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Here's welcome news for the serious user of Citizen's Band two-way radio. Heath's new Selective-Call Kit with tone squelch makes it possible for you to enjoy the calm of a CB station that is completely silent, yet ever alert for a personal call... makes it possible for you to call your choice of four specific units in your system at the touch of a button.

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HEATH COMPANY
Benton Harbor 39, Michigan

September, 1962
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• **All Quiet**

  All the Citizens Band activities you hear about are on the 27-megacycle frequency. What’s happening on that other Citizens Band, up at 462 mc?

  Herb Morris
  Miami, Fla.

  *Nothing.*

• **Hint**

  Your all-CB issue (May ’62 EI) was great and a big help to CBers. You also had an all-SWL issue. Now it’s only fair that you have all-ham and all-hi-fi issues with articles, projects, etc.

  I have one comment. You didn’t tell which CB channels are unofficially set aside for various uses... marine, travel, CD and others. The list would have been helpful.

  Devoted Reader

  Thanks for the compliments, Devoted. We did not list those unofficial channel designations because there are no national patterns. They vary widely from community to community, and rightly so. The FCC has told us it believes such channel reservations should be strictly local in scope in order to make the CB service as useful as possible to as many as possible. Channel assignments on a grand scale would have the effect of limiting the number of channels for general business and personal communications. We must agree. By common practice and agreement, however, some assignments are widely accepted.

• **Rocket Rattling**

  Your article on FLYWEIGHT TRANSMITTER FOR MODEL ROCKETS (May ’62 EI) is just what I’ve been waiting for. I hope you have more articles on amateur rocket instrumentation.

  Eric Alchowiak
  Rochester, N. Y.

  *We will.*

  Bravo for your article on the model rocket transmitter. It’s the most effective I’ve used to date. One suggestion. With low-velocity rockets the acceleration isn’t enough to affect the antenna but when you get into high-efficiency missiles (mach 3 or so), the antenna becomes twisted. The solution is to mount it in a downward direction flush with the instrument housing.

  Also, around mach 4 the components of a vertically mounted transmitter can be cut off as neatly as if snipped with clippers. The answer is to mount it horizontally or in latex rubber.

  Bob Vernon
  Los Angeles

• **A Penny Saved**

  I’ve always heard it is cheaper to let the lights in a home burn rather than turn them on and off every five minutes. I wish you would clear this up because

  [Continued on page 6]
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Feedback

Continued from page 4

my boss follows behind me and turns off every 150-watt light he sees on.

R.B.
Louisville, Ky.

Sorry, R.B., but what you heard is not correct. Turning lights on and off frequently will shorten bulb life (and run up your light bulb bill) but leaving them on will run up your power bill even more . . . unless you have an exceptionally kind power company at the other end of your lines.

• Club Man

I would like to form an Electronic Experimenters Club in the Chicago area. I believe there must be many experimenters around here who would like to get together and exchange ideas and meet people with like interests.

James T. Bates
5241 W. 23rd Place
Cicero 50, Ill.

Anyone interested in being a charter EEC member, drop James a note.

• An Antique

I've recently come in contact with a Collins 18-5 Xmitter-Rcvr, an old war surplus rig. I have been unable to get a schematic for it, not even from Collins. I'm wondering whether anyone in your audience could help me.

John Adamson, K4CGU
Box 312
Key Largo, Fla.

Happy hunting!

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A technical book list, issued by Howard W. Sams & Co., tells you about various volumes on TV, radio, hi-fi, computers, etc. For a free copy, write to the publisher's Technical Book Div., 2201 E. 46th St., Indianapolis 6, Ind.

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Sylvania’s wafer-thin Panelescent lamp is described in New Freedom of Lighting Design. Included are the lighting and electrical characteristics of the lamp and hints on its application. Free copies may be obtained from Sylvania, 60 Boston St., Salem, Mass.
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September, 1962
Three-Second Sun . . . An incredibly fast-heating furnace, able to produce 5,000-degree-F temperatures in three seconds, has been developed by Baird-Atomic, Inc., Cambridge, Mass. Science teachers and researchers are expected to use the Kopito Furnace, which produces sun-hot temperatures safely in the open.

The heart of the unit is a strip of low-resistance graphite cloth made by the National Carbon Co. Electric current from a step-down transformer is conducted to the cloth through water-cooled carbon rollers. The specimen to be heated sits on the graphite strip.

In effect, the furnace is a large version of a soldering gun. It pulls 30 amps at 110 volts.

Within seconds after the furnace has been shut off, it cools down to room temperature.

Night Sight . . . Engineers in RCA's Photo Tube Department have come up with a cascaded image photo tube designed to operate at light levels that are pitch darkness to the naked eye. The cascading intensifies the light seen by the tube by a factor of 100,000.

Astronomy, nuclear science and the Army have found wide applications for the new orthicon tube (which resembles the tube in a TV camera). The tube can record the image of a star many light years away in a hundredth the time required for the usual photographic exposure, and it also can photograph atomic particles with one-microsecond exposures. The Army has used the tube in a closed-circuit television setup to record nighttime amphibious operations.

The Vast Moneyland . . . Television, which already brings you murder, mayhem and madness, can now fix it so you don't have to go to your broker's to find out what's happening on Wall Street. You can make your daily million right at your desk if you have a Telequote II rig handy. It's an instantaneous quotation service devised by the Teleregister Corp. of Stamford, Conn. The viewing screen shows you stock, bond and commodity prices as they are flashed to brokerage offices by a computer in New York City. The system also may be adapted to duplicate current ticker and news tapes.

In essence, Telequote is a closed-circuit television receiver having four channels, each of which carries the prices on any group of 24 issues. A keyboard control unit selects channels and stocks.

Fast Start . . . The transistor gets the thanks for giving us instant warm-ups of electronic equipment, while the average electron tube has been left in the dust with a warm-up of 10 to 25 seconds. Engineers in General Electric's Tube Department have made a start toward cutting the delay with an experimental heater-type tube.
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Is the course “padded”?  
The streamlined Grantham course is designed specifically to prepare you to pass certain FCC examinations. All of the instruction is presented with the FCC examinations in mind. If your main objective is an FCC license and a thorough understanding of basic electronics, you want a course that is right to the point—not a course which is “padded” to extend the length of time you’re in school. The study of higher mathematics or receiver repair work is fine if your plans for the future include them, but they are not necessary to obtain an FCC license.

Is it a “coaching service”?
Some schools and individuals offer a “coaching service” in FCC license preparation. The weakness of the “coaching service” method is that it presumes the student already has a knowledge of technical radio. On the other hand, the Grantham course “begins at the beginning” and progresses in logical order from one point to another. Every subject is covered simply and in detail. The emphasis is on making the subject easy to understand. With each lesson, you receive an FCC type test so you can discover daily just which points you do not understand and clear them up as you go along.

Is the school accredited?
Accreditation by the National Home Study Council is your assurance of quality and high standards. Grantham is accredited.

Is it a “memory course”?
No doubt you’ve heard rumors about “memory courses” and “cram courses” offering “all the exact FCC questions.” Ask anyone who has an FCC license if the necessary material can be memorized. Even if you had the exact exam questions and answers, it would be much more difficult to memorize this “meaningless” material than to learn to understand the subject. Choose the school that teaches you thoroughly understand—choose Grantham School of Electronics.

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September, 1962
...electronics in the news

that gets going in 1.3 seconds.

Two techniques are employed: the heater is bonded to the cathode (although kept electrically isolated) to provide heat transfer by conduction instead of radiation, as is normal, and a ballast resistor is hooked in series with the heater, resulting in a relatively high initial shot of current.

The new heater-cathode structure is expected to have greater physical strength than conventional models and will operate at a lower temperature.

Electronic Fire-Finder... Thick smoke too often hampers the work of firemen because it obscures the center of a large blaze, particularly a forest fire. But an electronic camera that sees the hot spots right through the smoke has been designed by the Space-General Corp., Glendale, Calif. The rig, called a scanning microwave radiometer, records high-frequency radio waves emitted by the high-temperature areas of a fire. Such microwave-frequency energy penetrates smoke where energy in the visible light spectrum is stopped cold. Space-General's camera, carried in a plane, can shoot the ground from as high as 10,000 feet. The system was tried out in the recent Los Angeles blazes which destroyed so much property. Our photo shows a radiometer scan photo. The white spots are the hot points in the fire, which covers the whole area.

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September, 1962

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...electronics in the news

On Again, Off Again . . . A new outdoor lampholder has a built-in photoelectric switch that turns the lamp on at nightfall and off at daybreak. The switch, housed in aluminum, can handle one floodlight up to 150 watts or as many as three standard lamp fixtures. The Bryant Electric Co. of Bridgeport, Conn., the manufacturers, expect homeowners and outdoor advertisers to make use of the unit. Our photos show a flood-lamp blazing away in semi-darkness at left but turned off at right when the overhead bulb goes on.

Lethal Light . . . The death ray, a favorite subject of science-fiction writers for long years, is on the verge of graduating into fact with the demonstration of a laser light beam that can burn holes through stainless steel sheets and break balloons in mid-air. Our photo sequence, made in the Raytheon laboratory at Lexington, Mass., shows an LH-3 pulsed laser doing its dirty work on a balloon.

A laser’s destructive capability is based on the fact that the beam of coherent (in-phase) light it emits is several million times brighter than sunlight.

The Defense Department is awarding contracts for experimentation with lasers as a death-ray weapon. In the meantime, the laser is being put to peaceful use in communications, medicine and biology.

Chatterbox . . . Voice communications, teletype messages and even computer-type data can be transmitted simultaneously over a new radio communications system called RACEP, Martin Marrietta Corporation’s acronym for
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September, 1962
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New Alloy . . . General Electric has developed a new filament wire that combines tungsten—the element used in untold millions of tubes since 1930—with the rare metal rhenium, which costs more than gold. The alloy is stronger than tungsten alone and is expected to give longer life to tubes. A high electrical resistance enables a tungsten-rhenium filament to heat faster and also protects against those damaging initial surges.

In addition to its use in tubes, the wire is found in new GE flash bulbs.

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Audio Furniture ... A new line of hi-fi cabinets gives you the option of placing your speakers well inboard (see photo) or moving them off the shelves for greater separation. The cabinets naturally come without the tuner, amplifier, speakers, etc., consisting of two uprights with long shelves at top and bottom, a short equipment shelf and a back panel. The price is $69.50. Audio Originals, Indianapolis 25, Ind.

Kit in a Cabinet ... Amplifier and tuner kits in Harman-Kardon's Award Series are coming out in a cabinet-type package new to the field. The package (see photo) looks a little like a cross between a child's chemistry set and a refrigeration unit.
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September, 1962

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Marketplace

You set it on your workbench and swing open two doors. Mounted on shelves in the left door are the capacitors, tubes and switches. In the right door are slides holding the small parts. Behind the large photo in the center are the transformers and chassis. Little plastic posts hold the knobs on the front panel (top). H-K calls the package a tool box. It is made out of cardboard. You're supposed to work in front of the cabinet and then close it between wiring sessions. The big picture evidently is to remind you of what you'll have when you get done. Shown here is H-K's 50-watt integrated stereo amplifier, listing at $119.95. A 30-watt job is available for about $80. Harman-Kardon, Inc., Plainview, N. Y.

Stronger Stereo . . . One of the gremlins plaguing stereo FM is its reduced range as compared with monophonic broadcasts. The FMX Range Extender is intended to be a gremlin-killer, eliminating background noise and drift while souping up the signal with a gain of 20 db (making a healthy monster out of a weak, fringe-area signal). The one-tube broad-band amplifier plugs into a 117-volt outlet and operates anywhere along the downlead between antenna and tuner. It requires no tuning and consumes no more juice than your electric clock. It also can feed as many as four receivers at once. A 6DJ8 frame grid tube insures stable performance for continuous use. About $30. Jerrold Electronics Corp., Philadelphia, Pa.

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All in One ... EMC's 212 transistor analyzer is a compact unit that performs tests on transistors that used to require several instruments. It does its work both in-circuit and out.

The analyzer's meter registers DC current gain (beta) in three ranges to 200, checks leakage, and reads current drain on an 80- ma. scale. Battery voltage can be checked on a 12-volt range. The unit can be used to signal-trace in AF, IF or RF circuits and check diodes. It also makes an oscillator check on transistors as AC current amplifiers. $13.50 in kit form, $18.50 wired. Electronic Measurements Corp., New York 12, N. Y.

Suppressikit SK-1. It consists of five bypass capacitors and a supply of shielded wire, all of which is designed to short-circuit random radio-frequency energy to ground (the car's chassis, as a rule). Suppressikit also is usable on marine engines. About $20. Sprague Products Co., North Adams, Mass.

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PART I

We take a look at the inner workings of a crystal diode for clues to transistor operation. Comparisons are made among the basic tube and transistor configurations and their biasing requirements.

PART II

What happens to the phase of a signal going through an amplifier? The question has practical significance since it determines whether a common-collector, common-emitter or common-base mode best suits a circuit.

PART III

Transistor amplifiers have three types of gain. With tubes, it's usually voltage gain that counts. But transistors are current-operated devices, so current and power gains are most important.

FROM pocket radios to computers, the transistor and its semiconductor relations are taking over a host of jobs previously reserved for the vacuum tube. A working understanding of these mighty midgets is as important to today's electronics enthusiast as his soldering iron or Ohm's Law. One of the best ways to become familiar with an electronic circuit or component is to put it through its paces in a variety of test setups. This is the approach EI takes in its basic transistor course.

By Milton S. Kiver
Before dealing with the transistor, it would be a good idea to take a look at exactly how a diode works. A diode is made up of two crystals, a positive type (P) and a negative type (N) joined together. The P crystal serves as the anode and the N as the cathode. Fig. 1 shows a diode for two conditions of applied polarity. When the negative side of the battery is connected to the diode's anode and the positive to the cathode you have a situation known as reverse bias (A). Without getting into the matter of majority or minority current carriers, let it suffice to say that in the reverse bias condition current flow is minimized. In the forward bias condition (B), current flow is encouraged.

Under reverse bias, the diode exhibits a high resistance, known as the back resistance of the diode. You can check it out with an ohmmeter and any diode, such as a 1N34A. Simply place the ohmmeter leads across the diode and take a reading. Now reverse the ohmmeter leads and the reading will differ considerably. It is the polarity of the battery in your ohmmeter that determines whether the diode is biased forward or reverse.

Transistors vs Tubes

All common transistors are three-terminal, three-element devices. Unlike the two-element diode, the transistor consists of a three-layer sandwich of P and N semiconductor materials. NPN transistors have two layers of negative material sandwiching one of positive; PNP's have the opposite.

The interactions of the layers in a transistor can be compared to the functions of the three elements in an electron tube (see Fig. 2). The emitter is comparable to the cathode, the base to the control grid and the collector to the plate. In both devices a flow of current originates at the first element, is regulated or
controlled by the second and is received or collected by the third.

In a tube and in an NPN transistor the charges that travel from cathode to plate or from emitter to collector are electrons. In a PNP transistor, however, positive charges called holes are the carriers of electricity. This difference has little practical significance because PNP and NPN transistors in a circuit function the same way except that opposite polarity DC bias voltages are required.

**On The Bias**

If you've done any work with transistors, you're aware that they are biased differently than vacuum tubes. In tubes, the control grid is usually given a negative voltage with respect to the cathode (reverse bias) which tends to repel electrons coming toward it from the cathode. By varying this negative voltage, we can control the number of electrons attracted toward the positively charged (forward-biased) plate.

In the NPN transistor, a forward bias voltage is set up between emitter and base, while a reverse bias is established between collector and base, as in Fig. 3. The negative potential of battery B1 repels the electrons from the N-type emitter, while the positive potential at the base attracts them. Resistor R1 sets the bias level and, therefore, establishes the amount of current flowing from emitter to base.

Now let's look at the emitter-collector (EC) circuit. We take another battery (B2) and connect its negative terminal to the emitter and its positive terminal through R2 to the collector. Now the positive biased collector attracts the electrons from the base-emitter (BE) junction. However, the number of electrons that can enter the collector is determined by the current flow through the base-emitter junction. Without going into the complexities of semiconductor physics, let it suffice to say that the current flow in the base-emitter circuit controls the current in the emitter-collector junction. And since a small current variation in the BE circuit causes a much larger variation in the EC circuit, we have amplification.

The PNP transistor works in the same way as the NPN type discussed above. There is a difference in the hole and electron flow but, as we mentioned, the only practical distinction is in the bias polarities. It's easy to remember: the PNP transistor operates with a positive voltage on its emitter with respect to the collector and base; the NPN transistor operates with a negative voltage on its emitter.

**Three Ways to Amplify**

Vacuum tubes can be used in three distinct circuit configurations: grounded cathode, grounded grid and grounded plate, as shown in Fig. 4. A similar division exists among transistors. The...
common-base (CB), common-emitter (CE) and common-collector (CC) types are shown in Fig. 5. A standard CE amplifier using a PNP transistor is shown in Fig. 6. (NOTE: all resistors shown are 1/2-watt, 10% except R8, which is 2 watts. All capacitors are electrolytic, 10 volts or higher rating.) The input signal is applied to the base and the output is obtained at the collector. In the equivalent vacuum-tube amplifier the input signal is fed to the grid and the output obtained at the plate.

Note that unlike our previous theoretical example, in the practical circuit of Fig. 6 a single battery (B1) supplies bias voltage to both the base and collector. At the input, the base connects into the voltage divider formed by R1 and R2 across battery B1. This places a bias voltage on the base (with reference to the emitter) of about 1/10 the battery voltage.

Another resistor, R3, has been placed in the emitter lead. With

Three basic tube configurations and their transistor equivalents. Batteries are used to indicate polarity of the voltages applied to the elements. Note that the terms "common" and "grounded" are used interchangeably, although no grounds are shown in the schematics. The ground in each case can be placed at the junction of the two batteries.

A Grounded grid and grounded (or common-base) amplifiers. The tube version is encountered in RF front-ends and in cathode-coupled phase inverters. The common-base transistor circuit usually serves in oscillators.

B The grounded cathode tube and grounded (common) emitter transistor configurations are the standard workhorses found in conventional single or multi-stage amplifiers.

C The common-plate (better known as the cathode-follower) and the common-collector (or emitter-follower) generally serve to match a high impedance at their input to a low impedance at their output.
current flowing through the transistor, a voltage develops across R3 which makes the emitter negative with respect to R3's lead going to B1+. The total base-emitter voltage is thus equal to the voltage across R2, minus the voltage across R3. The two voltages buck each other, but the voltage across R2 is always larger; otherwise, no current would flow.

It is also necessary to provide a negative voltage (reverse bias) between collector and base. This is accomplished in Fig. 6 by connecting one end of resistor R4 to the negative terminal of the battery. Note that the negative voltage at the collector is far higher than the voltage the divider permits at the base. This establishes the reverse bias between these two elements.

In Part II we will examine the three basic circuits from the point of view of two of their significant operating qualities—input and output phase and amplification.

--- PART TWO ---

The phase change (or lack of it) that takes place when a signal travels through an amplifier stage is important when dealing with phase inverters and oscillators.

**Phase Flipping**

The standard common-emitter, like the standard amplifier tube circuit, reverses the phase of any signal passing through it. We can demonstrate this in a simple experiment using the circuit of Fig. 6. Connect a volt-meter or VOM set for a low DC voltage range with its negative lead to the collector and its positive to ground (B1+). The meter will read between 2 and 4 volts.

As a signal source we will use a 1.5-volt flashlight battery with a
4-inch piece of wire soldered to each terminal. Momentarily connect the positive battery lead to the base of Q1 and the negative lead to the common-ground (B1+). Note that the meter (which is reading the negative collector voltage) rises two or three volts. In other words, the collector went more negative. If we reverse the situation and connect the positive terminal of the battery to ground and the negative terminal to Q1's base, the meter reading falls: the collector goes more positive (or less negative).

We see, therefore, that a positive input signal produces a more negative collector voltage. This 180° signal phase change is characteristic of the common-emitter amplifier.

There are two remaining transistor amplifier arrangements, common-base and common-collector. We'll examine the common-base arrangement (Fig. 7) first.

In a CB amplifier, the input signal is fed to the emitter and the output signal obtained from the collector. As with the other circuits, the name for this arrangement stems from the fact that one element (in this case the base) is common to both the input and output circuits. Note that the CB circuit is equivalent to the grounded-grid vacuum-tube amplifier configuration, such as is used in phase inverters and RF amplifiers.

To determine what happens to the phase of a signal we'll use the circuit shown in Fig. 7. Connect the negative lead of the voltmeter to Q1's collector and the positive lead to common-ground (B1+). With the circuit in operation, the voltmeter will indicate 2-3 volts.

As before, we'll use the battery as a signal source. With the negative lead of the flashlight battery on the common ground (B1+), touch the positive lead to Q1's emitter and observe the meter needle. It will fall below scale and if you switch the meter leads you'll find that you have a reading of over 1 volt. In other words, a positive voltage signal at the input (emitter) of the common-base amplifier causes a corresponding positive signal at its output (collector).

As a double check, we can connect the battery with its positive terminal to ground and the negative lead to the input terminal (emitter). Note how the meter rises about 3 volts from its previous reading—indicating, as we would expect, that the voltage at the collector has gone more negative.

Now let's check the common-collector circuit of Fig. 8. Since the CC is the transistor analog of the vacuum-tube cathode-follower, it is frequently referred to as the emitter-follower. Like the CE amplifier in Fig. 6, the input signal is applied to the base. However, the collector doesn't feed a load resistor. It is connected directly to the battery. Signal output is obtained
at the emitter, clinching the resemblance to the cathode-follower.
We can check the phase shift from input to output in the following way. With the circuit wired as shown in Fig. 8, place a voltmeter across R4 with the positive lead to ground (B1+). Less than 1 volt should be read.

Now connect the test battery with its negative lead to ground (B1+) and its positive lead to Q1’s base. The meter falls to slightly below zero. Reversing the battery and placing the negative lead on the base of the transistor causes the voltage to rise about 1.5 volts. In other words, a negative signal at the input of a CC circuit caused an increase in the negative voltage at its output terminal. And, conversely, a positive voltage causes a decrease in negative voltage. This means that there is no phase reversal as a signal passes through the circuit, which is exactly the case with a vacuum-tube cathode-follower.

--- PART THREE ---

A key characteristic of an amplifier is its gain. In transistor amplifiers, we have three types of gain to consider. Most familiar (from vacuum-tube amplifiers) is voltage gain—the ratio of the output voltage of a stage to its input voltage.

Secondly, there is current gain—the ratio of output current to the input current. Finally, there is power gain—the ratio of output power to input power.

Amplification: E and/or I

Since transistors are primarily current-operated devices, current and power gain are most important. Transistors usually are employed as power amplifiers, even when used in the RF stages of a radio or TV receiver. Vacuum-tube amplifiers, on the other hand, usually are voltage amplifiers and their power gain becomes important only when a power-operated device such as a loudspeaker is to be driven.

There are times when transistor voltage amplification is important (for example, when a transistor drives a TV picture tube); however, if a transistor drives another transistor or a speaker, it must provide power—not voltage. Remember, in any circuit power equals voltage × current (W=EI) or the square of the current × the circuit's resistance (W=I²R). This means that any transistor with a high current gain usually has a high power gain. That is why such emphasis is placed on the current gain of a transistor stage.

In the experiments below we will first measure voltage gain and then check the individual current gains of the three basic amplifier configurations. From these two characteristics, we will be able to calculate their respective power gains.

Voltage Gain. For the experiments, we will use the transistor circuits of Figs. 6, 7 and 8. In each case, a small 6.3-volt filament transformer serves as the signal source, using the circuit shown in Fig. 9. The AC input signal is kept small in order not to overdrive the transistor. An oscilloscope will be used to view the transistor output.

The general procedure for each amplifier circuit is the same. We'll use the circuit of Fig. 6 and apply the AC signal voltage at the input of the stage. The oscilloscope is connected across
the output terminals. Start with zero AC input and gradually increase the signal (by rotating potentiometer R6) until the waveform of the oscilloscope screen starts to lose its sine-wave shape and distort. Then, back off R6 until the distortion disappears. Note the height of the pattern by measuring it with a ruler or using the ruled mask over the scope screen. Then, without touching anything else, place the input leads of the scope across the input voltage and measure the height of the sine-wave appearing on the screen. By dividing the input voltage reading into the output voltage reading, the voltage gain of the amplifier stage can be computed quickly. Check each set of measurements several times to make certain the correct figures are obtained.

Of the three circuits, it will be found that the CB amplifier has the largest voltage gain, while the common collector has the smallest. In fact, the voltage gain of the CC amplifier is somewhat less than 1—which means that you actually get less signal voltage out than you put in. In the CE and CB arrangements, a fairly sizeable voltage gain will be obtained.

**Finding the Beta**

Now we’ll measure the current gains of each amplifier type, starting with the common-emitter circuit of Fig. 10. In the CE mode, current gain is referred to as beta. Actually there are two current gains to deal with—AC and DC. A small-signal AC beta test is made on low- and medium-power transistors. The large-signal DC beta test is for high-power transistors. Low-power transistors designed for switching are exceptions to this rule, since the DC beta test best simulates their actual operating conditions.

**DC Beta.** When dealing with DC current gain, as we will be in the experiment below, the gain is determined with the formula:

\[ \text{beta} = \frac{\text{collector current}}{\text{base current}} \]

To set up the experiment, adjust R7 (Fig. 10) to 50,000 ohms as measured by an ohmmeter. The resistance in the base-emitter circuit (R7 plus R4) then totals 60,000 ohms. The 1,000 ohms of R3 can be disregarded since it is negligible in comparison to the other figures.

With a 6-volt power supply and 60,000 ohms in the base-emitter circuit there is .1 ma of current flow. Now measure the voltage across R4 (say it’s about 1.5 volts) and divide it by R4’s resistance (470). This gives you about .003 amps (3 ma) as the collector voltage.
current. If we now divide this 3 ma collector current by the .1 ma base current, we have the DC current gain for the stage—30. It's as simple as that!

With the 2N363 transistor, current gain of anywhere from 15 to 40 can be expected. As a check, we can set R7/R4 for a total of 40,000 ohms. Now .15 ma is flowing in the base circuit. If you calculate the collector output current as above, you'll find that the current gain has remained the same. This will be true over a moderately wide range of input current.

AC Beta. The AC current gain test gives a better idea of what we may expect of a transistor under operating conditions. The AC beta describes the amount that a small change in base current (Ib) is reflected by a change in collector current (Ic). Expressed as a formula:

\[
AC \beta = \frac{I_c \text{ change}}{I_b \text{ change}}
\]

The circuit of Fig. 10 will serve also for AC beta checks. As a start, we have the figures obtained in the DC beta measurement—.1 ma base current and 3 ma collector current.

Now set the R4/R7 combination to provide a total base circuit resistance of 30,000 ohms. With the 6 volts of B1, this produces a base circuit current of .2 ma (I = E/R). This represents a change in base current (Ib) of .1 ma from the previous value. This figure goes in the denominator of the equation.

For the Ic change figure needed for the numerator, we measure the voltage across R8 and divide it by R8's resistance. This gives the new Ic. The difference between this value of collector current and the previous DC beta value is placed in the numerator. Work out the equation and the answer is the AC beta value for the specific 2N363 transistor you used in the circuit of Fig. 10. (For other circuit arrangements, the transistor, may have slightly different values of AC and DC beta. In normal operation, however, all will be fairly close together.) If one checks out, the other will too.

Analyzing the Alpha

Let's turn to the current gain of the common-base circuit shown in Fig. 11. In the common-base configuration, the symbol \( \alpha \) is used for current gain. \( \alpha \) expresses the ratio of collector current (Ic) to emitter current (Ie) or

\[
\alpha = \frac{I_c}{I_e}
\]

Common Base Gain. First, adjust R2/R4 to a total value of 6,000 ohms for a current flow of about 1 ma in the base-emitter circuit. If you measure the voltage.

[Diagram of Fig. 10]
across R8 and divide it by 470 (ohms) you’ll find a collector current of between .9 and .95 ma. In spite of the fact that the common-base amplifier provides the best voltage gain, its current gain is less than 1. This means there’s a current loss between input and output.

As with the previous circuits checked, stage amplification can be approached from both DC and AC gain. The AC alpha is measured in much the same way as with the previous circuits. The formula is:

\[ AC \alpha = \frac{I_{c} \text{ change}}{I_{e} \text{ change}} \]

Note the currents in the emitter and collector circuits from the DC check. Now reduce the emitter current by increasing the resistance of R4 and note the corresponding change in collector current. Subtract the new figures from the old ones, insert them in the above equation—and you have the AC alpha.

If you’re wondering what the relationship is between \( \alpha \) and \( \beta \) (other than the fact that they follow each other in the Greek alphabet), it’s expressed in the formula:

\[ \beta = \frac{\alpha}{1 - \alpha} \]

Common-Collector Gain. Fig. 12 shows how a common-collector circuit’s current gain is checked, using the same techniques that served us for the other circuits. The R4/R7 combination is adjusted for a total resistance of 60,000 ohms. (We can ignore R8.) Measure the voltage across R8 and divide this value by 470 (ohms) to arrive at the current flowing in the emitter circuit. As in the common-emitter arrangement, a fairly high current gain is obtained.

Now let’s review our findings. We saw that the common-emitter and common-collector circuits have about the same current gain, whereas the common-base arrangement produces a current gain of less than 1. If we combine this information with the voltage-gain data determined earlier, we can determine the relative power gain of the three configurations.

In the CE stage, the voltage and current gain were both good. When these two quantities are multiplied together \((W = EI)\) excellent power gain will result. In the CB amplifier, the voltage gain was good, but the current gain low. Its power gain, therefore, is less than that of the common-emitter. Finally, in the common-collector circuit, we found a voltage gain of less than 1, but a good current gain. Here again, we see that the power gain of a CC amplifier is not as high as that of the common-emitter.
amplifier. Actually, the CC's gain is the lowest of the three types.  
Because the common-emitter arrangement has the best combination of current and power gain it is the type most frequently used.

The common-base arrangement is an excellent choice for oscillator circuits because the input and output phase are the same. By simply feeding a small amount of output voltage back to the input, oscillation can be obtained.

Finally, the common collector is useful as an impedance matching device because, like the tube cathode follower, it has a high input impedance and a low output impedance.

For those interested in pursuing transistors and transistor circuitry further, scores of books and pamphlets are available from libraries, bookstores, parts distributors or publishers. Here is a selection of these publications:

Basic Theory and Application of Transistors.  

Facts on Transistors. By Walter J. Cerveny.  
Hickok Electrical Instrument Co., 10532 Dupont Ave., Cleveland, Ohio. $1


Coyne Electrical School, 1455 W. Congress Parkway, Chicago 7, Ill. $4.95

McGraw-Hill, 330 W. 42nd St., New York, N. Y.

Transistor Manual. 4th Ed. General Electric Co., Syracuse 1, N. Y. $1

Prentice Hall, Englewood Cliffs, N. J.

Understanding Transistors. By Milton S. Kiver. Allied Radio, Chicago, Ill. 50¢

GERNBSACK LIBRARY, 154 W. 14th St., New York, N. Y.

Basic Transistor Course. By Paul R. Kennan.

Fundamentals of Semiconductors. By M. B. Scroggie. $2.95

Transistor Circuits. By Rufus P. Turner. $2.75

Transistor Techniques. $1.50

Transistors. $1.95

Transistors—Theory and Practice. By Rufus P. Turner. 2.95

JOHN F. RIDER, INC., 116 W. 14th St., New York, N. Y.

Basic Transistors. By Alexander Schure. $3.95

Fundamentals of Transistors, 2nd Ed. By Leonard Krugman. $3.50

Fundamentals of Transistor Physics. By Irving Gottlieb. $3.90

International Transistor Substitution Guidebook. By Keats Pullen. $1.50

Principles of Transistor Circuits, 2nd Ed. By S. W. Amos. $3.90

HOWARD W. SAMS & CO., Indianapolis, Ind.

ABC's of Transistors. By George B. Mann. $1.25

Transistor Circuit Manual. By Allan Lytell. $4.95

Transistor Substitution Handbook. $1.50
Dr. Jacob Millman is Professor of Electrical Engineering at Columbia University. He received his BS degree in physics at Massachusetts Institute of Technology, studied at the University of Munich and returned to MIT for his PhD in physics. Dr. Millman has a varied background as teacher, research and development engineer, inventor and consultant in radar and electronics. He began teaching electronics and physics at MIT in 1935 and later taught at the City College of New York before joining the Columbia faculty. Eight inventions in radar and electronic circuits are credited to Dr. Millman. During World War II he was project engineer on V-Beam radar at MIT’s Radiation Laboratory. He is author of one book, Semiconductor Electronics, and co-author of two others, Electronics, and Pulse and Digital Circuits. The three volumes were published by McGraw-Hill in its Electrical and Electronics Engineering Series.
By Jacob Millman, PhD

ELECTRICITY

A BRIEF exposition on the history of electrical science will be interesting and instructive, and will give us the answer to: "What is electricity?"

About 600 B.C. the Greeks made the observation that a piece of amber, when rubbed, acquired the ability to attract light objects to itself. William Gilbert (about 1600) introduced the word electricity from the Greek word meaning amber. It was found that other substances besides amber, when rubbed, also would exhibit this mysterious force of attraction. As a consequence, the phrase electrification by friction was born.

In the Sixteenth Century it was discovered that it also was possible to cause material to exert a repulsive force upon another electrified body. For example, let us rub two glass rods with silk and two ebonite rods with fur. We then find that the two glass rods repel each other, and the two ebonite rods likewise repel each other. But a glass rod is attracted to an ebonite rod. The conclusion that must be drawn, is that the glass, as a result of the friction, has acquired a "substance" which is of a different type from that left on the ebonite rod. These substances have been given the names positive and negative electrical charges.

The above-described experiment is interpreted to mean that positive charges repel each other, negative charges repel each other. But a positive charge attracts a negative charge. Electric charge is thus seen to be a fundamental concept required by the existence of forces which are experimentally measurable.

In 1800 Volta produced a "pile" (we now call it a battery), consisting of zinc and copper plates separated by blotting paper moistened in brine. If a piece of wire was connected between the plates of this Voltaic cell, heat was produced in the wire. It was hypothesized that chemical energy was being used to cause a hitherto unknown "fluid" to flow through the wire. The friction or resistance to the flow was what was causing the wire to become hot. Could it be that this "fluid" was the same substance causing the static electrification of the glass or ebonite rods? Experimentation by many scientists finally gave an affirmative answer to this question. Charges were flowing in the wire, and the total charge passing through any cross section of the wire in one second was called the electric current.

It was not until 1897 that J. J. Thomson was able to prove that a current (in a discharge tube) consisted of a flow of isolated "corpuscles" carrying a negative charge, and these fundamental particles were called electrons. Further experiments have revealed that all matter consists of atoms and in each atom there is one or more electrons surrounding a core of positive charge called a nucleus. An atom which has lost an electron is called a positive ion.

In summary, electricity represents a quantity of charge, either electrons or ions. These may be at rest on the surface of a conductor or in motion, as in a current through a wire, a gas, a liquid, a semiconductor or a vacuum.

Dr. Millman's essay represents an expert answer to the question, "What is Electricity?"—posed in EI's Electricity Contest. It concludes the contest.

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SIGNALS FROM SPACE. . . After our experiences on the air during John Glenn's orbital flight in Friendship 7, and the other Mercury shots, it is apparent that a new field has opened for short-wave listeners in North America and elsewhere.

Col. Glenn used one main frequency in the short-wave spectrum—15016 kc. His transmissions could, at one time or another, be received throughout the continent. Reception beyond the line of sight (which took in a lot of territory because of his altitude) was spotty due to poor ionospheric and atmospheric conditions, but ground stations in Florida, Texas, California and Mexico put out potent signals.

And every suspense-filled word was in English!

Few knew the Glenn SW frequencies in advance. They are not made public for obvious reasons—somebody with no more official standing than being a taxpayer might try to contact the capsule and foul up communications completely. The Mercury short-wave frequencies are given simply as "between 4 and 26.5 mc," although the exact operating frequency of the UHF gear is announced by NASA (see HOW WE TALK TO THE ASTRONAUTS, March '62 EI).

Even though you don't know the frequency, extensive tuning while one of the capsules is on this side of the earth should produce results, since there will be a whole net on that frequency.

The 15016-kc frequency mentioned previously is a good bet to monitor, being a regular Air Force channel. Others that bear watching are 13826, 13215.5 and 11228 kc. On the day of a shoot you should start checking at least an hour before blast-off. Most ground stations heard here identify themselves as Cap Con.

Confusion Reigns . . . Though international broadcasting has its bright moments and makes its contribution to international understanding, the word that too often describes activities on the short-wave BC bands is chaos. You might throw in confusion for good measure.

Mother Nature, the jammers and unscrupulous operators create enough QRM to make life hectic for the DXer, but that's not all we have to contend with. There also are just plain accidents, caused by well-intentioned people. Consider the recent collision on 11895 kc of Radio Free Europe and Radiodiffusion du Senegal.

RFE is known and respected throughout the free world for its anti-Communist broadcasts. In recent years R. Senegal, transmitting from Dakar, has come to rank high among African transmitters as an excellent, objective station with no ax to grind (at least not a big one). In December of last year it was one of the few stations on the

[Continued on page 116]
IT'S GETTING SO you can't tell the conventions without a score card. National Citizens Band conventions, that is. This year you'd use most of your fingers counting them up.

There has been some yelling and screaming about what is a true national convention and what isn't. We're of the opinion that any organization that can attract conventioneers from a fair spread of states can call its get-together a national convention without getting its knuckles rapped with a dictionary.

One of the main underlying reasons for so many national CB bashes is the great number of organizations that are trying to become the dominate voice of the Citizens Banders. One way to show your power would be a convention of World Series proportions. So far, we haven't seen one like that.

A few weeks ago this corner visited a convention held by the National Citizens Radio League at the Morrison Hotel in Chicago. It was a three-day affair and turned out to be a fairly large one, with some 4,000 people dropping in. It had all the trappings of a well-organized and professionally run convention and should have made NCRL's stock go up a few points with CBers.

More than 30 manu-
facturers exhibited their equipment, there was a goodly number of club presidents in attendance, and the Federal Communications Commission's top man on CB radio delivered a talk.

NCRL is a Chicago-based group that obviously is making a mammoth pitch for nationwide recognition from its central location in 18-land (address: 6272 W. North Ave., Chicago). As we've said before, CB needs and should have a truly representative national organization serving its interests. It's too early to tell whether NCRL might be that organization.

NCRL was started when Charles Greene, now president, got together with two fellow employees at the Admiral Corp. The idea was hatched and three others then were invited to form the nucleus of NCRL, a corporation chartered by the State of Illinois. The group, who've picked up the moniker of the Big Six in some circles, is well-rounded, having backgrounds in electronics, business, sales and accounting. There is no question but that the Big Six spent a lot of time and money to make the convention a success.

Like most beginning organizations, NCRL has its critics. The barbs were sharpest at a meeting of club presidents, who wanted to know whether the organization would be run democratically, when officers would be elected and how finances would be handled.

The last query turned out to be a small bomb when President Greene was unable to give an answer, going into a huddle with the Other Five instead. It appeared they simply had not decided about what was to become of dues money, for instance, that was paid into the corporation and who, if anyone, was going to reap the profits. The final answer was that dollars put into the organization by CBers would be held in a special account, while profits from exhibitions and conventions (such as this one) would go to Greene and his partners as being something apart from dues money.

All these details, said Greene, would be spelled out in a new constitution.

Heath's Al Tash holds new GW-12, superhet with transmit-receive crystal control; the price is $39.95.
disposal, according to Greene. Whether this proves a workable arrangement can be answered only by time. As Greene said during a taped interview we had with him, NCRL cannot hope to have a polished program overnight.

Browning presxy Gar Greene with module station, R-2700A receiver, matching 23/S-9 transmitter.

In general NCRL proposes to serve as the voice of CB by lobbying in Washington, to offer guidance to local clubs, and to aid clubs financially by conducting programs around the country that would turn a profit shared by the local groups.

The National Citizens Radio League, in its first announcements and releases, seems to be concentrating on the lobby angle. The rest of the program has not been spelled out in great detail to date but perhaps will be in the near future. Its biggest pitch now is simply for the support of Citizens Band licensees.

The exhibits by manufacturers were both entertaining and informative for CBers, who had a field day twisting knobs and filling shopping bags with literature.

One significant trend we spotted concerns the way the equipment makers have started dividing their wares into two groups. The first is for the CBer who wants a black box that transmits and receives. These stripped-down rigs give rugged, reliable performance at low cost. Although the chassis may hide advanced circuitry, it offers a minimum number of channels. The guy who goes for a black box, the companies say, is the all-business gent looking for equipment to do a specific job. Manufacturers are becoming convinced that the small industrial and commercial user may some day be the backbone of CB.

The second group of users naturally falls in the personal or non-business category—those looking for flexibility and features, and perhaps chrome trim.

Looking for gripes by manufacturers, we found the most popular beef to be with the CBer who doesn’t read his instruction book before setting up his gear. “They just read the instructions to find out the errors they’ve already made!” said one.

Raytheon demonstrated a versatile handi-talkie that operates at either 1-watt or 100-mw level.

The speaker we mentioned earlier was Ivan H. Loucks, chief of the FCC’s Land Transportation Division, who consequently is top man on CB. He gave an informative talk with wry touches of humor that went over well.
MACHINES THAT READ

Type it, print it or pen it and there's a robot to tell you what you said.

By Ken Gilmore

MACHINES have come a long way since the days when the best ones had nothing more to do than turn the paddlewheels of a steamboat. The smart machines now, after learning to add and subtract, are acquiring the ability to read. And it's not just numbers they're reading. They also recognize letters of the alphabet, whether typed, printed or written in longhand.

You've probably heard about the electronic monster that sits in a building just outside Washington, contentedly clucking to itself as it leafs through 10,000 letters an hour. It reads the addresses on typed envelopes and drops each one into the proper slot. This automated postal clerk is a prototype but its successful operation indicates it will soon be sorting part of the nation's mail on a full-time basis.

In New York's First National City Bank, a reading machine runs through cashed travelers checks at the rate of 100 a minute, reads the numbers and sorts them for processing. So sharp is the electronic scanning eye that it reads the information right through the rubber-stamp marks you see on cancelled checks.

A robot reading: image of type (A) goes through mirror (B), lens (C), second mirror (D), scan disc slits (E) and finally into photomultiplier tube (F).

Leading reading-machine producer is Farrington Co., whose ex-president, William Tetrick, stands with a machine that reads cards stacked at right.
At an Air Force base in Rome, N. Y., technicians slip stacks of typewritten messages into an electronic scanner called The Eye. This robot reader glances across each line at 3,000 words a minute, reads what it sees and translates it into computer language. These signals go out over the Air Force's communications network and appear on teletype machines all over the country without a single airman lifting a finger.

These are just three of almost 100 optical scanners, or reading machines, now plowing through the mountains of paper work it takes to keep our society running. They're catching on rapidly at banks, insurance companies, oil firms and other businesses because they whiz through stacks of material at inhuman speeds, rarely make mistakes and work 24 hours a day with no time off.

The reading machine boom that is now picking up speed began in 1950, when the Department of Defense found itself buried in paper work. Its computers could handle the load, but there weren't enough punch operators to translate the information into punched cards for computers to read.

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David Shepard, a 26-year-old engineer who worked for the department, decided to build a machine which could read the records and papers directly and feed the information to computers, eliminating card-punching.

During the war Shepard had studied to be a translator of Japanese, later becoming an engineer specializing in mathematics. He knew Japanese words are built on a number of long and short brush strokes in various positions, each of which means something. We usually think of the letters of our alphabet as single units. Shepard wondered whether they, like Japanese characters, could be analyzed on the basis of strokes.

Most others had tried to build reading machines which would match letters to be read with identical letters stored in a memory device. Trouble was, if a letter got tilted or out of line, no match could be found and any letter not printed perfectly was rejected.

Shepard's idea was a machine which would analyze each letter or number by its characteristics and identify it from this information. The machine would ask itself, for example, whether a character had one, two or three crossbars. Top, bottom or middle? Was there a long or short vertical bar on the right? On the left? Shepard made up a chart of characteristics for each character (see Fig. 7).

The scanner Shepard envisioned (see Figs. 1-5) would look over a character and tell its logic-memory computer circuits something like this: "It has crossbars at top, bottom and middle; long vertical line on the right; no vertical line on the left." The computer could then search through its memory, find that these were the characteristics of a 3 and order that a 3 in computer language be sent to the machine's output.

Shepard set to work in his attic in Falls Church, Va., helped by a friend, Harvey Cook, Jr. One year later—in March 1951—they unveiled the world's first optical reader. Total cost, including labor: $4,000. The first commercial
character is scanned 30 times or more, as shown in Fig. 5. A group of standard reading-machine characters is shown in Fig. 6. Stored in a reading machine’s logic and memory devices is information of the type shown in Fig. 7, including the characteristics of each letter and number. A 2, for instance, is identified as having horizontal strokes at top, middle and bottom, etc. By comparing incoming signals with the information in its memory, a reading machine is able to recognize characters having standard shapes. It can then provide a direct readout or store the information on magnetic tape. Machines now being designed can read any type of printed characters or even neat longhand.

model went on the job in 1955, when a large book club faced a serious problem. Some 15,000,000 member cards had to be processed twice a year. By the time the workers needed for the job were hired, trained and had finished the task, it was almost time to start again. The operation was costly and inefficient. The club used its new Shepard machine to read its cards and feed the information to computers. Result: the twice-a-year job was done in three days.

The Shepard-Farrington method of machine-reading is one of two main methods for getting the job done. In the second system, mentioned previously, the image of a whole character is matched with cut-outs in a template. When a character and cut-out match exactly, a photocell is activated and that character’s signal is produced.

Though all machines today require special characters for their reading operations, devices now in the laboratory stage will be able to read typed or printed characters of any size—and even well-written longhand.

If you have a credit card from any one of a dozen oil companies, your charge slips are being read by machines. Many insurance companies use machines to scan premium stubs. Quarterly dividend checks from AT&T are scanned by machines, which later look at the cancelled check and record the fact that you've got your money. Utility bills, driver's licenses and car registration forms are coming under electronic scanners in increasing numbers.

In a few years all large companies will give their painful paper work to reading machines. Some day newspapers and magazines (such as EL) will be set in type by machines which scan typewritten manuscripts. The seers of the reading-machine field foresee the day when your groceries will simply slide under a supermarket scanner, which will read the labels and tote up the price. You'll have only one complaint with this robot: your groceries will still cost just as much.
E. N. Pickerill, now retired at 77, holds photo showing early biplane in flight with wireless rig aboard. He was the pilot of the plane.

**FIRST FLYING RADIO MAN**

On August 4, 1910, a young wireless operator-pilot named E. N. Pickerill took off at Mineola on Long Island in a Wright Model B biplane, trailing two 200-foot wires and with a spark transmitter mounted behind his head. Operating a crude key on his control stick, Pickerill in an hour made history twice by sending the first wireless messages from a plane in flight to a receiver he had set up on the beach and to five ships at sea. It was quite a day for any man. Pickerill is now 77 and retired after working 46 years for RCA and its predecessors, including the American De Forest Co. and United Wireless Telegraph. He lives where his famous flight started—in Mineola.

Ground station which received Pickerill's first transmission from a plane in 1910 was in trunk. Pickerill in 1908 as operator at WZ, the United Wireless station atop old Waldorf-Astoria Hotel.
TRY THESE half-dozen experiments and you’ll find an electromagnet is more than a toy for picking up bits of metal. So important is electromagnetism that you’d search hard to find an electronic circuit that doesn’t use it in some form. With the setup described here you can explore several of its interesting properties.

The carriage bolt shown is a hardware store item, the compass from a dime-store and the other components are available from electronic parts distributors. The 0-1 DC milliammeter is indispensable for electronic experiments and will be used frequently in this series.

You can get results with a single 1.5-volt penlite battery but several cells in series provide higher voltage and a stronger indication. To conserve battery life, connect the electromagnet only when a particular step is being performed.

The magnetic field of the electromagnet is generated by its windings of fine wire. About 1,600 turns are needed. The coil need not be wound evenly and it shouldn’t take you more than ten minutes to complete the job.

Any wire carrying a flow of current has a magnetic field around it, but the coiled windings build it up by concentrating the energy. The bolt provides a convenient pathway for the magnetic lines of force to concentrate in.

You can start a magnetic mapping operation with some iron filings. Run a file over the end of the bolt or buy some filings at a local chemical supply house. Before the electromagnet is installed in its stand, lay it on its side on a wooden surface and hook it up. Over it place a sheet of paper. Sprinkle the iron filings evenly over the paper, tapping lightly as you sprinkle. The filings will arrange themselves in a revealing pattern. They will cluster at the ends of the bolt, indicating the strongest areas of magnetism—the magnetic poles. Between them the field grows weak and attracts fewer filings. Notice how the filings form curving lines between poles. These are lines of force, suggesting the path taken by the magnetic field from one pole to the other.

Are the two poles identical? With a small machine screw, feel the magnetic pull at each end of the bolt. The attraction is nearly equal, but the compass will reveal a key difference.

Place the electromagnet vertically for this step. If you hold the compass against the head of the bolt, one end of the needle will swing toward it. Move the compass to the other end of the bolt and the needle will swing around until its other end points to the bolt. This shows that the magnetic fields are not... [Continued on page 119]
"Keep it simple," a veteran ham tells beginners who are planning to set up their first amateur station.

By Howard S. Pyle, W7OE

Early in his study for the amateur license examination a beginner usually starts planning his station. After being on the air since 1908, my advice is—keep it simple! If you're not buying second-hand gear (which is a good way to get your rig cheaply), you're faced with a choice of new factory-wired equipment, kits or building your own. Of the three choices, kits are more practical today. They're economical, relatively easy to build and instructive.

But whatever you buy or build, I suggest you start with an inexpensive, simple station which requires some study and sweat to operate successfully. You'll learn more that way. The accompanying chart lists some of the better equipment buys for the novice, although it is by no means all-inclusive.

A good novice transmitter is particularly easy to assemble. It can be used later in your General Class operations by adding modulation for voice (if it does not have this feature built in). Your power limit is 75 watts.

A modest receiver also can be built from a kit by a beginner, although the procedure is not as simple as putting together a transmitter.

As a novice, your station's accesso-

Simple Antennas for Beginners

A—Popular first antenna is end-fed long-wire of random length: 65-75 feet is best length.
B—Windom is fed 14 per cent from center; the length shown is for operation on 80 meters.
C—Center-fed antenna cut for 80 meters: it can serve also on 40, 20 and 10 meter bands.
D—One-end antenna runs directly from single support to rig without conventional lead-in.
E—Quarter-wavelength insulated vertical is tuned with a coil having variable-slide tap.
or more. A hand key ($1 to $5), a pair of headphones (about $3) and one or more crystals is all you need. Get top-grade crystals because the best ones cost only about $3 each. Other accessories, such as antenna tuners, standing wave ration meters and so on should not come until later.

Avoid elaborate antennas. Those shown in our diagram are good for beginners. The skyhooks cut for 80 meters (130 feet long) are particularly useful because they can be employed successfully on the even-harmonic frequencies—the 40-meter band and, after you have your General ticket, 20 and 10 meters.

Many novices prefer to use two antennas—one for receiving and the other for transmitting—rather than bothering with a transmit-receive switch. Use your best antenna for transmitting. Your receiving antenna could be nothing more than 25 to 30 feet of wire on the attic floor. Try to keep it a reasonable distance from and at right angles to the transmitting antenna to minimize pickup of your own signals. To prevent damage in the front end of your receiver, connect an NE-2 neon bulb across the antenna and ground terminals of the receiver. The bulb will ground your own signals but not the weaker ones from other hams.
**THE ENGINE WITH THE MAGNETIC**

THE perfect engine that runs forever and requires no fuel hasn't yet been produced, but we're getting closer. Republic Aviation now is testing a little powerplant for outer space with such a minute appetite that it could cruise around amongst the stars for several years without dropping in at a celestial filling station.

The engine obtains its thrust from the magnetic pinching or squeezing of an inert gas such as nitrogen. A flyable model is expected to be ready for a shot into space this year.

Although producing only a tiny thrust, the engine could propel or steer huge spaceships through the heavens at fantastic speeds. In the near-vacuum of the wild blue yonder there is practically no resistance from air or gravity. Even a minute thrust can move huge weights.

Technician below adjusts squeeze engine in test chamber. Diagram above explains its operation. Capacitors surround black nozzle at the right.
Republic's squeeze engine carries a bottle of gas, which eventually would be exhausted. Its only other requirement, electricity, comes from a storage battery and can be replenished via a solar cell.

The operating principles of the squeeze engine are simple (see the diagrams on these pages). Two disc electrodes hold a quantity of gas between them. High voltage is applied to the electrodes (from the capacitors) and this ionizes (makes conductive) the gas, now called plasma.

Current begins to flow through the plasma. Because of what is called the "skin" current phenomenon, the current distribution is maximum around the edges of the discs, in effect making a sheath of current around the plasma. As with any electric current, this sheath current has a magnetic field. In this case, it is outside the current sheath and pushes in on it (squeezes) from all sides. The ionized atoms of gas, being conductors, cannot penetrate this electromagnetic sheath and are squeezed together. If a hole is made in one of the discs, the gas flows out under pressure and produces a thrust in the opposite direction, according to Newton's Third Law of Motion. The hole, of course, becomes a nozzle.

If the process is repeated over and over, you have an engine that goes a long way on very little fuel.

THE first full-size working model of an ion engine (see ENGINE OF TOMORROW, May '61 EI) was demonstrated a few weeks ago by the Hughes Aircraft Company. A thrust amounting to only a tenth of a pound is produced by the little powerplant, but that would be enough to move heavy loads in outer space.

Several different types of engines are being designed for the job of exploring space.

The Hughes engine vaporizes cesium to gain the required ions, which are accelerated to high speeds electromagnetically and expelled from a nozzle to produce thrust.

An ionized atom stream from ion engine is viewed by technician through porthole.
Automatic T-R switcher (VOX) for ham or CB rigs has dozens of other uses!

By Herb Friedman, 2W6045

When you mention voice-operated transmitter/receiver switching (VOX) to a ham or CBer they invariably associate the term with high-priced rigs. That's unfortunate because VOX can give you wonderfully convenient automatic transmit-receive switching on even rock-bottom-price Citizens Band or ham equipment. The only requirement is that your equipment has (or you can add) the push-to-talk feature (see PUSH-TO-TALK CB SWITCHING, Jan. '62 EI). In addition, a voice-controlled relay can be used in a great many practical non-radio applications in the home, shop or office.

Commercial units have a fairly steep price, but you can build EI's VOX for around $15. You'll find it a highly sensitive unit with a wide latitude of adjustment. Besides automatically switching ham or CB gear, EI's VOX (or VCR for Voice-Controlled Relay) can:

- Switch mobile units when used in conjunction with EI's SAFE MOBILE MIKE (May '62 issue).
- Start a tape recorder at a party or elsewhere when someone is talking, and turn it off during silent periods.
- Start and stop a model train or other such equipment (when you say, "Full steam ahead," the train starts).
- Act as a baby-sitter to switch off your TV speaker (or anything else) when the child cries.
- Serve as a sound-sensitive burglar alarm.

Parts List:

Resistors: 1/2 watt, 10% unless otherwise indicated
RI—Potentiometer, 5,000 ohms with DPST switch (S1)
R2—10 ohms
R3—27,000 ohms
R4—4,700 ohms
R5—1,000 ohms
R6—3,300 ohms
R7—100,000 ohms
Capacitors:
C1—50 mf @ 25 VDC miniature electrolytic
C2—500 mmf ceramic disc
D1, D2, D3—IN34A diode or equiv.
Q1, Q2—Transistors, high-gain NPN type (Semitron NA-30 or equiv.)
B1—4 v. battery (Burgess Z4 or equiv.)

B2—9 v. battery
RY1—Relay (Potter Brumfield type R55D, 6VDC)
J1—Jack for microphone
T1—Miniature transformer, 100,000 ohm pri./1,000 ohm sec. (Lafayette TR-97 or equiv.)
Amplifier—Lafayette PK-522
Misc.—Perforated board, flea clips, battery clamp, terminal strip, Minibox, etc.

A semiconductor kit containing the necessary diodes and transistors for the relay amplifier is available from Custom Electronics Co., 2929 Fulton St., Bklyn. 7, N. Y. Price is $3.60 Postpaid.

Electronics Illustrated
Schematic of relay amplifier shown with interconnections to preassembled amplifier.

Wiring details of various components and subassemblies of the VOX. Note that both relay amplifier and PK-522 must be grounded to the cabinet.

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You will be able to figure out many other applications, but that's a beginning.

Among the VOX's features are an adjustable sensitivity and a variable hold-in time delay. In normal operation when the relay closes it remains closed from one to three seconds after you stop talking, thus eliminating the relay chatter found in some VOXes.

EI's VOX consists of two units: a relay amplifier and an audio amplifier, both transistorized. The latter is a manufactured amplifier since its price ($3.75) is less than it would cost you to build your own.

The unit shown is built in a 5½ x 3 x 2¼-inch Minibox but if you lack experience in close-quarter wiring, a larger box and perforated board might be helpful. The relay amplifier is built on a 1⅛ x 2½-inch section of perforated board with flea clip terminal points. Since relay RY1's frame is connected to the center wiper contact, the relay is mounted so its frame does not touch any other component or the cabinet. Note that the transistor and diode leads are short. Use a heat sink (such as an alligator clip) when soldering them.

Drill all the Minibox holes before installing the relay amplifier board or other components. Make certain the layout permits the cover to be slipped into place.

To avoid hum or RF pickup the leads to RY1 must be separate from the shielded mike lead. Don't use one multiconductor shielded cable. Run a separate shielded lead for the mike.

If you plan to use the VOX only in non-radio applications and have no need for a microphone signal output, eliminate T1. Connect the microphone directly to the amplifier's input. Or, if you want an integrated unit, a small ceramic or crystal microphone element can be mounted in the box.

Mount the relay amplifier board with a ¼-inch stand-off or a stack of washers between it and the Minibox.

The PK-522 amplifier is mounted in the Minibox by two L brackets. Clip the 522's black lead (the one near its transformer) short and connect the yellow lead to the relay amplifier's ground terminal. Connect R2 across the 522's output leads or solder it directly to the printed circuit board. Carefully solder C1's negative lead to the 522's printed circuit wiring at point A in the pictorial. This is the collector of the output transistor. Mount B1's holder and complete the wiring. The 9-volt battery, B2, is mounted on the Minibox cover directly above B1. Check for shorts before installing the batteries.

**Adjustment and Use.** Switching on the VOX will cause the relay to close momentarily, so always turn on the VOX before the associated equipment.

Place the microphone in its usual position.

[Continued on page 116]
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September, 1962
THE BUG'S BITE...
It's a fact: If you come down with any common malady the doctor probably can tell you exactly what will happen next. But there's no way of predicting the reaction when the ham bug grabs you. I've just witnessed a case involving a longtime acquaintance of mine, a man who has been head of his own electronic manufacturing business almost 40 years. Amongst his products are some well-known pieces of ham gear, but the stuff used to be just so much hardware to him. No more.

Without warning my friend became entranced with the idea of talking via short wave to people in England and Africa and Brazil and who knows where else? Gripped by the hot hands of ham fever, he rushes off to a dealer and loads up his T'bird with a complete Collins single-sideband S-line, plus numerous accessories, all to the tune of about $2,000 bucks. What makes it even stranger is the fact that he doesn't know a dit from a dah.

The guy, probably wisely, doesn't go home with his loot but appears instead in my driveway, a slightly glassy look in his eyes. His recounting of his adventures staggers me but I hang on the ropes and come back with, "What about a license?"

"Yes, I know about the ticket," he says, "but I figure if I have the station I'll have to study hard and pass the test."

"What're you going to do in the meantime? That may take two months." 

"I want you to keep it warm in your shack," he says evenly. "If I take it home I might be tempted to hook it up."

Restraining myself from grabbing the stuff and manhandling it into my shack, I reply coolly, "Sure. Always glad to help a guy in need."

Well, the chap worked hard and he really tried, but the butterflies got him when he showed up at the FCC office for the exam. I'd checked him out at 18 wpm on code but he flunked under fire.

My friend will try again, of course, but in the meantime, gents, you know why I have such a solid SSB signal on 10, 15 and 20 meters.

And maybe he could flunk just one more time without getting too discouraged.

Just Call Him Doc . . . Many physicians are active hams, finding the game a welcome relief from professional activities. It was fun, therefore, to eavesdrop on a phone conversation between W2MD and WA2RAU and to hear one of them addressed repeatedly as Doc.

"Well," I thought to myself, "at last the FCC has issued the right call to the right man."

But it was too good to be true. When they signed off it turned out to be WA2RAU and not W2MD who was the doctor!
ALL through North America short-wave signals from our Latin neighbors to the south are so plentiful that most DXers pass them by. And because they are in Spanish, few short-wave listeners, looking for an interesting program, pay them much heed.

The fact is, Spanish stations deserve more. Their programming compares favorably with many European stations, and for sheer excitement there's nothing quite like Central and South America. Where else can you find such a heavy schedule of political revolutions and such widespread economic changes? These historic events, as well as lesser day-to-day happenings, are covered by and reflected in Latin America's radio programs.

Atmospheric and ionospheric conditions are unusually kind to signals from south of the border, and these signals also are the only ones available here which have traveled parallel to the lines of the earth's magnetic field. The exact effect of this on short waves is still a moot point but it appears to aid propagation.

Latin America presents many contrasts, so far as the DXer is concerned, because it stretches...
for 6,000 miles (twice the distance across the Atlantic) from the U. S. border to Cape Horn. The formula for bringing in Cuba or Mexico naturally is not going to hold for Chile or Argentina.

Although the Latins offer rewarding transmissions, permitting you to keep track of revolutions, propaganda wars and even minor shooting wars, they have a drawback in that most of their programs are (naturally) in Spanish. There are many English-language transmissions from down south, of course, but your listening can be more rewarding if you crack the language barrier. First step is station identification. An SW catch is worthless unless its source is known.

Unlike North American stations, many Latins do not identify by call letters. Instead, they use a slogan such as Radio Nacional, La Voz de Colombia, etc. These are not difficult to pick out, even in an all-Spanish program. A second clue to identification is location. Though the speaker may be Spanish, you will have no difficulty distinguishing names like Caracas, Havana, Bogota and so on. The trick here is to learn a
Many taped programs produced in U. S. are broadcast by Latin stations; tape above has just arrived.

little geography before listening. If you hear the word Fortaleza, for instance, you should know that you have Brazil. Such ID's often are preceded by a musical or gong signature.

Daytime reception of Latin America is pretty well limited to 19, 25 and 31 meters but at night the picture changes. Then you find them coming in on 49m (5950-6200 kc), 60m (4750-5060) and 90m (3200-3400). The high-frequency stations are still on after dark, of course, but for interesting reception you must tune the lower channels, too.

Interference can be a headache. Some channels are assigned to as many as five or six different stations. Thus, it becomes a matter of catching a station while it's on top. Generally speaking, Brazil (two hours ahead of EST) and lower South America are best around local sunset, with the Caribbean and Central America taking over later. After midnight most stations have signed off and those remaining are in the clear.

The 60m and 90m bands are different from any other SW frequencies. They are classed as tropical, being assigned to broadcasters only near the equator. Elsewhere they are open to utilities and the military. Because of high absorption, distant reception is possible only at night, sunset and sunrise. In summer, when static is a major problem, the best time is around 6 p.m., local standard time. At that hour it's already dark in Latin America (which lies east of North America), while local static has not yet built up.

You'll find many missionary stations in Latin America. They can be rewarding (DX-wise) because most now include news and local-color programs in their schedules, which was not the case at one time.

In the British West Indies is a veritable hive of broadcasters (13 in all) who transmit primarily in English and provide first-rate entertainment features.

All political persuasions dot Latin America’s map, from the staunch right (Argentina) through the middle-of-the-road (Organization of American States members) to the left (Cuba).
For the home recording buff: a mixer plus VU meter that will handle four microphones per channel.

By Harry Kolbe, Contributing Editor

**Schematic of the two-transistor VU meter amplifier. Toggle switch S1 connects the meter to either the right or left channel.**
IN THE past year or two, home tape recording has boomed in popularity. Relatively inexpensive stereo recorders are now available with quality approaching that of professional machines. Once the tape-recorder owner is bitten by the bug, he tries his hand at taping live performances. As he becomes proficient in the techniques, he realizes that he needs additional equipment to get professional-quality results.

The professional recording of a live situation may require the use of two or more microphones on each channel, or the mixing of other material into the program. Unfortunately, most stereo tape recorders can take only two inputs at a time. Professionals use a device called a mixer which is capable of accepting several different inputs and mixing them in any desired proportion into a single signal. Of course, a separate mixer is needed for each stereo channel.

The amateur can get the same kind of professional results with an ingenious low-cost transistorized mixer—one that can be built for under $20. Each channel of this mixer can take up to four signals from microphones, tuners, phonographs, recorders, etc. The level on all four of the mixer inputs can be varied independently and combined into a single output. For example, you may be taping a stereo record and at some point you may want to fade in a microphone and fade out the phonograph to make an announcement. With this mixer it’s a cinch.

In addition to the mixing facilities of the unit, a VU meter is included so the output of either channel of the mixer may be monitored. Once the VU meter is calibrated, it will be possible to adjust the relative levels of any of the mixer inputs so the signal to the recorder is at the proper recording level.

The heart of the stereo mike mixer consists of a pair of commercial four-channel transistorized microphone mixers. We found that these mixers had frequency response that was down 3 db at 8.5 kc and a gain of little over 1.5 db. Although this is sufficient frequency response for the microphones supplied with the average inexpensive recorder, it was felt that some attempt should be made to improve the response characteristics of the mixer for those people who have purchased better quality microphones. By adding three resistors and a capacitor, it was possible to broaden the frequency response to a point where the mixer was down only 3 db at 18 kc at a slight sacrifice in gain. At the low end, the mixers are flat to below 20 cps.

A high-input-impedance, high-gain, two-transistor amplifier is used to drive the VU meter and its gain is high enough that even a microphone signal of a few millivolts gives full-scale meter deflection. The current drain is so low

VU meter board. Dotted lines represent wiring on reverse side. In board's center are meter terminals.

September, 1962
the battery will last almost its shelf life. The input of the VU meter amplifier is connected through an SPDT switch which permits the meter to be switched to the output of either channel.

Modifying the Mixers. A good starting point in the construction of the mike mixer is the modification of the mixer units. Remove the covers of the two mixers. Soldered to one level control is a four-terminal tie strip (see Fig. 3). Remove the 330,000-ohm (orange-orange-yellow) resistor (R3). In its place, connect R1, R2 and C1 as shown. Next, referring to the transistor lead marked with an X in Fig. 3, install a 33-ohm resistor (R4) as shown. Connect a 10½-inch length of shielded audio cable to the output jack of each mixer. The inner conductor connects to the center terminal of the jack, shielding to the ground side. This completes the electronic modification of the mixers.

The VU meter and amplifier are mounted in a 5 x 2¼ x 2¼-inch Mini-box. Drill the holes required for M1, R1, S1, S2 and the audio cables from the mixers. Install the cabinet mounting components.

The VU meter amplifier is built on a 2¼ x 2-inch piece of perforated board. Mount the components by pushing leads through the board’s holes. Solder the connections on the reverse side as shown in the pictorial. Take care not to heat-damage the transistors. Mount the completed amplifier on the meter terminals and then make the appropriate connections between the amplifier and other components as shown.

The unit pictured was stacked by running bolts through the covers. If your setup requires a different arrangement, feel free to make modifications.

A word of caution: You may feel it’s more efficient to operate the two mixers from a single 9-volt battery. Don’t do it or you may run into a feedback problem due to the common power supply.

For maximum usefulness, the VU meter in the mixer should be calibrated to operate in conjunction with your recorder’s level indicator. Although not shown in the author’s prototype, use a pointer knob and scale on VU level control R1 to enable accurate re-setting. Make some test recordings with your usual microphone setup, and adjust R1 so that the average recording level falls on or about 0 db immediately before the recorder’s indicator shows overload.

Note that the mixer’s low output impedance enables long lines to be run between the mixer and recorder without noise pickup or high-frequency loss.
Details of feedback conversion made to commercial mike mixer to extend mixer's frequency response. Olson mixer is shown. Lafayette unit has same parts values, but different tie-strip arrangement.

Internal view of the completed VU meter amplifier. The bolts protruding from the case are used to hold the three units together when stacked as in photo at right. Any workable setup may be used.

www.americanradiohistory.com
WHAT IF you wanted to get hold of a good oscilloscope just long enough to check out your hi-fi system? If you're stuck for an answer, you may have stumbled onto a lucrative opportunity—the electronic rental business.

The idea of renting out equipment to people who have a temporary need for it must go back into antiquity, but now there's something new—the rental store that handles nothing but electronic equipment. A few of these stores already are in operation and more are certain to come. The fact that there are few of them means the field is wide open for a man looking for an opportunity.

Though the initial investment in equipment to set up a rental service is not on the piggy-bank level, the money doesn't have to be yours. Lending institutions are always willing to invest in a promising business. But it can be done on a shoestring.
Maurice Rosenthal, who with his brother Mike runs Ametron Rents in Los Angeles, could tell you that.

Maurice was an electrical engineering student in frigid Alaska when the electronic rental idea struck him. He started by renting sound systems to Far North PX’s, then moved south and in 1951 opened the doors of Ametron, specializing at first in portable TV receivers.

Nowadays Maurice and Mike will rent you almost anything, so long as it’s electronic. And they have a profitable point to make: it’s far easier to sell an electronic prospect on renting than talk him into buying.

At Ametron you can rent a $225 console phonograph for $15 a day, plunk down $10 a day for a pair of transistorized handi-talkies (cost: $320) or rent an entire sound system and a crew to run it for $350 a day.

“And,” says Maurice, who shelves more than 1,000 rentable items, “a renter’s check becomes his down payment, should he decide to buy.”

“We’re still something of an oddity,” the brothers say of their business. But the two are convinced that renting electronic gear is a golden career opportunity. How golden? Well, consider a transistorized wireless microphone that lists for $650, costs the rental man $445 and rents for $25 a day. At worst, he may expect to recoup his investment in a year (by renting the mike only 20 out of 365 days). Actually, he well may double or triple his investment. Comes the end of a year and he promptly sells the used mike for $225.

Multiply returns like that by 1,000 rental items and you’re headed for an enviable tax bracket.

Even in the electronic rental field you find specialists. Some stock nothing but medical equipment, others go for such construction-industrial gear as pipeline locators and spectroscopes.

The general rule about what to stock says you should have what your customers want. If you’re in mining country, you need such prospecting aids as electronic ore-finders. Marine radios and direction-finders find renters in boating communities.

Among your customers you should expect local business firms, service clubs, industrial plants and such consumers as hams, Citizens Banders, hi-fi fans and general hobbyists. Ametron’s business is about 50% industry, 25% consumer, 25% highly specialized. It stocks dictating and intercom systems, air purifiers, slide projectors, mikes, lecterns, prompters and page-turners, along with more common items for home experimenters.

Ametron and others have proved there is money to be made in renting electronic gear. It’s an opportunity worth looking into.
STEREO FM broadcasting brought new problems, as well as new joys, to the ardent audiophile. FM tuners which had more than adequate sensitivity for standard FM broadcasts suddenly delivered noise and distortion when adapted for stereo. As EI has mentioned several times, the effective range of stereo broadcasts may be cut by a third in comparison to the signal strength of the equivalent mono broadcast. A better antenna usually helps, but if its installation presents difficulties for you, a booster may be the answer.

EI's transistorized FM Booster adds two RF stages to your tuner. Connected between the antenna and the tuner, the Booster's 18-db gain (and noise figure of better than −50 db) will bring in those once faint stations with excellent fidelity.

Construction. The prototype was built on a perforated Bakelite board, but the reader has the option of construction techniques. To eliminate hand capacity effects, the Booster board could be enclosed in a metal cabinet. For clarity, the pictorial shows the leads somewhat longer than necessary. In practice, keep the leads as short as possible. The two coil forms shown (L2, L4) are modified by the addition of L1 and L5. These consist of 2½ turns of No. 28 enamel wire interwound between existing turns of

Booster schematic is simplified by showing SW1 with letters keyed to the connections.
input and output coils L2 and L4.

Inductance L3 consists of 2½ turns of No. 18 enameled wire wound on ¾” rod with the turns spaced about the diameter of the wire. After winding, remove the rod and mount L3 directly to the terminal strip.

If you have difficulty obtaining the coil forms specified for L2 and L4, you can make two more coils like L3, except this time leave in the 3/8” diameter forms. Then wind L1 and L5 on the forms as before.

Choke CH1 consists of 30 turns of No. 28 enameled wire close wound on a 1-megohm, 1-watt resistor.

Switch S1 both turns the booster on and off and switches the antenna from the input of the booster to the input of the FM set. A transistor radio 9-volt battery eliminator serves as B1.

Adjustment and Operation. For general use, tune in a weak station at the center of the dial and then switch on the booster. Tune C4 and C8 for maximum response as indicated either by the tuner’s tuning eye or meter. If it is not possible to peak C4 or C8 for maximum tuner response, its corresponding coil may not have sufficient inductance. You can vary the inductance by adjusting the coil cores. Note that the bandpass of the Booster is about 4 megacycles wide. This means that it would be best to use C4 and C8 to tune the Booster to the station you’re most interested in receiving.

Profile of the Booster shows the relationship of the coil forms and the other major components.

Resistors: 1/2-watt, 10% unless otherwise indicated
R1, R6—560 ohms
R2, R5—8,800 ohms
Capacitors: low-voltage ceramic disc, unless otherwise indicated
C1—10 mfd
C2, C3, C4, C6—22 mfd
C7—0.002 mfd
CH1—30 turns, #28 enamel wire wound on a 1-megohm, 1-watt resistor

A kit of the above parts (less power supply) is available from the Thermocare Co., 54 Butchertown St., Bethpage, N. Y. Price is $9 postpaid.

September, 1962
CONTINUITY CHECKER

FOR PRECISE measurement of resistance you need an ohmmeter. Usually, however, you're not interested in exactly how much resistance is present, but only whether there's continuity in the circuit or part under test.

A simple continuity checker that operates directly from the AC line can be constructed with less than a dollar's worth of parts. As shown in the diagram, a series resistance (150,000 ohms, ½ watt) in each probe limits the electrical current flow to a safe value. Simply plug the tester into any 117 VAC outlet and use both probes to check for continuity in tube filaments, flash bulbs, fuses, etc. Neons with built-in resistors don't need a 150K in series.

Grounding and Leakage Check

With this simple tester you can check for leakage currents in appliances and find out whether they're safely grounded. Plug in the tester and touch the probe with the neon indicator to a water pipe, the screw holding the plate on an AC outlet or some other ground. In one position of the AC plug the neon lamp will light when the probe touches ground. When the plug is reversed in the wall socket, the neon will not light. This last plug position is the one to use for testing current leakage. Plug in the appliance under test (radio, TV, hi-fi, electric iron, etc.) and touch the lamp prod to its metal housing or chassis. Observe the brightness and then reverse the appliance plug and repeat the test.

If the neon lamp lights at full brilliance (as when the checker's probe tips are shorted together) the appliance should be checked for a short to the AC line or for low resistance between the AC line and chassis. If the lamp lights dimly, there's probably a normal degree of leakage. In that case, it may be a good idea to run a ground wire (ordinary lamp cord will do) between the appliance cabinet and the nearest ground. This may save you from a dangerous shock in the future. A three-wire line cord can be used on units that won't take a separate ground wire.

Note that most receivers and hi-fi amplifiers will show a definite amount of AC leakage. This is usually due to the bypass capacitor connected from the primary of the AC power transformer to chassis. Do not place a ground wire directly to the chassis of an AC/DC receiver, you may blow a fuse.—Dave Gordon

Electronics Illustrated
The romance of chatting with people in far away places makes for a boom in recording societies.

By Alan J. Broder

AMATEUR tape recording, once the province of hi-fi fans, has in a few years blossomed into something infinitely larger than a spare-time hobby. Today the world is covered with a net of magnetic tape carefully put together by amateur recordists, some of whom have close friendships with people in 25 or 30 countries. Any avocation that can make friends of a farmer in Kenya, an engineer in California and a student in India must be reckoned a force for international goodwill and understanding. The photographs above give some idea of the magnitude of this network, showing a tape club leader in Tokyo, a Bolivian recording at his office desk in La Paz, school children putting their voices on tape in Rarotonga, and a tape party on an Israeli kibbutz. In any activity as widespread as this one, there must be clearing-houses that put people in contact with each other and keep communications orderly. The clearing-house for recordists
A tape-correspondence fan gets audio letters from many lands; this one came from England.

is the tape club. Several hundred clubs are scattered about the near and far corners of the world.

Largest and probably best known is World Tape Pals, Inc., organized ten years ago in Dallas, Tex. WTP and its associated clubs have a combined membership of some 5,000 people who represent every major free nation on earth. Other large groups include the Voice-spondence Club (1,400 members in 32 countries), the Organ Music Enthusiasts (200), Catholic Tape Recorders International (200), Stereo International (150) and American Tape Exchange (150).

Although tape clubs are gaining popularity here, in England their history has been nothing short of fantastic. In six years they've gone from one club to more than 150.

Tape clubs come in two varieties—large international ones and smaller local groups. To see how an international club works, let's look at what happens when someone joins—in this case myself.

To join World Tape Pals, I filled out an application, giving my equipment and my general and specific interests. Then I received a roster listing every WTP member. Beside each person's name was a list of his interests. In addition to serious music devotees like myself, I found those who went for stamp-collecting, theater (amateur and professional), sports cars, handicrafts, antiques and a great many other subjects.

After my name came out on the roster I began to receive (and send) written letters from other members in different parts of the world who wanted to exchange tapes. So it goes. Through clubs and mutual tape friends you acquire the names of others with interests similar to your own. Letters usually are exchanged and then tapes.

Most popular size audio letter is the "message" tape on a 3-inch reel. If you and your tape pal agree on a more extended exchange, you use 7-inch reels, or perhaps 5-inchers.

What do you get out of exchanging
Typical meeting of local club—the N. Y. Tape Recording Society. The president is speaking.

tapes? Aside from giving you new friends all over the world, listening by tape is the next best thing to being there in person, and no other form of communication is quite as intimate as a tape recording.

As a music lover, I have visited all the great concert and opera halls of the world without leaving my home, and I now have taped concerts from England, South Africa, Australia, Spain, New Zealand and several cities in this country. I’ve known of marriages between people who first became acquainted via tape, war brides who keep in touch with their distant families and friends through tapes, and people who’ve learned a foreign language by exchanging tape with a citizen of another country.

When you make your first tape you probably will find the conversational approach easiest and most interesting. My first tape to a new correspondent (or tapespondent, as some call them) usually consists of some kind of musical introduction, taken from a record, another tape or recorded off the air. Then I describe myself, my city, work and hobbies and come to my particular interest of music, recording samples from various works and sometimes commenting on them. On future tapes, complete musical compositions or concerts may be exchanged. Try to make your material as interesting as possible, even if your hobby is an all-talk one such as stamps or gardening.

Members of international clubs seldom meet face to face but in local clubs, serving in a social and informative role, they do get together every month or so in someone’s home or (more likely) a public building. Usually there’s a lot of informal chatting, and sometimes a member may play an especially entertaining tape he’s made or received. Quite often there’s a talk by a visiting

[Continued on page 112]

**POPULAR TAPE CLUBS**

- **Indiana Recording Club**
  3612 Orchard Ave.
  Indianapolis, Ind.
- **Organ Music Enthusiasts**
  152 Clube Ave.
  Amsterdam, N. Y.
- **Stereo International**
  1067 Flatbush Ave.
  Brooklyn 26, N. Y.
- **Union Mondial des Voix Francaises**
  886 Bushwick Ave.
  Brooklyn 21, N. Y.
- **New York Tape Recording Society**
  1 West 64th St.
  New York, N. Y.
- **American Tape Exchange**
  Box 324
  Shrub Oak, N. Y.
- **Catholic Tape Recorders of America**
  25 South Mount Vernon Ave.
  Uplandt, Pa.
- **World Tape Pals, Inc.**
  Box 9211
  Dallas 15, Tex.
- **The Voicepondence Club**
  Noel, Virginia
- **Australian Tape Recordists Assoc.**
  Box 570H, GPO
  Adelaide, South Australia
- **Club du Ruban Sonore**
  Grosse Ile, Cte.
  Montmagny, Que.
- **Canadian Bilingual Recording Club of Canada**
  1457 Gilford St.
  Montreal 34, Que., Canada
- **Magneo-Vox Club**
  8140 10 Iome Ave.
  Montreal 38, Que.
- **Canada Tape Recorders Club**
  123 Sutton Common Rd.
  Sutton, Surrey, England
- **New Zealand Tape Recording Club**
  39 Ponsonby Rd.
  Auckland, W.1., New Zealand
- **English Speaking Tape Respondents Assoc.**
  Schoolhouse
  Whitsome by Dums
  Berwickshire, Scotland
THE BRILLIANT Russian pianist Sviatoslav Richter seems ubiquitous in the recording world: he's on no fewer than seven labels. For Angel (see cut) he plays Beethoven's Tempest Sonata and Schumann's C Major Fantasy with insight and warmth. For the new Philips line, he is joined by the London Symphony Orchestra, led by compatriot Kiril Kondrashin, in scintillating performances of the two Liszt Piano Concertos.

On RCA Victor, Charles Munch and the Boston Symphony Orchestra collaborate with him in a sinuous, subtle reading of Beethoven's First Piano Concerto, encored with a lively reading of that composer's little-played Opus 54 Sonata. Lastly, Columbia has released another disc from the series of recitals he gave at Carnegie Hall in 1960, offering another Beethoven Sonata, Opus 10, No. 3, and a collection of Rachmaninoff Preludes, played with assurance and skill. Those four are his new discs.

Salome and Elektra, the two Richard Strauss operas that shocked audiences a half-century ago, comprise colorful fare, with opportunities for huge sonorities and subtle relationships between voices and orchestra. The London engineers and Georg Solti project Salome's theatrical effectiveness with imaginative engineering and conducting. Elektra is not nearly so successful a presentation. Its barbaric power is weakened by timid engineering and conducting that is deficient.

Two of the girls from the Metropolitan have a go at the pops repertoire, Patrice Munsel for the first time and Eileen Farrell for the third or fourth. Unpredictable is an accurate title for the former's disc; nobody would have predicted that a coloratura soprano could belt out rhythm numbers with the enthusiasm and power displayed here by the Munsel gal. Of course, where Farrell is concerned, we get what we expect, and that's a lot.

Belafonte's recordings are exciting entertainments and The Midnight Special is no exception. Each song is a special production, artificial and polished, to be sure, but made vital and artistic by personality and sensitivity and a tremendous amount of skill.

George Greeley does nice things on the piano with several of Gershwin's lovely songs. However, he was poorly advised to include truncated, undiomatic renditions of the Rhapsody in Blue and An American in Paris. These two concert works demand concentration and integrity; they firmly resist the casual approach.

Folksong: U.S.A. is a gaudy title for a program that includes Nothin' Like a Dame from South Pacific and Little Bit O' Luck from My Fair Lady. The Robbinsdale Chorale sings with enthusiasm and precision, however, while the recording captures the sound of a large chorus with commendable clarity and spaciousness, particularly in the haunting Shenandoah.

Herbie Mann at the Village Gate offers only three numbers: Comin' Home Baby, Summertime and an amaz-
ALTHOUGH the trend is toward integrated stereo preamp-amplifiers, the audiophile with a taste for top equipment usually goes for a separate stereo preamp and dual power amplifier with 50 watts or more per channel.

How good are these 100-watt-plus monsters? Do they live up to their specifications? To find out, we checked out one of the big-power units, Lafayette's KT-550, which has a power rating of 50 watts per channel.

Construction. The KT-550's manual is well done, but if yours is numbered IM-185 (inside front cover), make sure that amendment sheet IM-186 is included.

Sub-assemblies and two printed circuit boards make wiring this kit a cinch. Because the silicon rectifier's thin pigtail leads tend to bend, mount them so they are spaced well away from the chassis or other components. If the uninsulated rectifiers accidentally contact a ground, you'll short out over 400 volts of B+.

Another area where it's a good idea to cross-check every connection is in the control panel wiring. Take it slow here because you are dealing with a multi-contact switch, an area of potential trouble in any kit. Expect to spend about twenty hours on the kit before checkout.

Test results. How well does the KT-550 check out? In a word— superbly. In fact, some of our findings were slightly better than Lafayette's figures.

With both channels driven, we found each channel capable of 50 watts output from 20 to 20,000 cps at only .5% harmonic distortion. Fifty watts per channel also is available before intermodulation distortion hits .5%, and 60 watts before it hits 1%.

At the 1-watt level, frequency response was flat within 1 db from 5 cps to 100 kc. To understand the
reason for this sub-to-ultrasonic frequency response (when the human ear itself doesn’t cover the range), we’ll have to look into the subject of phase shift, a seldom-mentioned but important factor in any amplifier. A signal is flipped 180° in phase every time it goes from grid to plate of a vacuum tube. In addition, the signal is shifted plus or minus some extra degrees by the inductance and capacity in the circuit.

If an amplifier has non-linear phase shift, which is 10° at one frequency, 20° at another and 30° at a still higher frequency, the harmonics of the frequencies being amplified will be shifted out of their proper relationship. This is known as phase distortion, and many authorities consider it responsible for the “it tests good, but doesn’t sound right” problem. Phase distortion is fairly easy to test for, but hard to eliminate.

In order to minimize phase shift in the frequency range we can hear, the frequency response of an amplifier has to extend a decade plus an octave above and below the audible range. This means that for zero phase shift from 20 cps to 20 kc, an amplifier would have to be flat from 200 kc at the top down to 1 cps at the bottom end. Cost makes such a unit impractical but, as you can see from our figures, the KT-550 is one of the amplifiers that almost makes it.

The square-wave scope traces shown on these pages were taken with 20 cps and 20 kc signals at the output of the KT-550. The amount of tilt on the tops and bottoms of the waveforms indicates phase shift or lack of it. The 20-cps wave indicates practically zero shift, while the 20-kc square wave indicates a trace of ringing and has about 20° phase shift—still a respectable figure at that frequency.

Circuit Design. Since the designer of the Lafayette amplifier attacked a problem (phase shift) not usually recognized as significant, new paths were blazed. The design goal is for widest possible bandwidth in each stage while minimizing and compensating for phase shift. This was achieved in an interesting way.

Until recently, amplifiers used a single feedback loop, usually from the secondary of the output transformer back to the cathode of the input tube. Phase shift problems within the amplifier limited feedback to about 20 db. The use of multiple (six) feedback loops in the KT-550 permits over 50 db of distortion-reducing negative feedback.

You can see the interrelations of the various factors. Wide bandwidth is needed to eliminate phase shift. When you get rid of phase shift, you eliminate phase distortion and can use high feedback without instability. And you need high levels of feedback both to extend
The twenty cycle square wave demonstrates excellent low-frequency response.

Twenty thousand cycle square wave testing high-frequency response.

The frequency response (bandwidth) and to reduce harmonic and intermodulation distortion.

Let's look at the schematic of one channel of the KT-550. (Omitted are the metering circuit, bias and power supply.) We'll start at V1a, used in a standard pentode configuration, and trace the circuit to the output stage. Notice that a feedback loop is brought from the secondary of the output transformer to its cathode. The signal from the plate of V1a is fed to both V1b and V2.

V1b is a novel phase inverter. The tube has so much negative feedback around it (via R12, C3, C4) that gain is reduced to 1. However, since it is still functioning as an amplifier triode, it reverses the phase of the signal and feeds it to the grid of V3. Because of the heavy feedback around it, this type of phase inverter is virtually distortion-free and has excellent balance. While the signal from the phase inverter goes to V3, the non-inverted signal is fed directly from V1a to V2.

Drivers V2 and V3 (usually used as video amplifier tubes) feed a pair of push-pull 7027A pentodes operating in class AB1. The KT-550 is one of the first amplifiers to use this new tube. Operated conservatively, the 7027A is pushed to only about 80% of its maximum rating—which means a comparatively cool-running amplifier.

[Continued on page 117]
Square-Wave Adaptor

Transistorized trigger circuit changes any audio sine-wave signal into a fast rise-time square wave.

By Daniel Horowitz

IF YOU own a sine-wave generator which does not have provision for square waves, you can add this exceptionally useful feature with a simple two-transistor adaptor. The compact, self-powered unit, when driven by a sine-wave generator, provides high-amplitude square waves with a good waveshape over the entire audio range. Construction cost is under six dollars.

Most build-it-yourself square-wave adaptors have been clipping circuits which simply chop the tops and bottoms off the incoming sine wave. Even those clippers with built-in amplification are unable to provide a high-quality square wave because of the inherent slope of the sine wave it has to work with. EI's adaptor operates on an entirely different principle. Here the incoming sine wave serves simply to trigger a transistorized Schmitt multivibrator circuit. It is the Schmitt trigger, flipping
the position in ON pole switch S1 incoming signal. This makes possible types with techniques. See 101 Ways to Use Your Audio Test Equipment, H. W. Sams & Co.

Theory. Transistors Q1 and Q2 are connected in a Schmitt trigger circuit, a form of emitter-coupled multivibrator. With no input signal, transistor Q1 is cut off and transistor Q2 is conducting. Bias to keep Q2 conducting is supplied by the voltage divider composed of resistors R4, R5 and R6.

When the input voltage to the base of transistor Q1 increases past its emitter bias voltage, Q1 is switched on and Q2 switched off. When the input signal to the base of Q1 goes down again, Q1 goes off and Q2 is switched on. Since the switching action is rapid, the waveform at Q2's collector is a square wave. Symmetry potentiometer R2 controls the bias voltage of Q1 and therefore sets the level of input at which the circuit switches.

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TOR'S TEST BENCH in this issue). Since the adaptor can be set (with R2) to provide square waves with nonsymmetrical tops and bottoms, it is capable of some specialized testing techniques. See 101 Ways to Use Your Audio Test Equipment, H. W. Sams & Co.

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If you own a sine-wave generator as part of your test-bench equipment, you need not be reminded of its virtues. For audio experimentation, design or servicing, a sine-wave generator is mandatory.

Square waves, on the other hand, have their own special applications which supplement the standard sine-wave tests.

For example, let's say you wanted to run a fast frequency-response check on an amplifier, using a sine-wave generator. What you would do is feed in your sine wave at several spot frequencies—20, 100, 1,000, 5,000 and 10,000 cps, etc. You would keep tab on the input voltage from the generator and compare it with the output of the amplifier under test.

What you're doing is determining if the amplifier is amplifying all frequencies equally. For a professional approach, you would check even more frequencies and chart a curve on a sheet of five- or six-cycle semi-log graph paper. If the deviation (at a particular output power) is no more than ±3 db, the amplifier is considered flat over the frequency range checked.

These are standard techniques and work well. But, as you may imagine, they can be a little tedious. Three quick square-wave frequency checks, however, will show not only the frequency response but also such important amplifier characteristics as transient response, phase shift and stability.

How is a square wave able to do this? Its special properties derive from the fact that a square waveform, if broken down, can be shown to be the sum of a whole series of sine waves starting at the fundamental frequency (of the square wave) and including the third, fifth, seventh, ninth, etc., odd harmonics. Sending one square wave through an amplifier is, therefore, the equivalent of putting through a large number of sine-wave test frequencies simultaneously.

The trace displayed on the scope at the output of the amplifier provides a pretty good indication of how well the amplifier is able to handle the various portions of the frequency range that make up the square wave. As a rule of thumb, if a square wave of a given frequency comes out of the amplifier with the same waveform it had when it went in, we know the amplifier is essentially flat from about 1/10 to 10 times the fundamental square-wave frequency.

For example, if a 1,000-cps square wave goes through without visible distortion, the amplifier can be assumed flat from 100 to 10,000 cycles. You can see how square waves of only two or three frequencies can check an amplifier's response over the entire audio spectrum.

As I've mentioned, frequency response is not the only factor that square waves check. Arrayed on these pages are some oscilloscope trace photos I've made during various tests on amplifiers. The signal source for the tests was a Hewlett-Packard 200CD audio generator feeding the transistorized square-wave adaptor presented as a project in this issue. An RCA oscilloscope with a high-intensity CRT was used to display the waveforms.

There are certain points you should keep in mind when viewing a waveform display. The number and height of the
waves appearing on a scope face are determined not only by the voltage and frequency of the input signal, but also by the setting of the scope’s sweep and gain controls. Traces therefore are not directly comparable. The fact that three or four cycles may appear in one trace and only two in another has no significance so far as interpretation is concerned. The wave shape is the important factor. And because of that, you must make certain that before and during the tests the test equipment isn’t responsible for any distortion observed.

For example, if an oscilloscope does not have a wide bandwidth there is no point in trying to view a low- or high-frequency (10 cps, 100 kc) square wave. You will not be able to tell whether the amplifier or the scope is responsible for the distortion. Even when a scope does have adequate bandwidth, if its attenuator compensation capacitors are out of adjustment, visible high-frequency distortion will result. Let’s take up the specifics of the waveforms shown below.

**Photo 1.** This is a 20-kc square wave test signal fed directly from the square-wave adaptor to the oscilloscope. Note that as we’ve mentioned, both the amplitude and width of the square wave are controllable by the scope and hence are not significant in the testing. Actually, the waveform in photo 1 is a rectangle, but for our purposes it is just as good as a square wave and can be turned into one by the scope’s horizontal gain control.

**Photo 2.** This is a 1-kc square wave fed through an amplifier with the scope connected across a 16-ohm load resistor at the amplifier’s output. Note the peak (or overshoot) on the leading edge and the almost invisible sides of the square wave. The peak indicates a boost in high-frequency response which caused instability. The slight jaggedness shows a minor ringing or damped oscillation.

**Photo 3.** Here’s the same amplifier, but with a 10-kc square wave fed in. The ringing is quite evident. In an amplifier such as the standard Williamson this fault is due to phase shift at the high-frequency end, which turns some of the negative feedback to positive. The problem usually can be minimized by installing a small-value capacitor across the feedback resistor to compensate for phase shift within the amplifier.

**Photo 4.** The slight rounding of the leading edge indicates a small loss of high frequencies at about ten times the fundamental frequency of the square wave; the tilt indicates leading phase shift at low frequencies. The amount of tilt shown is not significant and the generator itself may be responsible.

**Photo 5.** Note while the tops of these square waves are concave, the bottoms are convex. If the amplifier under test is push-pull, an unbalanced condition exists somewhere in the circuit. The particular amplifier tested here is an inexpensive, single-ended type (one output tube). A 50-cycle square wave used in this test demonstrates the poor low-frequency response of the amplifier. The downward tilt following the leading edge indicates both low-frequency attenuation and phase shift. If a higher frequency, such as a 1-kc square wave, was used for this test, the amplifier would pass the wave without too much distortion.

**Photo 6.** This is the output waveform of the same amplifier as above when fed a 10-kc square wave. The severe rounding off of the leading edge of the square wave indicates the amplifier’s inability to reproduce frequencies of 10 kc and over. If this same effect were observed on a 1-kc square wave, it would indicate an almost total lack of high-frequency response.—Larry Klein

---

1. 20-kc test square wave.
2. High-frequency peaking.
3. Ringing due to amplifier instability.
5. Poor overall low-frequency response.
6. Extreme high-frequency loss.
WIN $20! With this issue EI begins a new series of awards for Citizens Banders, amateurs and short-wave listeners. In each issue we will publish photographs of the most attractive or efficient-looking shacks in those categories, along with the proprietor's name and a description of his equipment. To the owner of each Prize Shack will go a cash prize of $20. If you are a CBer, ham or SWL fan we invite you to send us a picture of your shack. Unused photos will be returned. The address: EI Prize Shacks, 67 W. 44th St., New York 36, N. Y.

**CB**

Our first Prize Shack in the Citizens Band category is owned by Charles (Red) Meyers, 2Q3459, Brooklyn, N. Y. Red has two transceivers—a Lafayette HE-20 and an EICO 761. He also has a short-wave receiver with converter for the public service band, a SECO antenna tester, field-strength meter and speech compressor. Red is 18, a high school student, and he helps dispatch equipment via CB for his father, who is an electrician.

**SWL**

Short-wave listener Lavoyd Kuney of Detroit has verified 142 countries and holds a Century Award from EI’s DX Club. He uses a Hallicrafter SX-100 receiver with a preselector. Lavoyd has a small forest of antennas, including a 29-foot vertical, a 20-meter folded dipole and a long-wire measuring 90 feet. He uses the tape recorder in the foreground to record his signals as proof of reception. His occupation is letter carrier.

**HAM**

Proprietor of our Prize Ham Shack is Dr. Harold H. Riker, K2JHA, a general practitioner in Flushing, N. Y. He has a Collins single-sideband 75 A-4 receiver and 1-kilowatt KWS-1 transmitter, plus a 2-meter Gonset Communicator. His antennas are a three-element (10-15-20 meters) Mosley beam and a trap doublet for 40 and 80 meters. Other equipment includes a band scanner and wattmeter. Note the wall-full of QSL cards.
For CBers...

a super-sensitive FIELD-STRENGTH METER

By Herb Friedman, 2W6045

Our SUPER-SENSITIVE Field-Strength Meter is designed specifically for the Citizens Bander new to electronic construction. No special wiring techniques are needed and the parts, including a stock coil, come to less than $6.

EI's Amplified FS Meter—like any other field-strength meter—indicates the relative power output of your transmitter or antenna system, or both. But because of its high sensitivity, our instrument can be used where its production-line counterparts fail. It is particularly valuable when tuning antennas, especially beams, because it indicates directly whether your adjustments are correct.

For accurate indications, any FS meter should be located a considerable distance from the antenna (ten wavelengths is...
recommended). Unfortunately, the output of a CB transceiver is insufficient to move the meter needle at any reasonable distance. But in the same location EI's amplified meter reads full scale.

Construction. The unit is built in a Minibox following the pictorial. Insulated antenna jack J1 is mounted in the center of the top panel. Transistor Q1 is specified as an RCA 2N406, but any low-cost small signal transistor may be used.

Wire in all the components, leaving diode D1 until last. When soldering D1, place an alligator clip on each of its leads to avoid damage. Since miniature parts are used, work with a soldering iron that has a 25-50 watt rating.

The tap on L1's coil is not used and is soldered to the terminal strip just to tie it down. Don't cut the tap short since the wires are enameled and it may be difficult to solder them together.

Leads may be soldered directly to battery B1 or a battery holder, mounted on the box cover, can be used. Since there is no measurable leakage current and the meter at full scale draws only 50 microamperes, any small 1.5-volt cell will give long-term performance.

The antenna is made from a section of coat hanger approximately 10 inches long. Be certain to scrape off the paint before installing the section in the antenna plug.

Adjustment. Run out L1's slug approximately 1/4 inch. Turn gain control R1 halfway up. Holding the meter near an antenna or transmitter tuned to the center of the Citizens Band (channel 9, 10 or 11), adjust L1's slug for maximum meter reading. As you peak L1, reduce the gain to avoid driving the meter off scale.

Using the FSM. Since the instrument is extremely sensitive, care must be taken to avoid overloading. Always start with the meter off, and advance R1 slowly until a half-scale reading is obtained. Once the meter is set for normal reading adjust the transmitter or antenna for maximum FRM response. This will insure optimum performance.

Theory. A standard-tuned circuit (L1, C1) picks up the RF signal and detector D1 rectifies it. The rectified RF (DC) is fed through gain control R1 to the base of a common-emitter amplifier and is amplified about 50 times.

All wiring in the unit is point-to-point. Jack J1 is insulated from the metal cabinet.

PARTS LIST
C1—52 mmf ±10% low voltage mica or disc
C2—100 mmf low voltage mica or disc
R1/S1—10,000-ohm miniature potentiometer with switch
D1—1N34A crystal diode
L1—Tuning coil (Lafayette Radio HP42)
B1—1.5 volt penlight cell
Q1—2N406 transistor or the equiv.
M1—Any 50 microamp meter movement. Type shown is an AM tuning meter
J1—Insulated banana jack and plug to match
Cabinet—approx. 1/2 x 2 x 3 inches
If you want to pick up single-sideband signals on the ham bands all you have to do is flip the switch on your receiver to SSB and begin tuning. That is, if your receiver came with a princely price tag and has this handy switch, it's all you have to do. But if you're a ham or short-wave listener with a more modest rig, bringing in SSB won't be quite so easy. It can be done, though. The secret lies in using your set's beat-frequency oscillator (BFO).

Unless your AM receiver is unusual, probably the first thing you should do in your SSB quest is to take off that dinky little knob on the variable BFO control and replace it with as large a knob as will fit on your rig conveniently. Why? Because a large knob's increased radius will permit fine adjustment of the control and a small knob does not. SSB requires a large amount of finesse in tuning the BFO control.

When you bump into an SSB signal it sounds like some kind of wild duck-talk. With BFO and automatic volume control (if your set has one) turned off, peak the signal as much as possible (this actually centers it in the intermediate-frequency pass band). You can tell when it's peaked by maximum readings on your S-meter or loudest audio. Turn the RF gain control to the minimum needed and the audio to wide open.

Now, with this unintelligible signal coming in, turn on the BFO and swing its variable control in either direction until the duck-talk is high-pitched. Then turn it slowly back so the audio comes down in pitch. Turning slowly and carefully on that large BFO knob, the duck-talk will suddenly become clear, intelligible speech.

The procedure may sound complicated, but after a couple of tries you'll find picking up SSB takes just a careful twist of the wrist. SSB stations can operate anywhere on the ham bands but by custom most of them congregate at the upper rim of the popular bands, and that's where to look for them.

A single-sideband signal actually is a regular AM signal stripped of one sideband and the carrier—leaving a single sideband, as the term implies. In order to recover the modulation in the signal, a receiver's detector needs the missing carrier. The output of your BFO provides it.—Nicholas Rosa, W1NOA

September, 1962
build your own

Radio Direction Finder

Poor man's RDF requires only a transistor radio and El's pocket-size adaptor.

By Len Buckwalter, Contributing Editor

NEXT to a compass, a radio direction-finder is a boat-owner's best friend. By giving bearings on any radio transmitter in its frequency range, an RDF enables the Sunday skipper to determine both the direction of shore points and his distance from them.

With about $10 worth of parts and a transistor portable radio, you can make your own radio direction-finder. And the radio will still do its usual job of furnishing music and news. The only modification to the set is the addition of a jack and two wires. The simple two-transistor RDF adaptor plugs into the jack.
You've probably noticed that transistor portables are sharply directional—as the set is rotated a station's apparent signal strength rises and falls. This is due to the loopstick antennas used in transistor portables. A loopstick responds best (produces loudest volume) when its side faces the transmitting tower. When either end points toward the station you get a null—the signal drops and background noise rises.

The signal changes affect the automatic volume control (AVC) voltage in the set. The RDF adaptor samples the AVC voltage and gives a reading on a meter. The two transistors serve as a meter amplifier and prevent the AVC from being loaded down.

Construction. The RDF adaptor is assembled in a standard Bakelite instrument case. Start by making the holes in the top panel for the meter control (R7), battery and switch. The battery holder is a clamp fastened to the panel with a single screw. Locate the hole for this screw at the center of the compass rose, which is cemented to the front panel. Choose a screw that's at least a half-inch long. After it is tightened in place with a nut (and holding the battery strap), use a file to smooth the screw threads above the top panel. This part of the screw later serves as an axle for rotating the radio.

The circuit board is wired separately, and when complete it is cemented to the rear of the meter. Two holes are drilled in the board so it can be slipped over the meter terminals.

Preparing the Radio. Because of the tight quarters inside the typical transistor portable, you may need a bit of ingenuity to mount miniature phone jack J1. Try to position J1 near the radio's volume control, but lead length is not critical. After thin, flexible wires have been soldered to J1 mount it on the case and locate the volume control and its five lugs. The two on the rear serve as the on-off switch. You want the two outer lugs of the control which are usually soldered directly to a printed-circuit board. If there is no room to connect wires directly to these lugs, solder to the printed circuit. You can hook the leads either way since polarity can be corrected later.

Check the position of the antenna loopstick in the radio. The loopstick usually lies parallel to one side of the

Simple direct-coupled transistor circuit functions as DC amplifier to AVC signal tapped from radio.
case. Make a mark along the edge of the case on this side and remember it as the reference edge.

**Checkout.** Plug the completed RDF adaptor into the transistor portable and turn on both. Tune in a station and adjust the radio's volume control to normal listening level. Now set R7 so the meter reads somewhere near center-scale. Dial across the broadcast band and see if the meter needle reacts to the signal strength—reading highest when nearby stations are heard. If the meter dips when a station is tuned in, reverse the leads of the connecting cable where they enter the RDF circuit board. Since the swing of the meter needle is influenced by the setting of the radio's volume control, simply turn up the radio's gain for a more positive indication.

Tune in a station, using the RDF meter as a tuning guide. Now, rotate the radio and notice the behavior of the needle. During one complete rotation it rises and falls twice. We're interested in the dip or null point (minimum reading on the dial) since it gives the most accurate indication. Either null may be used for direction-finding.

**Using the RDF.** You naturally need a compass on your boat in order to use a radio direction-finder. And you also need marine charts of your area, on which is noted the exact location of broadcast station transmitters (you draw in their locations). Such charts are available from the U. S. Coast & Geodetic Survey, Washington 25, D. C. (coastal waters), and the Army Corps of Engineers (inland waters), and also from local map houses. You could use road maps but they are not as accurate.

To check out your RDF before taking it aboard, place one of the charts on a flat surface and give it a northerly orientation. The longitude lines on the map should be parallel with the needle of a pocket compass placed on top of the chart.

Tune in a station and place the reference edge of the radio—mentioned earlier—on the map so it cuts across the marked location of the station's trans-
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GOOD READING

By John Milder

HOW TO BUILD ELECTRONIC EQUIPMENT. By J. Richard Johnson. John F. Rider, New York. 288 pages. $6.95

Nearly any electronic hobbyist, from a kit-builder to those who design their own construction projects, can profit from this book. A comprehensive guide to electronic construction techniques, it outlines methods to use in tackling virtually anything. Particularly valuable is the book's emphasis on mechanics: tools, hardware, chassis layout and design, and other matters which the average hobbyist learns to deal with only through a painful process of trial and error. Illustrations are plentiful. The typical one shown above demonstrates how to solder in a transistor without heat damage.

SINGLE-SIDEBAND CONSTRUCTION TECHNIQUES. By Harry D. Hooton. Howard W. Sams & Bobbs-Merrill, New York & Indianapolis. 286 pages. $6.95

Although they've been around more than 30 years, single-sideband techniques are still new to many hobbyists. Mr. Hooton's thorough handbook on SSB should be of value to amateur and professional alike. He has worked with SSB and other suppressed-carrier techniques some ten years. His book contains a good deal of new information, including new circuit designs and a limited number of construction projects.

BASIC RADIO COURSE. By John T. Frye. Gernsback Library, New York. 224 pages. $4.10 soft cover, $5.75 hard cover

This is a revised version of Mr. Frye's ten-year-old best seller. A glance will tell you why a new edition should do well. The author's clear, easy-going style can hardly be faulted. From the electron theory through resonant circuits and servicing techniques, Mr. Frye manages to be both informative and entertaining—an unusual feat in a basic text of any kind. The book is well organized and up to date, and has pertinent review questions after each chapter.

FM MULTIPLEXING FOR STEREO

By Leonard Feldman. Howard W. Sams & Bobbs-Merrill, New York & Indianapolis. 160 pages. $2.50

The first book this reviewer has seen on the Zenith-GE stereo FM system, this volume seems to be aimed primarily at the technician and serviceman. The latter should find it particularly valuable. The three multiplex circuits you find in most tuners and adaptors are thoroughly explained, as is the test gear required by the new medium. The author, a designer of multiplex equipment, dwells at length on the critical alignment necessary for good separation in the receiver circuits. There is room, however, for much more detail on the equally critical subject of antennas.

And make note of...

ELECTRONICS MATH SIMPLIFIED. By Alan Andrews. Sams. 224 pages. $4.95

VACUUM TUBE CIRCUITS FOR THE ELECTRONIC EXPERIMENTER. By Julian M. Sienkiewicz. Ziff-Davis. 176 pages. $4.95

101 MORE WAYS TO USE YOUR VOM AND VTVM. By Robert G. Middleton. Sams. 128 pages. $2.50
In this issue we conclude our CB servicing series by checking some typical transmitter circuits and their troubles.

POOR Transmitter Output; Receiver Operates. Prepare the transmitter for testing by connecting either the visual RF indicator, a power meter or a dummy load to the antenna jack. Transmitters under test always should be terminated, but never by the antenna. There is no excuse for jamming a channel with your testing.

In any transmitter failure the crystal should be checked first; defective crystals are the prime cause of poor transmitter performance. Transmitter oscillators are checked in the same manner as receiver oscillators. However, a weak transmitting crystal usually fouls up transmitter operation far more than a bad receiving crystal upsets a receiver. Also, transmit crystals have a
higher percentage of failure because they usually work in a relatively high-power circuit. For a quick crystal check, simply replace a suspect crystal with one of known quality. As a general rule, the CBer should have one known-good crystal which he uses for test purposes only. (Many is the rig that has had a full set of weak crystals.)

If the crystals are all right, check for an RF signal (grid drive) at the RF power amplifier grid point A, V2 (Fig. 1). This will be shown by a negative grid voltage of about -15 to -30 VDC. If there is little or no negative voltage, oscillator coupling capacitor C1 may be open. A positive grid voltage on V2 indicates C1 is shorted or leaky.

Let’s say that the crystal and C1 are okay, but the RF drive signal is still missing from the RF power amplifier grid. In that case, component aging may have detuned the oscillator plate circuit (L1-C2). A grid dip oscillator (GDO) is the best means for checking tuning (resonance). Place the GDO coil alongside the oscillator plate coil and tune the GDO through the 25- to 30-mc range. If the GDO dips, but not near 27 mc, it means the plate circuit is detuned. Consult the manufacturer’s instructions for his recommended procedure in this case. If the GDO does not dip, plate tuning capacitor C2 probably is defective.

If the oscillator is working (as evidenced by the presence of negative voltage) use the GDO as described above to check the plate circuit of power amplifier V2, Fig. 1.

While the transmitter circuit shown in Fig. 1 at one time was fairly standard, a variation shown in Fig. 2 is used in many late models. Usually the crystal is cut to half-frequency, 13.5 mc, with buffer doubler amplifier V3 doubling the crystal frequency to 27 mc. V3 also amplifies the signal, resulting in a more efficient transmitter having greater crystal stability since 13-mc crystals are more stable and rugged than overtone types. In some transmitters, the crystals are one-third frequency and use a tripling amplifier. In any event, the same troubleshooting techniques apply, the difference being an additional amplifier.

**Distorted or No Modulation; Receiver Operates.** Since the receiver is operative, the audio section common to the transmitter and receiver must be working; therefore, either the microphone preamplifier or the microphone itself is defective.
In order to check the transmit audio quality, some means of monitoring the audio must be provided. The simplest, though not the best, method is to connect one lead from a good-quality, high impedance (2,000 ohms or higher) headset to the chassis. The other lead is connected in series with a .05-mf, 600-VDC capacitor to the plate of modulator tube V1, Fig. 3. This arrangement enables you to judge whether the modulator is clean, but will not indicate the modulation percentage, which is as important as audio quality.

A CB transmitter tester such as the SECO 510 provides a power meter as well as a percentage modulation meter and an off-the-air audio detector. Since the instrument's audio detector is an off-the-air signal you get a true picture of the transmitted signal.

The combination of an RF signal generator and transmitter tester lets you make direct modulation checks. Feed an audio signal from the generator into the transceiver's microphone input. Start the audio output control low and raise it gradually until the transmitter tester indicates 100% modulation. With a headset connected to the tester detector output, listen for a distorted signal. If the signal sounds good, the amplifier is all right and the microphone is defective. To double-check, have someone speak into the microphone and listen for distortion.

---

**Fig. 3.** Typical audio output/modulator stage. Since it serves both transmitter and receiver, its troubles will appear in both. The preamp affects transmit only.

**Fig. 4.** Electronic switching eliminates the need for relays. The push-to-talk mike switch (S1) is shown in receive.
If the amplifier passes the audio signal test, but there is no response to the microphone, check for a shorted or broken mike cable. This is the major cause of microphone failure. Avoid connecting an ohmmeter directly across a ceramic or crystal mike element.

If the audio tone is distorted, the breakdown is in that part of the audio section used only for transmitting—the microphone preamplifier, V3, Fig. 3. Breakdown usually is due to a defective coupling capacitor, C2. With the transmitter on, check the voltage at the grid of V2; a positive voltage indicates C2 is shorted or leaky.

Switching Problems. Transceivers use multi-contact switches, relays, electronic or combined electronic-and-relay switching to go from receive to transmit. If a switch is erratic, the problem probably is dirt. Spray the contacts with a contact cleaner and work the switch a few times. Do not attempt to squeeze the spring contacts together for more tension.

If a relay is the suspect, clean its contacts. In a pinch, dip a business card in carbon tet or contact cleaner and, holding the contacts down lightly, pull the card through the contacts. If available, use a contact cleaning kit which includes a contact burnisher. Do not file relay contacts.

Electronic switching is reliable and causes little trouble. Fig. 4 illustrates how it works. A rectifier diode is connected to the power transformer to produce a high negative voltage. This voltage biases the transmitter tubes to cut-off when the transceiver is on receive. When microphone transmit switch S1 is depressed, the negative voltage is grounded, permitting the transmitter to operate. S1 simultaneously grounds the audio signal from the detector and opens a speaker lead, thereby preventing acoustic feedback.

If electronic switching fails, first check for negative voltage at point A. If the voltage is correct, the trouble is most likely caused by dirty microphone switch contacts.

Percentage modulation and a number of other important factors can be checked directly with an instrument such as the CB transmitter tester.
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—Mearl Martin, Jr., SENIOR ENGINEER, Field Support Manager, Tektronix, Inc., Portland, Oregon

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September, 1962
ULTRA LINEARITY PRO & CON

A NUMBER of high-power amplifiers marketed recently use straight pentode output tubes rather than an Ultra-Linear hookup in the output stage. Is the pentode circuit as good or are the manufacturers just trying to save money?

Charles Newman
Brooklyn, N. Y.

The U-L output stage is excellent. But this does not mean it is the only, or even the best, circuit.

In the early days of high fidelity the usual high-quality amplifier used push-pull triodes in its output stage. A major drawback of triodes were their low power output. The conventional pentode output stage was capable of high output power, but also had high distortion and required a regulated power supply because of the large swing in current drain from a no-signal to a high-signal condition. A regulated power supply which could handle the job probably would cost as much as the rest of the amplifier.

The Ultra-Linear output circuit eliminated the need for a regulated power supply and produced almost as much power as straight pentode operation.

The development of the high-voltage silicon rectifier opened new doors for the audio design engineer. Due to its low voltage drop and high current capacity, the silicon rectifier contributes excellent regulation to any power supply. The availability of low-cost, stable power supplies plus the development of new output tubes is enabling pentode operation to come back into its own for hi-fi use.

Tape Playback Problems

When I record and play back tapes on my machine they sound good. However, when I lend the tapes to a friend and he plays them on his machine they lack highs. To make things more complicated, the tapes my friend records and plays back on his machine sound fine. Is one of our machines defective?

L. Karmin

If both machines use a single record/playback head the the mystery is easy to clear up. Each head's record/playback angle is consistent with respect to itself, but may not be correct with respect to the head on the other machine. This is why the tapes sound all right when played back on the machine they were recorded on, but do not reproduce well on another machine. Check the head azimuth alignment on both recorders.

Low-Noise Preamp Tubes

I own a preamplifier that uses four 12AX7's. What equivalent replacement of the 12AX7 will give me the lowest noise as the phono preamp tube?

Herman Kraden
Jacksonville, Fla.

Almost every tube manufacturer in the past several years has produced a version of the 12AX7 under numbers such as ECC83, 12AD7, 12AY7, 5721, 6681, 7494, etc. Since no one of these types seems consistently better than any other, trial and error is your best bet for selecting a quiet tube.

Set your preamp to mag phono and insert a shorting plug in the phono input. With your amplifier hooked up normally—but with the gain, bass and treble controls on full—try substituting new tubes for the preamp tube in each channel. After a one-minute warm-up, tap each tube. You should be able to select a tube with less noise simply by listening. Tubes that aren't quiet enough for the phono preamp stage usually will serve without difficulties in a tone control or later stage.

Electronics Illustrated
Heathkit puts professional quality into new low cost stereo tape recorder

Here's the latest example of the Heath ability to give you more for less... the all new Heathkit 4-Track Stereo Tape Recorder. Its obvious quality yields professional results (less than .18% wow & flutter at 7½ ips). Its many extra features assure better, more convenient performance (see chart at right). Its fast, easy circuit board construction makes any tyro confident of technical excellence. Its versatility is remarkable... record and playback 4-track stereo tapes or playback 2-track monophonic tapes... use it as part of your stereo music system or as a portable. Choose your model now: the Model AD-12 provides the mechanism for playback of stereo or mono tapes (converts to a recorder later by adding the electronics) $324.95; the model AD-22 includes both mechanism and electronics for stereo record and playback, $179.95. Optional carrying case, $37.50. Accessory ceramic microphones, $9.95 ea.

Omitting test circuit: Fill out the order blank, include charges for parcel post according to weights shown. Express orders shipped delivery charges collect. All prices F. O. B. Benton Harbor, Mich. A 50% deposit is required on all C.O.D. orders. Prices subject to change without notice. Dealer and export prices slightly higher.

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HEATH COMPANY
Benton Harbor 39, Michigan

September, 1962
there's a **FUEL CELL** in your future

Electricity to run your car, your tools and even your home may one day come from tiny gas generators.

By Saunder Harris

---

Miniature fuel cell by Hoffman Electronics uses sodium amalgam and chlorine to produce 3.3 volts.

This massive experimental fuel cell built by the Union Carbide Corporation has 1-kilowatt rating.
MAYBE you've heard the one about the man who started cross-country in an electric car. Well, he didn't make it. Ran out of extension cord in Chicago.

That may be a limp joke, but in five years you might be able to head for distant parts in a shiny electric buggy and have every assurance of getting there. Your power would come from a small generator mounted on each wheel. They would be called fuel cells.

Though the term is new, the theory of fuel cells goes all the way back to 1839, the year Sir William Grove discovered that, when combined to form water, hydrogen and oxygen give off electrons.

After more than a century, we're trying to put Sir William's discovery to practical use by getting some work out of those electrons. Fuel cell research is eating up more than half the money spent today on developing exotic new sources of power—some $28,000,000 a year on more than 60 projects.

Scores of experimental and demonstration cells have been built. Our lead photo shows a General Electric cell, powered by gas from two balloons, turning a fan. Thousands of students have built demonstration cells as science projects, a large fraction of them following instructions in a booklet distributed free by the Esso Research & Enginee-

ing Co. (Box 45, Linden, N. J.). To date, not a single fuel cell has passed beyond the research stage, but practical ones are near.

One immediate job for a fuel cell is to furnish power to orbiting satellites. Other cells in the future will drive submarines, operate Army field equipment, run remote weather stations and power floating sea instruments. These uses are remote to you and me, but we'll have our fuel cells, too. We'll see lawn mowers, power tools and even tractors drawing their energy from fuel cells. One day homes in remote areas may get all their power this way.

The purpose of any electric cell—wet battery, dry battery or fuel cell—is to pile electrons up on one of two electrodes. The cell then is hooked in a circuit and the electrons flow out to perform work, such as lighting a bulb. In a dry cell the electrons are piled up by action of chemicals contained in the battery.

In a fuel cell the chemicals are two gases—not stored in the cell but fed into it.

One is termed the fuel (hydrogen is the most common) and the other the oxidizer (oxygen). The process that takes place is combustion. Free electrons and water are produced. The electrons can be put to work. The water is waste (except in regenerative cells).

Two diagrams accompanying this article show what happens in the combustion process. In the simplest cell two hollow carbon electrodes are surrounded by a potassium hydroxide electrolyte. Hydrogen fed into one electrode passes through the electrode's carbon wall and in so doing releases an electron, becoming a hydrogen ion. The electron flows into an external circuit, while the ion moves through the electrolyte to the other electrode. Oxygen entering this electrode combines with the hydrogen and the returning electron to form water.

More exotic fuel cells work the same way but have variations in fuel and structure. Other fuels include bottled gas, alcohol, lithium, sodium, potassium and cesium; oxidizers run from oxygen to chlorine, bromine and iodine. Our
Low-grade fuel cells have a potential as low as a half-volt, while one sodium-chlorine device produced 3.3 volts. Average is about 1 volt. To get higher voltages, you hook several cells in series. The amount of current produced depends on size—the surface area of the electrodes.

The Army has been experimenting with a fuel cell to power a portable radar set. It produces 200 watts of 24-volt direct current for 14 hours on one canister of fuel. Total weight is 30 pounds. By hooking enough individual cells together, almost unlimited power can be produced. The Navy has a 75-kilowatt unit. The only problem is size and weight.

A lightweight cell with high power naturally is the goal. The immediate prospect is a cell that produces 6 watts per pound or 200 watts per cubic foot.

One of the more interesting developments predicted is a marriage between fuel cells and solar cells. The latter would supply power during the day and at the same time decompose water into hydrogen and oxygen... which would be consumed during darkness by electricity-producing fuel cells.

In one simple fuel cell type hydrogen and oxygen produce electricity and water waste (see text). In cell built by General Electric the same gases are employed but electrolyte is a solid membrane.
The Fisher KX-200 80-Watt Stereo Control-Amplifier StrataKit, $169.50.*

It has four things that others haven't.

1. **StrataKit Construction.** Assembly by totally error-proof stages (strata). Each stage corresponds to a separate fold-out page in the Instruction Manual. Each stage is built from a separate transparent packet of parts. Major components come already mounted on the extra-heavy-gauge steel chassis. Wires are pre-cut for every stage—which means every page. Result: Absolutely equal success by the experienced kit builder or the completely unskilled novice!

2. **Built-In d'Arsonval Meter.** For laboratory-accurate adjustment of bias and balance. Assures peak performance from the start; permits 'touching up' for continued peak performance throughout the years, regardless of tube aging. No other single-chassis control-amplifier kit has this vital feature.

3. **Third-Speaker Output with Volume Control.** Blends the two stereo channel outputs to feed a third loudspeaker system—at any desired volume level. Ideal for center-channel stereo fill-in or for a mono extension speaker in another room of the home. A Fisher exclusive among control-amplifier kits.

4. **The Fisher Name.** No comment necessary.

---

*Walnut or Mahogany cabinet, $24.95. Metal cabinet, $15.95. Prices slightly higher in the Far West. Please send me without charge the complete Fisher StrataKit catalogue.

September, 1962
TWO POWER SUPPLIES for the test bench

The test-bench instruments most often forgotten in any list of useful equipment for the experimenter or technician are power supplies. Test-bench supplies can be divided into three basic categories: the variable AC type, the low-voltage, high-current DC supply and the high-voltage, low-current DC supply. The two kits we'll examine fall into the first two categories. Both kits are examples of EICO's new styling, which looks good on most anyone's test bench.

How easy are they to build? Actually both are mostly mechanical assembly
The 1064 is somewhat more complex because of the need for rectification and filtering. Component K1 in the schematic is a thermal circuit breaker which can be seen bolted to rectifier CR1/CR2.

jobs and neither one should take more than an evening to complete. Let's look at the specifics of each.

Variable AC Supply. EICO's model 1073 uses a standard circuit incorporating a variable auto-transformer—T1 in the schematic. The sliding tap on the autoformer boosts or lowers the line voltage from 0 to 140 volts. Separate meters monitor voltage output and the current drain. Switching (S2) provides a choice of current meter ranges: 0 to 1 and 0 to 3 amperes. The voltmeter in the 1073 turned out to be surprisingly accurate. In fact, it can be used to check the upper AC ranges of your VOM or VTVM.

Although EICO doesn't mention it, connecting a simple half-wave rectifier diode and filter setup to the AC output of the instrument will provide high-voltage DC (to about 175 volts). Write EICO for further information. Note that the output of the unit is not isolated from the AC line, so precautions should be taken to avoid shock hazards when [Continued on page 116]
expert on equipment or technique.

There are times when a local tape club receives a tape addressed to the membership as a whole. Recently I made such a tape for the Norwich (England) Gramophone Society. It was played as the program for one of their regular membership meetings.

In some less prosperous nations a local tape club is formed for the purpose of buying a recorder, which would be too expensive for any individual member. Then it is used by everyone in the group, and the club as a whole.

Both local and international clubs become involved in social service work. Typical projects are making tapes to entertain hospital patients and putting books on tape for the blind. World Tape Pals has congressional endorsement as part of our People to People Program, and it produces World Tapes for Education.

You can become an amateur recordist with an investment of about $100 ($50 more if you want to reproduce good music). It's not peanuts, but well below the ante needed to take up boating, ham radio or sports cars. There are tape recorders that cost less, of course, but for dependable equipment and usable tapes, this price bracket is the lowest advisable.

The most frequently used tape speed is 3¾-inches-per-second and half-track recording. You do, in the course of time, run into all speeds and track widths. The beginner should make sure his equipment can handle at least 3¾ and 7½ ips, and half- and quarter-track recording.

Tapes ordinarily are sent by regular mail. Shipping cartons to carry the reels can be purchased for a few cents.

What happens to the tapes you send and receive? If it is a reel you particularly value, you can arrange to have your tape sendent return it, and you send his back. It is usual, however, for him to keep your tape and you keep his, either erasing and recording again or putting the reel in your tape library.

When mounting (or placing) the RDF adaptor in your boat, it is advisable to line up the north point on the compass rose with the bow, although you can use any orientation you desire.

The compass rose is a refinement which allows you to take a null reading directly in degrees with the radio on an axle at the center of the rose (this is the screw you previously filed smooth). A small hole drilled in the radio case engages the axle so the set can be rotated.

When you swing the radio around and obtain a null reading you merely read the compass rose bearing at the set's reference edge. That is the bearing of the station in relation to your boat's heading. A little problem develops here in that you get two null readings 180° apart. You don't know whether the station is off your port or your starboard side. To determine which is the correct side, you cruise ahead a few minutes, taking null readings as you go. The null will pass to stern on one side (as the station falls behind). The station is located on that side.

It is important to keep both adaptor and radio several feet from your compass. Permanent magnets in the speaker and meter disturb the compass needle. When taking readings, keep your hands away from the loopstick by holding the radio on the other side of the case. And take nulls on stations which lie in different directions, at least 30° apart.

You would be wise to practice often with your RDF to give you confidence when you get in a tight spot and really need it.
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Radio-TV Broadcast Lab This Studio Lab has three separate control rooms and is equipped with five modern TV cameras, a switching and control console, TV film projectors, recording console, FM transmitter, microphones, special lighting facilities and other accessory equipment.

Practical Electronics Labs The practical application of theory is an important part of Central's home study and resident curricula. In Central's Practical Electronics Labs, students gain actual experience working with circuitry, components and test equipment.

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If you're interested in an electronics career, let Central Tech help you learn about the many profitable opportunities in the field. Mail the above Career Coupon Today!

Central Technical Institute
1644 Wyandotte, Kansas City 8, Missouri

September, 1962
Shown here are pieces of Citizens Band equipment that have just reached the market and redesigned versions of some older models.

Cadre C-75 has power rating of 1.5 watts, uses printed-circuit modules. Two crystal channels. Batteries are recharging type.

Heath "black box" type transceiver has minimum controls and one crystal channel; GW-12 kit: $39.95.

The Vocaline ED-27M Commaire offers crystal control on four transmit, one receive channel; price: $189.50.

Radio Shack Realistic TRC-5 has five channels, delivers 2 watts RF power; one crystal receiver channel; $69.95.

The SpeakEasy is an audio compressor by Communications, Inc. It is designed to increase average modulation and range of transmitter; price: $34.75.

General MC-5 is seven-tuber; six T and four R channels, 3.25 watts; $199.95.
Lafayette's revamped HE-15B has eight transmit channels, RF monitor meter jack: $59.50.

Kaar TR505-6 for Class A, 462 mc, 35 watts. $500. Control head is on dash.

Lafayette's new version of the HE-20B has eight crystal T-R channels and S-meter; price: $109.50.

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Written for the layman who wants to understand the latest developments in hi-fi, without first studying for a degree in electronic engineering. $6.50

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Hi-Fi Record Guide

Continued from page 80

...version of It Ain't Necessarily So that lasts for twenty minutes. It takes imagination and inventiveness to sustain interest in such extended renditions of songs, but the jazz flutist and his associates possess those virtues in considerable quantities—plus a few more like virtuosity, feeling and spontaneity. A fine jazz record.

Recorded in this column, with monaural discs listed first and stereo versions just below:

Beethoven: Sonata; Schumann: Fantasy
Sviatoslav Richter
Angel 35679 54.98
S-35679 5.98

Liszt: Piano Concertos
Richter-Kondrashin
Philips 500.000 4.98
900.000 5.98

Beethoven: Piano Concerto No. 1
Richter-Munch
RCA Victor LM-2544 4.98
LSC-2544 5.98

Beethoven: Sonata; Rachmaninoff: Preludes
Richter
Columbia ML-5725 4.98
(monaural only)

Strauss: Salome
Soldi, Vienna Philharmonic
London A-4247 9.96
OSA-1218 11.96

Strauss: Elektra
Boehm, Saxon State Orch, Deutsche Gram. 18690/1 11.96
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Unpredictable Patrice Munsel
Philips 202.020 3.98
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Eileen Farrell
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Folksong: U.S.A.
The Robinsdale Chorale
Audio Fidelity AFLP-1965 4.98
AFSD-58965 5.95

Herbie Mann at the Village Gate
Herbie Mann
Atlantic 1380 4.98
S-1380 5.98

Two Power Supplies

Continued from page 111

using the instrument as a power supply for AC/DC equipment.

Battery Charger-Eliminator. The model 1064's type of supply has been around a long time, and little need be said about its applications. As its name implies, the 1064 functions as both a storage battery charger and as a battery substitute for bench-testing auto radios. The important difference between this supply and less expensive or older models is in its filtering. The EICO has a full 10,000 mf of filter capacity in an LC pi arrangement. Our checks showed the instrument's residual ripple to be low enough to permit its use with any transistorized device from the pocket portable to automobile hybrid receivers.

The kit went together in about three hours with a few minutes wasted for puzzling out two or three obscure points in the instruction manual. Referring to page 10C, step 2, be sure to scrape the enameled coating off the wires before attempting to solder them. And on page 11C, add (S1) to step 9. If you have trouble making the instrument's handles lie flat after assembly, bend the small knockout tab in the channel on the handle's underside. Aside from a few minor problems (which EICO has promised to take care of) both instruments are easy to build and have a professional appearance. And, most important, they do their jobs well.

The Listener

Continued from page 42

Seething Continent to give a reliable account of the doings in Katanga.

Until the spring of 1962, Senegal's English-language newscasts, presented at 1540 EST, enjoyed a clear channel in Europe and North America. But during late March RFE, troubled by Communist jammers, moved around and came to rest on 11895 kc—Senegal's "clear channel." As a result, Dakar was buried.

Truth is, there aren't enough SWBC frequencies to go around, especially with a low sunspot count wrecking the upper bands. There's little hope of extending SWBC downward because the utility bands can't spare a kilocycle.

Voice Controlled Relay

Continued from page 58

sition and speak in a normal voice. Slowly advance R1 until the relay closes; at this setting the VOX will open and close at approximately the word rate. Keep advancing R1 until the relay remains closed between words; at this
setting the relay will remain closed for approximately one second after you stop talking. If you desire a longer delay simply advance R1 more. R1 sets both the sensitivity and the holding delay.

If you use the VOX with a CB or ham rig, remember that sound from the speaker can trip the relay. If you run into this problem simply talk closer to the mike and reduce the sensitivity. In fact, it's a good idea to use minimum VOX sensitivity, for at full gain a single footstep on a wooden floor trips the relay. C1 controls the time delay, the specified value giving a range of one to three seconds. For longer delay, use a larger value; for shorter delay, a smaller one.

Stereo Power Amplifier

Continued from page 83

A question may arise on the use of pentode-connected output tubes when the distributed-load or Ultra-Linear configuration is almost standard practice. Theoretically, pentodes are capable of providing low-distortion, 60-watt performance. However, until the advent of the 7027A there had been no tube which actually could do the job. In addition, pentode operation requires excellent regulation of the plate and screen voltages. The silicon diode rectifier solved that problem. In fact, with a moderately simple voltage-doubler power supply, there is a drop of only 4 or 5 volts in B+ at full amplifier output.

The Lafayette amplifier has one physical feature that our builder particularly liked. The bias adjust controls and a meter to determine optimum settings are centralized on a control panel (see photo). All bias and balance adjustments can be made easily without additional test equipment. In fact, the amplifier may be installed in a console with only the small brass control panel showing. As far as we know, this is the only basic amplifier available with this feature.

All factors, including laboratory and listening tests, establish the Lafayette KT-550 as one of the finest stereo basic amplifiers in its power class.
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identical, but have directions. If the dark end of the compass needle (the north-seeking pole) is attracted to the bolt, that end of the bolt is the north pole. The opposite end is the south pole. (Remember the north pole position.)

If you reverse the battery connections you demonstrate what determines the pole positions of an electromagnet. It's the direction of current flow. All the results described above will reverse if the batteries are reversed.

A basic law of magnetism says like poles repel and unlike poles attract. If the north poles of two magnets were placed near each other, their magnetic fields would push them apart. The compass and electromagnet can illustrate this. It makes no difference that compass and electromagnet rely on different sources for their magnetism. The compass needle is simply a piece of ferrous (contains iron) metal that was magnetized in a strong magnetic field. It has the ability to store its acquired magnetism. The electromagnet has a core of soft iron (the bolt) which must have a flow of current to form its poles. Unlike the compass, the bolt loses most of its magnetism when current flow stops. It has low retentivity.

To experiment with attraction and repulsion, we'll take a closer look at the compass. You'll recall that the dark end of the needle was called a north-seeking pole because it always points to the magnetic north pole of the earth. But here we'll call it by its right name—a south pole. Sounds confusing at first but a little thought will tell you that it must be a south pole to point north (unlike poles attract). The term north-seeking is a matter of convenience when you're reading a compass for direction.

You can prove this point by placing the dark end of the compass needle near the south pole of the electromagnet (determined earlier). The needle will swing away. This is a case of two like poles repelling (both are south). The needle will continue to swing until the light end points to the electromagnet's south pole. This end of the needle is a north magnetic pole and thus attracted by the south pole of the electromagnet.

The practical use of these principles? No electric motor could operate without magnetic attraction and repulsion.

Another area for experimentation with an electromagnet is induction. Not only can we demonstrate that a current flow produces magnetism, but we can show that a magnetic field can cause current flow in a coil if we add the meter and pickup coil to the previous setup.

If your meter has a zero-adjustment screw, turn the screw so the needle moves up the scale as far as it can go. This permits the needle to move right or left as current goes through. Connect the pickup coil to the meter and turn on the magnet. Now hold the pickup coil about two inches above the magnet and lower it quickly halfway down the body of the electromagnet. Do this a few times and watch what happens to the meter. The needle flicks to indicate a brief flow of current. Notice that the current is in one direction when you lower the pickup coil. When you start with the coil at the center and lift it the meter flicks in the opposite direction.

This demonstrates several aspects of induction. The magnetic field's cutting across the pickup coil sets up a current within the coil. (This is basically the operation of an electric generator.) Also, the direction of current flow, as indicated by the meter, depends on the direction of cutting.

Speed of cutting is another factor. Notice that if the pickup coil is moved slowly over the electromagnet, the amount of current generated is small. Place the pickup coil at about the center of the electromagnet and check what happens when you turn the electromagnet on and off. Note which direction the meter needle goes as you make and break contact. In this case the magnetic field is moving instead of the coil. The field builds up and collapses as you turn the electromagnet on and off.

If you'd like to make some discoveries on your own, try changing the size of the pickup coil and vary the distance of the compass from the electromagnet.

—Len Buckwalter
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