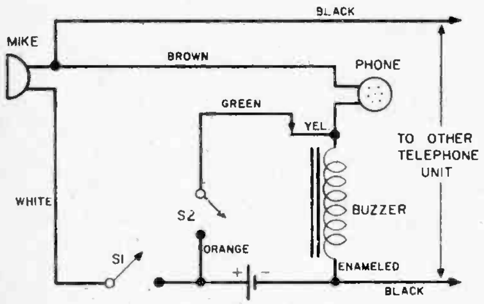
Toy telephone sets found in most department stores usually have one major defect—low volume. The addition of a simple one transistor amplifier not only "soups up" the volume but improves intelligibility.

The telephone set used in this conversion was a Zimphone, with each hand unit in the set consisting of a carbon microphone, a magnetic earphone, and a single flashlight cell. Any similar set—including conventional telephones now available on the surplus market—should work just as well. "Before" and "After" diagrams show the simple electrical modification on the Zimphone.

Identify all the wires in your set, both internal and external, and compare them with the wire color code in the "Before" diagram. If your color code is different, change the coding on the diagram to conform.

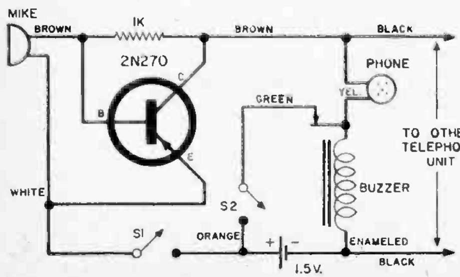
After soldering the transistor and resistor in place, tape all connections and gently press all internal wires and parts down into the back of the telephone handle. Be careful when you solder inside the handle because it is made of meltable plastic. Apply solder to the negative battery terminal as quickly as possible because this terminal is anchored in the plastic of the handle.

Put a dab of red paint on the positive battery terminal to aid in placing the battery in correctly. Reversed polarity can ruin the transistor.



BEFORE ▲

AFTER ▼



HOW IT WORKS

In the original circuit, switch *S1* connects the microphone to the battery and to the two parallel-connected phones (its own and that in the second telephone unit). The signal from the microphone is applied direct to the earphones without amplification. In the modified circuit a simple transistor amplifier is placed between the mike and two phones to boost the signal before it reaches the phones.

A medium-power transistor is used to give good power transfer as its input and output impedances are a reasonably close match for the mike and phones. The carbon microphone and a 1000-ohm resistor are used to bias the transistor base.

When the amplifier is in use, the mike resistance changes, and thus changes the base bias. The amplified collector output current flows through the load (the two magnetic earphones in parallel) to give a comfortable listening level. An identical amplifier in the second telephone unit sends an amplified signal back to the first earphone.

The original buzzer circuit is satisfactory and does not need to be modified.

ELECTRONIC FISH LURE

By
JAMES G. BUSSE

Fish lures come in practically all shapes and sizes. Whether it be a simple spinning reflector or the weirdest creation of an artistic angler, the fish lure's job is to attract fish to the hook. While conventional fish lures sometimes successfully employ light reflectors and motion to gain the attention of the fish, they fail to take advantage of the extreme sensitivity of the fish to the faintest underwater sounds. If a sound is not loud enough to frighten fish, experiments have shown that they may be attracted to it.

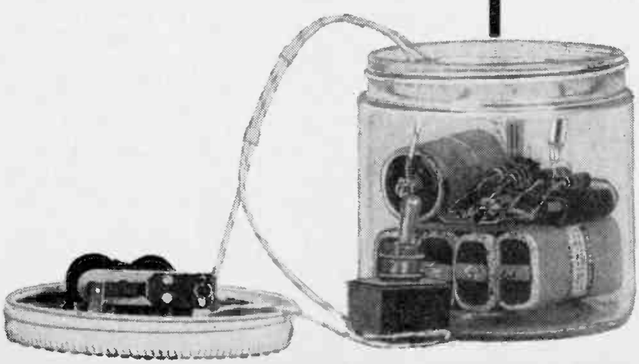
For some time now, a few cunning fishermen have sealed tiny electric buzzers in watertight jars and lowered them into the water at their favorite fishing spot. The faint steady vibration from the buzzer seems to create the illusion among the fish that a large tasty insect has fallen into the water. They swim around the jar until their disappointment is forgotten among all the other tempting bait offered by the fishermen.

This buzzer-in-the-jar idea has been expanded into an electronic fish lure. And, as an extra attraction, a dual neon flasher circuit has been added. The completed unit is entirely self-contained. The buzzer and neon flasher are on separate circuits so that one or the other or both can be used, as desired.

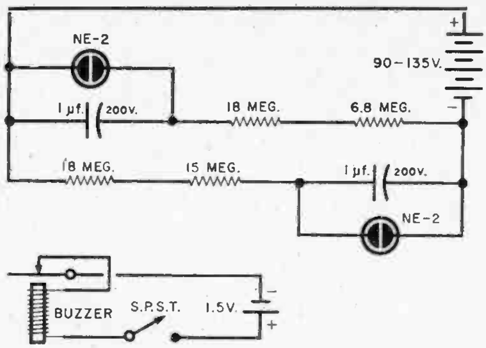
Assembly. Putting an electronic fish lure together is quite simple since placement of parts is not critical. Battery voltages from 90 to 135 volts can be used. The rate at which the bulbs fire depends upon the values of the resistors, capacitors, and battery voltage. The rate can be slowed down by using larger value capacitors and resistors or a lower battery voltage.

The buzzer shown is powered by a single flashlight battery. A somewhat more expensive buzzer, sold by the electronic supply houses, can be adjusted to operate at a number of different frequencies. If this type is used, adjust the control to the highest available frequency. A s.p.s.t. switch is employed in the buzzer circuit to silence the buzzer when the lure is not in use. To save space the buzzer circuit as well as the neon flasher circuit could be activated simply by connecting and disconnecting a couple of pairs of leads.

Size of the power pack and the other components used in the electronic fish lure



Flashing lights and buzzer attract fish



The high-value resistors can be made up from several series-connected resistors of lower value. Since current demands are low, the blinker battery may be a weak unit salvaged from your junk box.

will determine the size of the jar required.

The buzzer is mounted to the inside of the cover, which acts as a diaphragm to radiate the sound through the water. If the mounted buzzer makes a very tinny sound, try inserting a thin piece of rubber between it and the cover. Remember, too loud a vibration will most likely scare away the fish, not attract them. It may even be necessary to add a small resistance in series with the buzzer to produce the desired faint buzzing. In air, the buzz from the sealed jar should be hardly audible. Sound travels much better in water, and fish can hear sounds too weak to be heard by the human ear.

A small metal eye is attached to the top of the cover, through which a length of heavy fishing line is threaded. Be sure to seal every hole made in the cover with some type of waterproof cement.

Operation. Almost anyone can use an electronic fish lure successfully. Simply activate the buzzer and neon flasher circuits and screw on the cover tightly. Check for possible leaks. Then lower the electronic lure into the water, keeping at least four feet from your fishing lines. If you are fishing in shallow water, let it lie on the bottom. Otherwise, keep it a foot or two above the level of your baited hooks.

The fun of fishing with an electronic fish lure comes from the fact that you never know what the thing will attract! **Although no state prohibits the use of sound to attract fish, some forbid any use of light for this purpose. To be on the safe side, check with your state conservation commission.**

SECTION V: Ham And SWL

Build A Citizens Band Transceiver

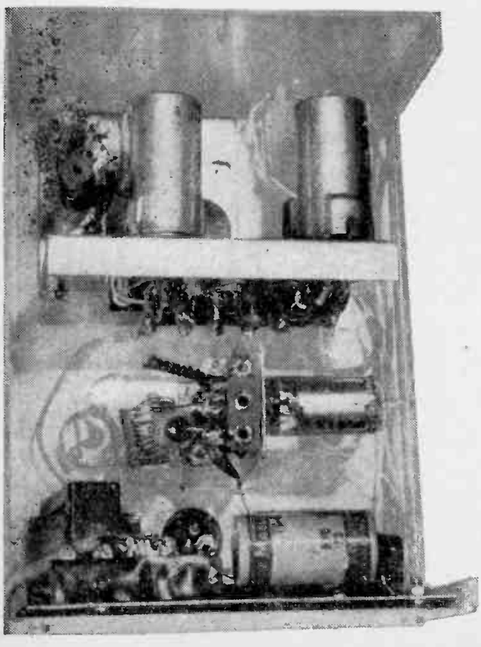
A "walkie-talkie" with simplified semi-kit construction puts you on the air—person to person

By **DONALD L. STONER,** W6TNS

Remember the "Walkie-Talkie" of World War II fame? How would you like to have your own compact transmitter/receiver that will let you "keep in touch" wherever you go? You say you don't have an amateur license? Don't let that bother you, because the recent opening of the 27-mc. Citizens Band by the FCC makes it possible for *anyone* (except minors and aliens) to own and operate a transmitter without a ham ticket. This "Citizens Talkie" transceiver is designed for battery operation in your car, boat, or at any fixed location where line power is unavailable.

The Citizens Talkie has a range of 2-5 miles when communicating with a fixed station using an *outside* antenna. The distance you can cover with a pair of these units using a whip antenna will be something more than one mile. On a high spot (such as on a hill top), the range is unpredictably good.

Completely assembled unit is shown at lower left with back cover removed. Reading from top to bottom, subassemblies are: transmitter, receiver, and the audio/modulator unit.



Ordinarily, the construction of a transceiver would be quite an undertaking. However, several innovations make this job as painless as possible. The transceiver is divided into three sections and the connections between the sections are "coded" for easy identification. Thus, you can build a section at a time and ease the wear and tear on both brain and budget.

The major portion of the transceiver, the transmitter section, can be purchased wired and tested, or as a kit which includes all the parts listed alongside the transmitter

Fig. 1. Pictorial diagram of the audio/modulator subchassis. The tube socket lip on the chassis should be cut in about 1" and folded up to an angle slightly less than 90 degrees.

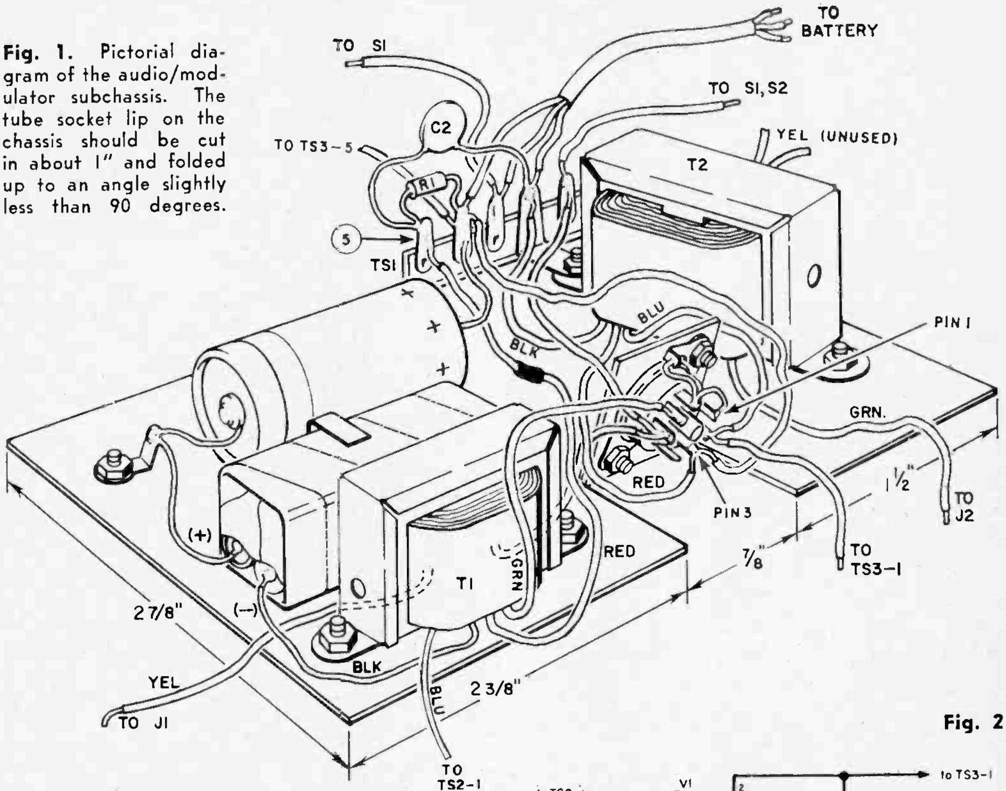
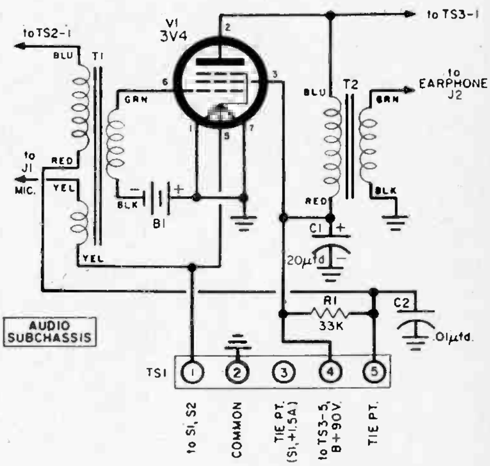


Fig. 2



schematic. This subassembly (available from International Crystal Mfg. Co., Inc., 18 N. Lee, Oklahoma City, Okla.) is a new development intended for Citizens Band or radio control applications.

Start construction by cutting the audio and receiver subchassis from a piece of Reynolds "do-it-yourself" aluminum as in Figs. 1 and 3. Punch all tube socket and other holes first. Then cut a slot in the audio chassis on each side of the tube socket hole and bend this "lip" up to an angle of 15° from the vertical. File the edges and steel-wool the aluminum for a neat appearance.

Terminal strips *TS1* and *TS2* are made from a standard 8-lug Cinch-Jones strip. Hold it with the two mounting feet toward you and cut it squarely between the third and fourth lugs from the left. The left section will have three lugs and the right section will have five lugs.

Prepare the bias battery (*B1*) by taping four miniature penlight cells together and connecting them in series. Solder a lead from the positive terminal of one battery to the negative terminal of the adjacent battery until you have two remaining terminals, a positive and a negative. Check the

AUDIO SUBCHASSIS PARTS

B1—6-volt bias battery (four RCA VSO74 cells wired in series)
C1—20-μfd., 150-volt electrolytic capacitor
C2—.01-μfd. disc ceramic capacitor
J1, J2—Open-circuit phone jack
R1—33,000-ohm, ½-watt resistor
T1—Transceiver transformer with plate, grid and microphone winding (Triad A-21X)
T2—Plate-to-phones or line transformer (Triad A-23X)
TS1—Terminal strip (Cinch-Jones 56C) (see text)
V1—3V4 tube
1—7-pin miniature tube socket
1—Headphone set (2000 ohms)
1—Carbon microphone

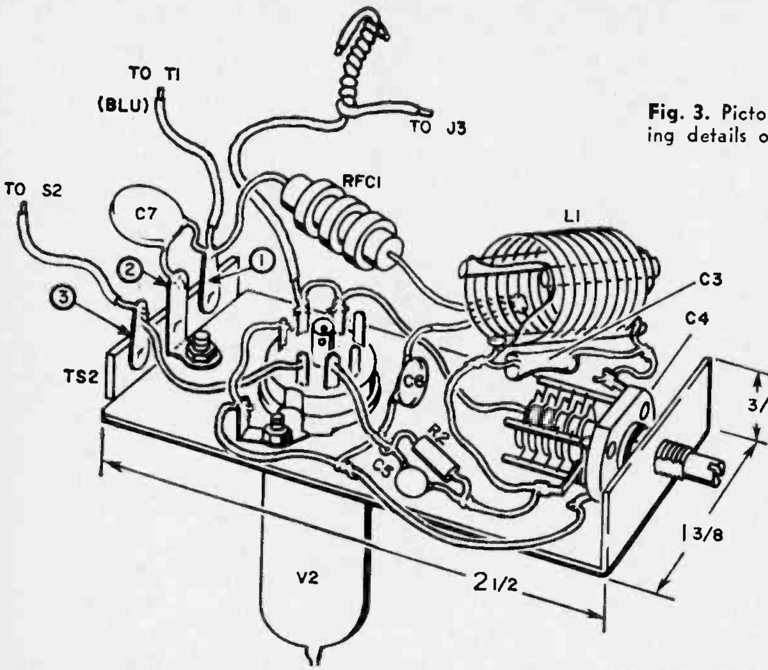
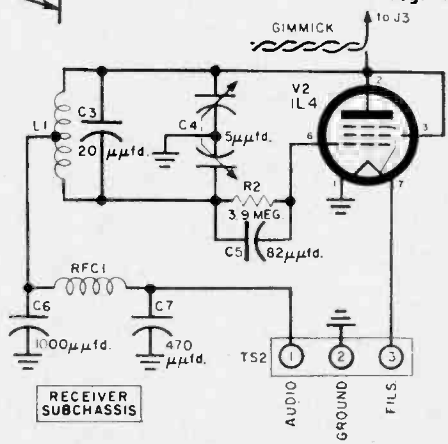


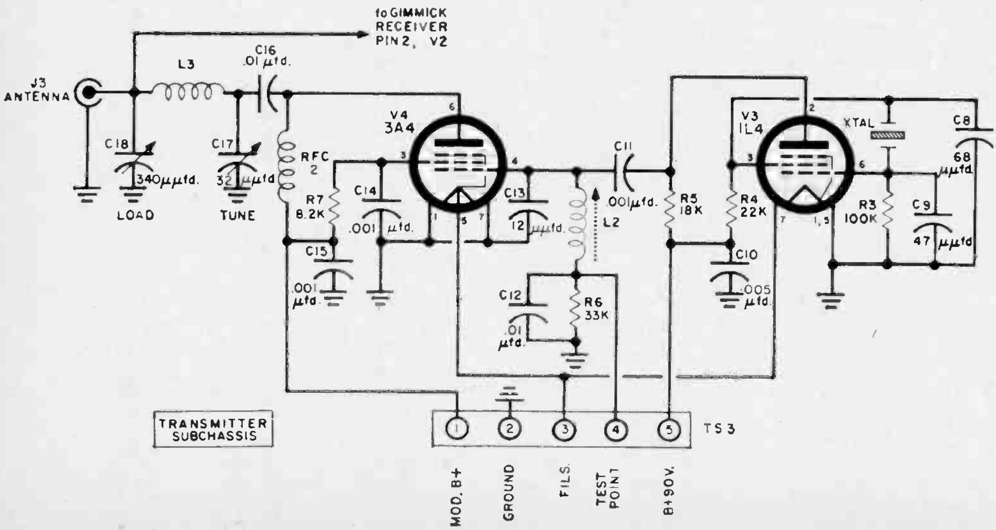
Fig. 3. Pictorial diagram showing wiring details of the receiver assembly.

RECEIVER SUBCHASSIS PARTS

C3—20 µµfd.
C4—5-µµfd. butterfly variable capacitor (E. F. Johnson Co. 5MB11)
C5—82 µµfd. *All capacitors disc ceramic,*
C6—.001 µfd. *200-volt rating or higher*
C7—470 µµfd. *unless otherwise indicated*
L1—11 turns of #24 wire 5/8" diameter, 16-turns per inch (Air Dux #516)
R2—3.9-megohm, 1/2-watt resistor
RFC1—2.5-mh. iron core choke (Miller #6302)
TS2—Terminal strip (Cinch-Jones 56C) (see text)
V2—1L4 tube
1—7-pin miniature tube socket

Fig. 4





voltage between the terminals—it should read about six volts.

The audio section is constructed first. Mount transformers *T1* and *T2* with *4/40* hardware with the 5-lug terminal strip (*TS1*) installed under the front mounting bolt of *T2,* as shown in Fig. 1. Secure the batteries next to *T1* with a bracket made from a ½" aluminum strip. (The remaining holes are used later for fixing the chassis to the cabinet.)

Now wire the audio circuit as in Figs. 1 and 2. Lead length is not critical but the parts placement shown is best.

Make sure to connect the color-coded leads of *T1* correctly: black to negative terminal of penlight cells, green to pin 6 of *V1,* red to *TS1-5,* and one of the yellow wires to pin 5 of *V1.* The remaining yellow and blue wires are connected later.

Connect the color-coded leads of *T2* in a similar manner: red to pin 3 of *V1,* blue to pin 2 of *V1,* black to ground. The green lead is later connected to *J2.* Clip the unused yellow wires short.

Complete the audio unit by connecting the battery three-wire cable. Connect one wire to *TS1-2* and label it *Common.* Connect the second cable wire to *TS1-3* and label it +1.5*A*. Connect the remaining wire to *TS1-4* and label it +90*B*.

The receiver section, which is shown in Figs. 3 and 4 is simple and can be constructed very quickly. The circuit consisting of *L1, R2, C3, C4* and *C5* is wired separately, before being mounted on receiver chassis.

Prepare the Air Dux coil (*L1*) so that you have 11 turns with 1" leads on each end. Solder the 20-μμfd. capacitor (*C3*) tight across the coil with short leads. Locate the exact center of the coil (5½ turns) and depress the adjacent turns slightly. Tin this center-tap so that *RFC1* and *C6* may be easily connected later. Solder the coil leads to the two stator terminals of capacitor *C4* and connect a 2" length of bare wire to the single rotor terminal.

Mount the tuned circuit assembly by *C4's* mounting nut; this nut should be only finger-tight as it will be removed later and used to mount the entire receiver subchassis to the cabinet panel.

The transmitter (Fig. 5) should be wired at this time, unless you purchased the unit prewired. Instructions are included with the kit and you should have no trouble if you follow them carefully. When the transmitter is completed, connect an 8" wire to the terminal designated *Filament* (*TS3-3*) and label it as such. The *B*+ (*TS3-5*) and *Modulated B*+ (*TS3-1*) terminals will be connected later.

The cabinet should be prepared next. Check the placement shown against your subassemblies for they fit quite closely.

Drill all holes, except the three (*Load, Tune,* and *Antenna*) associated with the transmitter. Then install *J1* and *J2* in ½" rubber grommets; you may have to push a bit, but the nuts will go on. Mount *S1* and *S2* with *S1* nearest the center of the chassis and wire as shown in Fig. 6.

Install the audio chassis in place with sheet metal screws through the bottom of the chassis box and wire this unit into the complete unit, following Fig. 7.

To install receiver subchassis, remove *C4's* mounting nut and mount the receiver subassembly over the ¼" front panel hole. The unit should be positioned so that tube *V2* extends over microphone jack *J1.* Now wire in the subassembly and connect a four-prong plug on the end of the battery cable as shown in Fig. 7. Install the knob on *C4.* Note that with this type of capacitor only 90° of rotation is required to cover the entire band. Cut a notch in cabinet cover so it will not crimp cable. After finishing this you

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TRANSMITTER SUBCHASSIS PARTS*

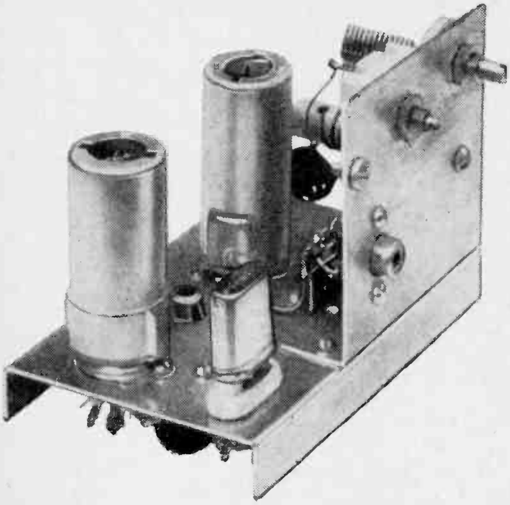
C8—68 μμfd.
C9—47 μμfd.
C10—.005 μfd.
C11, C14, C15—.001 μfd.
C12, C16—.01 μfd.
C13—12 μμfd.
C17—32-μμfd. variable capacitor (E. F. Johnson Co. 30M8)
C18—340-μμfd. (average) compression padder capacitor (Arco #303)
J3—RCA-type phono jack (Ant.)
L2—14 turns of #26 wire close-wound on ¼" slug-tuned form

All capacitors disc ceramic, 200-volt rating or higher unless otherwise indicated

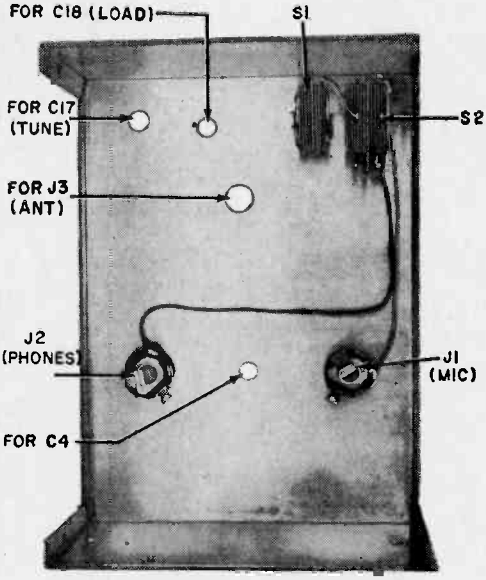
L3—17 turns of #26 close-wound on 5/16" form
R3—100,000 ohms
R4—22,000 ohms
R5—18,000 ohms
R6—33,000 ohms
R7—8200 ohms
RFC2—10-meter choke, 50 turns of #30 enameled wire close-wound on 1-watt resistor
TS3—5-lug terminal strip (part of transmitter)
V3—1L4 tube
V4—3A4 tube
Xtal.—Crystal for desired channel in Citizens Band (not part of kit)

All resistors ½-watt composition

* *Supplied with International Crystal FO-150 kit, $14.95, less crystal; Model FO-200, wired and tested, including crystal, $34.95.*



Transmitter subassembly at left is available prewired or as a kit. Construction from scratch is not recommended because of critical wiring and parts mounting.



Front panel holes and parts mounting are shown at right. Three upper holes are drilled to fit the jack and slotted capacitor shafts of the transmitter. Before assembling the transmitter, use its front panel as a drilling template.

can install the transmitter next. Visually check the chassis alignment and drill the holes to fit the shafts. Mount the transmitter using extra nuts on the *Tune* and *Load* capacitors. Now connect a 2″ piece of insulated hookup wire to pin 2 of *V2* and a 6″ piece of wire to the antenna jack. Run the longer wire through a convenient hole in the transmitter chassis and twist tightly around the shorter wire soldered to *V2*. This forms a "gimmick" capacitor a little

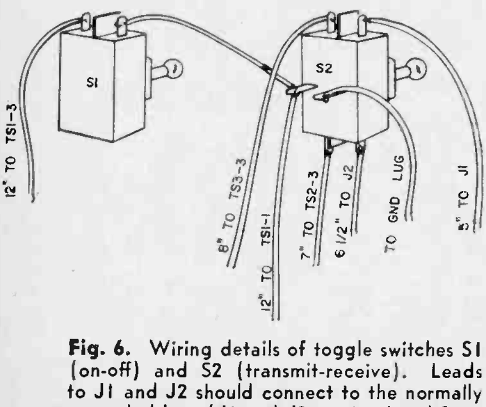


Fig. 6. Wiring details of toggle switches S1 (on-off) and S2 (transmit-receive). Leads to J1 and J2 should connect to the normally grounded lugs (J1 and J2 are insulated from the metal chassis by 1/2″ rubber grommets).

less than 1″ long and completes the wiring.

Check and double-check your wiring. Then check the power circuits—an error here could ruin the tubes or batteries.

Place both *S1* and *S2* in the down position (*Receive* and *Off*), and connect an ohmmeter between -A/-B and +1.5A of the plug on the end of the battery cable. (See Fig. 7.) The meter should read "open circuit." Now, flick the power switch to the *On* position. The meter should read very few ohms. Switch back to *Receive*, and remove tubes *V1* and *V2*. The meter should indicate an open circuit. Replace the tubes and move the ohmmeter lead from the +1.5A terminal over to the +90B wire. The ohmmeter needle will kick and then drift back to more than 100,000 ohms after the filter capacitor charges.

If these tests come out as described, you can safely energize the receiver. You should hear a very loud hissing noise, which indicates that the receiver is working. Connect an antenna to the transceiver as described below. If you are lucky, you may hear stations in the Citizens Band, but more than likely you will have to "trim" the receiver frequency for best results.

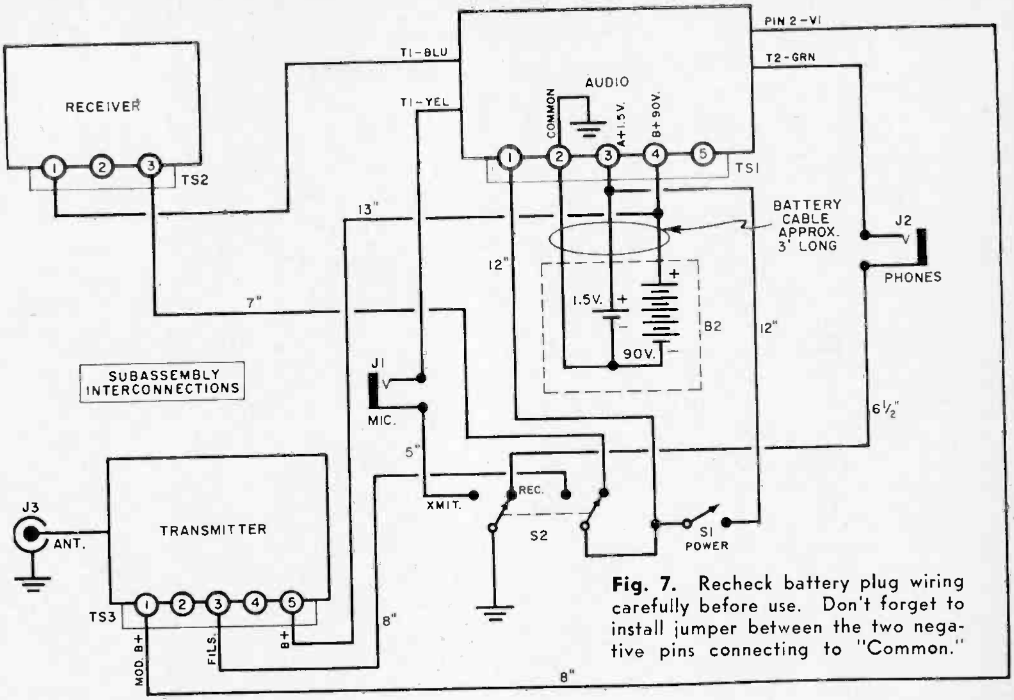


Fig. 7. Recheck battery plug wiring carefully before use. Don't forget to install jumper between the two negative pins connecting to "Common."

ADDITIONAL PARTS

B2—Battery pack, 1.5-volt "A," 90-volt "B" (RCA VS064)
S1—S.p.s.t. toggle switch
S2—D.p.d.t. toggle switch
1—3' length of flexible 3-wire cable
1—4-prong battery plug for VS064 battery
2—½" rubber grommets
1—3" x 5" x 7" cabinet (Bud Minibox CU-2108)

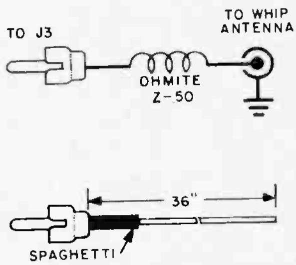


Fig. 8.

The coil has been constructed so that you will come out slightly lower than 27 mc. By bending in the turns of *L1*, you can put it "on the nose." It might be worth your time to have the unit aligned with an accurate TV marker generator. At the low end you should hear the generator on 26.9 mc., and at the high end on 27.3 mc.

The transmitter tune-up procedure is described in the information accompanying the International Crystal unit. You can make a dummy testing antenna with a #49 pilot lamp and a plug that will fit the antenna jack. With this inserted and the transmitter energized, adjust coil *L2* and the *Tune/Load* capacitors for maximum brilliancy. The bulb should light very brightly. Connect microphone and whistle into it. The bulb should get brighter.

The Citizens Talkie can be used with a dipole antenna (measuring 9' 6" tip-to-tip) fed by 25' of RG-58/U coaxial cable. You can also use a "whip" antenna so that it becomes a true "walkie-talkie."

A bracket for the whip antenna was drilled to hold an RCA type phono jack, secured to the top of the case. A 36" length of piano wire was soldered to a mating phono plug.

The 3' whip antenna is made electrically longer by inserting a coil between it and the antenna jack on the Citizens Talkie. This coil is an Ohmite Z-50 r.f. choke and exactly 32 turns are removed (about three-fifths of the winding) to resonate it. (See Fig. 8.)

You can get a license for the Citizens Talkie very easily. Just fill out the form enclosed with the International Crystal unit, and send it to the Federal Communications Commission, Washington 25, D. C.

Remember this transceiver is not a toy.

Build a SOLAR Powered 40 Meter Transmitter

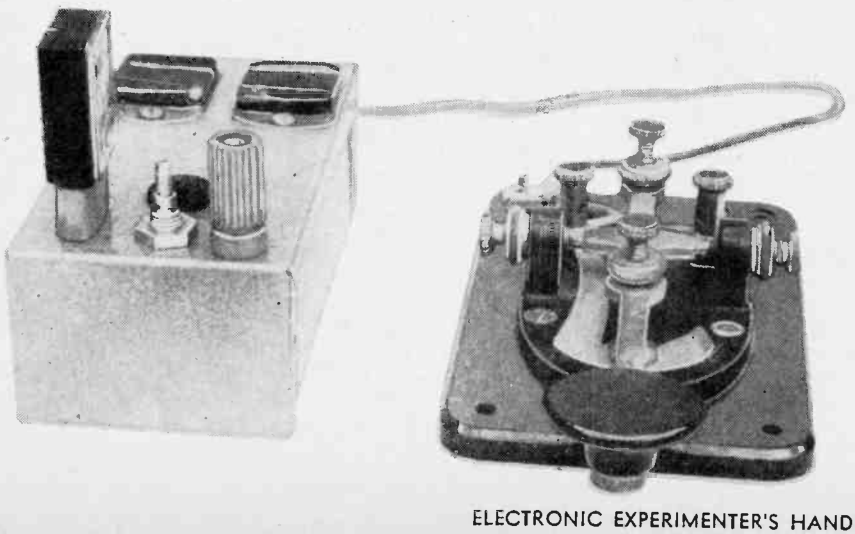
Radio amateurs with privileges in the 40-meter band (7.0-7.3 mc.) can build this solar-powered transmitter to make local contacts. When connected to a 66′ length of wire and a good ground, it is capable of transmitting several thousand feet. A test between WV6BGD and WV6BMI (about 1000 feet apart) produced an RST report of 569 in a heavily populated band. During the early morning hours, when 40-meter activity is low, the unit can be heard for even greater distances.

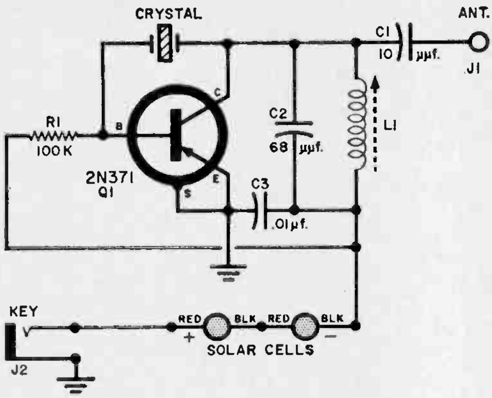
Simplicity is the keynote of the circuit. A single-transistor crystal-controlled oscillator is powered by two inexpensive silicon solor cells. The cost of all the parts will be less than $20.00. You can use the solar cells in other projects, too.

Construction. The unit is built on a 2¼″ x 4¼″ x 2½″ chassis box. The r.f. components (transistor, crystal, coil, and antenna terminal) are located at one end of the chassis, while the key jack and the solar cells are at the opposite end. Two ⅜″ holes are drilled below the cells for the red and black leads. A ⅜″ grommet is installed near the center of the chassis and the transistor is shoved tightly inside; this mounting is rugged and free from shock and vibration. The transistor leads are soldered directly to the components. A fourth transistor lead (exactly in the center of the case) is a shield connection and should be grounded along with the emitter lead. All components are self-supporting and no terminal strips are used.

Wire the solar cells by connecting a red lead from one cell to the black lead of the other cell, and tape the connection. The remaining black wire is connected to the lug of *L1* nearest the chassis. The remaining red wire is connected to the ungrounded terminal of the key jack. When you mount the key jack, it is automatically grounded to the chassis through the frame. The collector of *Q1* should be connected to the lug of

By
DONALD L. STONER
W6TNS

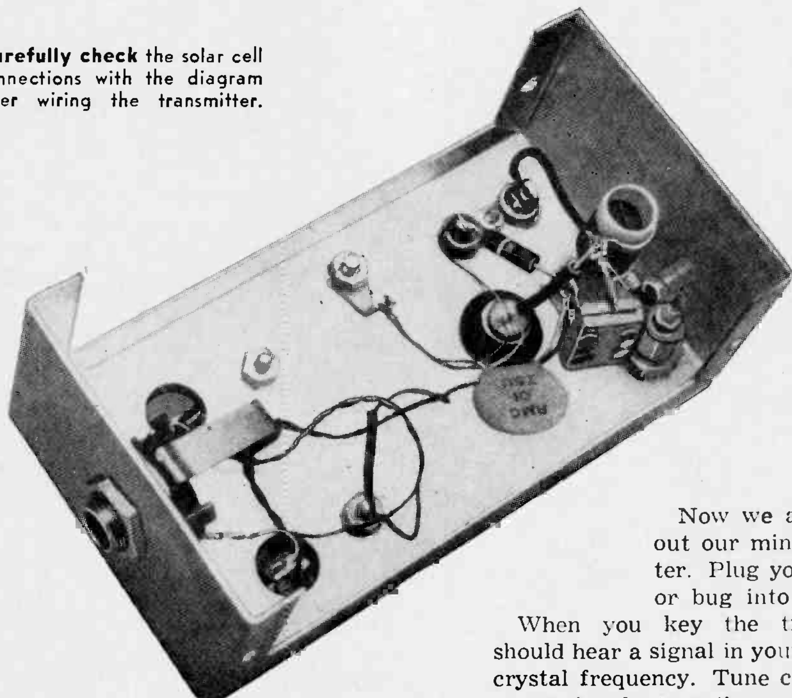




Carefully check the solar cell connections with the diagram after wiring the transmitter.

L1 that is farthest from the chassis.

Adjustment and Operation. The transmitter should be connected to a good antenna-ground system. Insert a 40-meter crystal and hold a lamp bulb near the solar cells. *Caution*—do not put the bulb any closer than two or three inches from the solar cells, as excessive heat will damage the cells. Feel the cells occasionally to make sure they are not too hot. They work much better at lower temperatures.



Now we are ready to try out our miniature transmitter. Plug your standard key or bug into phone jack *J2*.

When you key the transmitter, you should hear a signal in your receiver on the crystal frequency. Tune coil *L1* for maximum signal strength as indicated by an S-meter or with the help of a local ham. The adjustment is very broad and not very critical. The c.w. note should be "pure d.c.," with no sign of "chirp." After coil adjustment, the unit should operate with bright sunlight illuminating the cells.

Power can be greatly increased by replacing the solar cells with two series-connected 1.5-volt penlight cells (don't use more than two). Connect the positive terminal to *J2* and the negative terminal to *L1*.

Keep in mind that although this is a "micro-power" transmitter, you still need an amateur license to put it on the air. It does not qualify for the so-called "phono oscillator rules."

PARTS LIST

C1—10-µµf. ceramic disc capacitor
C2—68-µµf. ceramic disc capacitor
C3—.01-µf. ceramic disc capacitor
J1—Nylon pin tip jack
J2—Phone jack
L1—25 turns of #26 enameled wire, close-wound on 3/8" slug-tuned form
Q1—2N371 transistor
R1—100,000-ohm, 1/2-watt resistor
Solar Cells—Two 0.4-volt solar cells (Type SD-1020B, available from International Rectifier Corp., 1521 E. Grand Ave., El Segundo, Calif.)
1—Crystal, 7.0-7.2 mc. fundamental
1—4 1/4" x 2 1/4" x 2 1/2" chassis (LMB #777)
Misc. #6 solder lug, 6-32 nut and bolt, 4-40 nuts (4), bolts and washers

BUILD *A Cascode R.F. Unit*

. . . to boost reception on the 2- and 6-meter bands

By
DONALD A. SMITH
W3UZN

Here is the opportunity for hams and SWL fans to increase the sensitivity and gain of their present receivers by adding a cascode r.f. amplifier. This easily constructed, self-powered unit connects directly to the antenna terminal of your receiver, with no rewiring necessary.

Coil winding, parts layout and neutralization problems have been eliminated by the use of a kit available from International Crystal Company. And a small transformer-operated silicon diode power supply is added to the basic printed-circuit unit for shockless operation.

Construction. A small aluminum box houses the entire unit. Two cutouts are necessary for the power transformer and printed-circuit board.

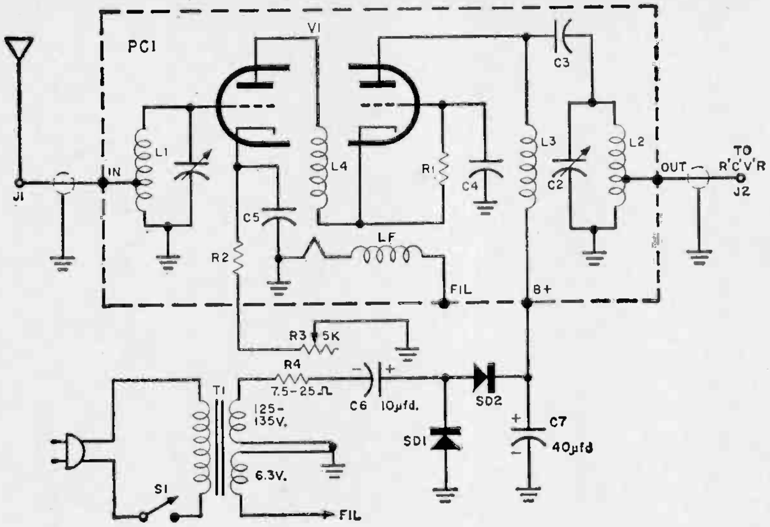
Since the parts received with the amplifier board are not yet mounted, this is the best time to mark off the board chassis cutout. Make it about ¼" smaller than the board. The edge of the printed circuit resting on the chassis provides the electrical ground. It may be necessary to file notches on the cutout to prevent shorting out of the terminals marked *FIL* and *LF*.

After all holes are drilled and the two cutouts made, mount the parts on the chassis. Follow the manufacturer's instructions when mounting components on the printed-circuit board. In the case of the 820-ohm resistor (*R2*), which is connected between tube pin 8 and ground, do not place the resistor as shown. Instead, connect it under the board, from pin 8 to the gain control (*R3*). *R3* permits lowering stage gain when extremely strong signals are received to prevent overload and blocking of the receiver.

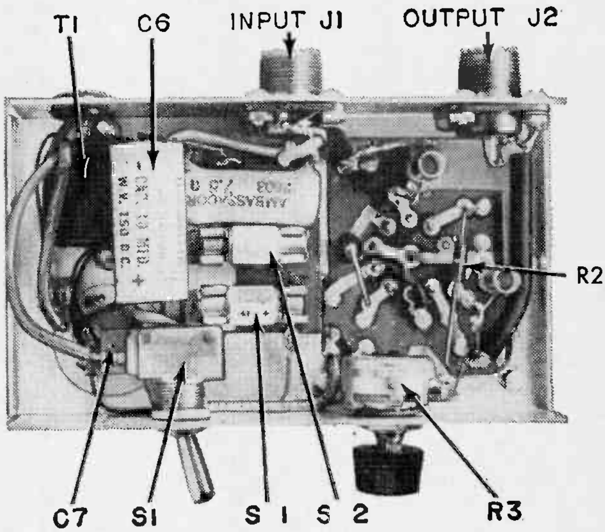
Use short lengths of coaxial cable to connect the input and output jacks (*J1* and *J2*) to the amplifier board. Observe polarity on *C6* and *C7*.

Alignment instructions are included with the kit. Don't be concerned if you find that the adjustment which gives the lowest noise during alignment is not the same as that which gives the greatest gain.

Using the Amplifier. The r.f. amplifier is complete in itself and therefore may be placed anywhere in the antenna lead-in



Schematic diagram of cascode r.f. unit. Part of schematic shown in dotted lines is printed-circuit board.



The r.f. section should not be cluttered by the power supply components. Note that resistor R2 is connected directly to R3. Use coax cables on r.f. input and output leads.

ahead of the receiver or converter. For best results, locate the unit on or near the receiver in order to keep the coaxial cable length short.

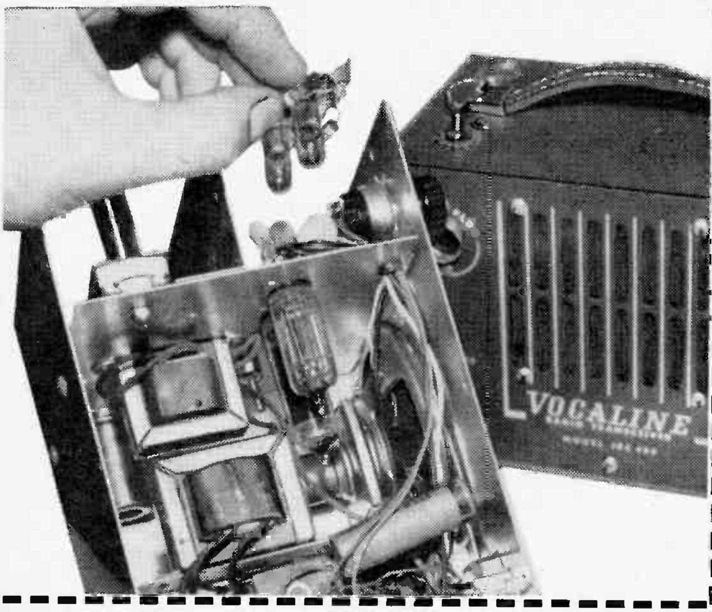
Both 2- and 6-meter amplifiers are available from the manufacturer. Tests made on the 6-meter unit, fed into a converter which already had a cascode front-end, showed good results. The over-all gain was approximately 30 db. The signal-to-noise ratio was improved 3 to 5 db.

When the cascode amplifier was connected to a converter which did *not* have a cascode front-end, gains of 10 to 20 db were not uncommon! And QRM in the i.f. frequency range was greatly reduced.

PARTS LIST

C6—10-μfd., 150-volt tubular electrolytic capacitor
C7—40-μfd., 350-volt can-type electrolytic capacitor
J1, J2—Chassis-mounting screw-type coaxial connector (Amphenol 83-1R or equivalent)
PC1—Printed-circuit board and parts (VFA-1, International Crystal Co., 18 N. Lee, Oklahoma City, Okla.—indicate choice of 6- or 2-meter cascode r.f. stage)*
R3—5000-ohm potentiometer
R4—7.5—25 ohm, 10-watt resistor
S1—S.p.s.t. toggle switch
SD1, SD2—150-ma. (or smaller) silicon diode rectifier
T1—Power transformer, 117-volt primary, 125-135 volt and 6.3-volt secondary (Triad R-20 or Stancor PS-8415)
1—5½" x 3" x 1¼" chassis (LMB #139)

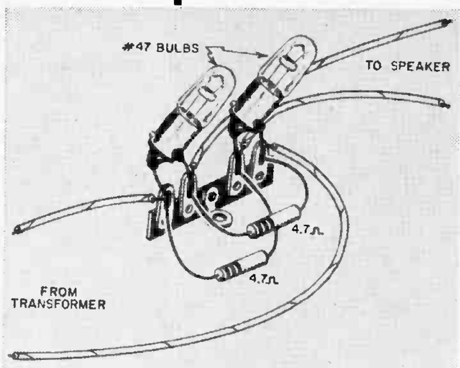
** C1—C5, R1, R2 and V1 are on printed-circuit board*

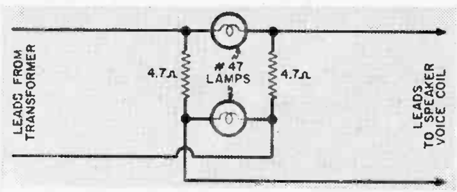


By
BOB WATSON
W8PBF

Transceiver Noise Suppressor

Wired as shown below, this simple audio volume expander functions as a noise suppressor. Bulbs may be socket-mounted or soldered directly to the tie lugs.





Small citizen band transceivers such as the Vocaline JRC 400 and 425 have a characteristic super-regenerative hiss, annoying to some owners. It can be eliminated by this simple substitute for a complicated squelch circuit.

Simply install a #47 pilot lamp across the speaker terminals. When a signal is received, it will cause the bulb to glow and its resistance will increase, thus allowing more signal to reach the voice coil. No signal together with the resistance of the lamp tends to short out the voice coil, and the hiss drops.

In adapting this circuit to one of the Vocaline units, it was determined experimentally that 4.7 ohms was the proper resistance value to use in conjunction with a No. 47 bulb in building the bridge.

When the bridge network is inserted in the Vocaline voice coil leads and the volume control is adjusted carefully, a point will be found where hiss drops to a very low level. A received signal will cause the light bulbs to glow, unbalancing the bridge and allowing the audio to reach the speaker at a useful level.

"Nifty Novice" 15-Meter Transmitter

Get on the air with this pretuned easily constructed rig

By
DONALD L. STONER
W6TNS

The 15-meter band (21 mc.) holds a world of adventure for the Novice class radio amateur. It is possible for a Novice to communicate with hams all over the world on this band which is "open" to many countries during daylight hours. The "Nifty Novice" 15-meter transmitter is designed especially for the Novice and runs 25 watts input power.

Although operating only on this one band, the Nifty Novice has many features that will appeal to prospective operators. The transmitter circuits are pre-tuned as much as possible and only two adjustments are required to get on the air. No meters are used during adjustments, as an inexpensive pilot lamp serves quite well as a tuning indicator. The two controls are set for maximum lamp brilliancy, and the transmitter is ready to operate.

The 25-watt power level is high enough for world-wide communication, yet low enough to minimize television interference. Another feature of this rig, usually found only in very expensive transmitters, is the provision for keying of the oscillator stage only. This produces very good keying notes, and the rig never fails to get a T9 (tone) report. This same circuit also protects the final amplifier so that it is virtually impossible to damage the tube or components by mistuning the transmitter.

Construction. Cut and drill the chassis holes and the aluminum capacitor brackets for later mounting of the tuning controls *C10* and *C11* as required.

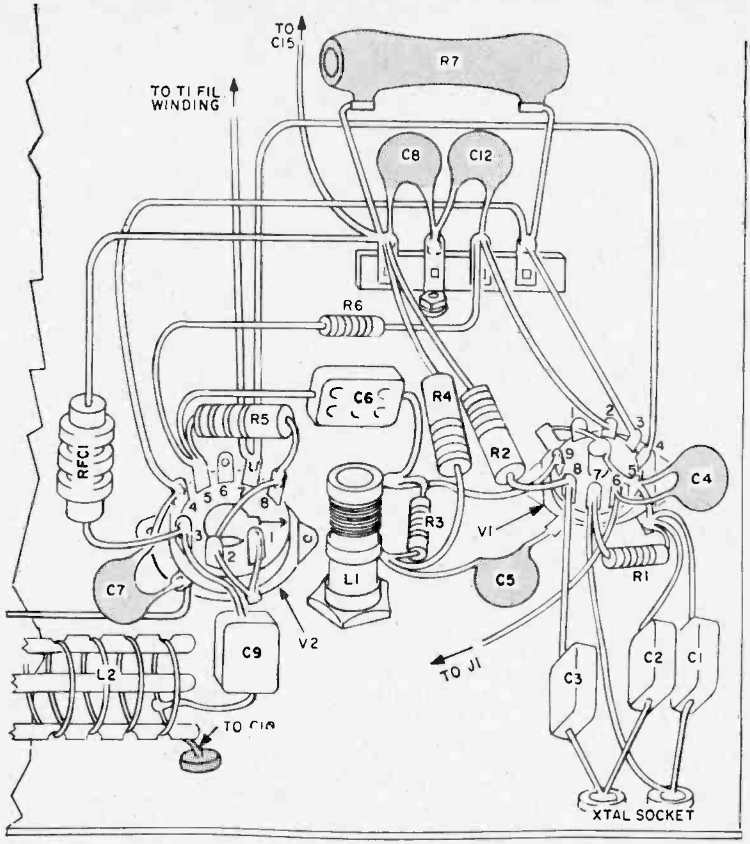
The sockets for the two r.f. tubes (*V1* and *V2*) should be the type with ground lugs on the mounting ring to facilitate wiring, with the associated components grouped tightly around the sockets to keep the leads short. Coil *L1* is located between the two tubes, and *L2* is located under the chassis, below *C10* and *C11*.

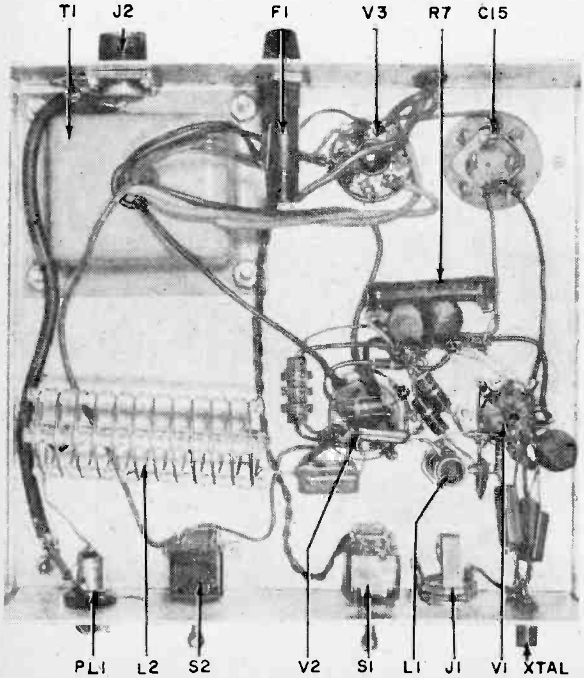
Coil *L2* is held in place by its own leads passing through the chassis (insulated by rubber grommets) and connected to *C10* and *C11*. *C9* is connected to *L2* at a point just before it passes through the chassis. In a similiar manner, the wire to *PL1* is connected to the other end of *L2*. After all the wiring is completed, recheck all connections carefully.

Testing the Transmitter. Use a volt-ohm-milliammeter (or preferably a VTVM) for the following checks:

(1) Remove all the tubes and measure the resistance across the line cord plug. With power switch *S1* off, the VOM should read infinite ohms. With *S1* on, the ohmmeter should read about 4.2 ohms. If readings are incorrect, there is a short or open in the power supply circuits.

(2) Insert *V1* only and switch on the transmitter. The tube filament should

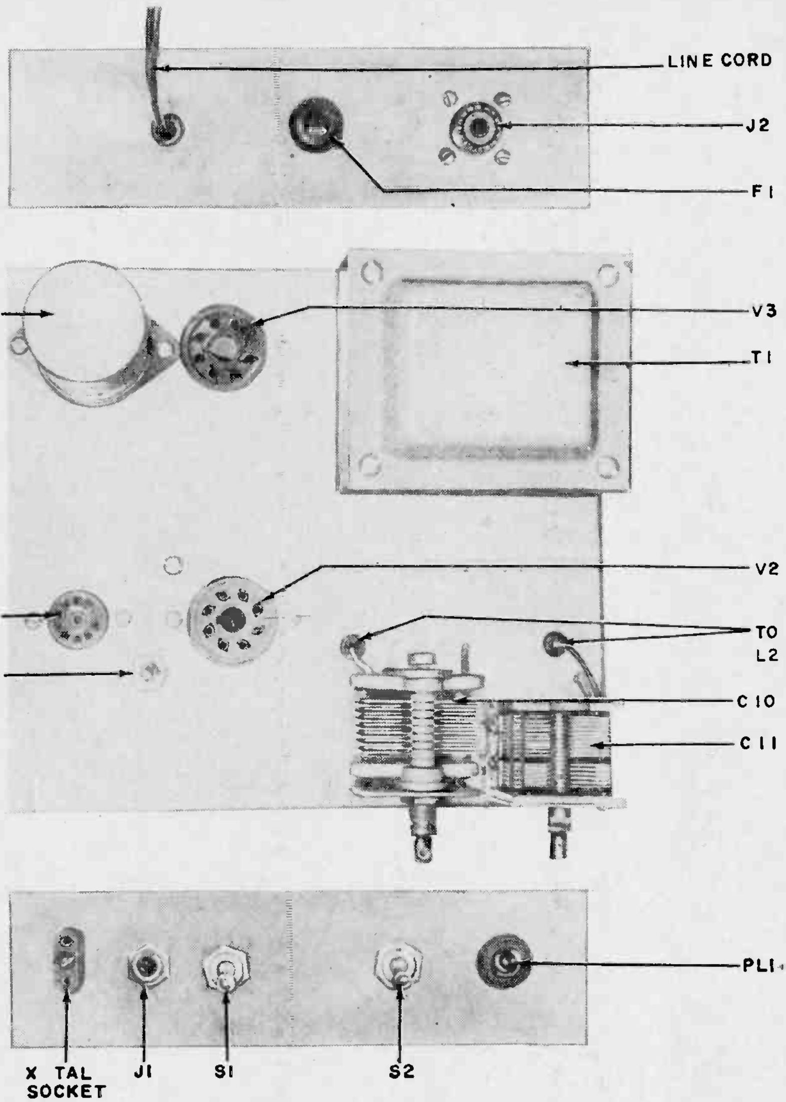




Pictorial diagram above details the connections to tube sockets V1 and V2. The leads need not be as long as this but should connect to points indicated.

Underchassis view at left shows general layout of completed transmitter. Capacitor C15 may have four 20-μfd. sections or be a single 80-μfd. unit.

Chassis layout on the next page indicates convenient parts placement. Front and back aprons of the chassis have been "folded out" for clarity.



light. If it doesn't, check filament wiring.

(3) With the transmitter off, remove *V1* and measure the resistance from pin 2 of the 5Y3 rectifier (*V3*) socket to the chassis ground. The VOM should read close to zero ohms, and then slowly drift back to 50,000 ohms or higher.

(4) Place switches *S1* and *S2* in the "off" position and insert *V3*. Turn on *S1*, and *V3*'s filaments should light up immediately. Connect the meter (500 volts d.c. scale) from pin 2 of *V1*'s socket to chassis ground. Flip the *standby* switch on and read the B-plus voltage. It should read about 370 volts (±10%).

(5) Install *V1* and *V2*, and again check the B-plus voltage. It should drop to about 330 volts. If it does not, this may indicate that a connection has been omitted and the tubes are unable to draw power from the supply.

If these simple tests have produced satisfactory results, you are now ready to tune up the transmitter.

Tune-Up Instruction. Connect a key and crystal to the transmitter, and set *L1* fully counterclockwise so that the slug is all the way out of the coil. Set *C10* and *C11* at maximum capacity. Connect the negative lead of your voltmeter to pin 2 of *V1* and the positive lead to ground.

Switch on the transmitter, and observe

PARTS LIST

C1—47-μμfd. mica capacitor
C2—39-μμfd. mica capacitor
C3—.001-μfd. mica capacitor
C4, C5, C7, C8, C12, C13, C14—.005-μfd., 600-volt disc ceramic capacitor
C6—10-μμfd. mica capacitor
C9—.002-μfd. mica capacitor
C10—100-μμfd. variable capacitor (E. F. Johnson 100R-12 or equivalent)
C11—365-μμfd. variable capacitor (J. W. Miller #2111 or equivalent)
C15—80-μfd., 450-volt electrolytic capacitor (Sprague TVL-1735 or equivalent)
F1—3-ampere fuse and mounting assembly
J1—Open-circuit phone jack (key)
J2—Coaxial connector (Amphenol 83-1R or equivalent)
L1—18 turns of #26 enameled wire, wound on 3/8" slug-tuned form (J. W. Miller #4405)
L2—12 turns of #18 tinned wire, 1" diameter, spaced 1/4" between turns (Air Dux #408)
L3—6 turns of #22 enameled wire, 1/4" diameter (see text)
PL1—#49, 2-volt, .06-amp. pilot lamp
R1, R6—100,000-ohm, 1/2-watt resistor
R2—47,000-ohm, 1-watt resistor
R3—15,000-ohm, 1/2-watt resistor
R4—1000-ohm, 1-watt resistor
R5—15,000-ohm, 1-watt resistor
R7—25,000-ohm, 10-watt wire-wound resistor
RFC1—2.5-mh. r.f. choke
S1, S2—S.p.s.t. toggle switch
T1—Power transformer, 525 volts ct., 90 ma.; 6.3 volts, 5 amp.; 5 volts, 2 amp. (Triad R-10B or equivalent)
V1—6AU8 tube
V2—6L6 tube
V3—5Y3 tube
XTAL—Quartz crystal, 7035 to 7080 kc.
1—Chassis or chassis box approx. 7" x 7" x 2" (L. M. Bender #20—plain, or equivalent)
Misc. crystal socket, octal tube sockets (2), 9-pin socket, rubber grommets, knobs, 8" length of RG-59/U coaxial cable, 4-lug terminal strip

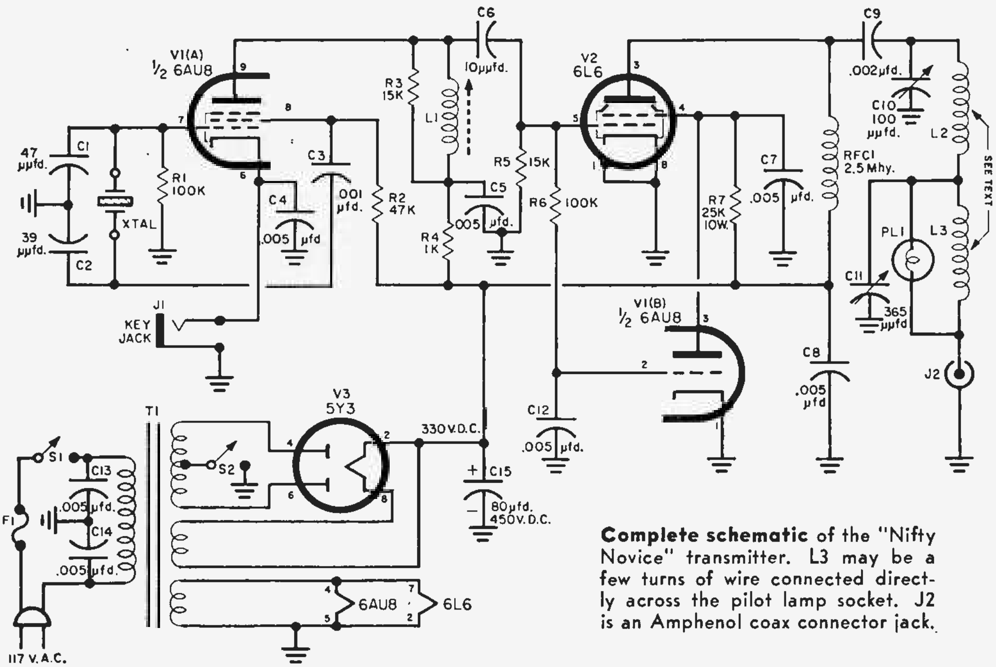
the d.c. reading while rotating the slug of *L1*. Set the slug for maximum voltage and glue it in place. Measure the power supply voltage, and set capacitor *C10* at the point where maximum *B*-plus is obtained.

The coil (*L3*) across the pilot lamp (*PL1*) should be adjusted so that the bulb can be used as an antenna current reference. Connect a 75-ohm, 2-watt carbon resistor from the center pin of the antenna jack (*J2*) to chassis ground. If *PL1* has not been lit before, it should light now. Adjust *C10* and *C11* for maximum brilliancy but do not leave the power on too long or the 75-ohm resistor will overheat.

If the bulb is extremely bright, spread or reduce the number of turns on *L3*. You won't want the bulb to be very bright for the power it uses up could be working for you in the antenna. Have it just bright enough so that it can be seen easily.

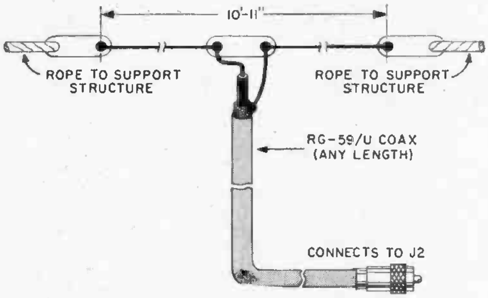
After these steps are completed, remove the 75-ohm resistor, and the transmitter is ready to connect to your antenna.

Antenna System. The antenna that you use with this transmitter will determine how successful you are on 15 meters. No matter how much power you run, you will not "get out" with a poor antenna. About the simplest antenna that will produce good results is a dipole, which is shown on next page. The dimensions should be followed closely, with



Complete schematic of the "Nifty Novice" transmitter. L3 may be a few turns of wire connected directly across the pilot lamp socket. J2 is an Amphenol coax connector jack.

lengths cut to the nearest inch. Get the antenna up in the air, the higher the better. Face the broadside of the antenna in the direction you want to work (north-south-east-west, or in-between); for DX contacts,



a north-east south-west direction would prove quite satisfactory. This antenna is simple enough so that you can erect two of them, 90° apart.

HOW IT WORKS

The 15-meter transmitter uses a three-tube circuit, employing a 6AU8 oscillator/clamp (*V1*), 6L6 power amplifier (*V2*), and a 5Y3 rectifier (*V3*). Power input, when fully loaded, runs about 25 watts.

The oscillator circuit uses the pentode section (*A*) of *V1* in a modified Pierce connection. Feedback occurs between the screen and control grid, at the fundamental crystal frequency (7035-7080 kc.). The plate circuit of this stage is tuned to the third harmonic of the crystal (21.1-21.25 mc.). This r.f. energy is applied to *V2* for power amplification.

V1's triode section (*B*) is used as a "clamp" tube and is connected between the screen grid of *V2* and ground. The control grid of *V1(B)* is connected to the control grid of *V2* through *R6*, causing *V1(B)* to act as a very low resistance from *V2*'s screen to ground, hence limiting the amount of current drawn.

When the oscillator is keyed and r.f. energy applied to *V2*, a negative voltage will develop across *R5* due to *V2*'s grid current. Since this negative voltage is also applied to *V1(B)*, it acts as a bias to cut the tube off. The effect is much the same as removing the low resistance between *V2*'s screen and ground. The screen voltage goes up and allows *V2* to amplify to full power.

The tank circuit is composed of *C10*, *C11*, and *L2*. Pilot lamp *PL1* is connected in series with *L2* and the antenna jack (*J1*) so that the antenna current flows through the bulb. Thus, the brilliancy of the bulb will indicate relatively how much power is being delivered to (and radiated by) the antenna. Coil *L3*, shunting the bulb, prevents burn out.

HANDY FLUX CAN

Do you ever have trouble locating that can of rosin flux amidst the confusion of small parts on your workbench? To insure that flux is always at hand when needed, simply spot-solder the flux can to the end of your solder spool. —*H. J. G.*

The Trans-Six Receiver

By **JOHN J. SURY,** K8NIC

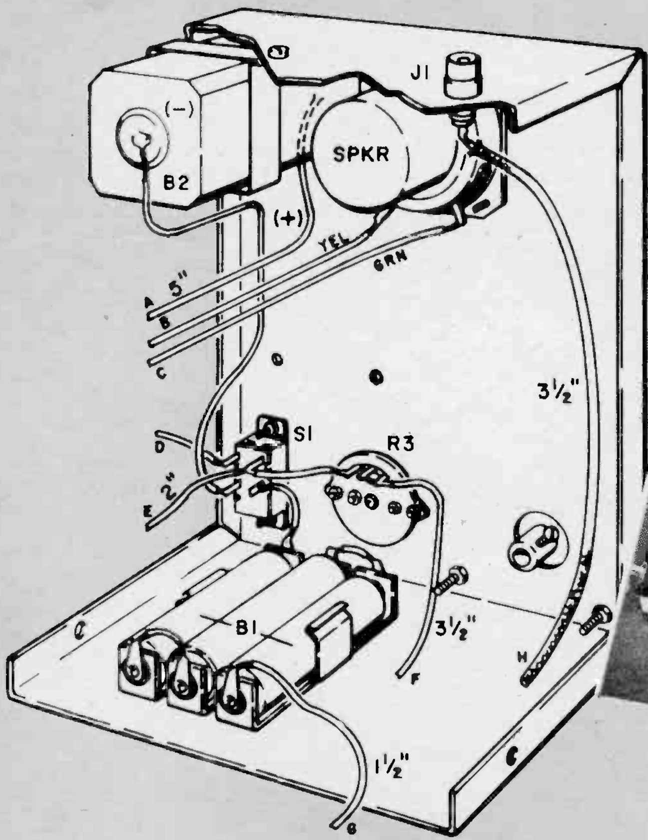
Transistorized superregenerator tunes 6- and 10-meter ham bands

Here is a "hot" little superregenerative receiver designed for the ham or ardent DX'er. It includes an audio section with a push-pull output feeding a miniature speaker.

The tank circuit coil may be rewound for the 10- and 20-meter bands, and amazing pickup can be had with only a short whip antenna. The superregen pot does a fine job in separating stations in conjunction with the tank circuit.

Total cost of the project should be $16.00 or under, made possible by the introduction of the Philco 2N588 MADT transistor at less than $3.00.

Chassis and Cabinet. The subchassis is made from a piece of $\frac{3}{32}$" fiberboard. A triangular file can be used to make the rectangular transistor socket holes. L-brackets of scrap aluminum mount the sub-

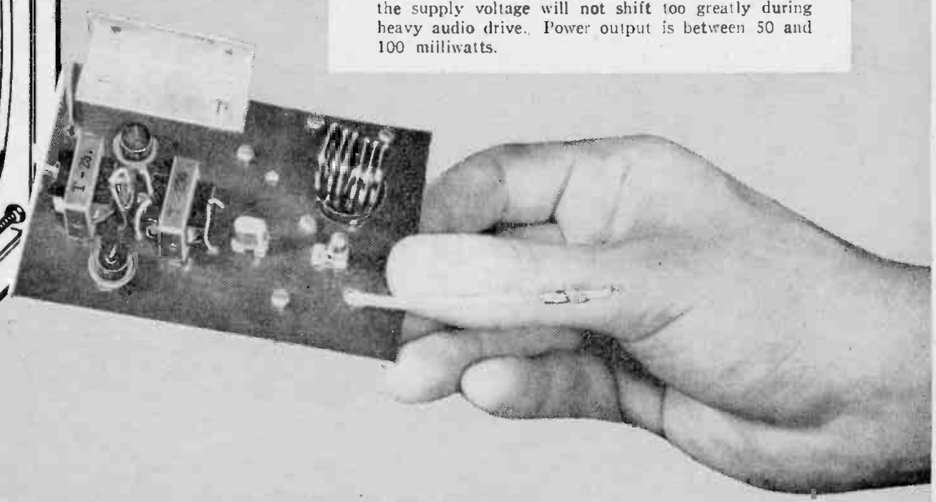


HOW IT WORKS

A Micro-Alloy Diffused-Base (MADT) Philco transsistor *(Q1)* is employed in a superregen circuit. When *Q1* oscillates, a negative voltage charges *C4* and the transistor blocks. As *C4* discharges, conduction resumes. The periodic blocking results in background hiss. Choke *RFC1* in the emitter lead blocks the signal.

Diode *CD1* rectifies the signal and feeds back energy so that the superregenerator also amplifies at audio frequencies. The signal is then fed into the base of *Q2* which is coupled to driver transformer *T1*.

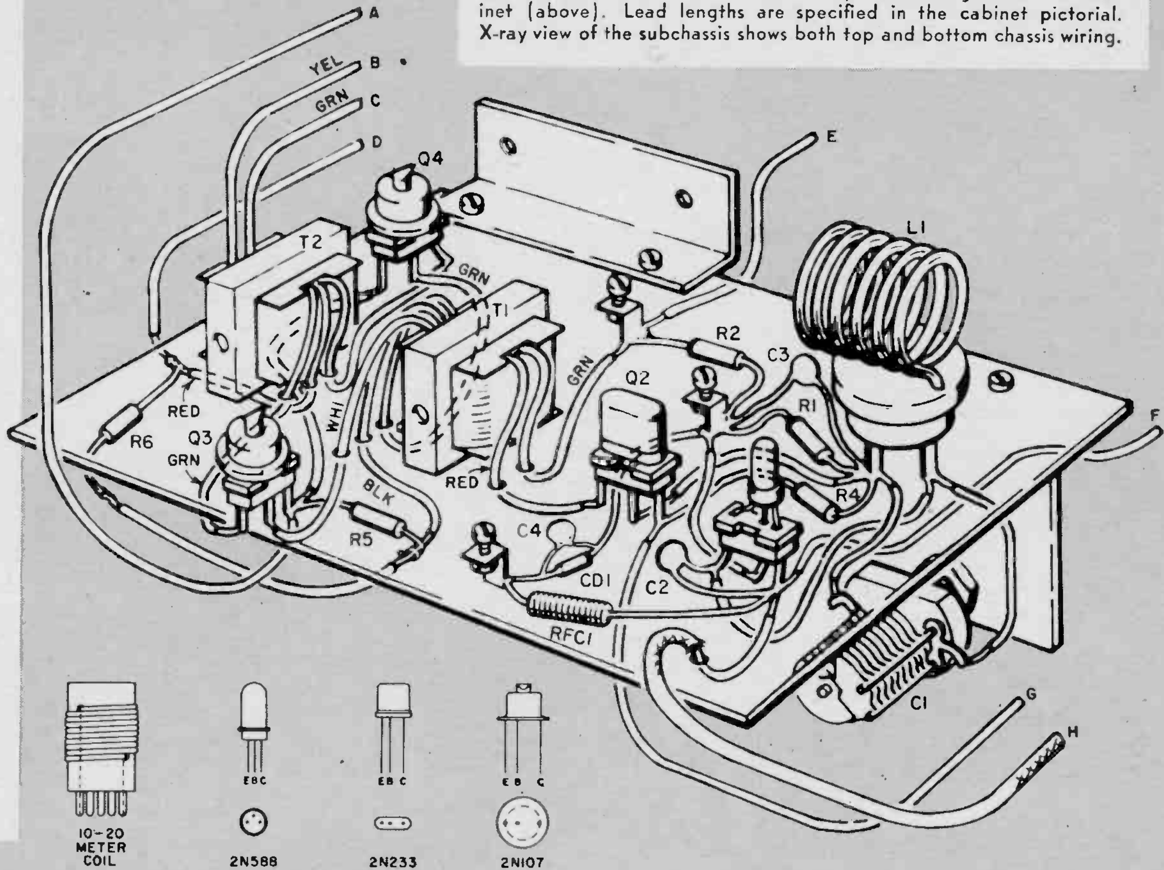
The push-pull stage consists of two *p-n-p* transistors *(Q3* and *Q4)* connected in Class B using the grounded-emitter arrangement. Two separate battery supplies are employed in this circuit for stability, as the supply voltage will not shift too greatly during heavy audio drive. Power output is between 50 and 100 milliwatts.

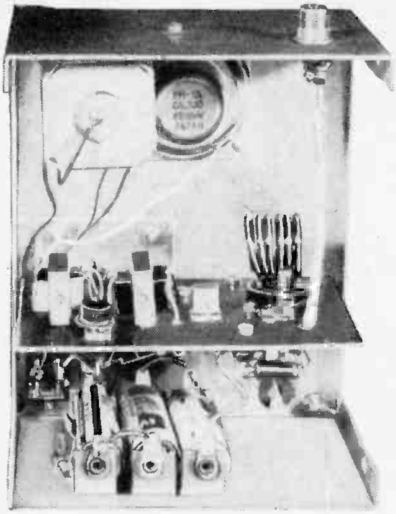


PARTS LIST

B1—4.5-volt battery (3 penlight cells in series)
B2—6-volt battery (Eveready 724)
C1—15-$\mu\mu$f. variable capacitor (Johnson 15M11)
C2—10-$\mu\mu$f. disc ceramic capacitor
C3, C4—.001-μf. disc ceramic capacitor
CD1—1N34A diode (or equivalent)
J1—RCA-type phone jack
L1—6 turns of #14 enameled wire, 3/4"-diameter
Q1—2N588 transistor (Philco)
Q2—2N233 transistor
Q3, Q4—2N107 transistor
R1—18,000 ohms
R2, R6—2700 ohms
R3—5000-ohm miniature or standard potentiometer
R4—270 ohms
R5—150 ohms
(All resistors 1/2 watt)
RFC1—32 turns of #28 wire close-wound on 1/8" form
S1—D.p.s.t. slide switch
T1—Driver transformer; primary 10,000 ohms, secondary 2000 ohms (Olson T-230 or equivalent)
T2—Output transformer; primary 500 ohms, secondary to match speaker voice coil impedance
1—1 1/2"-3" speaker
1—5" x 4" x 3" Minibox
1—3 1/2" x 2 1/2" x 3/32"-thick fiberboard subchassis
1—Vernier dial (Calrad VD-36 or equivalent)
4—3-pin transistor sockets
1—Coil socket (Amphenol 78-S5S)

The letter-coded leads from the subchassis are connected to the equivalently coded leads shown in the pictorial diagram of the cabinet (above). Lead lengths are specified in the cabinet pictorial. X-ray view of the subchassis shows both top and bottom chassis wiring.





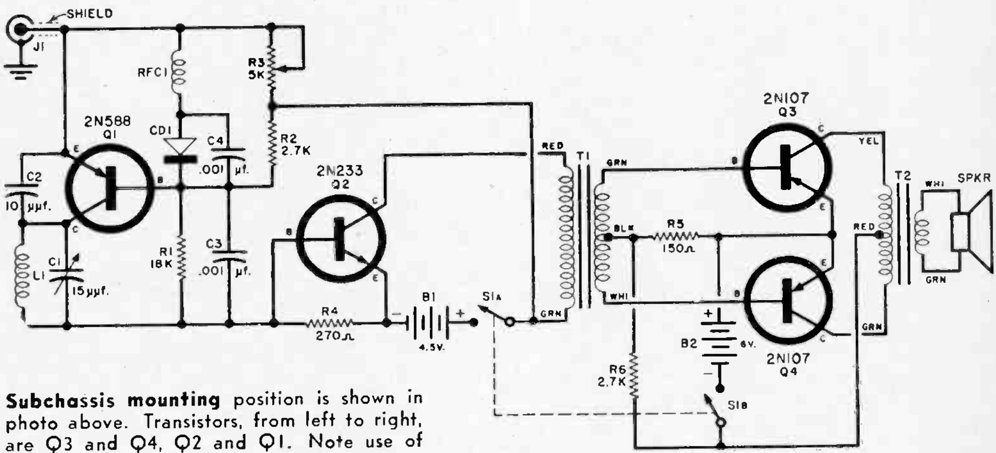
the cabinet. A ¼"-o.d. and 3/16"-i.d. sleeve will be needed to couple the dial to the shaft of *C1*. Once the vernier dial is properly aligned with *C1*, drill the holes and mount.

Install the 6-volt battery that powers the amplifier with a small bracket. Then wire the battery into the amplifier circuit, carefully observing polarity.

For the antenna connection, use a piece of RG-58 A/U shielded cable and connect it from the emitter pin of *Q1* to the antenna connector *J1*. Do *not* ground the shield at either end.

Coil *L1* consists of six turns of ¾"-diameter #14 enameled wire, closely spaced. Tin the ends of the coil for better contact in the socket.

After you insert all transistors and *L1*



Subchassis mounting position is shown in photo above. Transistors, from left to right, are Q3 and Q4, Q2 and Q1. Note use of two battery supplies for increased stability.

chassis to the inside of the cabinet and *C1* to the subchassis.

Prepare the cabinet by drilling all holes except the ones that are to be used for mounting the vernier dial. To insure good alignment, don't drill holes for the vernier dial until the receiver is assembled.

Wiring and Mounting. Keep all wires in the superregen circuit as short as possible, using ground lugs as tie points. After subchassis wiring is completed, mount the chassis to the inside of the cabinet using an L-bracket and *4-40* hardware. Install the penlight battery holders in the cabinet beneath the chassis and wire to the superregen circuit.

Install the vernier dial on the front of

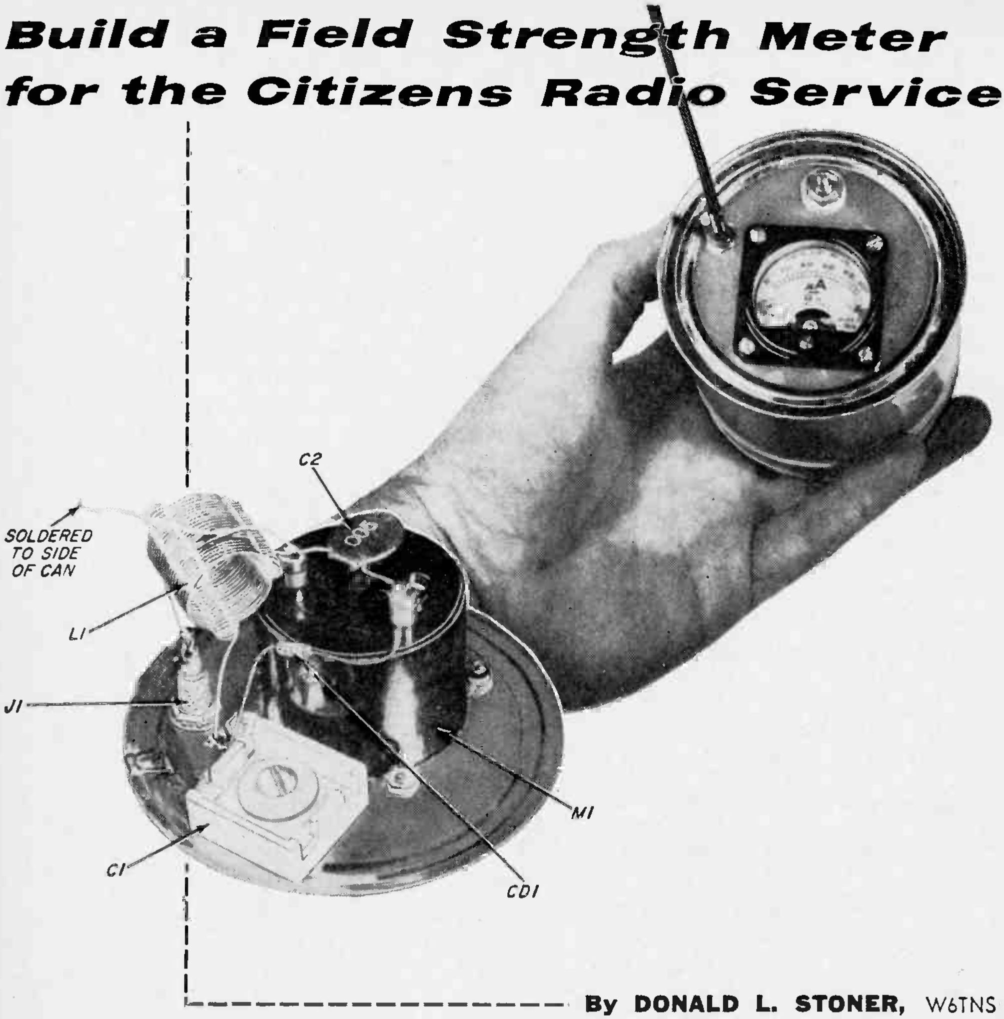
in their proper locations, you will be ready to use the receiver.

Tuning and Operation. This is a very easy superregenerative receiver to tune. Hook a fairly good six-meter antenna to it, then turn the receiver on and adjust *R3* until a loud hiss is heard. Tune the vernier dial and adjust *R3* until you get the best reception.

The author had no problem in receiving hams on six meters. Also on the higher end of the band is TV Channel 2.

Additional coils may be made up for the lower ham bands, but use only a single wire antenna. With this little rig, the author has heard stations all over the United States and South America.

Build a Field Strength Meter for the Citizens Radio Service



By **DONALD L. STONER,** W6TNS

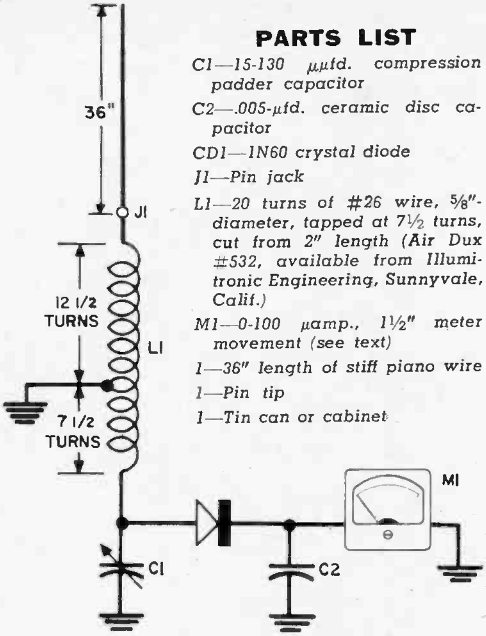
You can squeeze the last drop of power from your transmitter and antenna system with the help of this Citizens Band Class C and D field strength meter. By "peaking-up" the transmitter adjustments for the highest field strength meter reading, you can be sure that your Citizens Band station is working at top efficiency. The antenna length of the transceiver, which is usually critical, can be "trimmed" for the strongest signal.

The author's model was constructed in a discarded peanut can, but any suitable metal cabinet will serve. You can cut holes in the metal with a sharp jack knife, or drill them in the normal manner.

Construction. The meter *(M1)*, *sensitivity* control *(C1)*, and the antenna jack *(J1)* are mounted on top on the "front panel" and are positioned to avoid ridges in the can. The relative positions of these components are not critical.

Coil *L1* is formed by counting off 20 turns and cutting off the remainder of the coil, making sure to leave about 1" of lead on each end. Prepare the coil for tapping by counting up 7½ turns from one end. Depress the turns on each side of the tap to prevent shorting the turns. Tin the tap point for connection later.

Ground one terminal of *C1* to the can. Connect one end of *L1* (closest to the tap) to the *ungrounded* terminal of *C1*. The other end of *L1* (furthest from the tap) is connected to *J1*. Connect the *unbanded* end of diode *CD1* to the ungrounded terminal of



PARTS LIST

C1—15-130 μμfd. compression padder capacitor

C2—.005-μfd. ceramic disc capacitor

CD1—1N60 crystal diode

J1—Pin jack

L1—20 turns of #26 wire, 5/8"-diameter, tapped at 7½ turns, cut from 2" length (Air Dux #532, available from Illumitronic Engineering, Sunnyvale, Calif.)

M1—0-100 μamp., 1½" meter movement (see text)

1—36" length of stiff piano wire

1—Pin tip

1—Tin can or cabinet

HOW IT WORKS

The unit consists of a "loaded" whip antenna tuned to 27 mc. which feeds coil *L1* and capacitor *C1*, tuned to the same frequency. R.f. energy from your Citizens Band transmitter appears across the tuned circuit and is rectified by crystal diode *CD1*. The rectified signal is filtered and used to actuate meter *M1*.

Note that when the instrument is hand-held, body capacity is added to the antenna system. To obtain accurate measurement, calibration and adjustment must always be made in the same way, i. e., if you operate the instrument hand-held at one time, it must be hand-held the next time. Or if it is calibrated on an insulated workbench, it should be operated on the bench.

C1. Connect the banded end of *CD1* to the plus terminal of *M1*. Then connect the .005-μfd. capacitor *(C2)* across the meter terminals, and wire last connections.

The antenna consists of a 36" length of stiff piano wire (available at model shops) soldered to an earphone tip plug to fit *J1*.

Sensitivity. The sensitivity control will allow you to obtain a meter reading up close. By proper adjustment, you can obtain a meter indication as much as 100 feet away from the transceiver. If this sensitivity is not required, use a less sensitive (and expensive) meter than the 0-100 μamp. unit specified. A 0-1 ma. meter will reduce the range to about 10 feet. Any odd-value meter movement can be employed whose sensitivity is within ranges specified as scale markings are not used. Tune for maximum swing of the meter needle.

Build a Novice Band Receiver

Two-tube regen circuit features wide bandspread on 80, 40 and 15 meters

Here is a receiver which uses only two tubes, requires no alignment, yet will give the average low-priced superhet a run for its money in Novice band c.w. reception. And it has an important advantage usually found only in expensive communication receivers: the Novice bands are spread over a large portion of the main tuning dial for easy tuning. For example, the 80-meter c.w. band occupies almost half the total dial space on the main tuning dial, a big aid to the beginner in finding the band and tuning in stations.

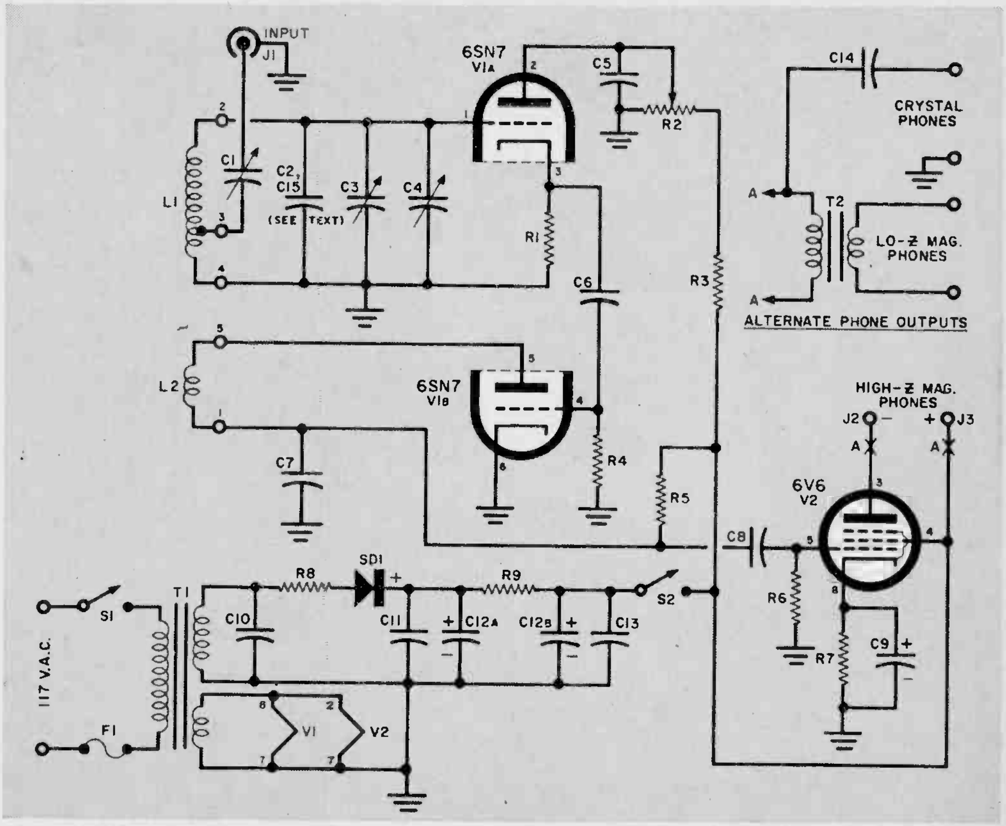
Two octal base tubes are used in the receiver. The 6SN7 and 6V6 are readily available types, with tube sockets large enough so that soldering is easy. Likewise, layout is "wide open" for ease of wiring. Coil winding is no problem as coils are available "ready made" (although they have to be modified slightly).

Construction. Drill and cut the chassis and front panel following the layout shown in the illustrations. Notice that the tubes and coils are located close to the front panel to keep tuning leads short and to provide shielding from hand-capacity effects. The power supply is at the rear of the chassis.

The coils are the heart of the receiver, so prepare them with care. One plug-in coil (*L1, L2*) is used for each of the three Novice bands. In order to achieve high "C," each coil is used on a *lower* frequency than that for which it is marked when it comes from the factory. For example, the coil used to tune the 80-meter band is a 40-meter B&W, 25-watt "Baby" inductor, the type ordinarily used in small transmitters. A similar B&W 20-meter coil is used for receiving the 40-meter band, and a 10-meter coil for 15 meters.

There are several coil modifications to be made. On both the original 40-meter and 20-meter coils, a 100-$\mu\mu$f. silver mica capacitor is soldered *across* the total coil winding. As shown on the coil socket diagram, this capacitor is connected to pins "2" and "4." On the original 10-meter coil, no capacitor is used; however, the center

By
JOHN STOCKTON



Phones used with receiver can be crystal, low-impedance or high-impedance type. If output circuit for crystal or low-Z phones is employed, transformer T2 should be mounted away from tuning coils.

PARTS LIST

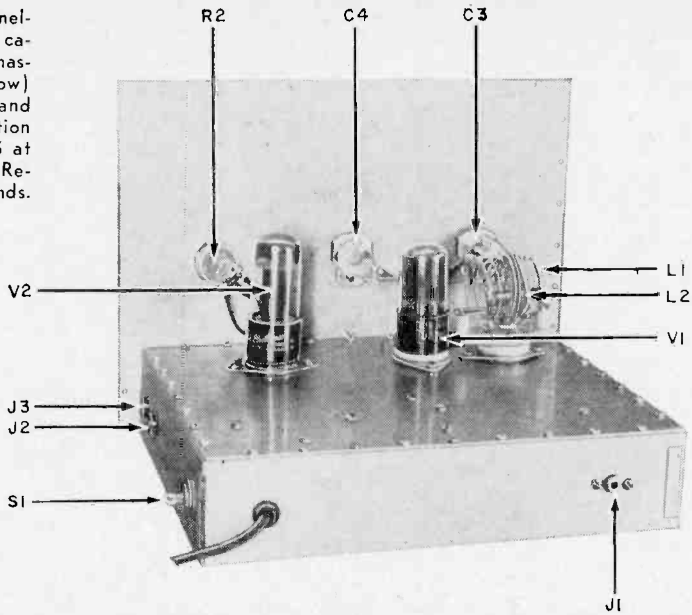
C1—3-30 μμf. mica trimmer capacitor
C2, C15—100-μμf. silver mica shunt capacitor (one used to modify 40-meter coil for 80 meters, the other to modify 20-meter coil for 40 meters)
C3—100-μμf. variable capacitor
C4—15-μμf. variable capacitor
C5—0.5-μf. (or higher), 200-volt capacitor
C6—250-μμf. mica capacitor
C7—100-μμf. mica capacitor
C8—.01-μf. 400-volt capacitor
C9—20-μf., 25-volt electrolytic capacitor
C10—.005-μf., 600-volt capacitor
C11, C13—.01-μf., 600-volt capacitor
C12a/C12b—Dual 30-μf., 150-volt electrolytic capacitor
C14—.01-μf., 600-volt capacitor (used with crystal headphones)
F1—1-amp. fuse and holder
J1—Antenna jack
J2, J3—Pin tip jacks
L1, L2—See text
R1—4700-ohm, 1-watt resistor
R2—100,000-ohm, 2-watt potentiometer (Ohmite CU1041 or equivalent)
R3—47,000-ohm, 2-watt resistor
R4—1.5-megohm, ½-watt resistor
R5, R6—470,000, 1-watt resistor
R7—2500-ohm, 2-watt resistor
R8—47-ohm, 1-watt resistor
R9—1000-ohm, 2-watt resistor
S1, S2—S.p.s.t. toggle switch
SD1—Silicon diode, 50 ma. or higher
T1—Power transformer; secondaries, 125 volts, 50 ma.; 6.3-volt, 2-amp. filament winding (Merit P-3045 or equivalent)
T2—6V6 output transformer, single plate-to-voice coil (see schematic diagram)
V1—6SN7 tube
V2—6V6 tube
1—2" x 8" x 10" chassis
1—8" x 11" aluminum front panel
Misc. hardware, grommet, terminal lugs, five-prong ceramic coil socket, octal tube sockets (two—one ceramic)

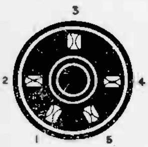
tap on the coil is moved over and resoldered so that it is approximately 1⅛ turns from the pin 4 end of the coil (closer to "ground" to reduce antenna coupling).

Once the above modifications are completed, the next step is to add tickler windings. This is very easy to do, except that care is needed to avoid the possibility of improper polarization of windings. Start out by looking at the bottom of the modified 40-meter coil, with the pins facing you.

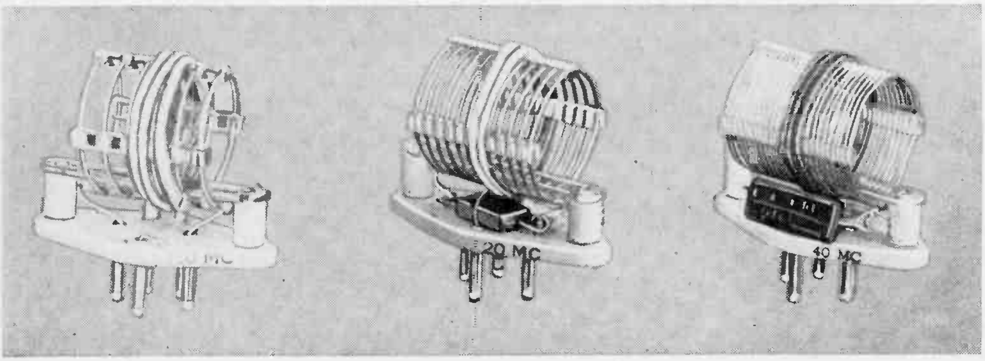
As shown on the socket diagram, this

All receiver controls are panel-mounted except antenna trimmer capacitor C1, located under the chassis. Tuning coils (see photos below) are modified for specific ham band on which each is used; note location of shunt capacitors C2 and C15 at base of 80- and 40-meter coils. Relabel coils for new operating bands.





5-PRONG SOCKET (BOTTOM VIEW)



tickler winding starts with unused pin 1. Solder one end of a piece of hookup wire in this pin. Then make three turns around the center of the coil and solder the remaining free end of the wire into unused pin 5. It is important that this winding, like the winding already on the coil, be in a clockwise direction.

The tickler for the modified 10-meter coil should also have three turns, while the tickler on the modified 20-meter coil should be wound with two turns.

Testing and Adjustments. Before applying power, it is a good idea to "polarize" high-impedance magnetic headphones by making certain that the B-plus lead on the phones goes to the B-plus in the set. One pin on most magnetic headphones has this lead identified by a colored stripe (usually red). Low-impedance magnetic headphones or crystal headphones must *not* be placed in the plate circuit of the 6V6. See the schematic diagram for circuits used with various headphones.

There are two power switches. The "stand-by" switch (*S2*) on the front panel is used to shut off the receiver when you are transmitting. At the side of the chassis is the main power switch (*S1*). Both are s.p.s.t.

In testing the set, first connect the antenna and ground. The antenna can be a single wire, preferably 60′ or longer, erected as high as possible. While the set will work on an indoor antenna run around the room, much better results can be expected from a good outdoor antenna, for example, your transmitting antenna. Any type of convenient jack or terminal can be used for the antenna connector (*J1*). The chassis should be grounded to a cold water pipe or other good ground.

For evening tests, plug in the 80-meter coil (15 meters is good in daylight hours), and switch on the a.c. and B-plus. As a starting point, set antenna trimmer *C1* to approximately one-half capacity. Advance the regeneration control (*R2*) approximately half way, and turn band-setting capacitor *C3* until you hear the 80-meter amateur phone stations. Then tune band-spread capacitor *C4* with the main tuning dial. The 80-meter Novice band will be found at a slightly *lower* frequency (capacitors more "closed").

With a little experimenting, you will be able to set *C3* for the best coverage on the main tuning dial. On the original model of the set, the same setting of *C3* would "hold" for all three Novice bands, so, once set, it could be left alone. Only minor adjustments should be needed.

Operation. Now advance regeneration control *R2* to the point where the set just breaks into oscillation. This is the best operating condition for receiving c.w. stations. For phone reception, the control should be backed off till whistling stops.

Should the set refuse to oscillate, the most probable cause would be that the tickler windings were not properly polarized. Reverse the connections of the tickler windings to the coil pins, and try again.

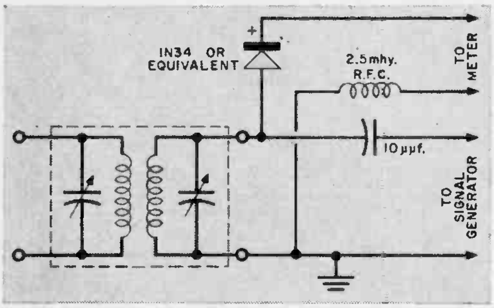
The antenna trimmer capacitor (*C1*) should be adjusted for the best reception on the 21-mc. band. If desired, *C1* can be replaced by a knob-operated variable capacitor which will let you trim the antenna for best reception on each of the bands.

HOW IT WORKS

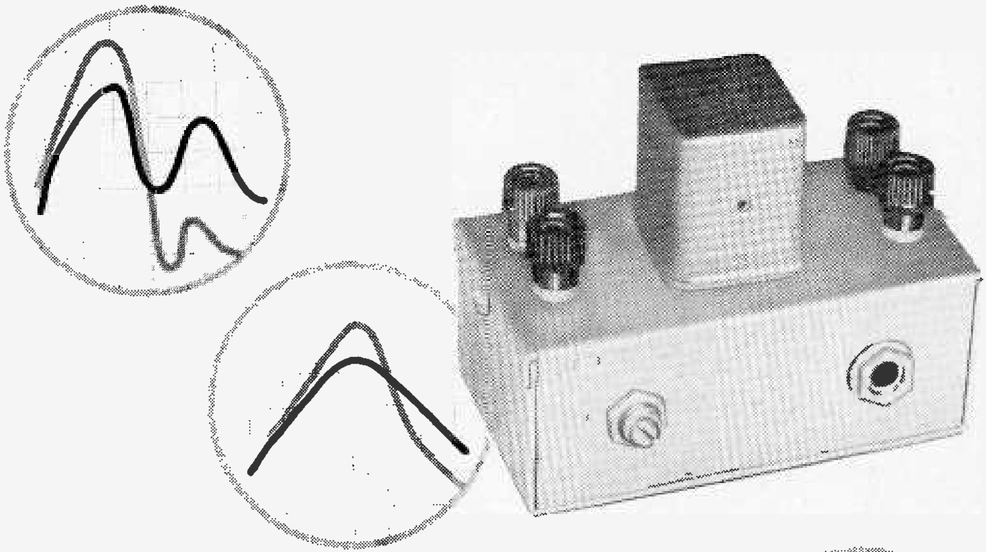
This circuit is essentially a regenerative detector followed by one stage of audio. A high "C" and high "Q" tuned circuit is used to increase the stability of the detector stage. Triode *V1a* is connected to the tuned circuit and is operated as an r.f. amplifier with a cathode-follower output. The r.f. from *V1a* is detected by triode *V1b* which also operates as a feedback or regeneration stage. Since the detector does not load the tuned circuit, improved selectivity and sensitivity result.

The audio output stage, *V2*, is heavily biased to keep plate current down and to avoid any damage to series-operated magnetic headphones. The power supply is a conventional half-wave rectifier. Small capacitors across the high-voltage winding of *T1* and across the filter capacitors eliminate tunable hum and line noise.

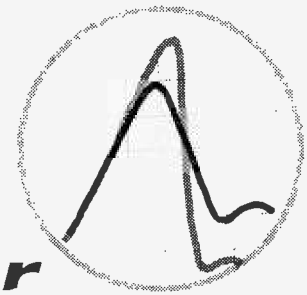
Finding I.F. Transformer Frequencies



To determine the frequency of an unmarked i.f. transformer, use a signal generator and a sensitive milliammeter or low-range voltmeter. When the signal generator is tuned to the resonant frequency of the transformer, a sharp rise in the meter reading will result. A 5000-ohms-per-volt meter will be sensitive enough for most applications, but if the signal generator used has a low output, try a 20,000-ohms-per-volt unit or a VTVM to obtain a satisfactory reading. —*Robert B. Kuehn*



Build This Signal Peaker



A useful accessory for the ham or SWL

By
RUFUS P. TURNER

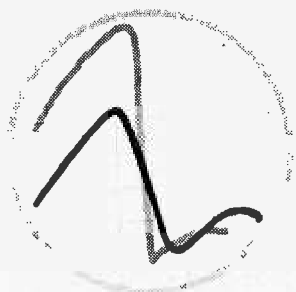
Here is an easily constructed signal peaker that requires neither tubes nor transistors nor a d.c. power supply. It tunes sharply to pass any selected frequency between 600 and 1100 cycles. Approximately 14 to 1 rejection is provided for frequencies as close as 1 octave on each side of the operating frequency.

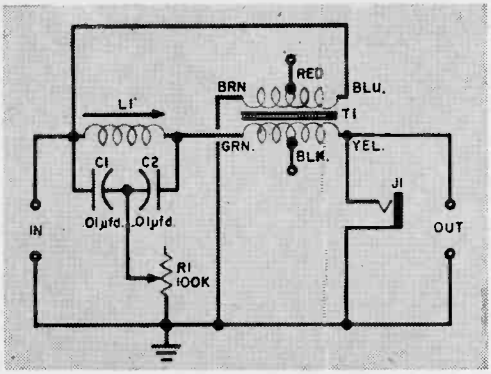
While other filters only knock the available signal down, this circuit introduces no insertion loss. Instead, when operating into a high-impedance load (such as an a.c. VTVM, oscilloscope, or crystal headphones), it provides a voltage gain of approximately 10 at signal peak. The graph shows the circuit's performance curve at 1000 cycles.

Construction. The device should be built in an aluminum chassis box. Neither layout nor wiring is critical, since the frequencies are low. The only wiring precaution is to connect all ground leads to one soldering lug which should be attached to the chassis.

Mount inductor *L1* and the binding posts on top of the chassis. Mount *R1* and *J1* on the front. All other circuit elements are mounted inside the chassis box.

Follow carefully the color coding of *T1*'s leads as shown in the schematic. If this is not done, the transformer will not be





PARTS LIST

C1, C2—0.01-μfd. mica capacitor
J1—Miniature open-circuit phone jack
L1—Miniature 5-henry tunable inductor (UTC VIC-15)
R1—½-megohm potentiometer
T1—Miniature transistor-type transformer: primary impedance, 2000 ohms CT, secondary impedance, 8000 ohms CT (Argonne AR-115)
4—Insulated binding posts, with lugs and fiber washers
1—Solder lug
1—4" x 2⅛" x 1⅝" aluminum chassis box

HOW IT WORKS

The primary winding of transformer *T1* is connected in parallel with the signal input terminals. The secondary winding is connected effectively in series with the *Input* and *Output* terminals. It is wired to buck the input voltage. Because of this phasing, the output voltage would be reduced to zero if the secondary voltage were exactly equal to the input voltage. Thus, the signal through this circuit would be cancelled.

But there is connected in series with the *Input* terminals and the transformer secondary a bridged-T network *(L1-C1-C2-R1)* which removes one frequency (actually, a very narrow band of frequencies) from the signal. This prevents transformer *T1* from bucking out the signal of the bridged-T network frequency. The net result is an output signal at the null frequency of the T network, while adjacent frequencies are attenuated.

Headphone jack *J1* is provided in addition to the *Output* binding post terminals to allow the device to be used directly with headphones for sharpening c.w. signals or balancing a bridge.

phased correctly and the output signal will dip instead of peaking.

By employing an adjustable inductor, *L1*, the response to the network may be changed to any desired frequency within a tuning range governed by *L1* and capacitors *C1* and *C2*. The specified inductor (UTC Type VIC-15) is adjusted by means of an Allen wrench inserted into a tuning screw.

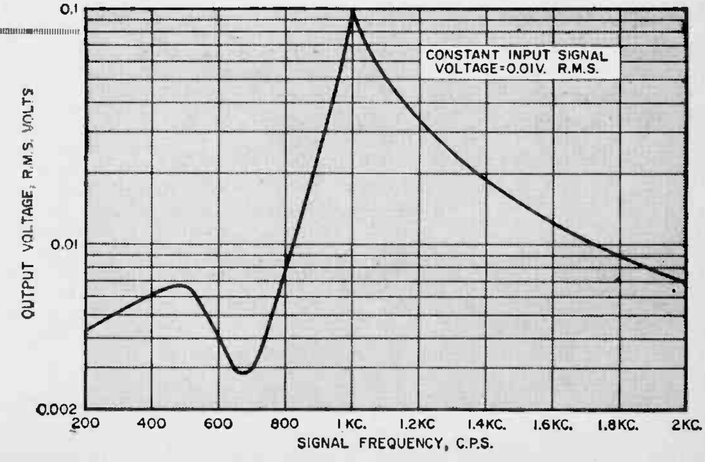
If the builder is not interested in the tuning feature, a conventional, iron-cored choke coil may be used, but it must have high *Q* in order for the output peak to be sharp.

Tuning. Connect an audio oscillator to the *Input* terminals. Connect an a.c. VTVM to the *Output* terminals. Be sure that the ground terminal of the oscillator and VTVM are connected to the grounded binding posts. Tune the oscillator to 1000 cycles.

Adjust *L1* for peak deflection of the VTVM. Adjust *R1* for the highest VTVM reading at the peak. Now, without disturbing the oscillator output control, run the oscillator through its tuning range, noting that the output voltage rises sharply at 1000 cycles and falls on each side of this frequency.

The signal peaker can be tuned to any frequency between 600 and 1100 cycles by repeating the above procedure. Just set the signal generator at the desired frequency.

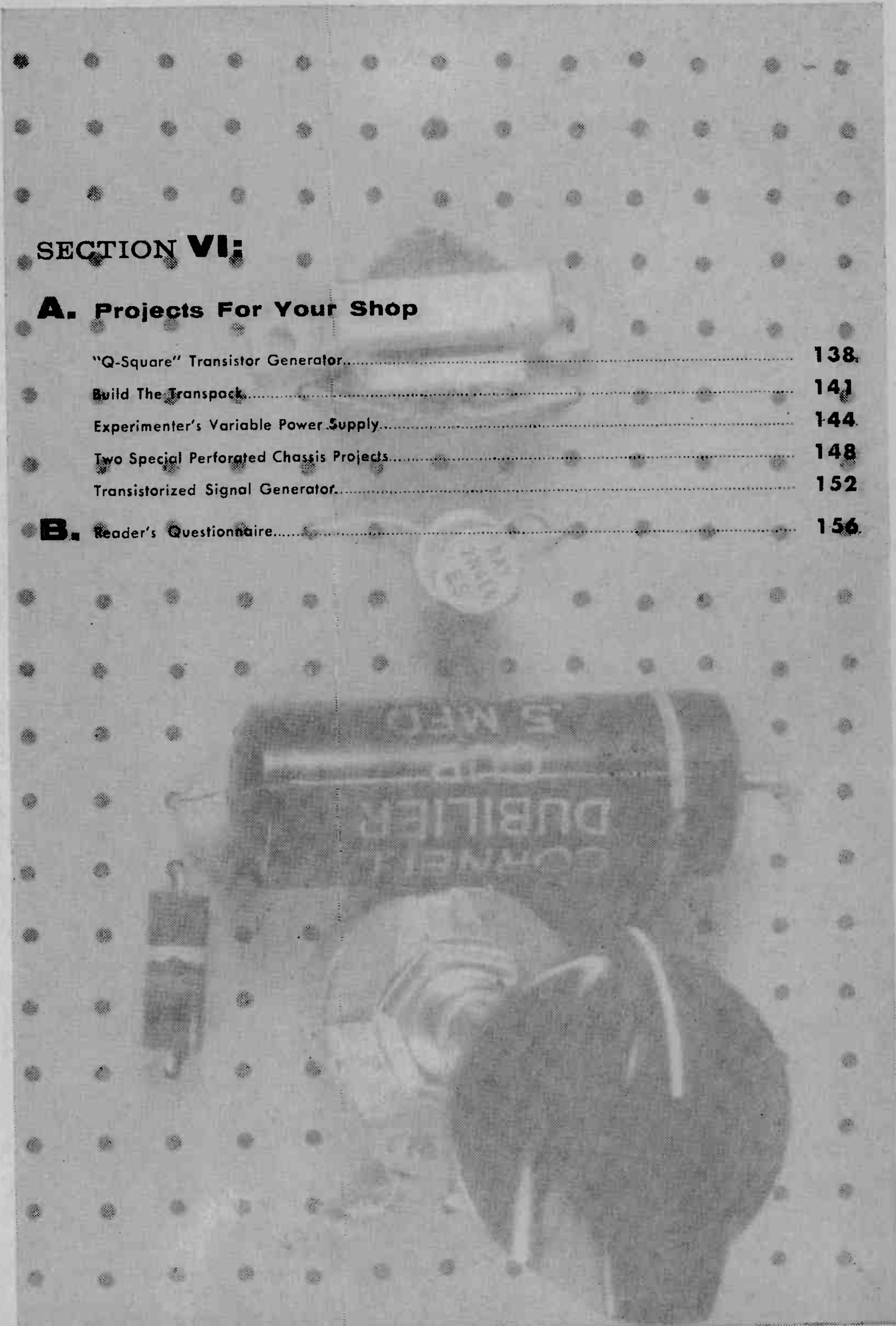
The setting of *R1* does not affect the frequency but varies the height of the output signal peak. It is set for maximum peak height. Resetting is required only when the frequency is changed.



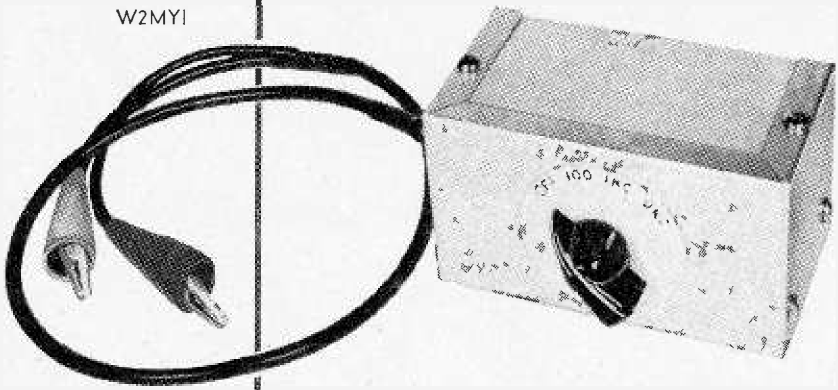
Graph of the output voltage with the signal peaker tuned to 1000 cycles and a varying input frequency. In the schematic of the peaker (above), jack J1—for direct phone connection—is optional.

SECTION **VI:**

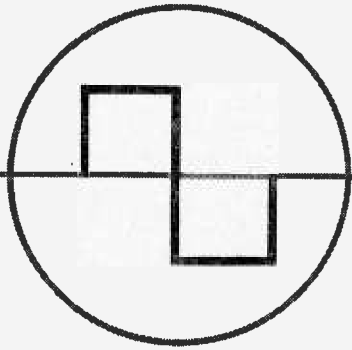
A. Projects For Your Shop



By
M. REVZIN
W2MYI



"Q-Square" Transistor Generator



Check your hi-fi audio amplifier with a multi-square-wave generator

We have all read of the advantages of using square waves to test our hi-fi equipment, only to be scared off by the cost and complexity of the generator. The rise-time requirements are strict, or interpretation of the results is very difficult. However, low-cost transistors are available which make possible a simple unit with rise-times as good as 2.5 *micro*seconds.

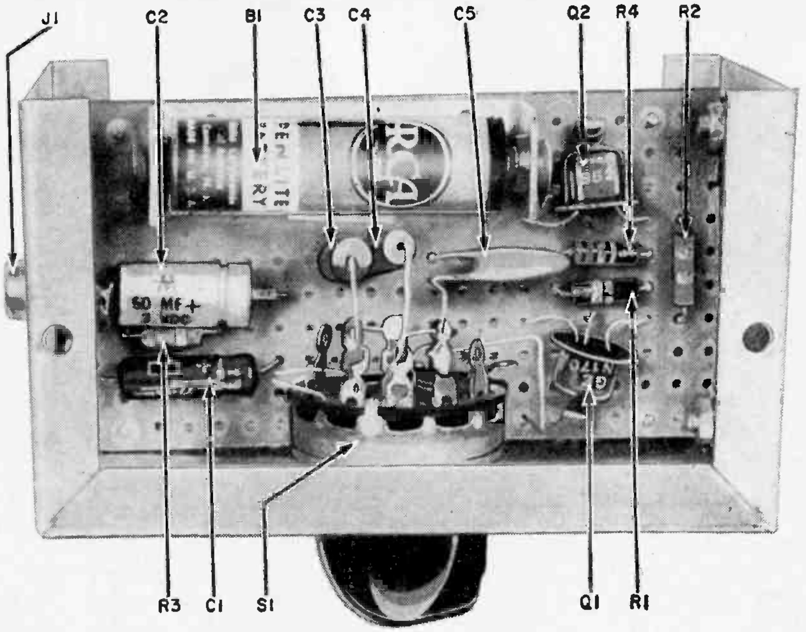
The cost of the complete transistor square-wave generator is less than $10. Single-knob control is used, for selecting 100-cycle, 1-kc. or 10-kc. output, and for turning the generator on automatically. An *Off* position is provided to save the battery when it is not in use, although the operating current is about the same as normal leakage for a penlight battery.

Mounting and Wiring. Components of the "Q-Square" are mounted by their own leads to a perforated Bakelite board. Cut to fit the Bud CU-3003 box, the board is held by four small brackets. Note the neat placement of the parts. Wiring is done by laying the component leads next to each other and soldering.

Be careful to heat-sink the transistors when soldering. And where connecting wires are required, use solid tinned hookup wire with the insulation removed. The result looks like a printed circuit, without its headaches. The battery holder is fastened to the board with #2 sheet-metal screws.

Wire in all components except *R4*. Temporarily connect a 1-megohm potentiometer as a variable resistor in its place. After all wiring has been carefully checked, insert the battery with the positive end toward *Q2*. Plug in the output lead and connect to the vertical input terminals of your oscilloscope. Turn *S1* to the 1-kc. position.

It will take several seconds for *C2* to



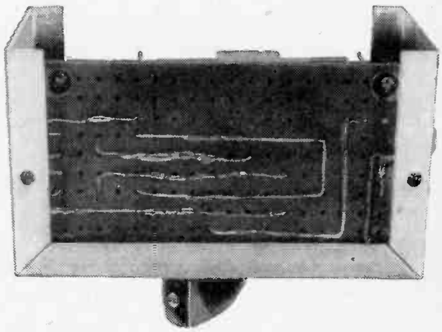
charge and allow the generator to operate. Vary the potentiometer resistance until the square waves are symmetrical. Shut off the generator, disconnect the potentiometer without disturbing its setting, and measure its resistance. Then select a resistor of the same value and wire it in place.

Substitutions. If the generator does not give a stable pattern with any value of *R4*, or a symmetrical pattern cannot be obtained, interchange the transistors. Performance may be improved somewhat by the use of more expensive transistors i.e. 2N168A.

Don't be surprised if the 100-cycle and 10-kc. square waves do not look square on your scope—its response may be much worse than you thought. Remember that a response to at least 100 kc. is necessary to get a square waveform.

It may also be necessary to try several different capacitors for *C3*, to set the operating frequency far enough away from a multiple of the a.c. line frequency. If this is not done, the interaction (in the scope) will cause the pattern to exhibit "crawl" or be difficult to lock.

Using the Generator. Square waves are very rich in harmonics. When they are used for testing, a great deal of information about the frequency response, phase shift and transient response of your amplifier



Phenolic subchassis is prewired, then installed in the cabinet with small brackets.

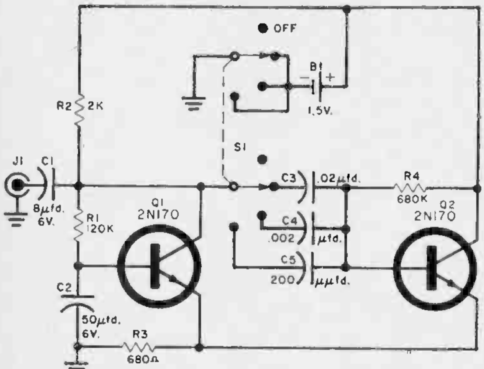
HOW IT WORKS

The circuit consists of a common-base amplifier feeding a common-collector stage through a frequency-determining capacitor (*e.g.*, *C4*). Feedback is provided through the common emitter resistor (*R3*). When power is applied the base bypass capacitor (*C2*). charges through *R1*, applying a reverse bias to *Q1*, turning it *off*, and thus allowing *C4* to charge through *Q2*, turning it *on*. This state continues until *C2* is fully charged. Thereafter, *C2* serves merely as a low-impedance a.c. path to ground.

With the inhibiting effect of *C2* removed, *C4* discharges through the *Q1* collector load resistor (*R2*). *Q1* is kept *off* by the current drawn through *R3* by *Q2*. The voltage applied to the base of *Q2* is reduced, lowering the bias current through *R3*, turning *Q1 on*. The drop in collector voltage through *R2* is transmitted as a pulse to cut *Q2 off*. At this time *C4* begins to charge through the base-emitter path of *Q2*. When its charge is great enough, it will turn *Q2 on*, initiating a new cycle.

can be seen at a glance. The "Q-Square" was designed to operate into at least a 20,000-ohm load, making it suitable for most hi-fi amplifiers.

Connect the output lead to the amplifier input, disconnect the speaker and replace it with a resistor, and connect your scope across the resistor. Be sure that your load resistor is rated to carry the power output of your amplifier. Now turn the amplifier



Frequency-determining capacitors C3, C4 and C5 will provide 100-, 1000-, and 10,000-kc square waves. Other frequencies can be obtained by using other capacitor values.

PARTS LIST

B1—1.5-volt penlight cell
C1—8-μfd., 6-volt electrolytic capacitor
C2—50-μfd., 6-volt electrolytic capacitor
C3—.02-μfd. capacitor (100 cps)
C4—.002-μfd. capacitor (1000 cps)
C5—200-μμfd. capacitor (10,000 cps)
J1—RCA-type phono jack
Q1, Q2—2N170 transistor
R1—120,000 ohms
R2—2000 ohms
R3—680 ohms
All resistors ½-watt composition
R4—680,000 ohms (see text)
S1—3-pole, 4-pos. switch (Mallory 3134J)
1—Chassis box (Bud CU-3003)
1—Battery holder (Acme #5)

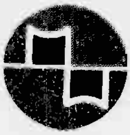
gain control to minimum, set your tone controls for flat response, and turn on the generator.

Bring up the gain control until you see a clear pattern on your scope. Then compare the pattern to those shown here. You can also rotate the tone controls to see just how much cut and boost they allow.

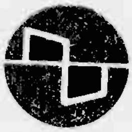
With your speaker connected, the "Q-Square" will enable you to check for speaker "hangover," transient response, and cabinet rattles and resonances.

TEST FREQUENCY = 100 CYCLES

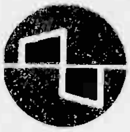
Excessive low-frequency response (bass boost)



Insufficient low-frequency response (bass cut)

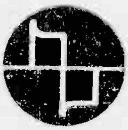


Leading phase shift



Lagging phase shift

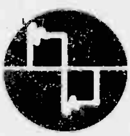
TEST FREQUENCY = 1 KC. or 10 KC.



Peaked high-frequency response (treble boost)

Slight high-frequency loss

Severe high-frequency loss (treble cut)



Damped oscillation (ringing)

Typical square-wave distortions which are encountered in hi-fi amplifier testing.

Build the "Trans-Pack"

Convert battery voltage to 250 volts d. c.

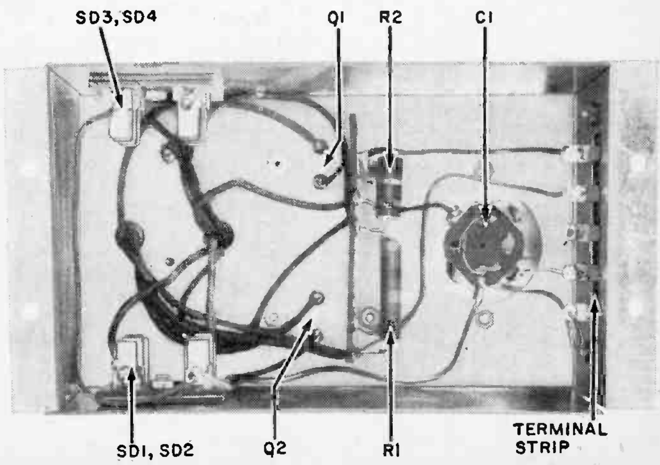
By
DON LEWIS

Here is an easy-to-build two-transistor power supply that will deliver a whopping 250 volts d.c. at 125 ma. from any 12-volt automobile battery. Although this project was specifically designed to provide power for a modulator six-meter station, it can be used wherever high voltage d.c. is required and where there is only a storage battery available.

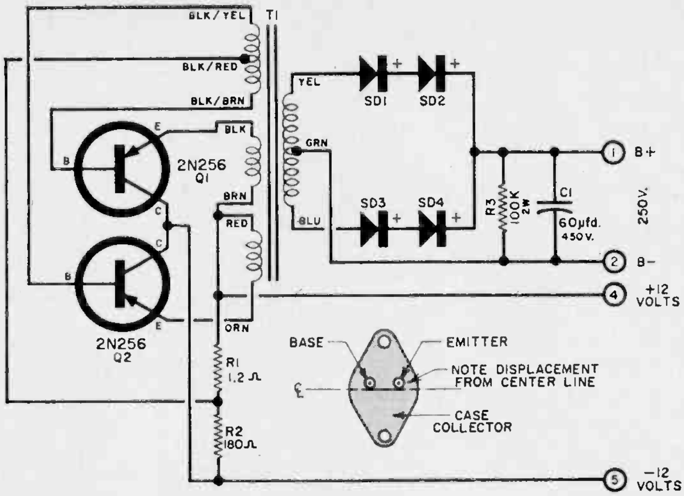
Construction. Components are mounted on a small aluminum chassis measuring 3⅝" x 6¼" x 2". The chassis shown is a cover that was left over from the six-meter station project. An LMB #138 chassis has nearly the same dimensions will serve nicely also.

The power transformer, transistors and filter capacitor are mounted on top of the chassis. The rectifiers (and holders), terminal strip and the two resistors are mounted under the chassis. Keep the distance between the transistor mounting screws to 1⅞"; this allows the terminal strip to be mounted on the same screws that are used to secure the transistors. Anodized (insulated) aluminum washers insulate the transistors and fiber washers insulate the terminal strip from the chassis.

All common ground connections are made to the chassis at the metal filter capacitor



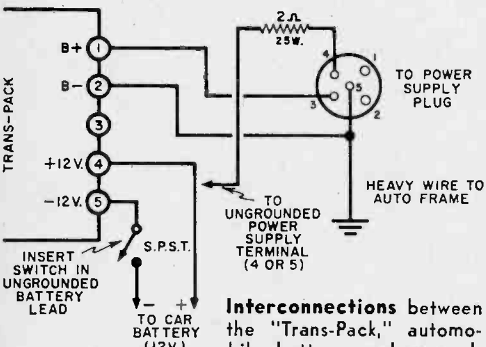
Parts arrangement beneath the chassis is non-critical. Holders for the silicon rectifiers may be fuse clips or special diode clips. Make sure that all components are properly insulated and polarized,



Special circuit of the "Trans-Pack" is made possible by transformer T1 which was developed for transistor oscillator power supply applications.

PARTS LIST

C1—60-μfd., 450-volt can-type electrolytic capacitor (single or multiple section unit wired in parallel)
Q1, Q2—2N256 transistor
R1—1.2-ohm, 2-watt resistor
R2—180-ohm, 4-watt resistor
R3—100,000-ohm, 2-watt resistor
SD1, SD2, SD3, SD4—500-ma. silicon diode rectifier (Sarkes-Tarzian M500 or Audio Devices A750)
T1—275-volt, 125-ma. transistor power transformer (Chicago Transformer Co. DCT-1)
1—Aluminum chassis (LMB #138—see text)
2—Dual silicon rectifier holders
2—Power transistor insulating kits (Lafayette M-20)
1—5-screw terminal strip
1—8-lug terminal strip
Misc. 4/40 nuts, bolts, washers, and 6/32 nuts, bolts and washers



Interconnections between the "Trans-Pack," automobile battery, and a modular six-meter station.

mounting plate. The 5-screw terminal strip is mounted on the *outside* of the chassis lip to minimize the possibility of shorts.

Testing. Before applying power to the "Trans-Pack," make a few ohmmeter checks. The resistance from the 12-volt terminals (either plus or minus) to the chassis should be higher than 100,000 ohms. If it is lower, check the insulation between transistors and chassis. There should be no metallic connection between *Q1-Q2* and the chassis.

Next, check the resistance between B-plus and B-minus. The ohmmeter should jump over to zero and then slowly drift back towards a high resistance reading, stopping at about 100,000 ohms if your wiring is correct.

If everything checks okay, you can apply power to the supply. Warning: do not get the plus and minus 12-volt terminals reversed, or you will "wipe out" the power transistors faster than you can say "ELECTRONIC EXPERIMENTER'S HANDBOOK."

A 20-watt load resistor, about 4000 ohms, should be connected between the plus and minus high-voltage terminals (it can be made up of several different size resistors in series or in parallel). This resistor will have high voltage across it and run very hot, so be careful.

As soon as the 12-volt battery is connected, the supply will "take off" and an audible whistle will be heard. Although the voltage across the load resistor should be between 250 and 275 volts, it may vary widely, depending on the condition of the transistors and the battery.

Using the "Trans-Pack." If your receiver has an accessory socket and requires about 250 volts B-plus, you can use the "Trans-Pack" to provide this power. The power transformer in the receiver must be disconnected from the circuit. The filament supply, if six volts, can be obtained from a 12-volt car battery by using a suitable series dropping resistor.

When the "Trans-Pack" is used to provide power for the modulator six-meter station, a 2-ohm, 25-watt wire-wound resistor will drop the 12 volts of the battery down to 6 volts for the filaments. Just mount this supply in place of the regular a.c. supply. The station's front panel power switch and the line cord are not used but an additional s.p.s.t. toggle switch must be added to turn the 12-volt supply on and off.

If you are careful not to reverse the 12-volt connections, the "Trans-Pack" will run forever. It is impossible to overload. If you attempt to make it work too hard, it will quit operating without damaging any of the components. If you short the output, the supply will not "take off."

HOW IT WORKS

The two transistors of the "Trans-Pack" are hooked up as a free-running multivibrator. One transistor starts the oscillation by drawing somewhat more collector current than its mate (due to the inevitable differences between transistors, and as the collector current flows through transformer *T1*, a current is induced in the base winding. This winding has been so connected that the current is in the right direction to bias the conducting transistor base more negatively, and more collector current flows. The conducting transistor continues to conduct as long as the rising collector current is matched by a rising base current.

Eventually, the transformer core material saturates and its field commences to collapse. When this happens, the current in the base winding suddenly reverses, the conducting transistor is switched *off*, and the one that is not conducting is switched *on*. This results in a square-wave voltage being induced in the secondary. The secondary winding of *T1* steps up the induced voltage, and a bridge-type rectifier circuit changes the a.c. output to about 250 volts d.c.

The 2N256 transistors were used in the "Trans-Pack" because of their low cost. However, you can obtain more output voltage and slightly higher efficiency with more expensive transistors. The 2N301, for example, works well and is directly interchangeable with the 2N256.

TEST PROD SAFETY DEVICE

When you are measuring voltages around crowded tube sockets and the like, cut about a half inch of 1/8" "spaghetti" and slip it over the end of the test prod. This will reduce the possibility of touching nearly exposed leads. The spaghetti can be slipped off for less cluttered circuits. —*Arthur Fregeau, Bristol, Conn.*

Experimenter's Variable Power Supply

Special circuit provides 0-500 volts of filtered regulated d. c.

By

CHARLES H. WELCH

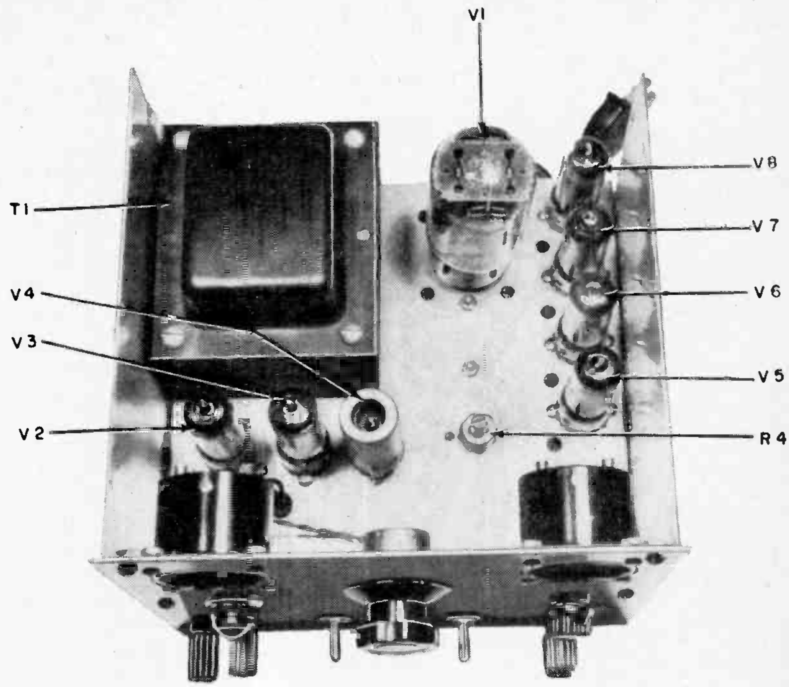
If you "breadboard" much electronic equipment, you know that it is sometimes a tedious chore. When you start "stealing" B-plus and filament voltages from other instruments, the usual result is a string of voltage-dropping resistors crawling over your workbench. And, not infrequently, the aroma of charred resistors hangs heavily on the air. If you want to eliminate these headaches once and for all, try investing a little time and cash in this variable power supply.

Utilizing a standard series-type regulation circuit, the variable power supply will provide from zero to 500 volts d.c. at currents ranging up to 100 milliamperes. And the regulation is so good that at a no-load output of 300 volts, the sudden application of 3000 ohms (representing a 100-ma. load) to the output terminals will not even produce a visible twitch of the voltage meter. The filtering, too, is excellent, with the a.c. ripple content held to a small fraction of 1%.

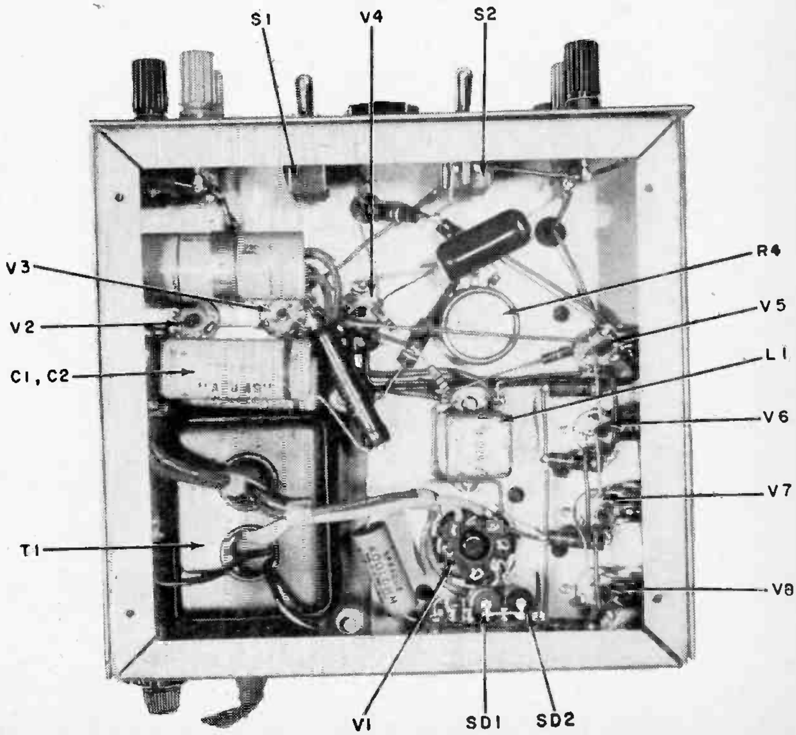
The power supply is built on a 7" x 7" x 2" aluminum chassis with front panels and sides made of sheet aluminum and top and bottom covers of perforated aluminum. All the sheet metal parts can be fabricated in the home shop without any special tools, or chassis boxes may be used. The bottom cover is simply a square of this material which is held in place by the screws which mount the rubber feet.

Heat Dissipation. Since parts layout is not critical, the photographs provide sufficient information for duplication of the author's unit. The same physical layout need not be followed if the very important considerations of heat dissipation and ventilation are kept in mind.

Heat is a special problem since the series-regulator tubes, which act as a sort of variable resistor, grow quite hot when low-



Parts arrangement shown in the top and bottom chassis layouts is recommended for best heat dissipation of the variable power supply.

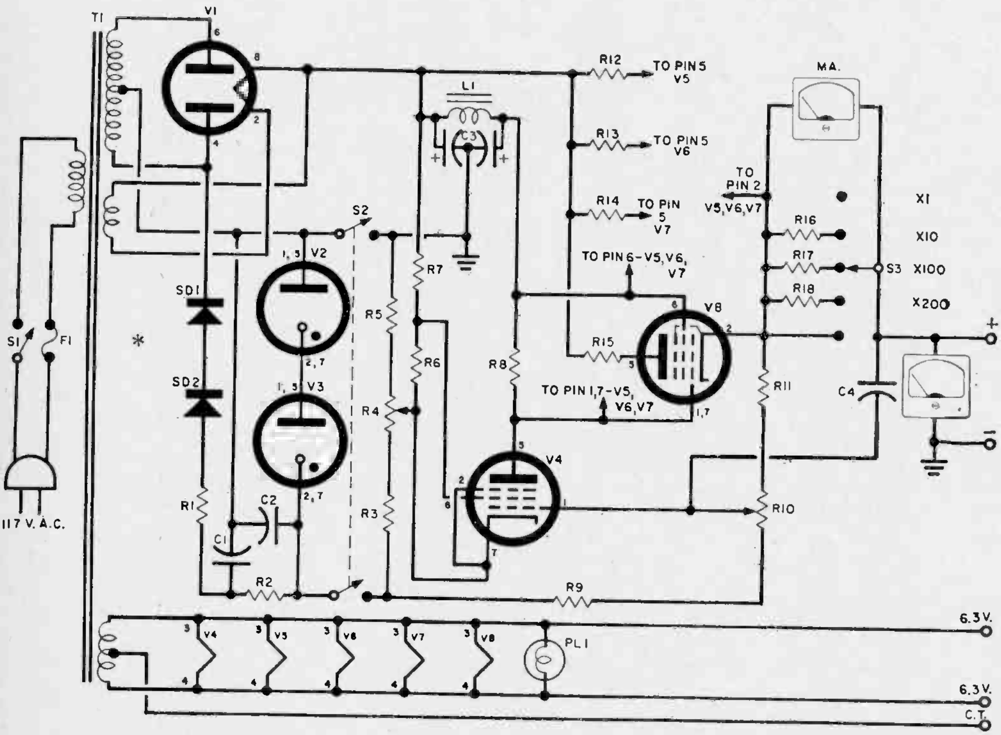


PARTS LIST

C1, C2—12-µfd., 450-volt electrolytic capacitor
C3—8-µfd., 600-volt dual unit or separate electrolytic capacitors
C4—0.1-µfd., 500-volt capacitor
F1—3AG fuse holder with 2-amp. fuse
L1—10-henry, 25-ma. choke
PL1—6.3-volt pilot light assembly
R1—600-ohm, 5-watt wire-wound resistor
R2—10,000-ohm, 10-watt wire-wound resistor
R3—12-000-ohm, 1-watt carbon resistor
R4—5000-ohm, 2-watt wire-wound potentiometer (slotted shaft)
R5—39,000-ohm, 1-watt resistor
R6—560,000-ohm, ½-watt resistor
R7—1-megohm, ½-watt carbon resistor
R8—10.0 megohm, ½-watt carbon resistor
R9—220,000-ohm, 1-watt resistor
R10—500,000-ohm potentiometer (linear taper)
R11—2.2-megohm, 1-watt resistor
R12, R13, R14, R15—22-ohm, 1-watt carbon resistor
R16—22.5-ohm meter shunt (x 10)—see text
R17—2.25-ohm meter shunt (x 100)—see text
R18—1.1-ohm meter shunt (x 200)—see text
S1—S.p.s.t. toggle switch
S2—D.p.s.t. toggle switch
S3—1-pole, 5-pos. rotary switch (shorting type)
SD1, SD2—Silicon rectifier (Sarkes-Tarzian K200)
T1—Power transformer, secondary 750 volts center-tapped @ 150 ma.; 5 volts @ 3 amp.; 6.3 volts @ 5 amp.
V1—5U4GA tube (rectifier)
V2, V3—0A2 tube (gas regulator)
V4—6AU6 tube (control amplifier)
V5, V6, V7, V8—6AQ5 tube (series regulator)
1—0-1 ma. d.c. meter (1½")
1—0-500 volt d.c. voltmeter (1½")
5—Five-way binding posts, three red, two black
1—7" x 7" x 2" aluminum chassis

voltage, high-current output requirements are met. For this reason the series-regulator tubes and the rectifier tube have been located near the back of the chassis and adequate holes provided for convection air circulation. In addition, the electrolytic capacitors and the silicon bias rectifiers have been located below the chassis since they are quite sensitive to heat.

Optional Meter. The metering circuits, which measure the output voltage and current of the power supply, are strictly op-



Regulator tubes V5, V6, and V7 have been omitted from schematic for clarity. Voltmeter is across output leads. * SD1 and SD2 are shown in reverse polarity. Mount opposite way.

tional and may be omitted entirely in the interests of simplicity or economy.

If you use the meters, wire the voltmeter permanently across the output terminals of the power supply. The current meter, which is basically a 0-1 milliammeter, is provided with shunts which may be switched in for full-scale readings of 10, 100, and 200 ma., plus an *Off* position in which the meter is shorted out entirely.

The shunt resistors can be selected from stock carbon resistors if an accurate means of resistance measurement is available, or they could be wound of resistance wire. Since the exact ohms-per-foot value of resistance wire is always specified, very accurate resistances can be determined by careful measurement of the length of the wire.

Output Filtering. The circuit may appear to be lacking in proper output filtering when you are used to thinking in terms of the brute force filtering usually employed in power supplies. Actually, it is adequate for any normal use, and is based on the fact that series regulator tubes are able to respond quickly enough to variations in output voltage to regulate ripple right out of the output.

HOW IT WORKS

The secret of the circuit's ability to control the output voltage of the power supply lies in the bank of series-regulator tubes: *V5, V6, V7* and *V8*. These tubes are connected in series with the load and act like variable resistors since the amount of current which may flow through them is controlled by the bias voltage applied to the control grids.

Grid bias for the series-regulator tubes is developed by the *IR* drop across the plate load resistor (*R8*) of the control amplifier tube (*V4*), and will vary according to the current flow through *V4*. Since the bias voltage on the control grid of *V4* is taken from the slider of *output* potentiometer *R10*, the position of that slider will decide the current flow through the control tube, the bias on the series regulators and, finally, the output voltage of the power supply.

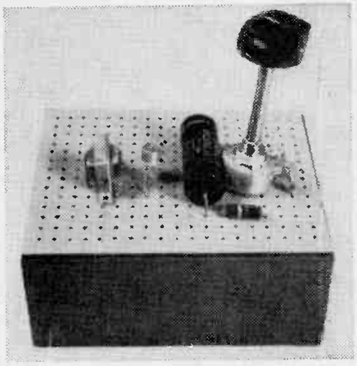
Since *R10* is part of a voltage divider, the upper end of which is connected to the output voltage, any variation in output voltage because of load changes will be reflected in a proportional voltage shift at the control grid of *V4*, causing an instantaneous corrective action in the series-regulator tubes.

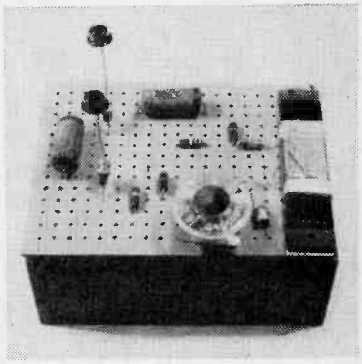
Zero Adjustment. Slotted-shaft potentiometer *R4* is the zero adjustment control. To set this control, turn the power supply on with switch *S1* and allow the filaments to warm up thoroughly. Then switch *high-voltage* switch *S2* on and turn the output control *(R10)* to the full counterclockwise position.

Check the voltage at the power supply output terminals with a test meter. It will probably be a few volts positive or negative, and *R4* should be adjusted carefully until the output is exactly zero as read on a low-voltage scale of the power supply test meter.

Lock *R4* in that position. The full travel of *R10* should then swing the output voltage from zero to approximately 500 volts with no load.

TWO PERFORATED CHASSIS PROJECTS





Most of the projects in the EXPERIMENTER'S HANDBOOK are for skilled and semi-skilled experimenters. If you are new to electronics, a neophyte, these two perforated chassis projects are for you.

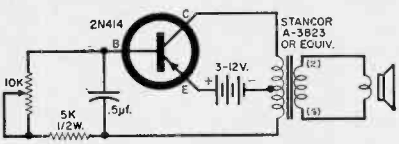
We named Project I the "Monophonic, Omnitonal, Universal Oscillator"—a big name to compensate for its simplicity! It can be used to practice code by inserting a key in series with the battery, or you can use it as a signal generator. Various output transformers are suggested in the parts list for output flexibility. Symbols (2) and (5) in the schematic are output leads from the transformer and should feed a 3 ohm speaker.

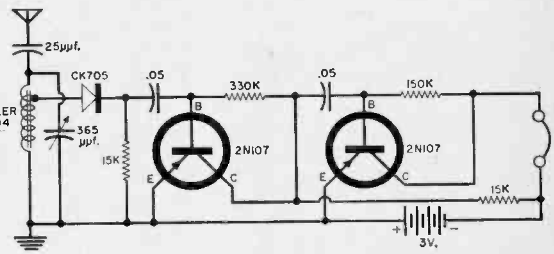
Project II, "Two-Transistor Special Radio" is straightforward, yet it allows many substitutions of components. Almost any coil should work, as well as any PNP transistor. The output is good and tone is clear.

Make sure you have correctly connected the batteries as shown!

Instructions:

1. Cut out and place template A on perforated board and refer to dot (lower right corner) for orientation of parts.
2. Template B can now be placed on underside of board with dot at upper right corner. Connect wires per black line. For substitutions, refer to template A only.
3. Attach battery, phones, etc. (watch polarity!)
4. Check transistor theory discussed throughout pages 14-29.





Monophonic Omni-tonal Universal Oscillator

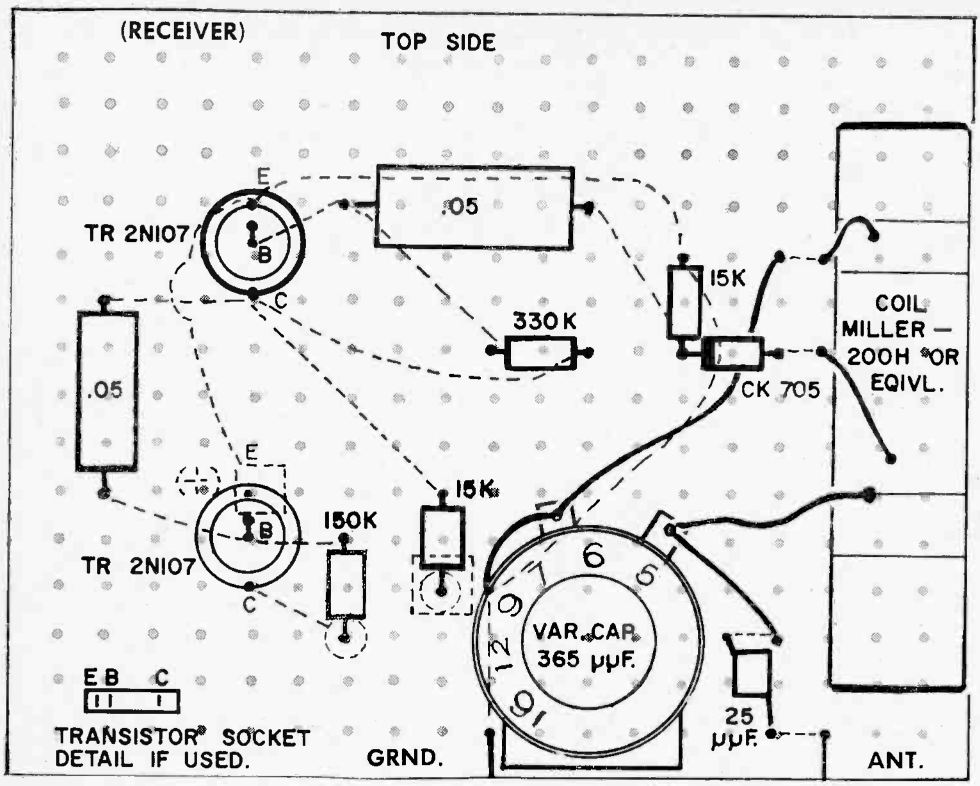
parts list

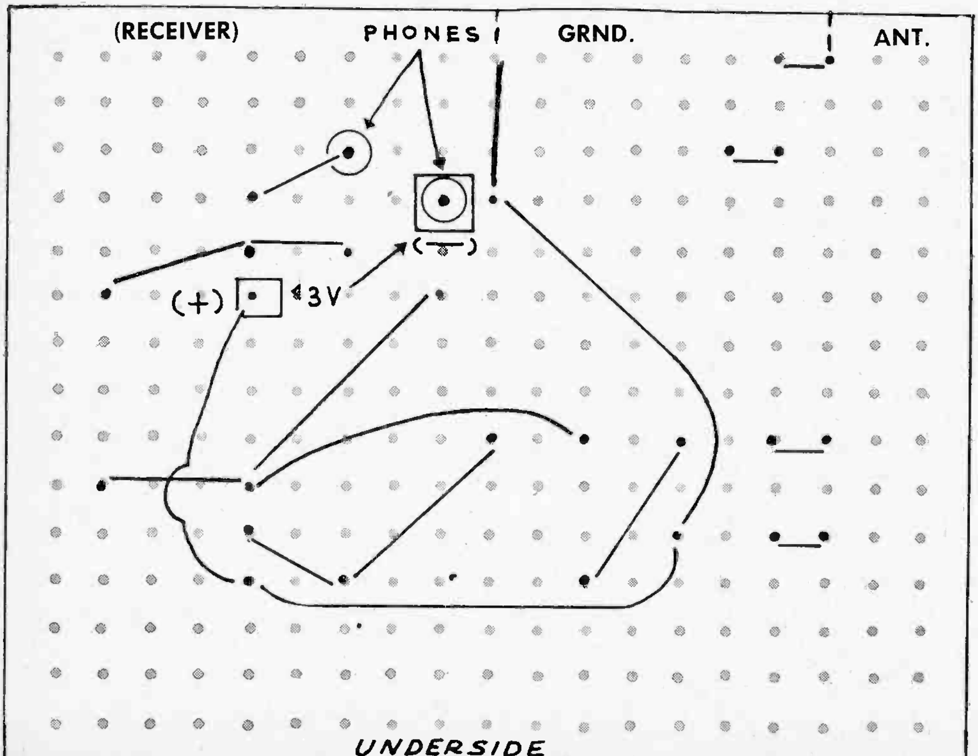
1—10K pot.
1—5K-ohm 2½w Resistor
1—Universal output transformer (Stancor A3823 for speaker or argonne AR109 phones)
1—.5 mfd. capacitor (any voltage)
1—2N414 Transistor (Raytheon)
1—"Experimenter's custom-perforated chassis"
1—Battery 3 to 12 volts

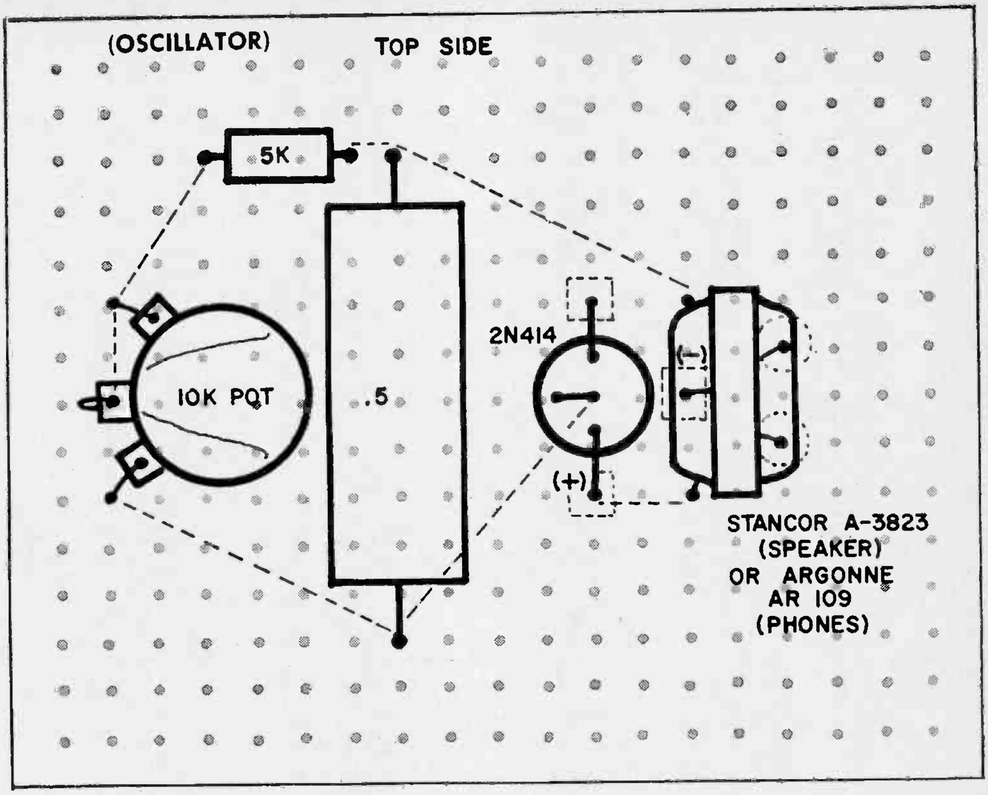
Two Transistor Special Radio

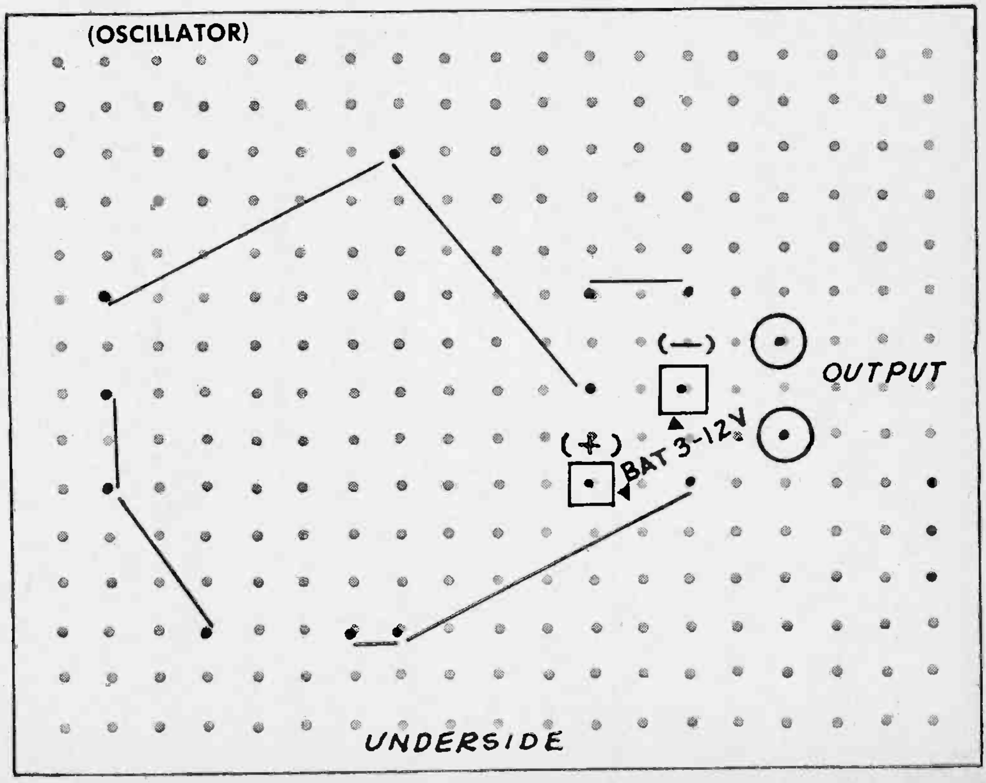
parts list

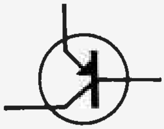
2—.05 mfd capacitors (any voltage)
2—15,000-ohm ½ watt resistors
1—150,000-ohm ½ watt resistor
1—33,000-ohm ½ watt resistor
1—Miller #2004 Ant. coil or equiv.
1—365 mmf. Var. condenser (Lafayette MS445 or equiv.)
1—25 mmf. capacitor
2—2N107 transistors
1—CK705 diode or equiv.
1—"Experimenter's Custom Perforated Chassis"
1—3V battery
1—Phone

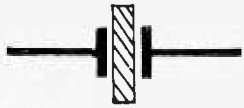

(RECEIVER)
TOP SIDE
E
TR 2N107
B
C
.05
15K
330 K
COIL
MILLER —
200H *OR
EQIVL.
CK 705
.05
E
15K
150K
B
TR 2N107
C
6
7
5
9
12
16
VAR. CAP.
365 μμF.
E B C
TRANSISTOR* SOCKET
DETAIL IF USED.
GRND.
25
μμF.
ANT.


(RECEIVER)
PHONES
GRND.
ANT.
(+)
3V
(–)
UNDERSIDE

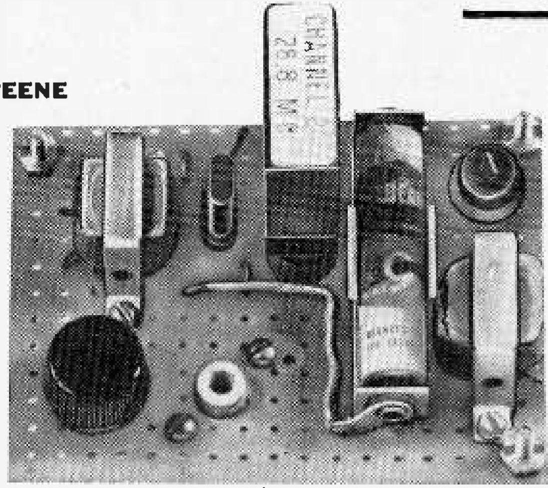

(OSCILLATOR)
TOP SIDE
5K
10K POT
.5
2N414
(−)
(+)
STANCOR A-3823
(SPEAKER)
OR ARGONNE
AR 109
(PHONES)

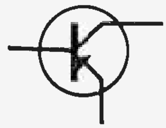

(OSCILLATOR)
(−)
OUTPUT
(+)
BAT 3-12V
UNDERSIDE





By ERROL GREENE





Transistor Signal Generator

Crystal control, a familiar feature of transmitters, can be put to work in other areas where stability and accuracy are needed. Crystal control of an r.f. signal generator, for example, is invaluable when calibrating and/or aligning receivers.

An extremely simple generator can be built that uses only two transistors and yet supplies an on-the-button r.f. signal with or without modulation. Depending on the crystal used, fundamental outputs from 370 kc. to over 3.6 mc. are possible.

Crystals which will put out a signal in the broadcast receiver range are available from a large number of manufacturers at low cost, often less than $1.00. They are identified in two ways: by a channel number and by a frequency (in mc.).

To find the *actual* fundamental frequency, proceed as follows. If the channel has one or two digits, divide the number of mc. by 54. If there are three digits, divide number of mc. by 72 to find the fundamental.

Construction. The specific manner of construction and packaging of the generator can be left to the builder's discretion. The author's model was built on a perforated phenolic board and left uncased. If you run into radiation problems, you can box the unit in an aluminum or steel cabinet.

To start the generator, simply slide a

On-the-button r.f. test signals are guaranteed by fixed frequency crystals

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	0Z4M	.79		4AU6	.54		6AL5	.47		6BZ7	.97
	1AX2	.62		4BA6	.51		6AM8	.78		6C4	.43
	1B3GT	.79		4BC5	.56		6AN4	.95		6BC6	.54
	1DN5	.55		4BC8	.96		6AN8	.85		6CD6	1.42
	1G3	.73		4BE6	.54		6AQ5	.50		6CF6	.64
	1J3	.73		4BN6	.75		6AR5	.55		6CG7	.60
	1K3	.73		4BQ7	.96		6AS5	.60		6CG8	.77
	1L6	1.05		4BS8	.98		6AT6	.43		6CM7	.66
	1LA6	.69		4BU8	.71		6AT8	.79		6CN7	.65
	1LC6	.79		4BZ6	.58		6AU4	.82		6CR6	.51
	1LN5	.59		4BZ7	.96		6AU6	.50		6CS6	.57
	1R5	.62		4CB6	.59		6AU7	.61		6CU5	.58
	1S5	.51		4CS6	.61		6AU8	.87		6CU6	1.08
	1T4	.58		4DE6	.62		6AV6	.40		6CY5	.70
	1U4	.57		4DK6	.60		6AW8	.89		6CY7	.71
	1U5	.50		4DT6	.55		6AX4	.65		6DA4	.68
	1X2B	.82		5AM8	.79		6AX7	.64		6DB5	.69
	2AF4	.96		5AN8	.86		6BA6	.49		6DE6	.58
	2BN4	.60		5AQ5	.52		6BC5	.54		6DG6	.59
	2CY5	.71		5AT8	.80		6BC7	.94		6DQ6	1.10
	3AL5	.42		5BK7A	.82		6BC8	.97		6DT5	.76
	3AU6	.51		5BQ7	.97		6BD6	.51		6DT6	.53
	3AV6	.41		5BR8	.79		6BE6	.55		6EU8	.79
	3BA6	.51		5CG8	.76		6BF6	.44		6EA8	.79
	3BC5	.54		5CL8	.76		6BG6	1.66		6EB8	94
	3BE6	.52		5EA8	.80		6BH6	.65		6H6GT	.58
	3BN4	.63		5EU8	.80		6BH8	.87		6J5GT	.51
	3BN6	.76		5J6	.68		6BJ6	.62		6J6	.67
	3BU8	.78		5T8	.81		6BK5	.80		6K6	.79
	3BY6	.55		5U4	.60		6BK7	.85		6S4	.48
	3BZ6	.55		5U8	.81		6BL7	1.00		6SA7GT	.76
	3CB6	.54		5V6	.56		6BN4	.57		6SK7GT	.74
	3CF6	60		5X8	.78		6BN6	.74		6SL7	.80
	3CS6	.52		5Y3	.46		6BQ5	.65		6SN7	.65
	3CY5	.71		6AB4	.46		6BQ6GT	1.05		6SQ7	.73
	3DE6	.62		6AC7	.96		6BQ7	.95		6T4	.99
	3DK6	.60		6AF3	.73		6BR8	.78		6T8	.80
	3DT6	.50		6AF4	.97		6BS8	.90		6U8	.78
	3Q5	.80		6AG5	.65		6BU8	.70		6V6GT	.54
	3S4	.61		6AH6	.99		6BY6	.54		6W4	.57
	3V4	.58		6AK5	.95		6BZ6	.54		6W6	.69

Qty.	Type	Price	Qty.	Type	Price	Qty.	Type	Price	Qty.	Type	Price
	6X4	.39		12AT6	.43		12DB5	.69		17DQ6	1.06
	6X5GT	.53		12AT7	.76		12DE8	.75		17L6	.58
	6X8	.77		12AU6	.50		12DL8	.85		17W6	.70
	7AU7	.61		12AU7	.60		12DM7	.67		19AU4	.83
	7A8	.68		12AV5	.97		12DQ6	1.04		19BG6	1.39
	7B6	.69		12AV6	.41		12DS7	.79		19T8	.80
	7Y4	.69		12AV7	.75		12DZ6	.56		21EX6	1.49
	8AU8	.83		12AX4	.67		12EL6	.50		25AU4	.87
	8AW8	.93		12AX7	.63		12EG6	.54		25BQ6	1.11
	8BQ5	.60		12AZ7	.86		12EK6	.56		25C5	.53
	8CG7	.62		12B4	.63		12EZ6	.53		25CA5	.59
	8CM7	.68		12BA6	.50		12F5	.66		25CD6	1.44
	8CN7	.97		12BD6	.50		12F8	.66		25CU6	1.11
	8CX8	.93		12BE6	.53		12FM6	.45		25DN6	1.42
	8EB8	.94		12BF6	.44		12K5	.65		25EH5	.55
	10DA7	.71		12BH7	.73		12SA7M	.86		25L6	.57
	11CY7	.75		12BK5	.70		12SK7GT	.74		25W4	.68
	12A4	.60		12BL6	.56		12SN7	.67		25Z6	.66
	12AB5	.55		12BQ6	1.06		12SQ7M	.73		35C5	.51
	12AC6	.49		12BY7	.74		12U7	.62		35L6	.57
	12AD6	.57		12BZ7	.75		12V6GT	.53		35W4	.52
	12AE6	.43		12C5	.56		12W6	.69		35Z5GT	.60
	12AF3	.73		12CA5	.59		12X4	.38		50B5	.60
	12AF6	.49		12CN5	.56		17AX4	.67		50C5	.53
	12AJ6	.46		12CR6	.54		17BQ6	1.09		50DC4	.37
	12AL5	.45		12CU5	.58		17C5	.58		50EH5	.55
	12AL8	.95		12CU6	1.06		17CA5	.62		50L6	.61
	12AQ5	.52		12CX6	.54		17D4	.69		117Z3	.61

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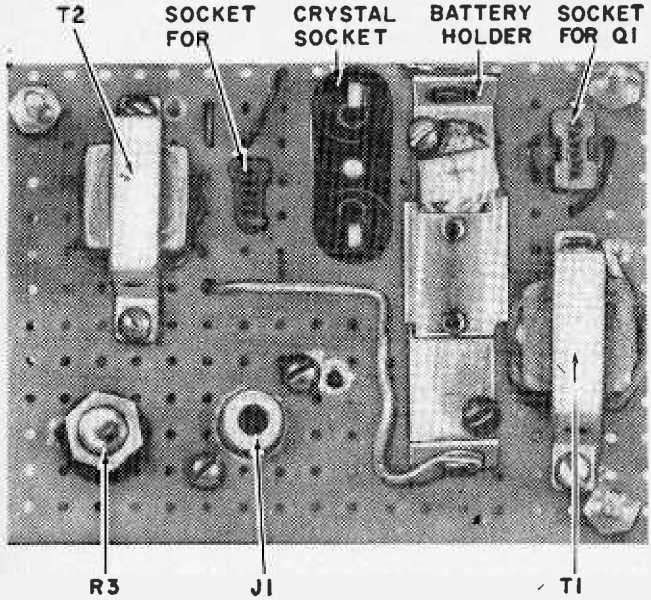


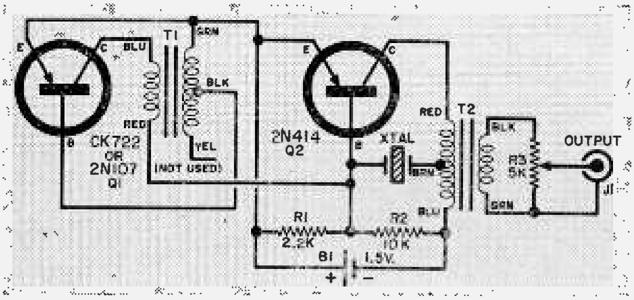
HOW IT WORKS

An Argonne AR-118 transformer (*T2*) is hooked up to provide the necessary feedback for oscillation and its low secondary impedance serves to isolate the output load from the generator.

The audio oscillator is powered by the low voltage across *R1*. The audio signal, which is about 4000 cps, is at a high enough level both to modulate the r.f. and to be used in audio testing, code practice, etc.

Either a CK722 or 2N107 will serve as the audio oscillator. The CK722 produces less output but its waveform is more nearly sinusoidal. Although the 2N107's output is higher, its waveform is rather peaked.

Note that the r.f. part of the generator consists of *Q2*, *T2*, two resistors and the crystal. The output control (*R3*) is optional.



PARTS LIST

B1—1.5-volt battery
J1—Phono jack
Q1—CK722 or 2N107 transistor
Q2—2N112 or 2N414 transistor
R1—2200-ohm resistor
R2—10,000-ohm resistor
R3—5000-ohm potentiometer
T1—Transformer; 10,000-ohm primary, 2000-ohm secondary (CT) (Argonne AR-109 or equivalent)
T2—Transformer; 500-ohm primary (CT), 16-ohm secondary (Argonne AR-118 or equivalent)
1—Crystal (see text)
1—Perforated phenolic circuit board
1—Crystal socket
2—Transistor sockets

penlight cell into the battery holder and plug in the crystal. Normally the output signal will be audible in a nearby receiver tuned to it without direct coupling to the antenna.

For maximum signal, connect the generator directly to the antenna post of the receiver, and then adjust the output control to the lowest level required. The maximum voltage is approximately 0.3 volt. To obtain an unmodulated r.f. signal, remove transistor *Q1*.

If you use a crystal in the i.f. range, you will hear its second or third harmonic on the broadcast band. For example, if you use a 40-kc. crystal, you will hear the signal at 800 kc., 1.2 mc., 1.6 mc., etc.

Crystal Selection. For calibrating broadcast and short-wave receivers, certain crystals are especially useful. Among those which have convenient harmonic frequencies are: 400 kc. (the crystal is marked 28.8 mc., channel 288); 375 kc. (marked 20.3 mc., channel 3) and 416 kc. (marked 30 mc., channel 300).

Another useful crystal is the one marked 21.0 mc., channel 10, which puts out a ninth harmonic at 3.5 mc. Thus it marks the beginning of the 80-meter band as well as higher bands (40, 20, etc.).

Crystals of up to 3.6 mc. will oscillate in this circuit without adjustment, which makes them useful for putting "pips" in the ham bands. To use the generator as an audio voltage source, remove the crystal. This will increase the audio output to a level usable for code practice or signal tracking by injection.

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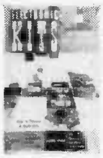

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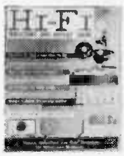

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Dear Reader:

We hope you are enjoying your 1960 ELECTRONIC EXPERIMENTER'S HANDBOOK. It represents a lot of work by a faithful staff. However, you the reader, are the only one who possibly can make the book better. Of course, we can't please everyone, but if we know what our readers want as a group, we will do our level best to please you.

To make it easy for both of us, I'm going to ask you to fill out the four pages that follow completely, and return them by April 15, 1960. As a token of my appreciation, I will send you your choice of any one of the Ziff-Davis Electronic Annuals shown on the opposite page.

Please accept my personal thanks along with those of the rest of the staff.

Sincerely,

Jack Allison

John K. Allison
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JKA:brh

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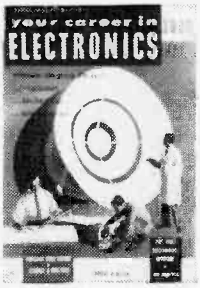
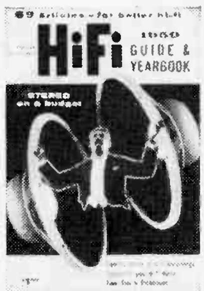
☐ 

☐ 

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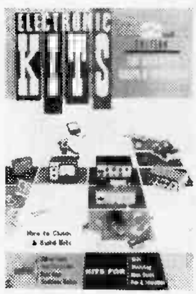

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To the Editors: Electronic Experimenter's Handbook
Ziff-Davis Publishing Company
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ELECTRONIC EXPERIMENTER'S HANDBOOK

Reader's Report to the Editors

ABOUT THIS ANNUAL:

1. Where did you obtain it? Newsstand ☐ Parts supplier ☐ From a friend ☐
   Office or business copy ☐ Other (Specify)________________

2. Which electronic magazines do you read regularly? (list)________________
   ____

3. Which of these do you have a personal subscription to? (list)________________
   ____

4. Have you ever read **ELECTRONIC EXPERIMENTER'S HANDBOOK** before? No ☐ Yes ☐
   Which year(s) 1957 ☐ 1958 ☐ 1959 ☐

5. Have you ever read any of the other Ziff-Davis Annuals (See page 157)? Which ones? (List)
   ____

ABOUT YOUR HOBBIES:

6. Do you have a home workshop? yes ☐ no ☐ (If "no", do you use a friend's ☐ company shop ☐ local YMCA or school shop ☐ other (Specify) ________________

7. If "yes", where is your home workshop? Basement ☐ garage ☐ spare room ☐
   Other (Specify) ________________________________

8. How large an area does it occupy? Length ______ ft. Width ______ ft.

9. Do you share your workshop with any other hobbies?

photography ☐	woodcraft ☐
jewelry ☐	metal work ☐
leather ☐	boats and marine ☐

   other (Specify) ________________________________

10. Would you tell us which of the following pieces of shop equipment you now own or are planning to buy in the next few months:

Soldering pencil	now own ☐	plan to buy ☐
Soldering iron	now own ☐	plan to buy ☐
Soldering gun	now own ☐	plan to buy ☐
Wire strippers	now own ☐	plan to buy ☐

Long nose pliers	now own ☐	plan to buy ☐
Side cutters	now own ☐	plan to buy ☐
Circular saw	now own ☐	plan to buy ☐
Lathe	now own ☐	plan to buy ☐
Drill press	now own ☐	plan to buy ☐
Sander	now own ☐	plan to buy ☐
Router	now own ☐	plan to buy ☐
Hand drill	now own ☐	plan to buy ☐
Band saw	now own ☐	plan to buy ☐

Other shop equipment (Specify) ______________________________

____

TEST EQUIPMENT

VTVM	now own ☐	plan to buy ☐
Oscilloscope	now own ☐	plan to buy ☐
VOM	now own ☐	plan to buy ☐
Signal Generator	now own ☐	plan to buy ☐
Tube Tester	now own ☐	plan to buy ☐

Other (Specify) ______________________________

11. What is your favorite type of construction article?

things for the home ☐ educational projects ☐
novelty items ☐ ham radio ☐
shop items ☐ hi-fi items ☐
marine items ☐ safety items ☐

12. About how much would you say you spent on electronic hobbies in the last 12 months?

$______________

13. How much for the rest of your hobbies in the last 12 months? $______________

14. In order that we may best suit your needs, please indicate your subject preferences by placing numbers 1 through 6 on the appropriate lines. "1" will be your favorite, "6" your last choice:

hi-fi_____ amateur radio_____
electronic theory_____ experimental_____
citizens band radio_____ construction_____

15. Please check your favorite construction component:

tubes ☐ crystal diodes ☐ transistors ☐

16. I prefer simple ☐ complex ☐ circuits.

17. I enjoy ☐ do not enjoy ☐ electronic game projects.

18. I would like to see more: construction ☐ editorial and news ☐ articles.

19. Please list the projects that you have constructed from all **ELECTRONIC EXPERIMENTER'S HANDBOOKS** in the last year ______________________

____

20. Please list those you intend to build in the next year or so ______________________

____

21. Are there any articles you would particularly like to see in the next Annual? ______________________

____

22. About how long will you keep the Annual? ______________________

23. Any idea on how often you will use it? every day ☐ more than once a week ☐ once a week ☐ less than once a week ☐ but more than once a month ☐ once a month or less ☐

24. What do you like BEST about this Annual? ______________________

____

25. What do you like the LEAST about this Annual? ______________________

____

ABOUT YOURSELF:

Educational background: (please check)

	have attended or taken course	am now attending or taking course	plan to attend or take course
high school	☐	☐	☐
trade school	☐	☐	☐
correspondence school	☐	☐	☐
college — engineering	☐	☐	☐
college — other	☐	☐	☐
military electronics course	☐	☐	☐

other (please specify) ______________________

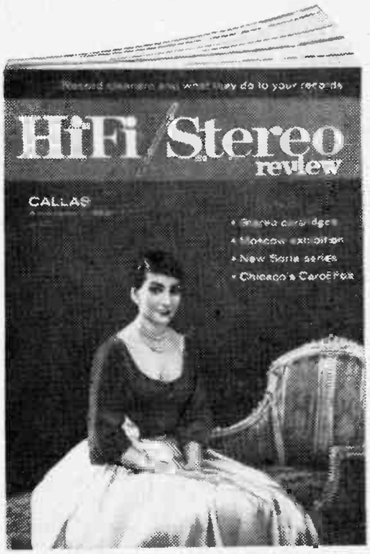
What is your job or occupation? ______________________

What is your title or position? ______________________

Would you please check your approximate total family income bracket? (This is STRICTLY confidential)

☐ less than $3000
☐ $3000 - $4999
☐ $5000 - $7499
☐ $7500 - $9999
☐ $10000 - $14999
☐ $15000 - $19999
☐ $20000 - $24999
☐ $25000 and over

Do you own ☐ or rent ☐ your home? ______________________



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Electronic Experimenter's Handbook 1960 INDEX