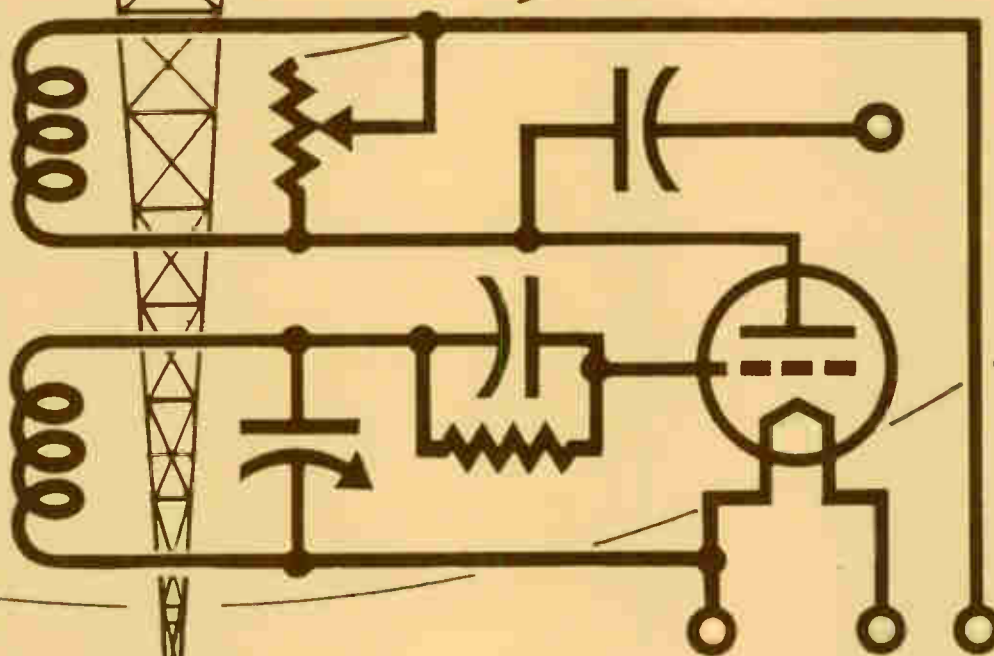


TWENTY-FIVE
CENTS

ALLIED

RADIO CIRCUIT HANDBOOK

A COMPILATION OF BASIC ELECTRONIC
CIRCUITS WITH SIMPLE EXPLANATIONS
FOR STUDENTS AND EXPERIMENTERS



ALLIED RADIO

100 N. WESTERN AVENUE

CHICAGO 80, ILLINOIS

ALLIED'S RADIO CIRCUIT HANDBOOK

A COMPREHENSIVE GROUP OF RADIO AND
ELECTRONIC CIRCUITS WITH ANALYSIS, COM-
PARISONS AND DISCUSSIONS FOR STUDENTS
AND EXPERIMENTERS

Compiled by the Technical Staff of
ALLIED RADIO CORPORATION

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FOREWORD

THE purpose of this book is to illustrate basic radio principles by presenting, comparing, and analyzing some of the most popular conventional radio and electronic circuits. All diagrams cover dependable systems which are in actual use. Each circuit was carefully selected as the result of many year's experience of Allied's Technical Staff and Educational Division with radio students, instructors, experimenters and engineers.

Fundamental principles are illustrated and explained by the "Basic Circuits" and the text in the first part of the book; then the application of these principles to various components of receivers, transmitters and other electronic units is shown. Thus the student gains a knowledge of how and why different circuits operate.

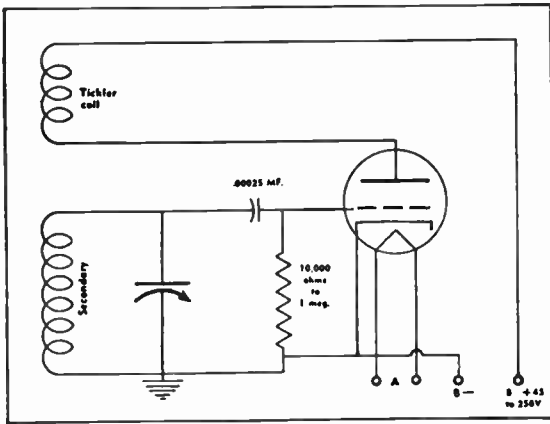
The method of presentation was especially planned to make this book a useful text for the classroom and for home study, as well as a reliable guide for experimenters and builders.

The projects described in this publication which bear the Knight-Kit name are available in kit form. See your latest Allied catalog.

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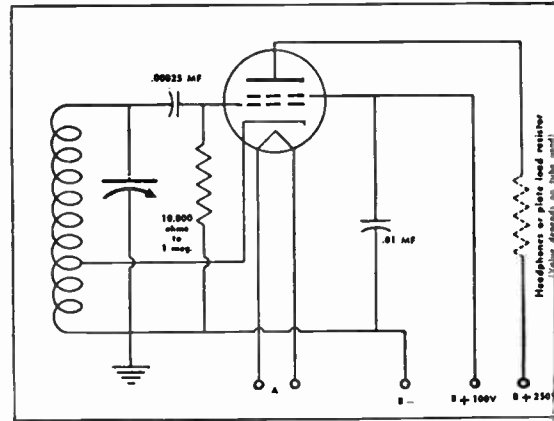
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1. Tickler Coil Oscillator



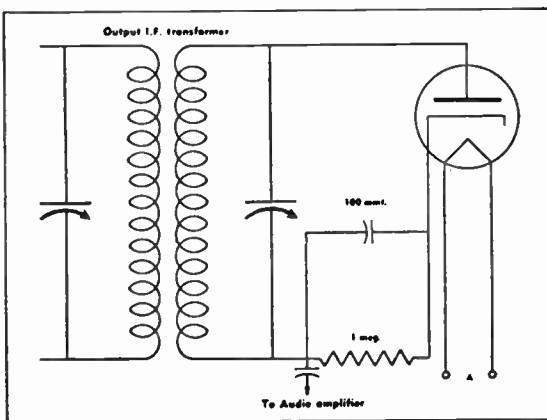
THIS type of oscillator is used in regenerative receivers and in the converter stage of superhets. Oscillation is attained by feeding more energy from plate to grid circuit than the amount required to compensate for the loss in the grid circuit. Feedback is accomplished by coupling between grid and plate coils. When feedback energy is greater than the loss in the grid circuit, the tube oscillates at a frequency governed by coil and capacitor values.

2. Electron-Coupled Oscillator



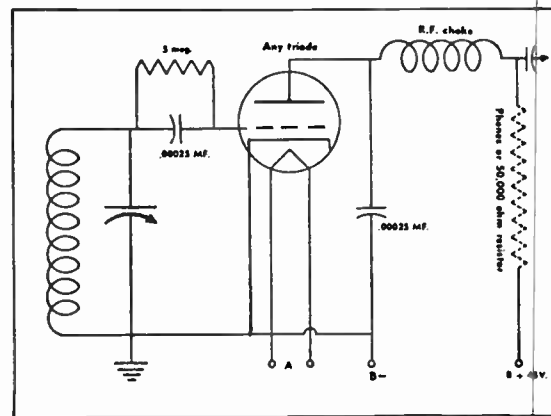
THE single tapped coil operates as two separate coils, divided by the point at which the tap exists. The two parts of the coil, above and below the tap, are mutually inductive. Action is similar, otherwise, to that in the tickler coil oscillator (described at left). The tube elements, making up the oscillator, are the cathode, grid and screen grid. Oscillations are transferred to the plate circuit through the electron stream. Plate current variations do not affect stability.

3. Diode Detector



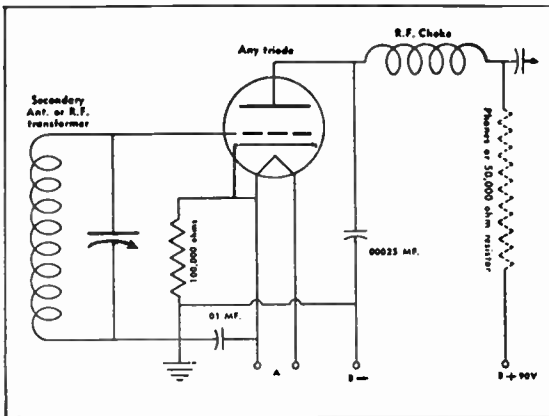
ACTION of a diode detector is like that of a half-wave rectifier. AC current (the modulated input signal) coming from the secondary of the transformer, flows through the plate only on the half cycle when the plate swings positive. The resulting pulsating DC current varies in accordance with the amplitude of the positive half of the modulated wave and produces an audio frequency signal. The capacitor across the load resistor must be large enough to smooth out the RF pulsations but not too large, or it will short-circuit the audio signal.

4. Grid-Leak Detector



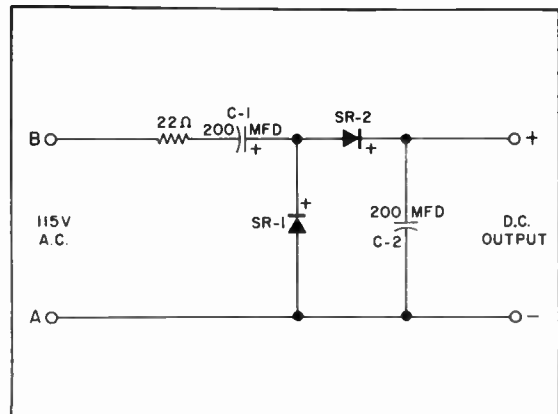
GRID-LEAK detector action resembles that of a diode detector with one added stage of amplification. The grid and cathode of the tube serve as a diode with the grid acting as a plate. The grid-leak resistor and the grid capacitor act as an impedance that matches the load impedance of the diode detector. The RF choke prevents any RF that has been amplified by the tube from entering the next stage (if used) as well as the B+ power supply. This RF is then shorted to ground (by-passed) by the 0.0025 mfd. capacitor.

5. Biased Detector



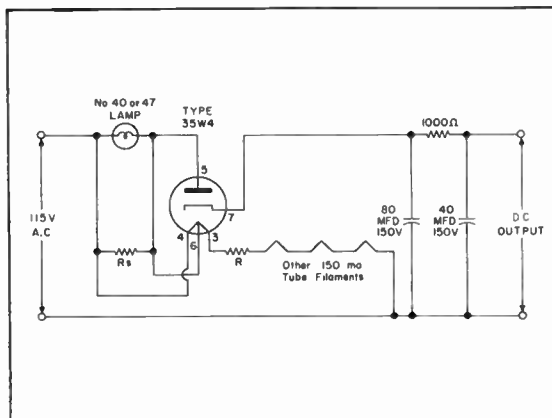
THE grid is biased almost to cut-off because of the high value of bias resistor, and plate current is practically zero with no signal in the grid circuit. When a signal is received, amplification takes place, but more plate current flows on the positive half cycles than on the negative half cycles. This results in demodulation of RF signal in the plate circuit. Filtering of RF currents in the plate is accomplished by the RF choke and the .00025 capacitor.

6. Half-Wave Selenium Power Supply



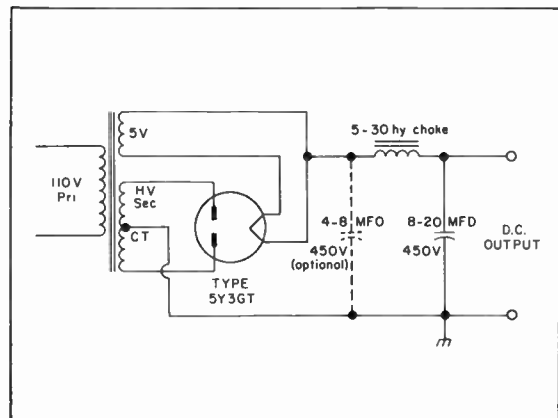
THIS selenium rectifier power supply delivers DC output at twice the AC line potential without a step-up transformer. When point A is positive with respect to B, current flows through SR1 charging C1 to peak line potential. On the next half cycle point B is positive with respect to A and the charge stored by C1 plus the line potential flows through SR2 developing a voltage equal to twice the line potential across C2.

7. AC-DC Power Supply



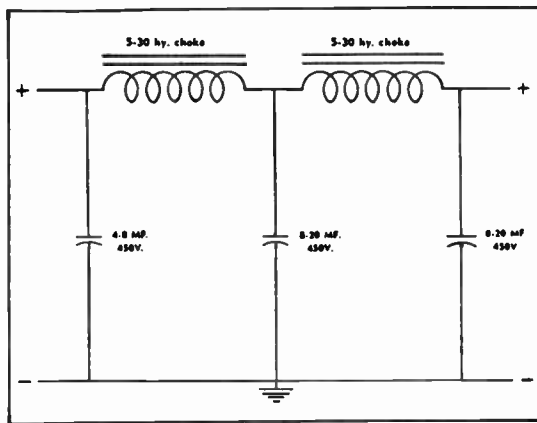
THE half-wave rectifier circuit shown is commonly used in AC-DC radios. As current flows only on the half cycle when the plate is positive with respect to the cathode, the DC output has a 60 cycle ripple. Large values of capacity are therefore required in the filter network. The voltage drop across R and all heaters should total 115 v. Rs should be 300, 150, 100 ohms for load currents of 70, 80, 90 ma respectively. Rs is not required for loads under 70 ma. The values given are for a type 35W4 tube.

8. Full-Wave Power Supply



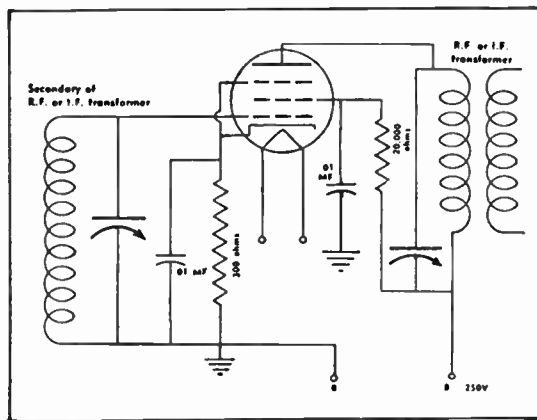
THE diode used here has one filament and two plates. Current flows from each plate alternately on its positive half-cycle and results in pulsating DC, which is at twice the frequency (120 cycles per second) provided by a half-wave system. The full-wave system, since current flow is more uniform, is easier to filter. The capacitor, shown by dotted lines, increases output voltage but decreases regulation. Use of a power transformer provides higher voltages than those available from an AC-DC supply.

9. Power Supply Filter



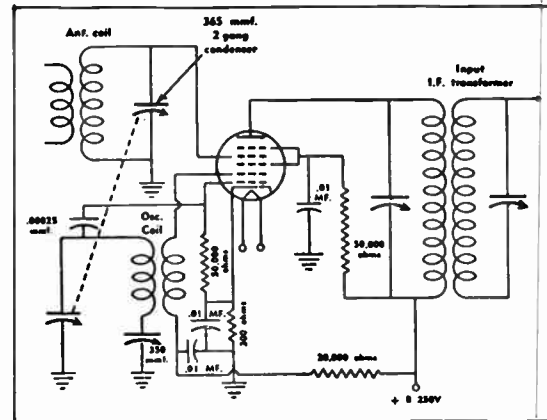
THE function of the filter is to smooth pulsating voltage, supplied by the rectifier output, into steady DC voltage. Filter networks may be single- or double-section types; the latter provides better smoothing. Filter chokes should have high inductance and low DC resistance. Current-carrying capacity must exceed total plate current of all tubes plus any voltage dividers or bleeder resistors. Capacitor voltage ratings should be higher than voltage between plus and minus.

11. RF Amplifier



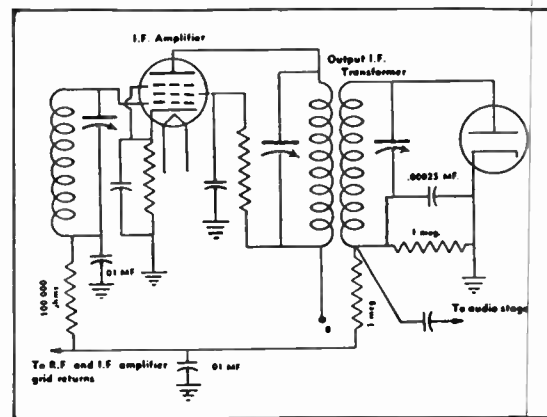
THE principles of RF and AF amplification are the same. A small signal voltage impressed on a grid controls a large output in the plate circuit. The grid must be correctly biased, and the tube must work into the proper load impedance. Bias is obtained from the 300-ohm cathode resistor. Input and output circuits must be thoroughly isolated from each other to prevent oscillation. The necessary high load impedance is secured by use of the parallel resonant circuit. The system amplifies the signal on the desired frequency and eliminates signals on other frequencies.

10. Frequency Converter



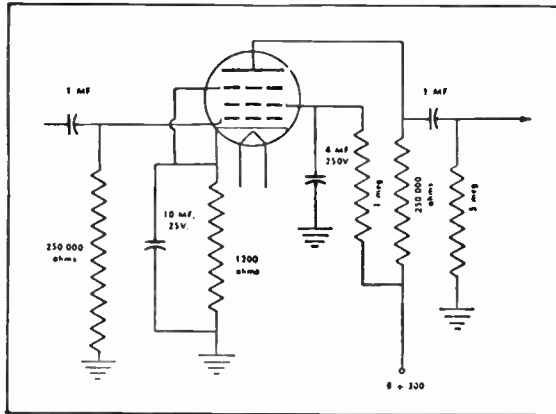
THE frequency converter is used in superheterodyne receivers to change the frequency of the RF signal to an intermediate frequency. The tube used is called a "mixer." The cathode and grids 1 and 2 (from the cathode) comprise a tickler-type triode oscillator. Signals from the frequency of the antenna coil mix (heterodyne) with the frequency of the oscillator and result in a new frequency, called the "intermediate frequency," which is equal to the difference between the two.

12. Automatic Volume Control



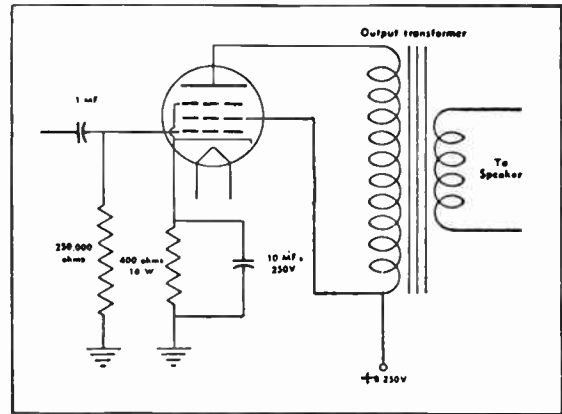
AUTOMATIC volume control is used to provide a constant output despite variations (fading or more-than-normal increase) in signal strength. This circuit combines circuits 3 and 11. The rectified DC voltage developed across the 1-meg. diode load resistor is added to the bias voltage of the IF or RF amplifiers. When the amplitude of the incoming signal decreases, the IF output tends to decrease, thereby decreasing the negative bias and increasing the gain of the amplifier. When the signal increases, the process is reversed and gain is reduced.

13. Audio Voltage Amplifier



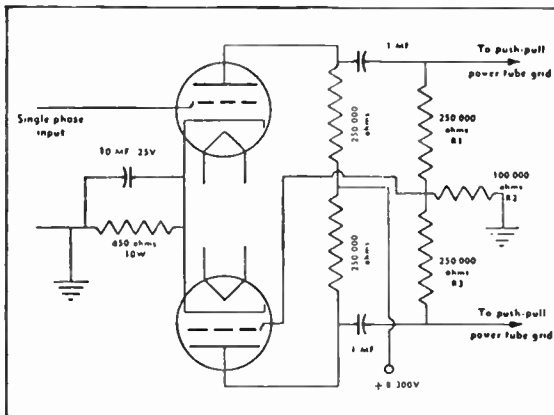
THE tube is operated at proper grid bias to keep input grid voltage on the straight line of the grid voltage vs. plate current characteristics curve. A small signal voltage impressed on the grid is reproduced in essentially the same form, but in increased amplitude, in the plate circuit. The ratio between the signal voltage at the grid and plate voltage in the load resistance is the gain of the tube. In this circuit, gain is over 140 when tube used is 6AU6, 6J7 or 6SH7.

14. Power Amplifier



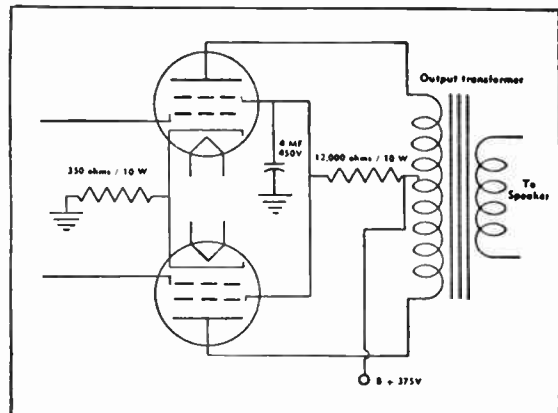
A POWER amplifier must supply large amounts of distortionless power to the loudspeaker. Power amplification is, therefore, more important than voltage amplification. A 6V6, 6F6 or similar type pentode tube may be used with the values of the components shown in the above circuit. The output transformer must have the proper ratio to match the output of the tube to the speaker voice-coil. This circuit is capable of 4½ watts output when a 6V6 or 6V6GT is used.

15. Audio Phase Inverter



THE function of the phase inverter is to feed signal voltages, 180° out of phase with each other, to the grids of a push-pull stage. When the grid in one tube is swung positive, the grid of the second is swung negative by an equal amount. The output AC voltage from the first triode appears across R1 and R2. The portion across R2 is fed to the grid of the second triode, and its output appears across R3 and R2 but out of phase with the voltage from the first triode. These voltages feed the P.P. amplifier.

16. Push-Pull Power Amplifier



TWO 6L6 tubes are used in this amplifier. The same value of voltage is applied to the grid of each tube, but voltages are 180° out of phase. The outputs of the tubes are combined by the center-tapped output transformer. The direct currents in the two halves of the primary are in opposite directions, and so DC saturation is impossible. Push-pull circuits substantially cancel out harmonic distortion and offer more power per tube. The push-pull amplifier above develops nearly 25 watts of audio power.



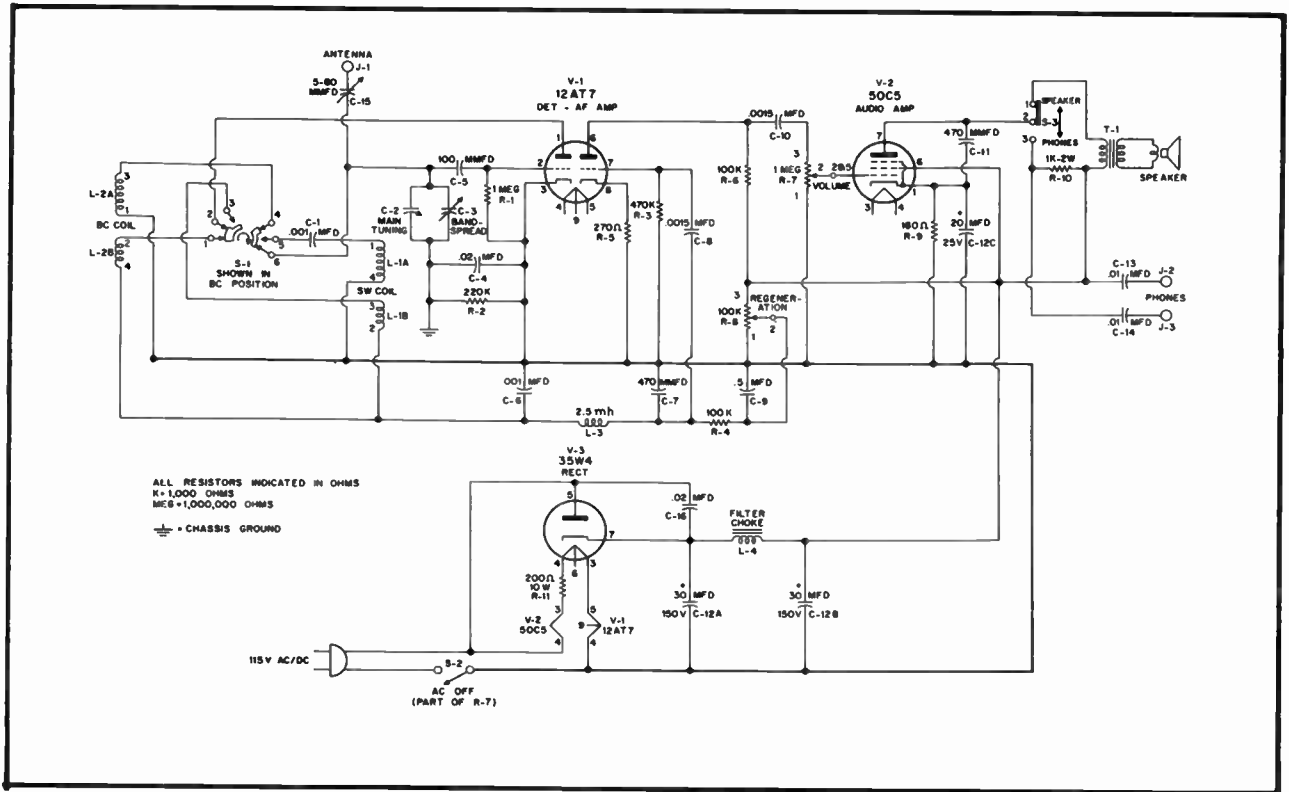
***knight-kit* AC-DC "Space Spanner"**

THE "Space Spanner" circuit illustrates the versatility and operating convenience that can be built into a simple AC-DC receiver. The basic circuit is the extremely efficient, highly sensitive, regenerative type — similar to that used in the "Ocean Hopper"; but with such added refinements as bandswitching and an added stage of audio amplification.

This receiver will provide excellent reception of broadcast and shortwave transmissions through the built-in speaker or through headphones. It covers the entire broadcast band from 540 to 1700 kilocycles — and by turning the bandswitch to the shortwave position it covers the international and Amateur shortwave bands between 6.5 and 17 megacycles. These include the 40 and 20 meter Amateur bands, and the 49, 41, 40, 31, 25, and 19 meter international bands. When used with an efficient antenna system, this receiver will bring in stations from "all corners of the earth" with amazing clarity. Local broadcast reception is possible with only a few feet of antenna wire strung around the room.

The filament wiring and power supply of the "Space Spanner" are conventional. As the total voltage drop of the tubes (wired in series) is only 97.6 volts, a 200 ohm dropping resistor is used to permit operation from a 110-120 volt AC or DC source. A type 35W4 halfwave rectifier is used in the power supply. The large electrolytic capacitors and the filter choke smooth out AC ripple to reduce hum to a minimum.

The type 12AT7 is actually two triode tubes in a single envelope. Except for a common heater, they operate independently of each other. One section functions as a highly efficient regenerative detector, and the other as a high gain stage of audio amplification. Separate antenna coils are used; L-2 for broadcast, and L-1 for shortwave reception. The position of the band switch, S-1, determines which coil is connected in the circuit. Each coil has two separate windings; the "A" section is the grid circuit winding, and the "B" section is the plate circuit winding. The "A" section of the coils with the main and bandspread tuning capacitors make up a "tank" which



***knight-kit* AC-DC "Space Spanner"**

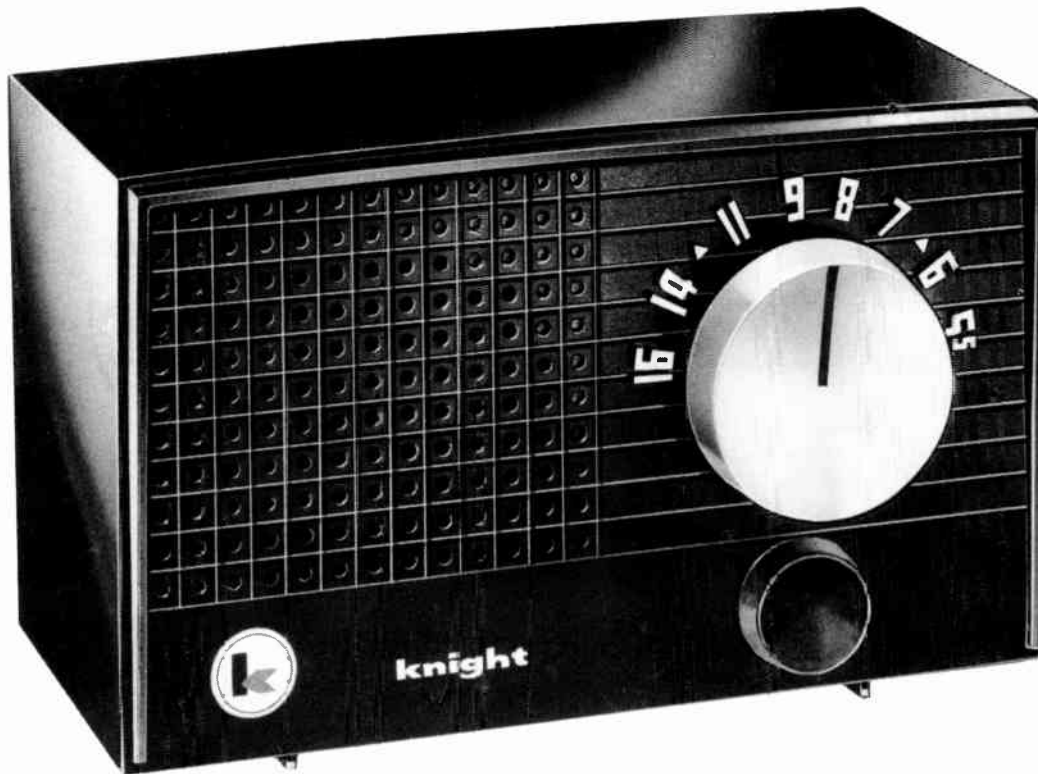
can be resonated to any frequency within the range of the coil in use. This is how the receiver is tuned. For broadcast reception, only the main tuning capacitor is used. On shortwave, only the main tuning capacitor is used to locate the approximate range or frequencies to be covered and the bandspread capacitor is used to pick out a particular station. In operation, the antenna control is adjusted for best results with the antenna being used and the frequency being received.

Incoming RF signals, with the exception of the frequency to which the "tank" is tuned, present a low impedance and are shunted to ground. The desired signal is fed to the grid of the 12AT7 and detected in the grid-cathode circuit. The detected signal, now an audio frequency, travels through the plate circuit and is fed through C-8 to the grid of the second section of the 12AT7. A portion of the original RF signal appearing at the detector grid of the tube is amplified in the plate circuit. This RF appears in the "B" section of the antenna coil and is inductively

coupled back into "tank" circuit, thus producing regeneration as the signal is fed back into the grid of the tube. The RF choke which allowed the audio frequency to pass, opposes the flow of RF and keeps it from the power supply and the audio section of the receiver. The amount of regeneration is controlled by a potentiometer that varies the detector plate voltage.

The audio portion of the signal is amplified in the second section of the 12AT7 and is coupled through C-10 and the volume control to the 50C5 power amplifier. The 50C5 is capable of delivering approximately 2 watts of audio power—more than enough for loudspeaker reproduction. The speaker-headphone switch, S-3, permits operation with the built-in speaker or with headphones. Capacitors C-13 and C-14 isolate the headphone jacks from the DC voltage present in the plate circuit of the 50C5.

The Knight-Kit "Space Spanner" radio in kit form, complete with all parts, tubes and hardware, is listed in the kit section of the Allied Radio catalog.



knight-kit "Ranger III" Superhet

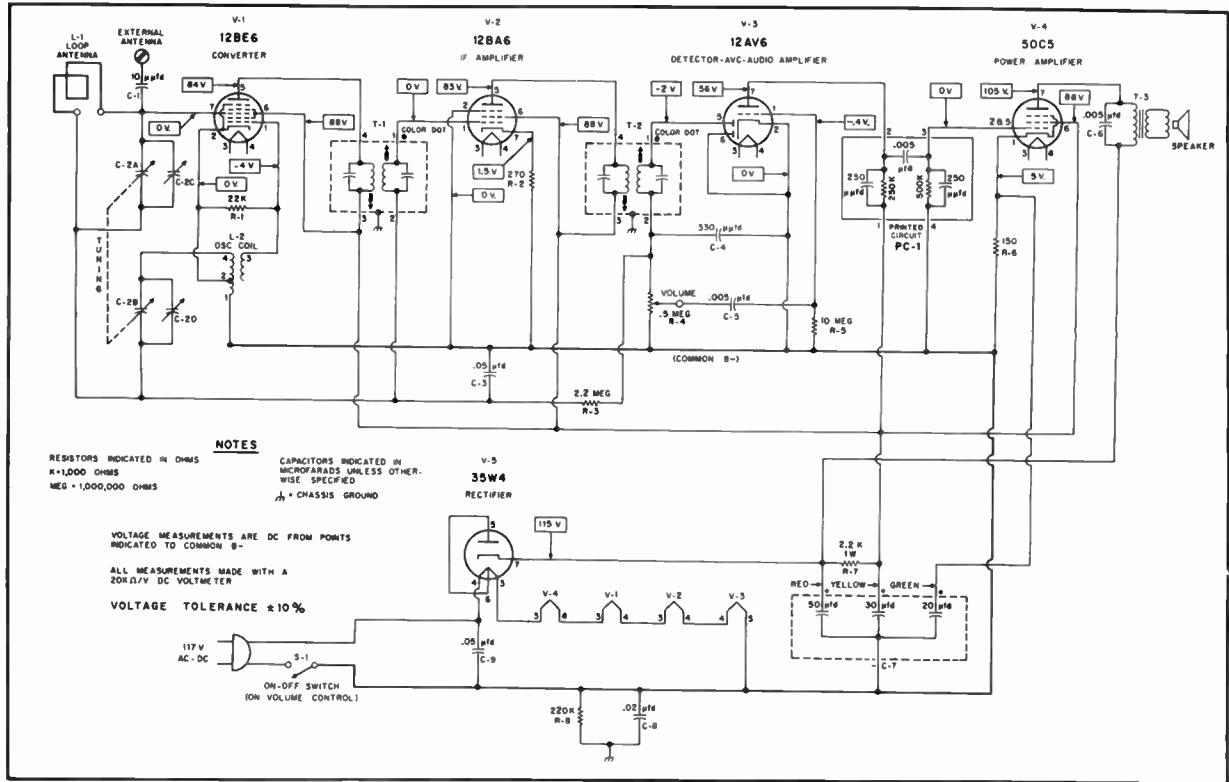
THIS circuit has many unusual features that make it worthy of study. It is so designed that the heaters of the tubes, connected in series, may be operated directly from 120-volt line without a dropping resistor. The heaters add up to 122.8 volts, but will operate from line voltages as low as 105.

The 12BE6 tube is the converter. It produces local oscillations at a frequency which can be varied. These oscillations beat with the incoming signal, and the combination of the two signals produces a beat signal known as the heterodyne signal. The name "Superheterodyne" is derived from the action. Heterodyning is used to change the incoming signal frequency to a predetermined intermediate frequency (known as I.F.) of 455 KC. The loop antenna is nothing more than an antenna coil, wound so that it is large in size and therefore capable of direct pickup of radio signals without the necessity for an external antenna. However, if an external antenna is necessary for satisfac-

tory reception, it may be connected to the 10 mmf capacitor on the loop antenna without disturbing the tuned circuit (see schematic diagram).

In order to obtain an I.F. frequency of 455 KC, the oscillator must produce RF voltage at a frequency which is 455 KC higher or lower than the incoming signal frequency. In broadcast band receivers it is customary for the oscillator to be 455 KC higher. While the antenna section of the two-gang tuning capacitor tunes the loop to resonate with signals from 1620 KC to 540 KC, the oscillator section of the tuning capacitor varies oscillations from 2075 KC to 995 KC. The oscillator section of the tuning capacitor has a lower maximum capacity. The oscillator coil has lower inductance than the antenna coil, or loop, and the oscillator section of the capacitor and oscillator coil are designed to "track" with the antenna circuit.

The I.F. stage amplifies at higher efficiency because its function is to amplify only one fixed frequency.



knight-kit "Ranger III" Superhet

It is also possible to obtain high amplification because of the comparatively low I.F. frequencies.

The output of the I.F. stage is coupled to one of the diode detector plates in the 12AV6 detector-AVC-1st audio amplifier. Here the audio modulation of the signal is separated from the radio wave that carried it. The output voltage of the diode detector appears across the diode plate load resistor, (the volume control). Adjustment of the volume control permits coupling just the right amount of this output voltage to the grid of the 1st audio amplifier to produce the desired listening level. The triode section of the 12AV6, the 1st audio amplifier, amplifies the signal from the volume control and a signal many times the value of that applied to its grid appears across its plate load resistor. This voltage is fed to the grid of the 50C5 audio output stage through a coupling capacitor. The coupling capacitor also keeps the DC voltage from the plate of the 12AV6 from being applied to the grid of the 50C5. The audio output stage

(also called the power amplifier) is capable of delivering 2 watts of audio power. The impedance of the primary winding of the output transformer matches the plate load resistance of the 50C5 for maximum efficiency. The impedance of the secondary winding of the output transformer matches the voice coil impedance of the speaker to provide maximum transfer of energy. A permanent magnet type speaker with a 3.2 ohm voice coil is used in this circuit.

The tubes obtain their DC operating voltages from an AC-DC type power supply using a 35W4 half-wave rectifier. Hum-producing ripple in the DC supply is filtered out by a resistor-capacitor network. A filter choke is not required because of the large amount of capacitance used.

This receiver will pick up an RF signal of only a few billionths of a watt and transform it into 2 watts of audio power—more than adequate for loudspeaker reproduction. The Knight-Kit "Ranger III", complete with cabinet, is listed in the Allied Radio catalog.



***knight-kit* 12-Watt High Fidelity Amplifier**

THIS 12-watt high fidelity amplifier uses one of the finest circuits ever designed for home construction. Many deluxe features are included to assure performance that compares very favorably with that of commercially built amplifiers.

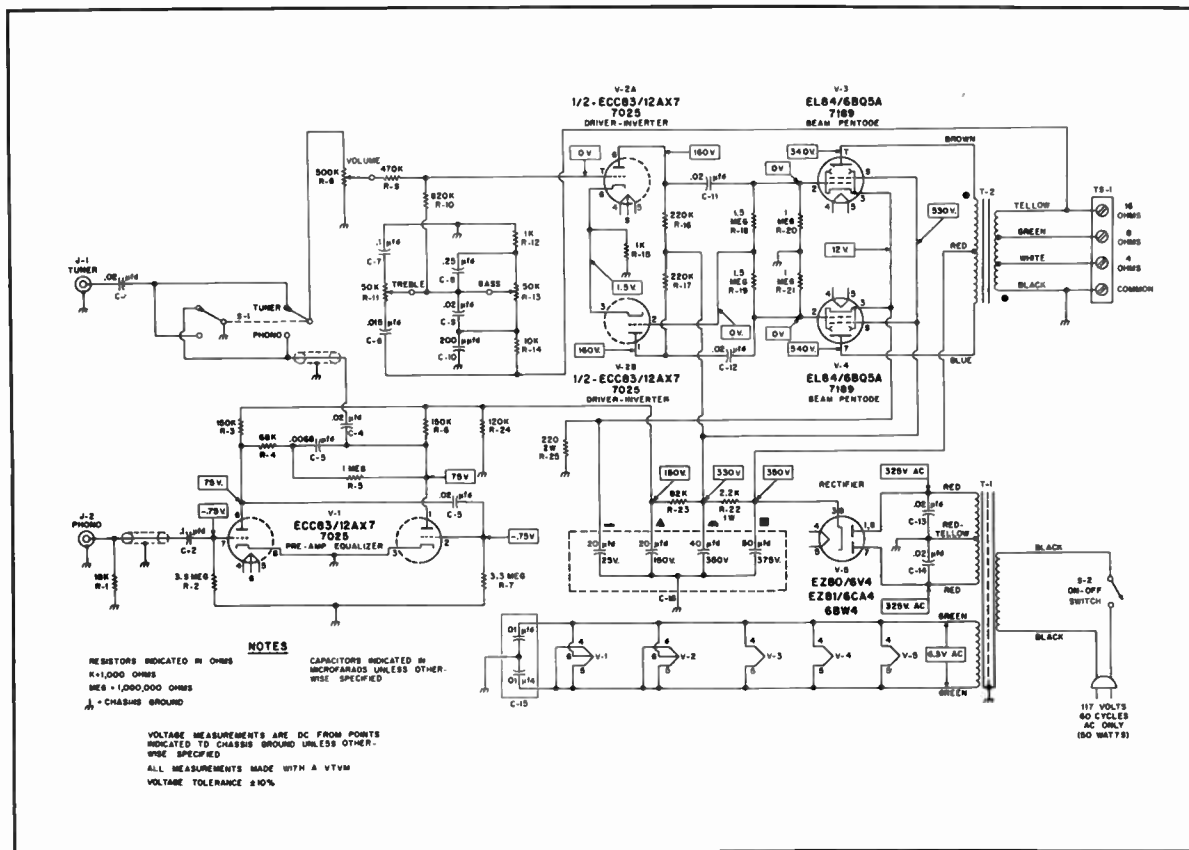
The amplifier will deliver full 12 watts output from either a radio tuner or a record player with a crystal cartridge plugged into the input marked J-1; or from a record player with magnetic cartridge (G.E., Pickering, Audax, etc.) plugged into the input marked J-2. The switch, S-1, selects either input and grounds the one not in use, to prevent cross-talk between the inputs. Resistor R-1 is the terminating resistor for magnetic cartridges.

The circuit of V-1 (12AX7 tube) provides preamplification and equalization for magnetic cartridges. The two sections of the tube are connected in cascade to provide the high gain needed. Both cathodes are grounded for better shielding and to reduce hum. Bias is derived from grid-leak resistors R-2 and R-7. Equalization is achieved by plate to plate feedback

through capacitors C-3 and resistor R-4, with resistor R-5 limiting the bass boost to prevent rumble.

V-2, the second 12AX7 tube, is connected in a circuit which provides phase inversion. Here the incoming signal is split into two signals 180° out of phase with each other, as required to drive the push-pull output stage. Phase inversion takes place because the cathode of V-2A is connected to the cathode of V-2B, and the grid of V-2B is in effect grounded. V-2A operates as a conventional amplifier, with a positive-going signal at the grid appearing as a negative-going signal at the plate, and a positive-going signal at the cathode. Since the cathodes are connected together, the cathode of V-2B will also go positive, and the grid of V-2B will go negative with respect to the cathode. This results in a positive-going output signal at the plate of V-2B at the same time the output signal of V-2A is going negative.

One signal from V-2 is coupled through capacitor C-11 to the grid of V-3. The other signal from V-2, 180° out of phase with the signal going to V-3, is



knight-kit 12-Watt High Fidelity Amplifier

coupled through capacitor C-12 to the grid of V-4. V-3 and V-4, the 6BQ5 output tubes, are connected for push-pull operation with their cathodes connected together and their plates connected to opposite ends of the primary winding of the output transformer. In this way, the outputs of the two tubes are combined in the output transformer, resulting in reduction of distortion by cancelling out harmonics and hum.

Feedback voltage is taken from the 16-ohm tap on the secondary winding of the output transformer to perform a dual function—reduction of distortion and for tone control. The feedback voltage is divided by filter networks so that high frequencies go to the treble control, R-11, and the low frequencies go to the bass control, R-13. Moving either control clockwise (upward on the schematic) reduces the amount of feedback of the selected frequencies, resulting in an increase of bass or treble, as desired.

T-2, the output transformer, has a 10,000 ohm primary impedance to match the load requirements of

the two 6BQ5 output tubes. The secondary winding of T-2 has taps to match 4, 8, or 16 ohm speakers. A high-fidelity PM speaker should be used to maintain the wide frequency range which this amplifier delivers.

A transformer-type power supply is used to provide high voltage for peak efficiency of the output tubes. The 3-section resistance-capacitance filter and full-wave rectifier circuit smooth out the AC ripple effectively reducing hum to a minimum. AC hum which might be picked up from the filament circuit is shorted to ground through capacitor C-15.

Any of the alternate tube types indicated on the schematic diagram will give excellent performance in this circuit. This amplifier with its complete set of controls is an excellent companion unit for any basic hi-fit tuner and record player. The Knight-Kit 12-Watt High Fidelity Amplifier is listed in the kit section of the Allied catalog.



***knight-kit* 2-Band Transistorized "DX'er"**

THIS interesting radio circuit employs one of the most important recent developments in the field of electronics, the transistor. Extremely small size, minute power requirements, and very low operating temperatures are characteristics that make the transistor ideal for many applications not only in electronic equipment that previously employed vacuum tubes, but also in new miniaturized equipment.

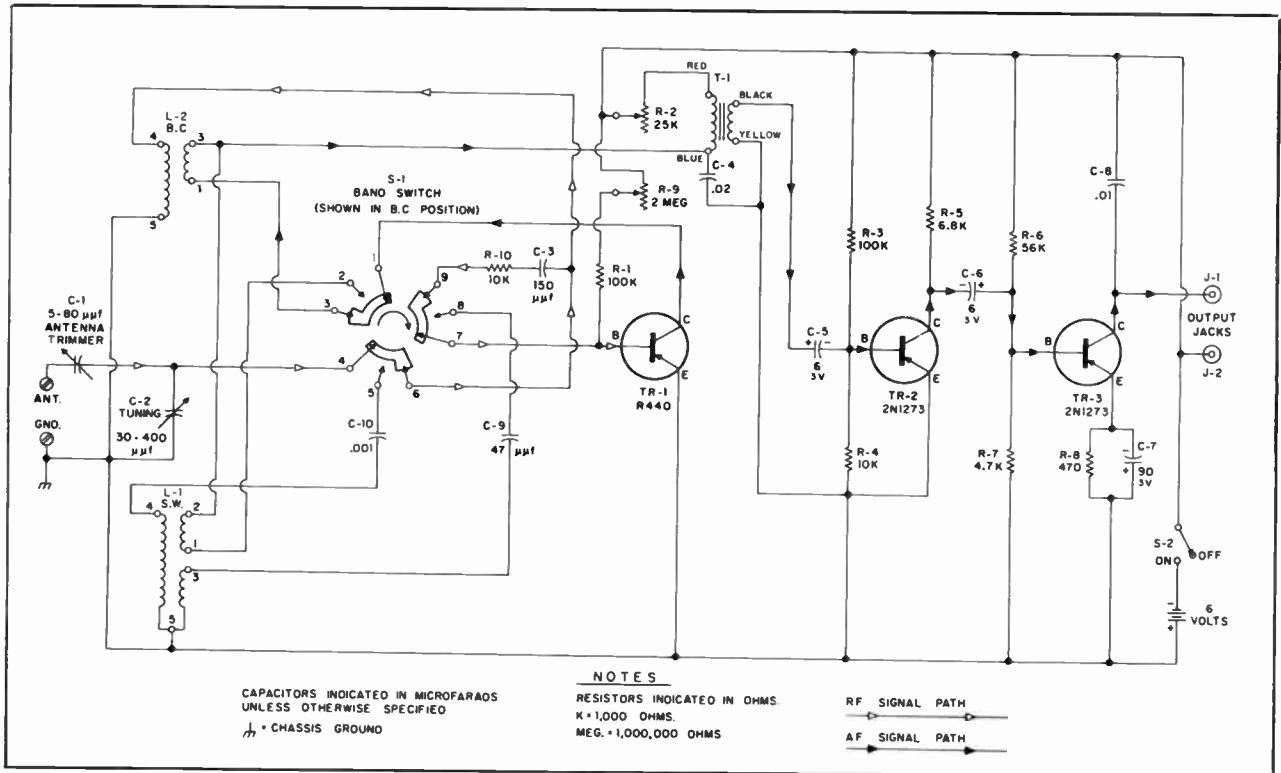
The Knight-Kit 2-Band Transistorized "DX'er" can be built in a few hours. The first kit of its kind, it is battery-operated, compact and highly portable. With it, AM broadcast stations can be received in the 550 to 1500 kc range. When the bandswitch is turned to the shortwave position, the receiver tunes from 7.5 to 17.5 mc. Here foreign broadcasts on the international shortwave frequencies, messages from ships and planes, and transmissions from Ham radio operators can be heard.

The theory of circuit operation in this unique radio is as follows. Radio waves traveling through the air from all stations are picked up by the external wire antenna and pass to the antenna trimming capacitor C-1. The antenna trimmer forms a series-tuned cir-

cuit with the antenna and helps to tune it to the frequency desired. Rotating the bandswitch selects the desired set of coils and connects them to the circuit. The tank circuit, which consists of C-2, a variable tuning capacitor, and either L-1 or L-2 depending on the position of bandswitch S-1, presents a very low impedance to all undesired frequencies and shunts them directly to ground. The RF signals at the frequency to which the "tank" is tuned are coupled through C-3 and R-10 to the regenerative detector, TR-1.

A portion of the RF signal is amplified by TR-1 and appears at the "tickler" section of L-1 or L-2, producing regeneration and a resulting tremendous increase in gain. Controls R-9 and R-2, coarse and fine regeneration controls, adjust the amount of feedback for maximum sensitivity. If the regeneration is adjusted to the point of oscillation, CW (continuous wave transmissions in Morse code) and SSB (single-sideband, a form of radio telephone) signals can be received.

Diode detection takes place in the base-emitter circuit of TR-1. When a common-emitter PNP tran-



knight-kit 2-Band Transistorized "DX'er"

istor has a negative voltage applied to the base, current will flow in the base-emitter circuit. Therefore, when the negative half of the RF signal is applied, current will flow in the base-emitter circuit. When the positive half of the signal is applied no current will flow. The value of the current flow in the base-emitter circuit will vary in accordance with the modulation of the RF signal.

The rectified RF signal contains both an AC component (the intelligence or audio modulation) and a DC component (the average value of the RF signal). The DC component serves to bias the transistor and permits the AC signal to be amplified, appearing as an audio signal voltage across the collector load T-1.

The two audio amplifiers, TR-2 and TR-3 are PNP junction-type transistors. These are resistance-capacitance coupled, common-emitter amplifier circuits. The audio signal is coupled through the audio transformer T-1 to the base of TR-2. R-4 provides operating bias for the transistor and signals appear-

ing at its base are amplified and pass through C-6 to the base of TR-3. R-5 is the collector load for TR-2. TR-3 gets its bias from the voltage drop across R-8. C-7 bypasses the bias resistor and provides a return path to ground for the audio signal. The audio signals from TR-3 are directly coupled to the headphones through J-1 and J-2. A 2000-ohm headphone set is recommended for use with this kit because the headphone set acts as the load for the collector of TR-3. Use of headphones of a different impedance can result in a severe loss of audio gain.

Power for the 2-Band Transistor DX'er is supplied by four penlight cells. Battery current drain is very small and long battery life can be expected. A good external wire antenna is required for best results, especially on the shortwave band. A wire 50 feet or so in length should be sufficient to bring in stations from around the world. The Knight-Kit 2-Band Transistorized "DX'er" is listed in the kit section of the Allied catalog.



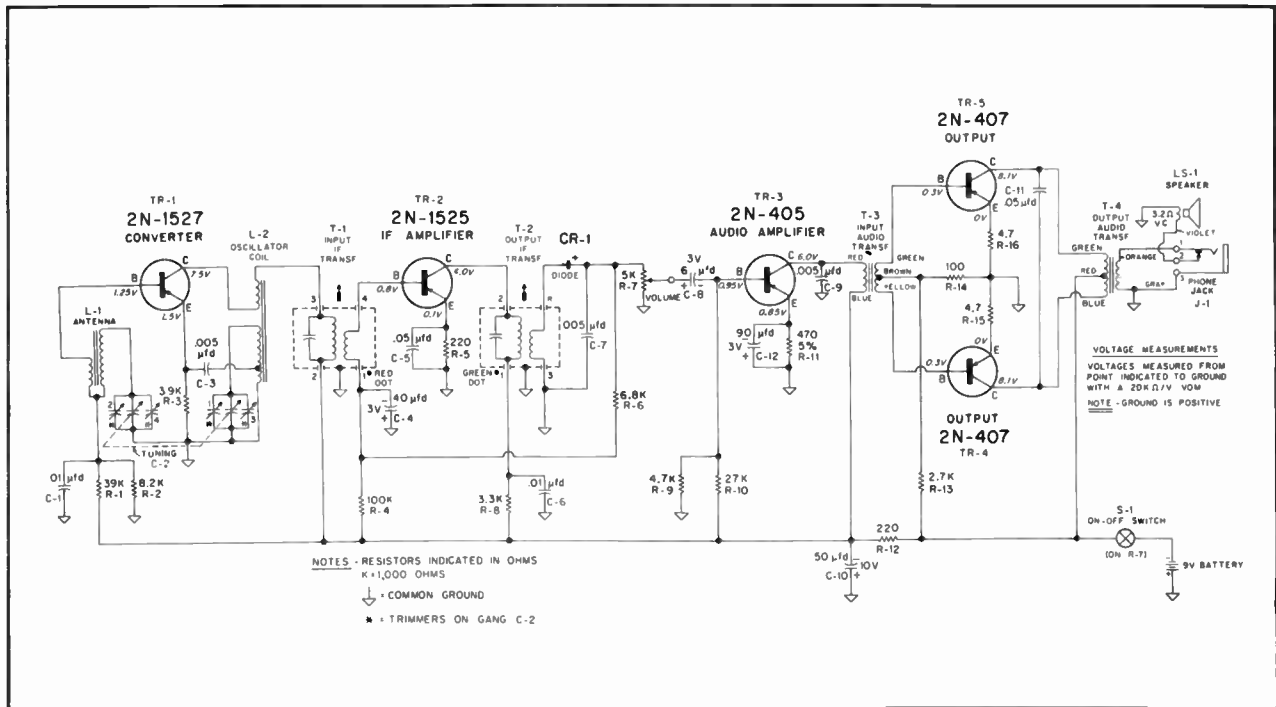
knight-kit 5-Transistor Portable Radio

THIS circuit illustrates the use of transistors in a standard AM broadcast receiver. The transistors perform the same functions as vacuum tubes would in an equivalent circuit. The extremely small size of the transistors in comparison with the tubes they replace makes possible the assembly of a portable receiver that is ultra-compact. The receiver operates from a self-contained 9 volt battery. Transistors have no heater filaments so there is no need for an "A" supply. Current requirements of the transistors in this circuit are minute and the battery will usually last for months. The push-pull output stage, made up of TR-4 and TR-5, delivers ample power to operate the built-in speaker with plenty of volume. A highly efficient, ferrite loopstick antenna is used to provide sensitive reception both indoors and out.

In the circuit shown, transistor TR-1 functions as the converter, combining the mixer and oscillator in one stage. Incoming signals from all radio stations in the area are picked up by the antenna coil, L-1. The first section of C-2, a two section variable capacitor,

is in parallel with the secondary winding of L-1 forming a tuned circuit. Radio signals at the frequency to which L-1 and C-2 are tuned are accepted and passed through to TR-1. Any frequency between 540 and 1650 kilocycles may be selected as the capacity of C-2 is changed.

The second section of C-2 is in parallel with the tapped winding of the oscillator coil L-2, forming a resonant circuit. Component values have been selected so that the oscillator frequency is always 455 kilocycles higher than the frequency to which the receiver is tuned. The output of the oscillator is fed into TR-1 where it "mixes" with the incoming signal from L-1. When these signals mix, a resultant frequency is formed which is called the "beat" frequency. It is the difference between the frequencies being mixed, in this case 455 kilocycles. The "beat" frequency is used as the intermediate frequency or IF. The intermediate frequency is always 455 kilocycles, regardless of the frequency to which the receiver is tuned. The IF is coupled directly from untapped winding of L-2 to the



knight-kit 5-Transistor Portable Radio

input IF transformer T-1. This transformer is designed to accept 455 kc and to reject other frequencies. The secondary winding of T-1 feeds the IF signal into transistor TR-2, the IF amplifier. Here the signal is greatly amplified and passed through to T-2, the output IF transformer, which is also designed to accept only 455 kc signals. Extremely high efficiency is achieved in the IF amplifier stage because it is designed to amplify one frequency only.

The amplified IF signal is directly coupled to CR-1, the crystal detector. The function of the detector is to separate the audio signal from the IF signal. The audio signal is a varying voltage representing the voice or music of the specific broadcast being received. The rectified IF signal is fed back to the input IF transformer T-1 to provide automatic volume control action. This AVC action is described on page 6 in the basic circuits. The audio signal from CR-1 develops a voltage across R-7, the 5000 ohm volume control. Adjusting the volume control couples the proper amount of this voltage through C-8, the coupling capacitor, to the audio amplifier for the desired listening level. TR-3, the audio amplifier, greatly amplifies

the voltage received from R-7 and feeds it through T-3 the audio input transformer, to the push-pull power amplifiers, TR-4 and TR-5

The audio input transformer has a center tapped secondary winding to provide the phase inversion necessary for push-pull operation. An input signal is fed alternately to TR-4 and TR-5 so that while one one transistor is conducting, the other is not. The outputs are combined in the audio output transformer, T-4. Operating the power amplifiers in push-pull is desirable because in addition to providing the needed power for loudspeaker operation, better fidelity is obtained due to the cancellation of even harmonics. The secondary winding of T-4 has an impedance selected to match the impedance of the speaker voice coil to provide a maximum transfer of energy. The closed-circuits jack, J-1, permits the use of headphones for private listening. The jack is wired to open the speaker circuit when the headphone plug is inserted.

The Knight-Kit 5-transistor portable radio, complete with cabinet is listed in the kit section of the Allied Radio catalog.



knight-kit Transistor Code Practice Oscillator

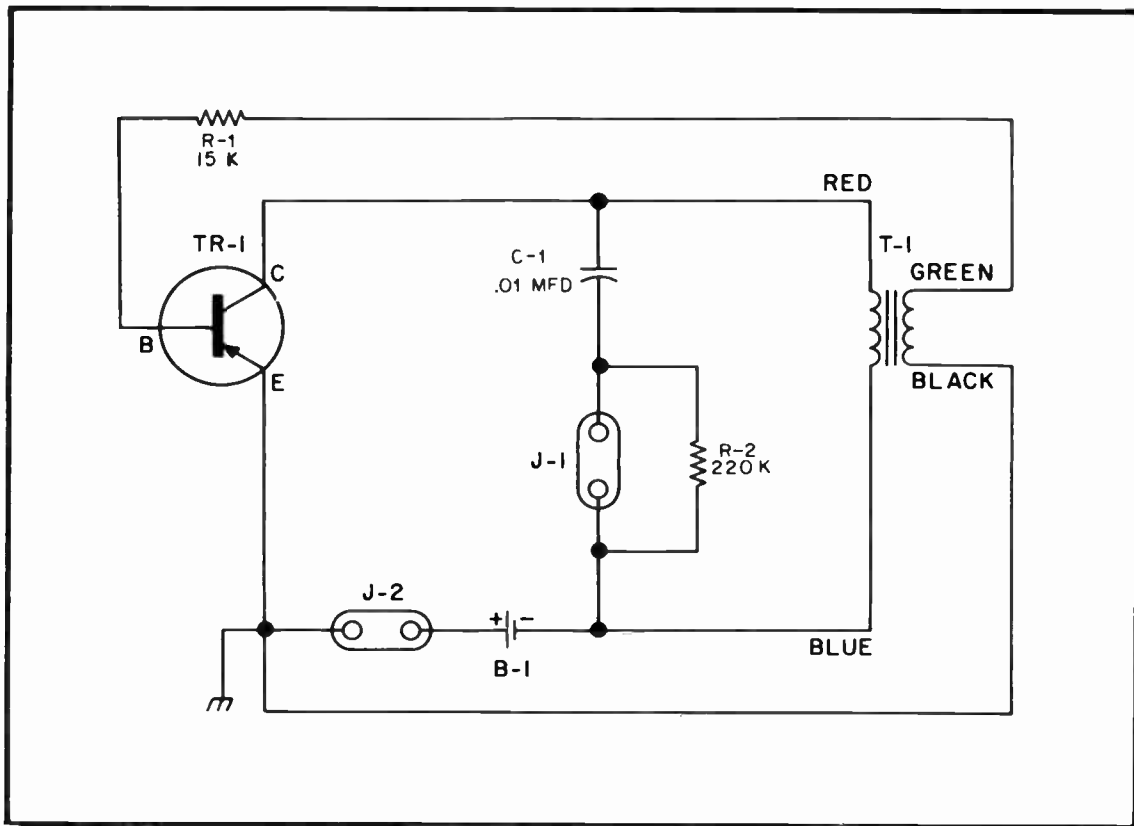
CODE practice oscillators have been popular with aspiring Amateur and commercial radio-telegraph operators for many years. The development of a good "fist", that is, the ability to send clearly defined dots and dashes with the proper spacing between characters and words, requires consistent practice with a telegraph key and an audible signal source.

While a signal source as simple as a door bell buzzer keyed by applying its required operating voltage can be used, it is desirable to use a signal source that simulates the actual sound of radio-telegraph transmissions. 500 to 800 cycles per second is a pleasant, non-fatiguing note.

Electronically operated signal sources (oscillators) give the best results. These are simply audio oscillators capable of producing clearly defined dots and dashes even when being turned on and off at a very rapid rate. Oscillators of this type have been designed

using one or more vacuum tubes, neon bulbs, and combinations of both.

The Knight transistorized code practice oscillator is a marvel of compactness, simplicity of construction, and rugged dependability. As can be seen in the above diagrams, the circuit consists of only two resistors, a capacitor, an audio transformer, a 1.5 volt battery, and a transistor. The entire unit is housed in a case which measures only $1\frac{1}{8} \times 2\frac{7}{8} \times 3\frac{7}{8}$ ". Hardly bigger than a package of cigarettes! It can be built in a matter of minutes. Any type of headphones, low or high impedance can be used. Jacks are provided for headphone cord tips and terminals for key leads. No external power source is required as all operating voltage is supplied by the 1.5 volt pen-lite battery. Because of the extremely low current drain, the battery can be expected to last its normal shelf life. Transistor life is estimated at tens of thousands of hours.



knight-kit Transistor Code Practice Oscillator

In the schematic diagram shown, TR-1 is a P-N-P junction-type transistor. The letters B, C and E identify the base, collector and emitter. These elements of the transistor correspond to the grid, plate and cathode of a triode vacuum tube. The transistor is connected in what is fundamentally a blocking type oscillator circuit. The blocking oscillator is a variation of the Armstrong or tickler coil oscillator. Comparison of the above circuit with that of the tickler coil oscillator (see page 4) shows the marked similarity. Notice that the only difference between these circuits is that the polarity of the voltage applied to the collector of the transistor and that applied to the plate of the triode is reversed and the polarity of the base and grid return resistors is reversed. In addition, the vacuum tube circuit requires a blocking capacitor in the grid circuit.

To operate the code practice oscillator, a telegraph key must be connected to J-2 and headphones to J-1.

When the key is closed, current flows in the collector circuit through the high impedance winding of the audio transformer, T-1. This current flow causes a voltage to be induced in the low impedance winding of T-1. The induced voltage developed across R-1, the 15,000 ohm base resistor, drives the base positive and cuts off the collector current flow. Remember, the base corresponds to the grid of a vacuum tube. When the collector current stops, the induced voltage drops and the blocking bias provided by R-1 is removed, so collector current again begins to flow. The component values in the schematic diagram plus the distributed capacity of the transformer windings cause this cycle to repeat itself 600 times per second. An audio voltage is coupled through capacitor C-1 to the headphones where it produces a 600 cycle per second tone. The tone stops each time the key is opened. The Knight-Kit transistor code practice oscillator is listed in the kit section of the Allied catalog.



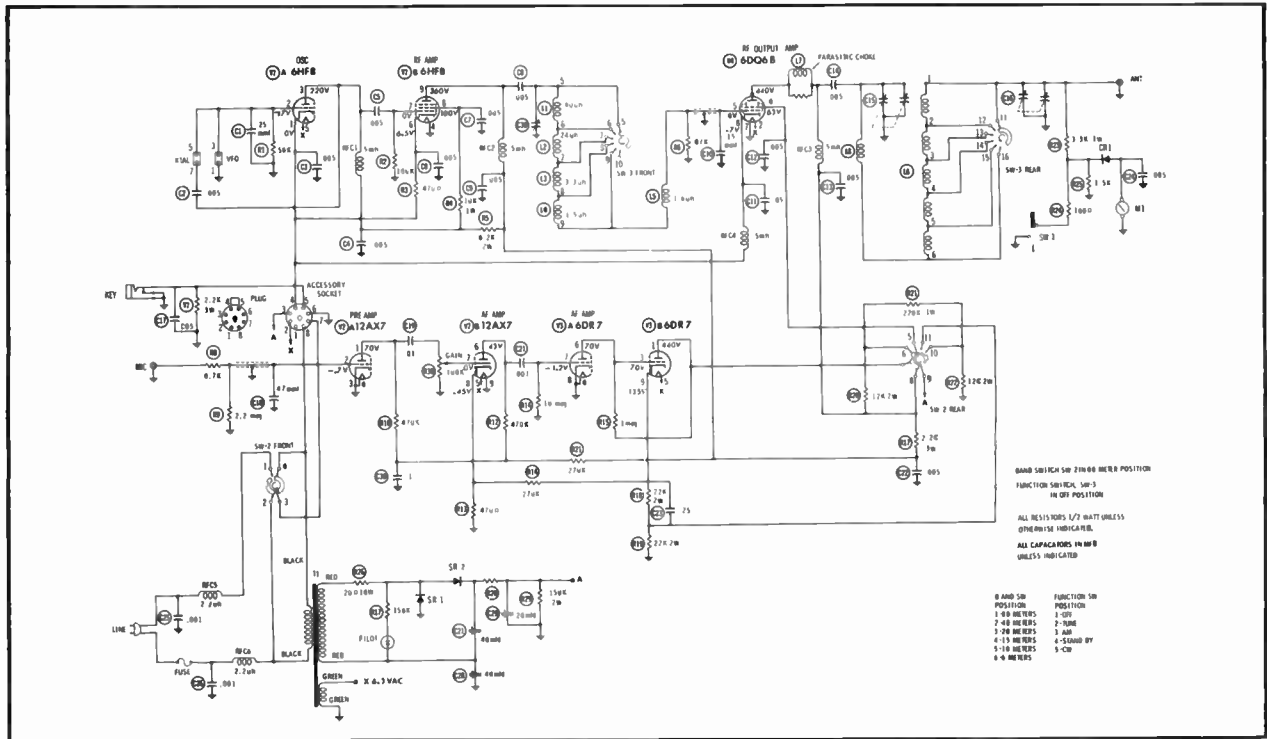
knight-kit 60-Watt Phone-CW Transmitter

THE Knight-Kit 60-watt transmitter is a high-power radio frequency generator designed to operate at 60 watts of power input on either CW (continuous wave) or peak carrier-controlled AM (amplitude modulation) on the 80, 40, 20, 15, 10 and 6-meter Amateur bands. The band desired is selected by the two-section bandswitch SW-3, front and rear, in the schematic diagram. The switch sections move simultaneously to select the proper taps on the plate coil L-6 and the proper combination of coils L-1, L-2, L-3, L-4 and L-5. The specific frequency of operation is determined by the frequency of the crystal that is plugged into the oscillator circuit and by the frequency to which the various tank circuits are tuned. The operating frequency can also be selected through use of an external VFO (variable frequency oscillator) plugged into the oscillator circuit.

The oscillator stage consists of the triode section of V-1, a type 6HF8 triode-pentode, in a Pierce type oscillator circuit. This oscillator requires no tuning. The crystal replaces the tank circuit in a tunable oscillator like that shown in circuit 2 (see page 4). C-1 makes more of the voltage across the crystal available for excitation and insures oscillation even with low-activity crystals.

The output of the oscillator stage is capacitively-coupled to the grid of the pentode section of V-1, the frequency multiplier. A frequency multiplier is similar to an RF amplifier. Its grid is biased heavily through R-2 and it has a high-impedance plate circuit tuned to a harmonic of the input frequency. The tank circuit, C-30 and L-1 through L-5, selects the proper harmonic of the crystal frequency. This circuit is a pi-network interstage coupling device. The coupling system is effective in reducing v.h.f. harmonics because the output capacitor, C-10, provides a direct capacitive shunt for harmonics across the amplifier grid circuit. C-10 also helps to stabilize the final RF amplifier stage and eliminates the need for neutralization.

The 6DQ6B final amplifier provides 60-watts input on all bands, 80 through 10 meters and slightly reduced power on 6 meters. In the 6-meter band, the final amplifier acts as a doubler, its tank being tuned to twice the input frequency. The parasitic choke L-7 filters out v.h.f. harmonics. The pi-network output circuit matches any antenna impedance between 40 and 600 ohms. A portion of the RF output is rectified by CR-1 and the resulting voltage across R-25 is measured by M-1, which indicates relative RF output.



knight-kit 60-Watt Phone-CW Transmitter

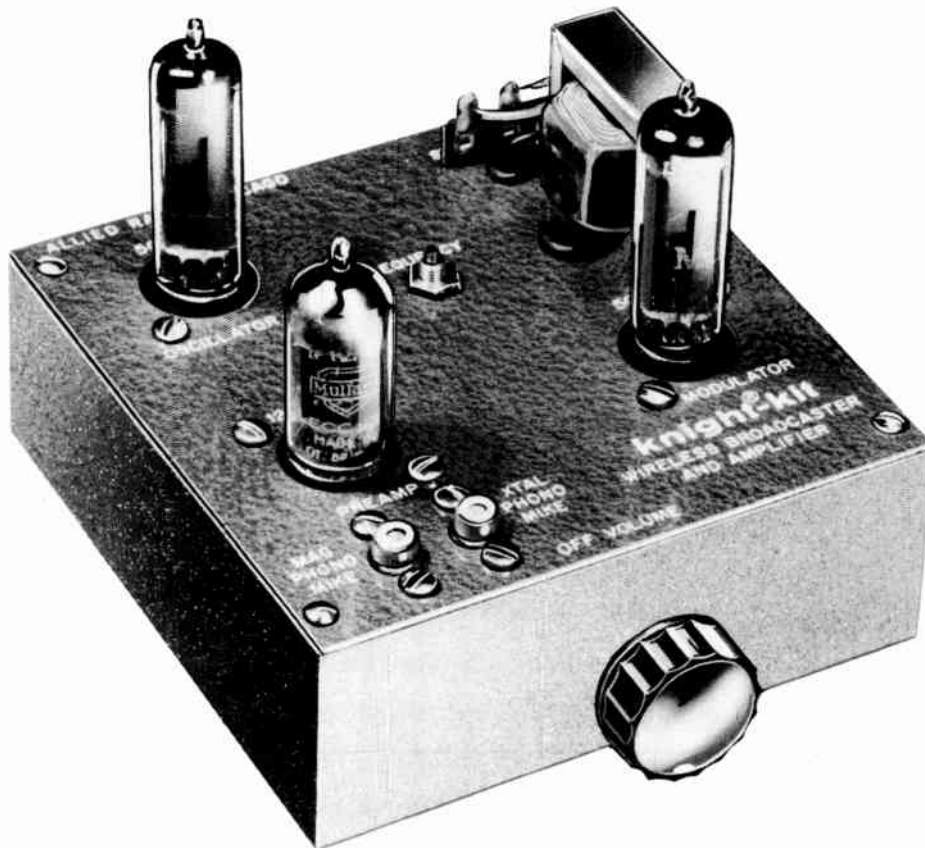
Actual output power cannot be measured since it is dependent on the antenna impedance.

The transmitter is keyed in all stages simultaneously. This is accomplished by biasing all stages to cutoff through the 2.2K keying resistor. The key shorts R-7 and grounds the cathode circuits of the stages, permitting the tubes to conduct. This feature provides chirp-free CW (continuous-wave) keying and eliminates the danger of high voltages appearing at the key terminals.

Controlled-carrier modulation allows the final to run at only one-quarter of the full CW input power when there is no modulation, permitting almost 100% of the CW input to be used on modulation peaks. Modulation is obtained by applying a lower value of DC to the screen of V-4 than is used for CW. The screen return is to the junction of R-18 and R-19. V-3A is not self-biased; therefore, AC voltage appearing at the grid of the tube is rectified and biases the tube. C-21 and R-14 form an RC circuit whose time constant is such that the DC element on the grid of V-3A builds up and decays at the proper rate. The plate of V-3A is directly coupled to the grid of V-3B. Voltage changes on the grid of V-3B will result in changes in cathode current. Cathode current increases modulation. The screen of V-4 therefore increases in

voltage with modulation, resulting in an increase in RF output, and at the same time the screen and plate carry the AC modulation. Stages V-2A, V-2B and V-3A amplify the audio voltage and feed the audio signal to the control tube, V-3B.

The power supply of the T-60 employs two silicon diode rectifiers, SR-1 and SR-2. These provide lower operating temperatures, require no filament supply, and are more efficient than tube-type rectifiers. R-29 is a bleeder resistor that stabilizes the high voltage by providing a minimum fixed load and, in addition, discharges the filter capacitors C-27, C-28 and C-29 when the power is turned off. RFC-5, RFC-6, C-25 and C-26 bypass the incoming power line for RF and help eliminate TVI (television interference). The accessory socket permits voltages to be tapped off the power supply for operation of a VFO or other auxiliary equipment. SW-2 is the 5-position function switch. In the "Tune" position, the screen voltage is lowered to protect the final amplifier tube during the tune-up procedure. In the "Standby" position, the plate voltages are removed from the tubes. The Knight-Kit transmitter comes complete with all parts, wire, solder, and instructions. It is listed in the kit section of the Allied catalog.



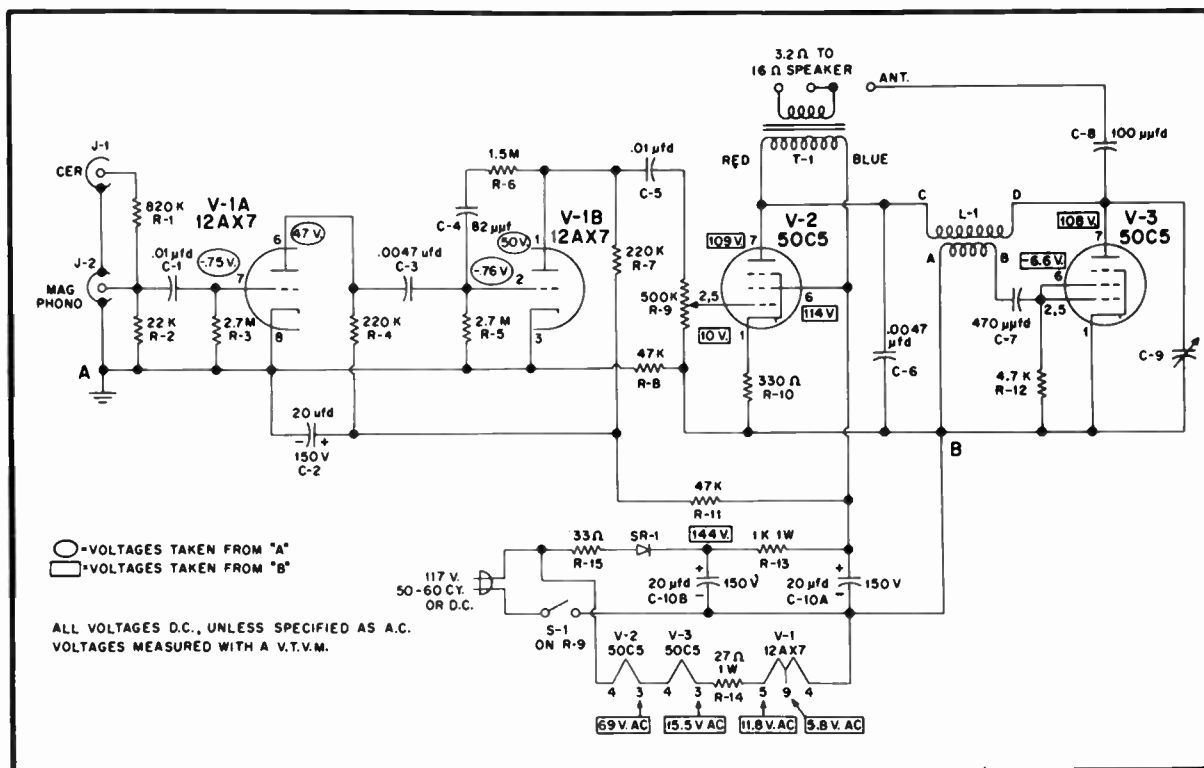
knight-kit Wireless Broadcaster-Amplifier

AS its name implies, the wireless broadcaster-amplifier performs a dual function. It can be used as a miniature broadcast station and as a phonograph amplifier. When used with a record player, it will transmit a modulated signal that can be picked up on any standard AM broadcast receiver within a limited range. A speaker can be connected to the output terminals to permit using the unit as a phonograph. In addition, both functions can be performed simultaneously, phonograph and broadcaster, to create a pleasing dimensional effect.

The phono amplifier section consists of V-1A and V-1B, a 12AX7 dual-triode tube; and V-2, a 50C5 beam power amplifier. The minute voltage developed by the record player cartridge, as its needle follows the grooves of a record, is amplified greatly to provide the power necessary to drive the speaker and produce audible sound with ample volume. Ceramic, crystal, or magnetic cartridges can be used. By connecting the record player to either J-1 or J-2 inputs jacks, proper loading for the specific cartridges is

provided by resistors R-1 and R-2. The output voltage of the cartridge is coupled to the grid of V-1A through the .01 mfd capacitor, C-1. This small voltage is amplified in V-1A and the output voltage developed across the plate load resistor, R-4. This output voltage is coupled to the grid of V-1B through capacitor C-3.

The equalization required for magnetic cartridges is supplied by the feedback loop, R-6 and C-4, between the plate and grid of V-1B. Output voltage from the V-1B is developed across the plate load resistor, R-7, and coupled through capacitor C-5 to the grid circuit of the power amplifier, V-2. The proper amount of input voltage to produce the desired volume level from the speaker is selected by adjusting R-9, the volume control. The output voltage from V-2 is developed across the primary winding of T-1, the audio output transformer and is inductively coupled into the secondary winding. The impedance of secondary winding is selected to provide a proper match with speakers having voice coil impedances



knight-kit Wireless Broadcaster-Amplifier

between 3.2 and 16 ohms. The impedance match is necessary to assure maximum transfer of energy to the speaker.

When the unit is used as a wireless broadcaster, V-3, the second 50C5 tube, is used with V-1 and V-2. The unit operates much like a regular AM broadcast station. It sends out a signal between 600 and 1500 kilocycles which can be picked up by any AM broadcast radio. The signal being broadcast is made up of two parts. One is the information or sound, which because it is an audio frequency cannot be broadcast by itself. The second part is the carrier, a radio frequency, on which the sound signal "rides". The carrier frequency is selected to fall within the tuning range of the radio being used for reception.

V-3 functions as a radio frequency oscillator. The frequency of oscillation is determined by the values of L-1 and C-9. The inductance of L-1 is fixed, but the capacitance of C-9 is variable to permit tuning the wireless broadcaster between 600 and 1500 kilocycles. V-3 oscillates because of feedback from the plate to the grid circuit. Part of the output voltage of V-3 developed across the primary winding of L-1, the plate coil, is induced in the secondary winding

and capacity coupled through C-7 to the grid.

The sound signal, that is the audio frequency, is impressed on the carrier frequency at the plate of V-3. The plate voltage of V-3 varies at an audio rate because it is connected through L-1 to the plate of V-2. V-2 acts as the audio power amplifier to drive a speaker and the modulator to supply audio voltage to V-3. The combined signal, that is the modulated carrier, is coupled to the antenna through capacitor C-8. C-8 also keeps DC voltage from the plate of V-3 off the antenna. The antenna radiates the signal which is picked up by the radio.

The power supply uses a conventional half-wave rectifier circuit to convert 50 or 60 cycle AC to DC for operating the tubes. R-15 is a limiting resistor that protects SR-1, the selenium rectifier, from current surges. Electrolytic capacitors C-2, C-10A and C-10B, with resistors R-11 and R-13 form a resistive-capacitive network that filters out hum-producing ripple from the rectified DC. The filaments of the tubes are wired in series with a dropping resistor, R-14, to permit operation from 120 volt AC or DC.

The Knight-Kit wireless broadcaster-amplifier is listed in the kit section of the Allied catalog.



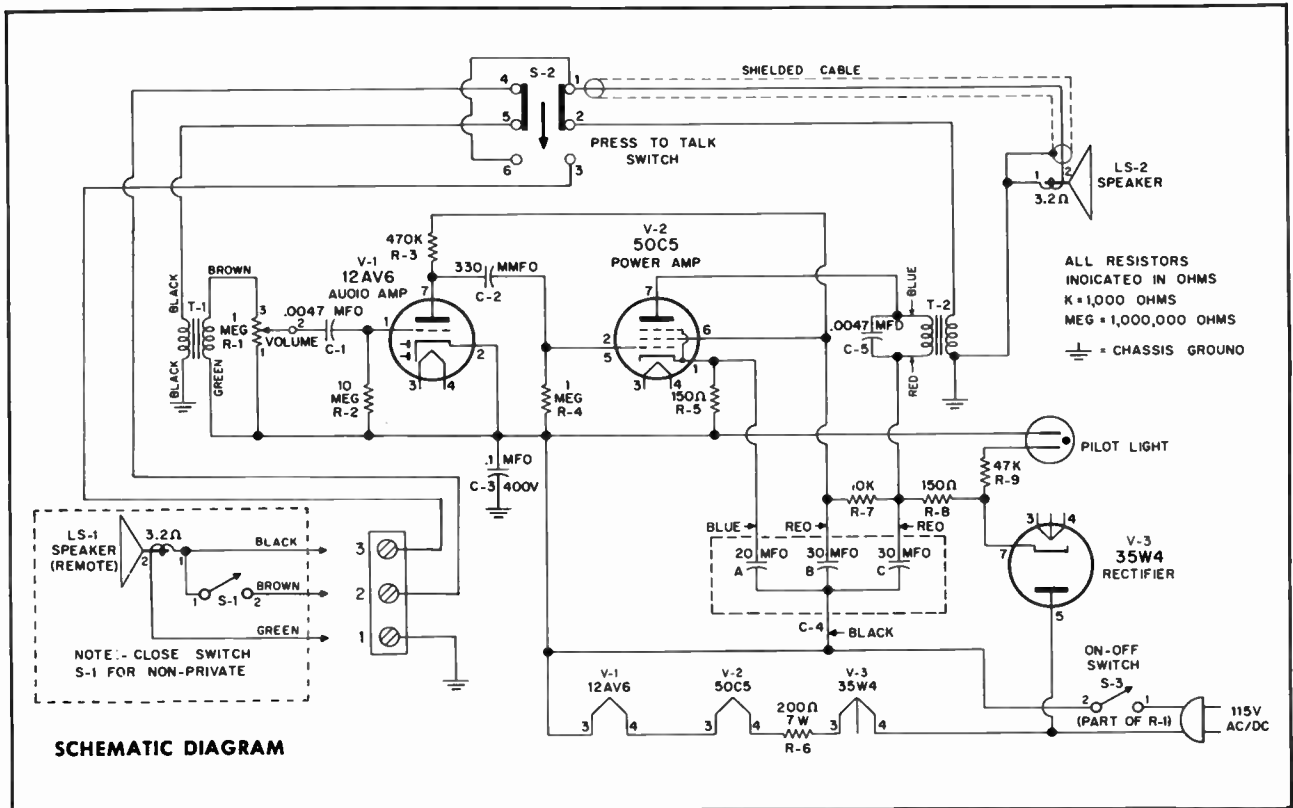
knight-kit Intercom System

THE Knight-Kit 2-way intercom incorporates an efficient amplifying and switching circuit which is both economical and easy to build. Intercoms are extremely popular in industrial plants, offices, shops, schools, and in the home. The convenience they afford in saving time as well as energy more than offsets their small cost of operation.

In general, there are two basic circuits to be considered in an intercom system. These are the audio amplifier and the speaker switching arrangement. As can be seen in the schematic diagram, the audio amplifier is of the AC-DC type with the tube filaments (heaters) wired in series. The triode portion of the type 12AV6 tube is used as a high gain voltage amplifier; the dual diode section of this tube is not used. The type 50C5 beam power pentode tube is used as the power amplifier supplying the necessary voltage amplification for loudspeaker operation. The type 35W4 half-wave rectifier converts 50 or 60 cycle alternating current (AC) to the direct current (DC) needed for operation of the amplifier circuit. Because the total voltage drop of the tube filaments is only 97.6 volts, a 200 ohm, 7-watt resistor is used to provide the additional voltage drop needed to permit operation from a standard 115 volt AC or DC line.

It is interesting to note that the speakers in an intercom system serve as either microphones or loudspeakers, as required. In the circuit shown, up to 3 remote stations can be used with one master unit simply by wiring the cables of the remote stations in parallel to the terminal board (numbered 1, 2 and 3) on the master unit. This arrangement permits calls originating from the master unit to be heard by all remote stations regardless of what position their switches are in. Calls originating from a remote station will be heard by the master and any remote stations that have their switches in the listen position. The switch on the master station is spring-loaded and must be held down to talk. When the switch is released it automatically returns to the listen position.

Inasmuch as the 3 remote stations all function in similar manner, we can consider the operation of the circuit with only one remote station illustrated. With switch S-2 in the position shown and switch S-1 in the talk position, speaker LS-1 is used as a microphone and speaker LS-2 as a loudspeaker. When a person speaks into LS-1, the voice coil and cone move with the sound waves that are set up. Current is induced in the voice coil as it moves in the magnetic field of the speaker magnet. This current travels



knight-kit Intercom System

through switches S-1 and S-2 to the primary winding of the input transformer, T-1. Current flow here induces a voltage in the secondary winding of T-1 which is developed across the volume control, R-1. By adjusting the slider of R-1, the proper amount of input voltage may be selected for the volume level desired. The input voltage is fed to the grid circuit of the 12AV6 tube, it is amplified in the plate circuit and coupled to the grid of the 50C5 power amplifier through C-2, the 330 mmfd. coupling capacitor. The value of C-2 has been selected to provide best frequency response for speech intelligibility. The initial input voltage, now greatly amplified, appears across the primary winding of the output transformer, T-2 in the plate circuit of the 50C5 tube. Current flow here induces a voltage in the secondary winding of T-2. Current from this induced voltage flows through S-2 to the voice coil of speaker LS-2. The voice coil of LS-2 moves forward and backward over the speaker magnet as the voltage induced in it aids and

opposes the field of the speaker magnet. Motion of the voice coil moves the speaker cone (which is attached to the voice coil). This action sets up the sound waves which are heard.

The power supply consists of a conventional half-wave rectifier with a resistance-capacitance filter to minimize hum. The pilot lamp, which indicates when the system is on, is of the neon type. It consumes very little current and it also acts as a bleeder to discharge the filter capacitors when the system is turned off. Because only the master unit needs to be connected to an AC or DC power outlet, the remote stations may be located at almost any desired point. Use of 22-gauge, 3 conductor interconnecting cables between the units permits operating them at distances up to 50 feet from the master unit. With 18-gauge interconnecting cables, the remote station or stations may be located up to 200 feet from the master unit. The Knight-Kit Intercom System is listed in the kit section of the Allied Radio Catalog.



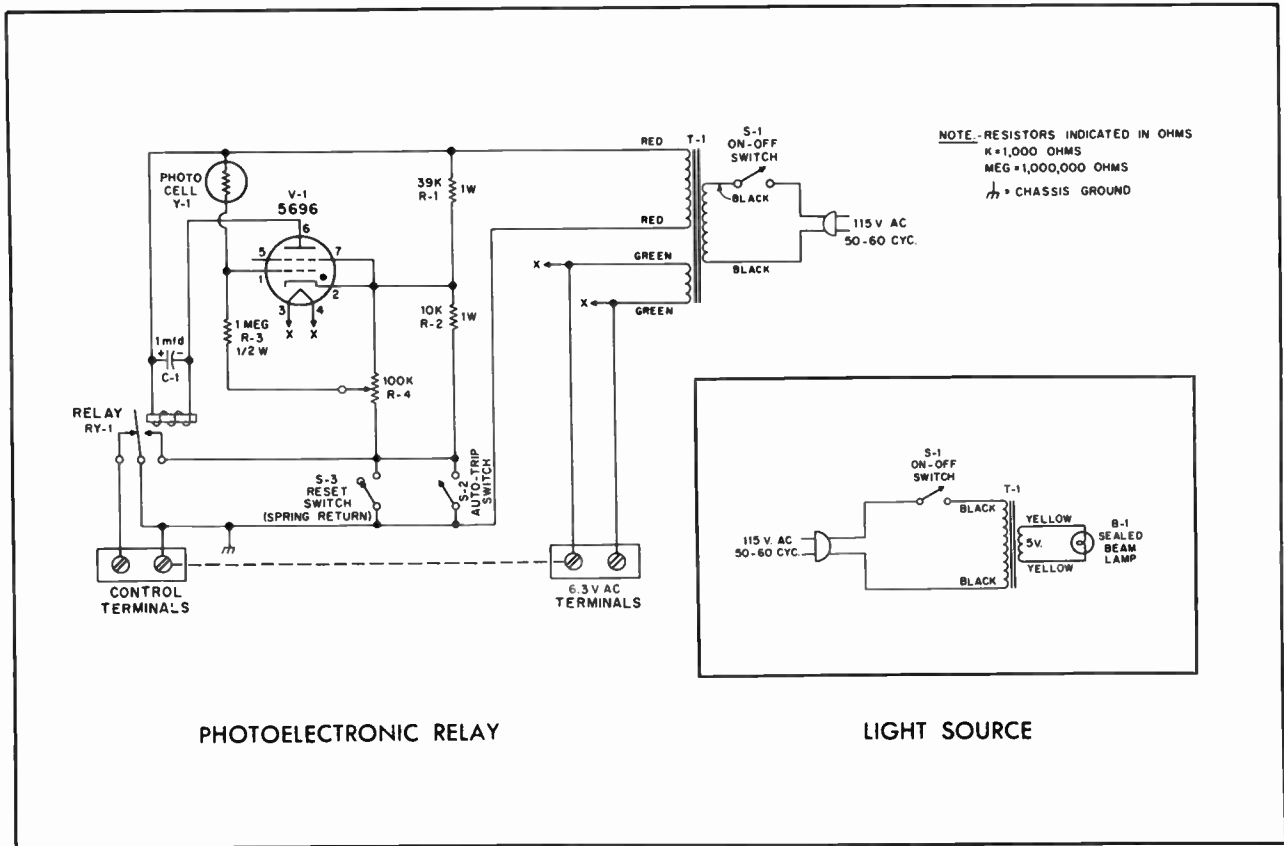
knight-kit Photoelectronic Relay and Light Source

THE Knight-Kit photoelectronic relay, or “electric-eye”, is a device which is controlled by light to automatically open or close the contacts of a switch. Used as the “heart” of control circuits, it has numerous applications in the home, office, and in industry. Photoelectronic relays are used to actuate burglar alarms, control lighting of outdoor signs, operate door openers, trigger counting machines, and to operate many other electrical devices.

The photoelectronic relay illustrated on these pages is extremely versatile, thoroughly dependable, and it is available in kit form at very low cost. A new development in this kit is the use of cadmium selenide photocell instead of the conventional phototube. The cadmium selenide photocell provides increased sensitivity and permits reliable operation at distances up to 250 feet when used with the Knight-Kit light source, which is available as a companion unit. The photocell is also sensitive to daylight, incandescent, or fluorescent light, and radiant energy from molten metal. A sensitivity control permits adjusting the

unit for operation at the light level desired.

The photoelectronic relay is basically a thyratron (grid-controlled gas rectifier) circuit. Operating voltages are obtained from the AC line through an isolation transformer, T-1 in the diagram. The type 5696 thyratron has AC voltages applied to its plate, grid, and cathode. The tube functions as a half-wave rectifier, that is, current flows only when the positive half of the voltage cycle is applied to its plate. Resistors R-1 and R-2 form a voltage divider to supply the cathode voltage. A portion of this voltage is applied to the grid circuit through R-4, the sensitivity control, and R-3, the grid bias resistor. The grid also receives voltage through Y-1, the cadmium selenide photocell. A characteristic of this photocell is that its resistance varies inversely with the amount of light shining on it. As a result, the grid voltage varies with light intensity. With a light shining on the photocell, its resistance is reduced and the grid voltage increases to a value which will permit the tube to conduct current. The setting of the sensitivity control



knight-kit Photoelectronic Relay and Light Source

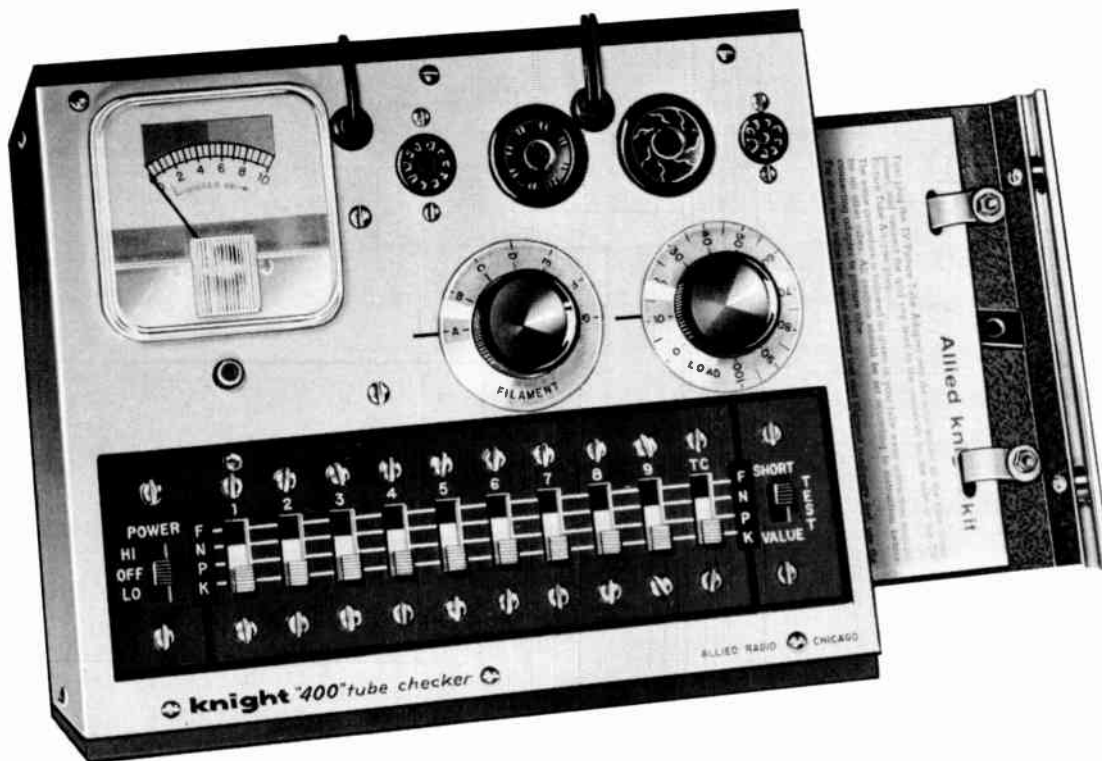
determines how much of a change in light intensity is required to make the tube stop conducting current. It is this current flow that energizes the relay causing the control contacts to open. Capacitor C-1 provides a DC pulse on alternate half cycles, when the tube is not conducting, to keep the relay from chattering. When the light beam is interrupted and no plate current flows the relay is de-energized and the control contacts close.

Either of two types of operation, "auto" or "trip", are made possible by the use of two switches for selection of cathode-to-ground circuits. With S-2 in the "auto" position (switch closed), the control contacts remain closed only for the duration of time that the light beam is interrupted. The relay resets automatically as soon as light falls on the photocell again. This method of operation is used for actuating counting devices and announcing systems. With S-2 in the "trip" position (switch open) there is no cathode-to-ground circuit until S-3, the reset switch, is closed. Closing S-3 momentarily, permits plate cur-

rent to flow through the relay coil. The energized relay opens the control contacts and closes a cathode-to-ground circuit. S-3 can now be released and the control contacts will stay open until the light beam is interrupted. Notice that when the relay is de-energized the control contacts close and the contacts forming the cathode-to-ground circuit open. This type of operation is used for burglar alarms, since once the light beam is broken, no matter for how short a time, the control contacts (to which the alarm must be connected) stay closed until the reset switch (S-3) is operated manually. Terminals supplying 6.3 v. AC are provided for operation of external devices (chimes, bells, lights, etc.)

The Knight-Kit light source kit is supplied with a deep red filter to reduce the visibility of the light beam for inconspicuous installations. Reliable operation of the system using the red filter is 125 feet.

The Knight-Kit photoelectronic relay and its companion light source are listed in the kit section of the Allied Radio Catalog.



knight-kit "400" Tube Tester

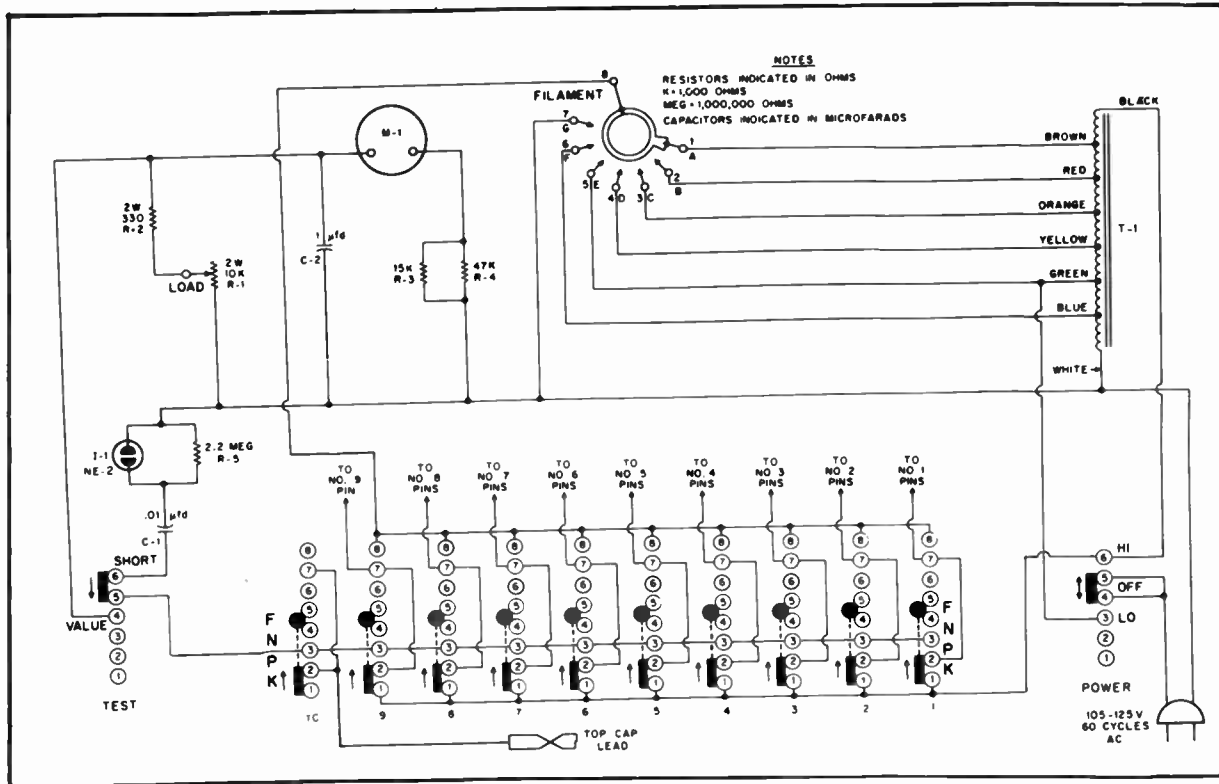
A TUBE tester is one of the greatest time savers the electronic technician, hobbyist, or serviceman can have on his work bench. It is considered good practice, when checking or trouble-shooting any piece of electronic equipment, to first make certain that all tubes are functioning properly. A tube tester such as the one described here will permit quick and accurate testing of over 1300 different types of popular radio and television tubes. All too frequently, hours have been spent trouble-shooting a piece of electronic equipment which finally proved to require nothing more than a tube replacement.

A tube tester consists basically of a power supply, a meter, an indicating light, sockets to accommodate a variety of tube types, and the switches with which proper connections to the various tube elements are established. In the circuit above, the power supply is of the autotransformer type with numerous taps and a selector switch, for selecting the proper filament voltage for the tube under test. Because filament voltages are critical, the power switch has a high and low position to compensate for abnormally high or low line voltage conditions. When the line voltage is

between 105 and 115 volts, the switch should be set in the low position. In this position, the line voltage is across the black and green leads of the autotransformer to develop a higher ratio. When the line voltage is between 116 and 125 volts, the power switch should be set in the low position. This applies the line voltage across the entire autotransformer and a lower ratio is developed.

As can be seen in the photograph on this page, the four tube sockets used in the Knight-Kit "400" tube tester will accommodate 7-pin miniature, octal, loctal and 9-pin miniature tubes. Three types of tests can be conducted individually on tubes. In tubes with more than one section, such as dual triodes or triode-pentodes, each section can be tested separately. Tests are made for filament continuity, shorts and value.

To permit the presentation of an easy-to-follow schematic diagram, the diagrams of the four tube sockets have been omitted. The captions above each of the selector slide switches numbered S-1 through S-9 indicate the tube socket pin number to which each lead connects. The selector slide switch labeled TC is connected to the top cap lead which is used for



knight-kit "400" Tube Tester

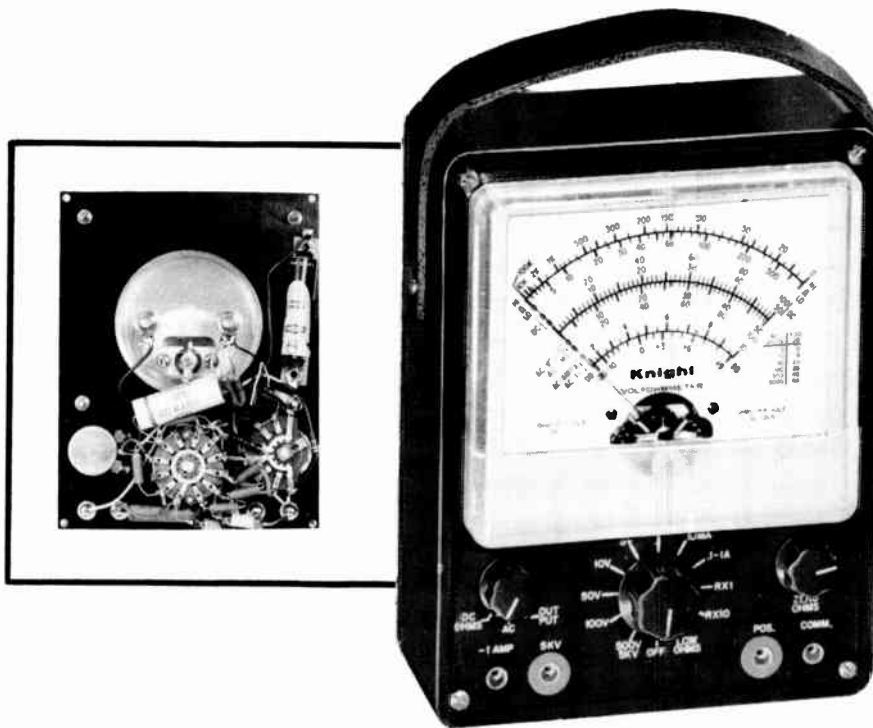
testing tubes with a top cap connection. Each of the selector slide switches can be placed in any of four positions; "K", "P", "N", or "F". These positions are marked on the panel of the tester. Tube charts, stored in the slide-out drawer of the tester, indicate the proper positioning for all switches and controls when making any of the three possible tests.

When any of the selector slide switches is set in the "K" or cathode position, the tube element connected to that particular switch is not used in the actual test, but is connected to the cathode or return circuit of the tube. When any of the selector slide switches is set in the "P" or performance position, the tube element connected to that particular switch is placed in series with the indicating light, NE-1. With the Test switch in "Short" position, the light will indicate filament continuity and shorted tube elements. With the Test switch in the "Value" position, the tube elements with selector slide switches set in the "P" position are connected in series with the load control, R-1, and the meter, M-1. When any of the selector slide switches is set in the "N" or neutral position, the tube element connected to the particular switch is isolated from all other tube ele-

ments. When any selector slide switch is placed in the "F" or filament voltage position, the voltage selected by the filament voltage switch, S-10, appears between the tube element connected to that selector slide switch and all other tube elements that have their selector slide switches in the "K" or cathode position.

The Test switch is a two position, spring return, slide switch which is normally in the "Short" position connecting the indicator light to the test circuit. When the Test switch is held in the "Value" position, the meter is connected in the test circuit and a voltage is applied to the proper tube element causing a flow of free electrons from the heated cathode. The rate of current flow or emission is measured by the meter. The meter scale is calibrated to indicate whether or not the tube is good. Accurate tube testing requires proper loading of the tube to simulate average operating conditions. The Load control, R-1, performs this function. The proper setting of this control for any specific tube being tested is given in the tube chart supplied with the tester.

The Knight-Kit "400" tube checker is listed in the kit section of the Allied Radio catalog.



***knight-kit* 1000 Ohms/Volt VOM**

A VOM (Volt-Ohm-Milliammeter) is one of the most basic test instruments, yet it is probably the most useful single piece of test equipment in the service or home workshop. Because it is a multiple function instrument, it has numerous applications in building or servicing all types of electronic equipment. It is also useful in servicing appliances.

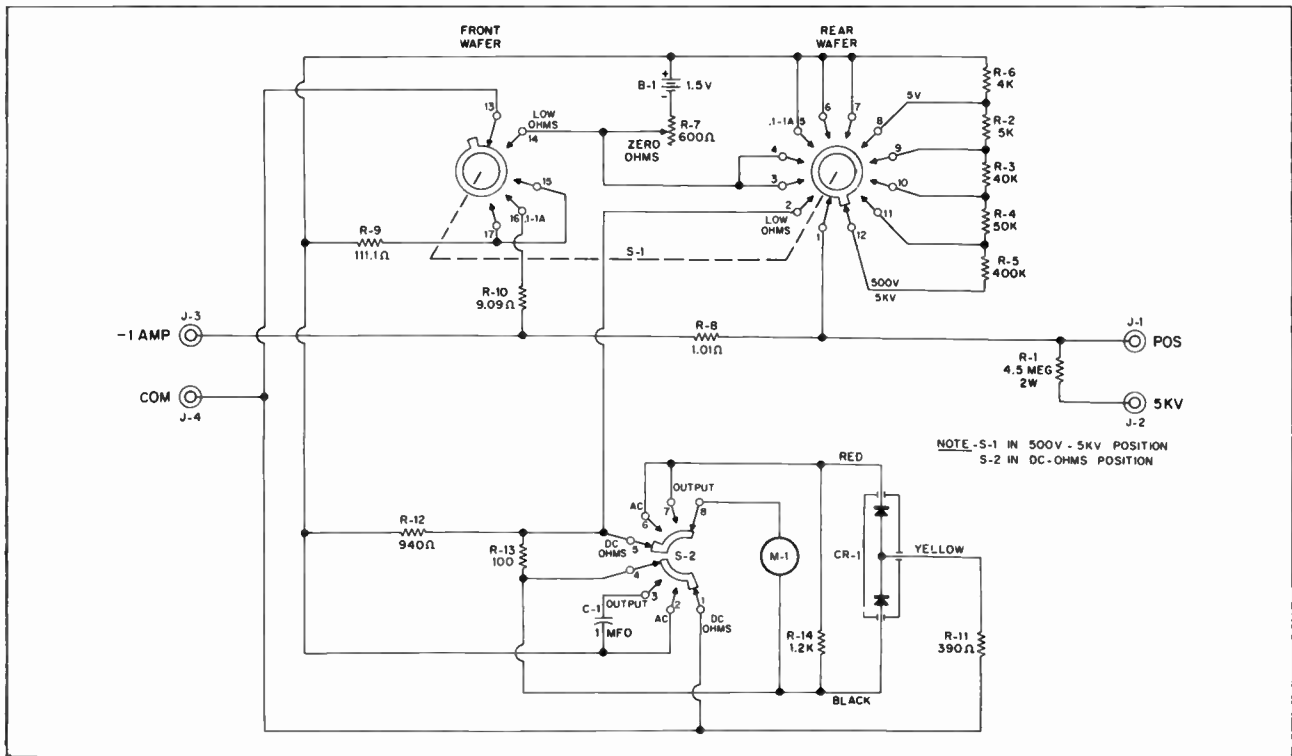
A VOM will measure DC voltage, AC voltage, and Audio Output voltage (AC in the presence of DC), as well as DC resistance and current. The VOM must be able to give readings over a wide range in each of its functions. If only a single range were provided for each function, it would be difficult to make accurate readings as the scale would be crowded. When several ranges are provided for each function, it permits selection of a range which gives the most accurate in the specific application. This is the range which provides the greatest deflection of the meter needle. Usually the approximate value of the voltage, current, or resistance to be measured is known, permitting selection of the required range. When you have no idea of the value, begin with the highest range for the specific function and switch down to the range which gives the greatest needle deflection.

The instrument consists of a milliammeter, M-1,

with a scale calibrated for specific functions and ranges, function and selector switches with appropriate shunt and multiplier resistors, a battery to provide current for resistance readings, a rectifier to permit AC readings, a blocking capacitor used when measuring output voltages, and a rheostat to compensate for the change in battery voltage with aging. The schematic and pictorial diagrams on these pages illustrate the Knight 1000 Ohm/Volt VOM.

To measure voltage, the function selector switch, S2, is set to the desired position (Output, AC, or DC-Ohms). In the Output position, the blocking capacitor, C1, allows AC to be measured in the presence of DC (as in the plate circuit of an audio stage). In both AC and Output positions the rectifier, SR-1, converts AC to DC which causes deflection of the meter needle. The range switch S-1, selects the desired full scale reading. Positions are provided for 1, 5, 10, 50, 100, 500 volts full scale, plus a jack, J-2, for up to 5000 volts. The illustrations show the function selector switch in the DC-Ohms position and the range selector switch in the 500V-5KV position.

The position of the range selector determines how many of the multiplier resistors, R2, R3, R4, R5 and R6, are placed in series with the meter movement.



***knight-kit* 1000 Ohms/Volt VOM**

The multipliers limit the amount of current from the voltage source being measured to the amount required for full scale deflection on each specific range.

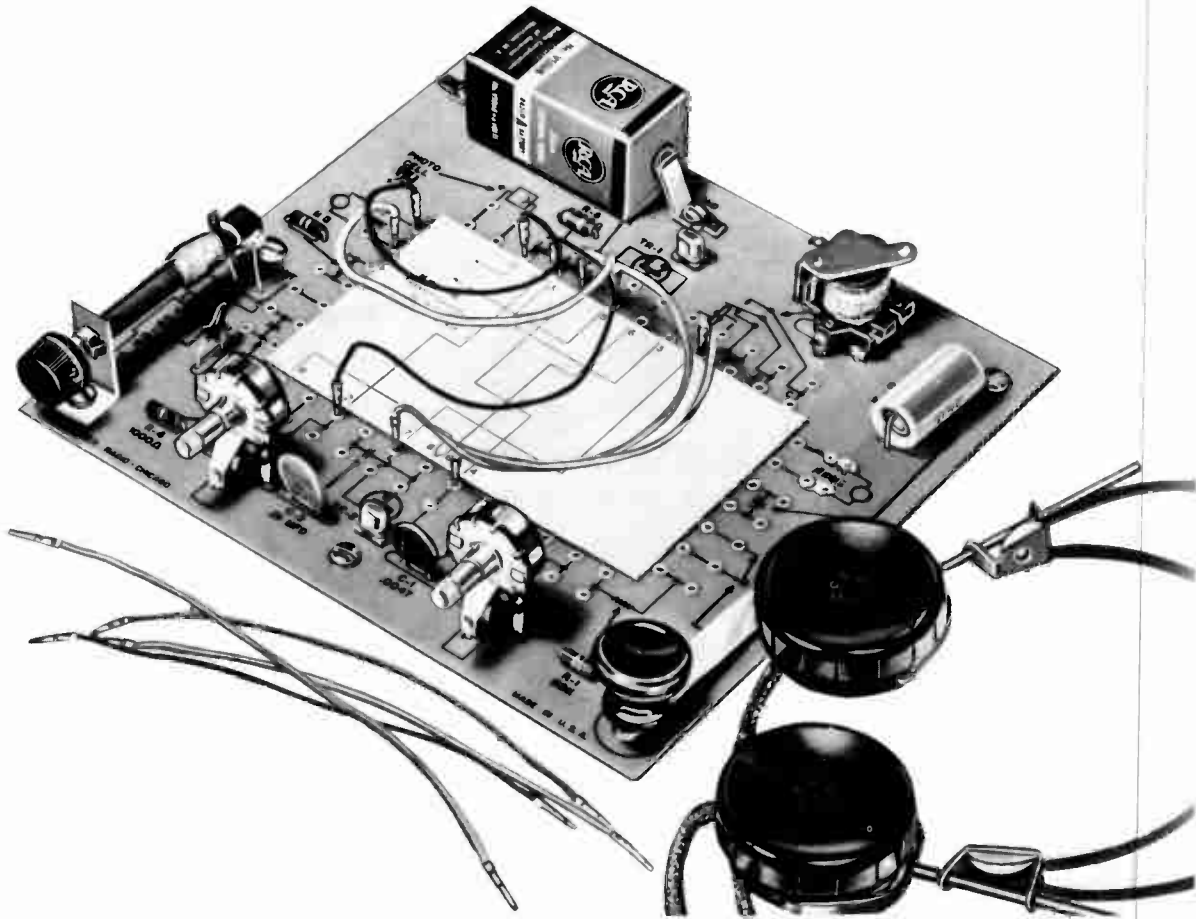
To measure a DC resistance, the function selector is switched to DC-Ohms and the test leads temporarily shorted while R7, the zero ohms calibrator, is adjusted till the meter reads zero. The range selector is then set to the position which gives the greatest needle deflection with the resistance being measured. When making resistance measurements the circuit under test should be turned off. The battery, B1, provides the current necessary for needle deflection. The position of the range selector determines the resistance which the meter will read at full scale, in the three positions provided, by shunting or placing in series with the meter and the battery, the resistors R9, R12, R13 and R7. In the Low-Ohms position the meter draws current from the battery at all times; therefore the range switch should be moved from this position as soon as readings are completed. In normal use, the battery will last approximately its shelf life.

When measuring direct current, the function selector is set to DC-Ohms. The VOM must be inserted in series with the circuit in which current is to be measured. The range selector places R8, R9, R10, R12 and

R13 in various series and parallel combinations with the meter in each of the three current ranges. Full scale deflections at 1, 10, and 100 milliamperes are available. The jack, J-3 permits readings to 1 ampere. In making current measurements, begin on the highest scale and switch down to a range which will give a reading. This precaution will protect against possible damage to the meter movement from overload and will permit making the most accurate reading.

In the AC and Output positions of the function selector, the bridged rectifier, CR-1, converts the AC or audio voltages to DC which will deflect the meter needle. In the Output position, (used for measuring AC in the presence of DC), the blocking capacitor, C-1, keeps out DC but permits AC or audio voltages to pass through.

The sensitivity of a VOM is expressed in ohms per volt. 1000 ohms per volt sensitivity means that when the instrument is being used as a voltmeter, its resistance is 1000 times the full scale range to which it is set. The higher the resistance of the voltmeter, the more accurate the voltage measurements in high resistance circuits will be. The Knight-Kit 1000 ohms/volt VOM is listed in the kit section of the Allied Catalog.



***knight-kit* 10-Circuit Transistor Lab**

THE 10-circuit transistor lab kit was designed to show the relationship between different electronic circuits, and in addition, to show how transistors are used in various applications. The circuits illustrate the fact that most circuits use the same basic components and that the difference between them lies in a few simple wiring changes.

In the lab kit illustrated, assembly is accomplished "breadboard" style. That is, all components are mounted permanently on a board and their terminals connected to eyelets into which tapered pins on the ends of wire leads are plugged to complete circuits. Of course, any of these circuits may be built in conventional style using a chassis base. 10 guide cards are supplied which fit over the board. When changing circuits in the above kit, it is only necessary to unplug the wire leads, place a different circuit guide card on board and plug in wires to match the guide.

BROADCAST RECEIVER. In this circuit, transistor TR-2 functions as a detector, separating the audio signals from the RF signal to which the antenna cir-

cuit is tuned. Transistor TR-1 functions as an audio amplifier, making the audio signal many times stronger so that it can easily be heard in the earphones. R-3, the 500K potentiometer is the volume control.

AUDIO AMPLIFIER. In this circuit, the transistors are connected as a 2-stage audio amplifier. R-2, the 50K potentiometer controls the gain of TR-1 and R-3, the 500K potentiometer controls the gain of TR-2. One phone is used as a mike and the other as a sound reproducer. The input signal is amplified 800 times.

CODE PRACTICE OSCILLATOR. In this circuit, the 2 transistors are connected as a high-gain, 2-stage amplifier which oscillates because of feedback through C-2. R-3, the 500K potentiometer controls the audio tone and R-2, the 50K potentiometer controls the volume. The audio note is heard in the phones each time the key is closed.

CAPACITY OPERATED RELAY. TR-2 is wired as a Hartley oscillator with C-2 providing feedback. The oscillations develop a voltage across R-4 which is applied to the base of TR-1 causing it to conduct and

***knight-kit* 10-Circuit Transistor Lab**

close the relay. When someone touches the antenna, oscillations stop, and the relay opens.

ELECTRONIC SWITCH. TR-1 cannot conduct until the circuit between R-6 and the base is closed. Under this condition TR-2 has full voltage and conducts heavily closing the relay. When used as a moisture sensing device, a drop of water between the sensing leads closes the circuit causing TR-1 to conduct and reducing the voltage on TR-2, opening the relay.

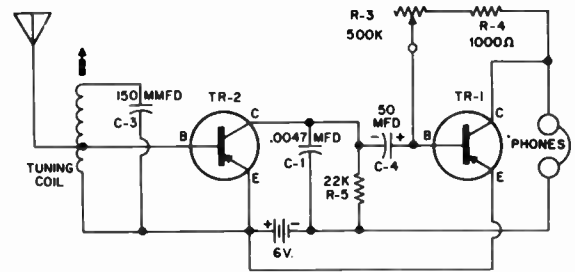
VOICE OPERATED RELAY. In this circuit, R-3 is adjusted so that TR-1 will not conduct when no sound is entering the phone. This causes full battery voltage to be applied to the base of TR-2 and it conducts heavily closing the relay. When sound enters the phone, the added voltage causes TR-1 to conduct, voltage to TR-2 is reduced and the relay opens.

WIRELESS BROADCASTER. TR-2 functions as a self-excited RF oscillator with C-2 providing feedback from the output circuit to sustain oscillation. TR-1 operates as an amplifier and modulator. It amplifies the minute voltages generated when sound is directed into the phone. This voltage is mixed with RF in the tuned circuit and broadcast from the antenna.

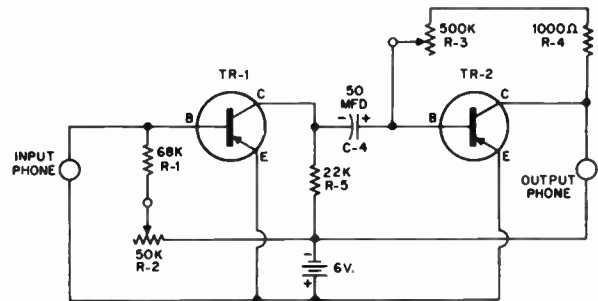
PHOTOELECTRIC RELAY. When R-2 is adjusted so that TR-1 does not conduct with no light striking the photocell, the entire battery voltage is applied to the base of TR-2 causing it to conduct heavily and close the relay. When light strikes the photocell the voltage it generates causes TR-1 to conduct, reducing the voltage to TR-2 and causing the relay to open.

ELECTRONIC TIMER. When C-4 is discharged, TR-1 conducts through R-6 and R-2 to charge it. During this cycle voltage on the base of TR-2 is not high enough for it to conduct, so the relay is open. When the capacitor C-4 is charged to the battery potential, TR-1 stops conducting and the battery voltage at the base of TR-2 causes it to conduct and close the relay. The cycle is repeated by closing the key to discharge the capacitor C-4. The setting of R-2 determines the time cycle.

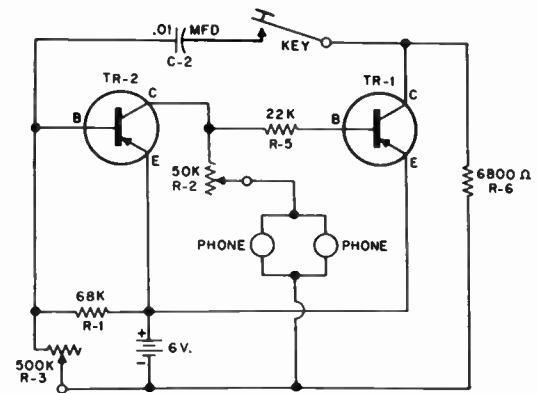
ELECTRONIC FLASHER. When capacitor C-4 is discharged, TR-1 conducts through R-6 and R-2 to charge it. The greater the resistance setting of R-2, the longer the charging time. During this cycle no voltage appears at the base of TR-2 so it cannot conduct and contacts A and B are closed. When C-4 is charged to the battery potential, TR-1 stops conducting and the battery voltage appears at the base of TR-2. TR-2 now conducts and closes contacts B and C which shorts C-4. C-4 discharges rapidly to start the cycle again. A lamp with a power source connected to terminals A and B will flash on and off.



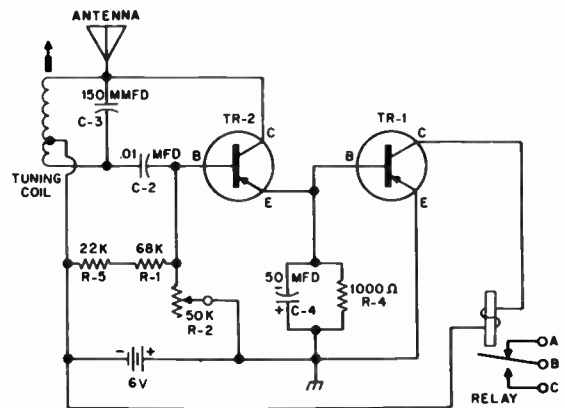
BROADCAST RECEIVER



AUDIO AMPLIFIER

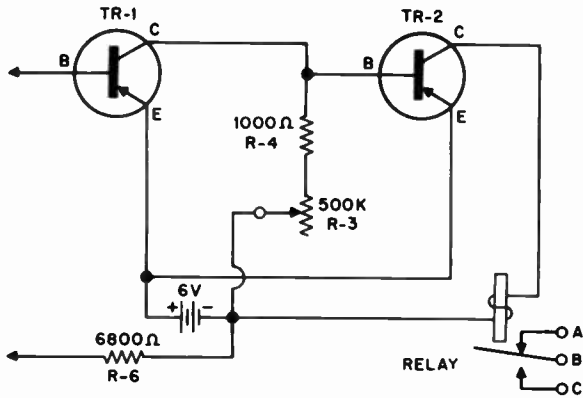


CODE PRACTICE OSCILLATOR

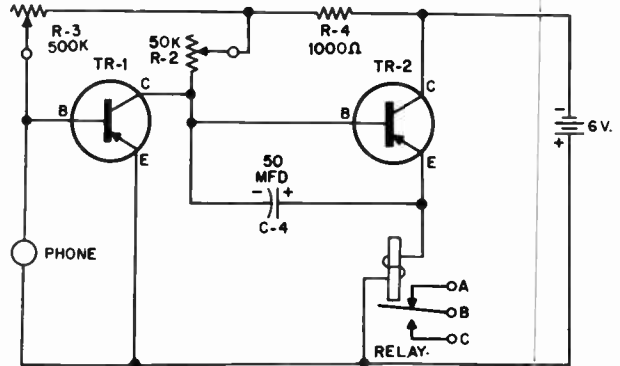


CAPACITY OPERATED RELAY

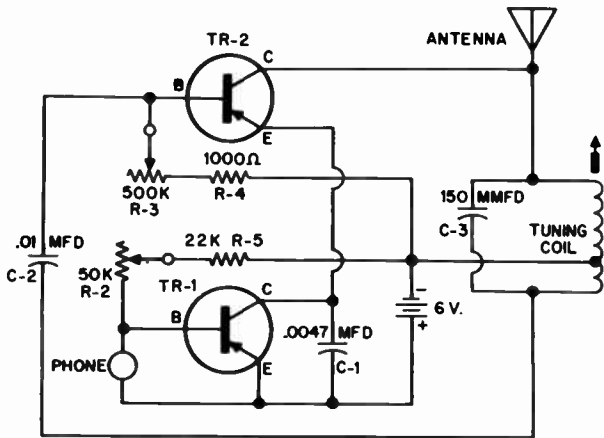
knight-kit 10-Circuit Transistor Lab



ELECTRONIC SWITCH



VOICE OPERATED RELAY



WIRELESS BROADCASTER

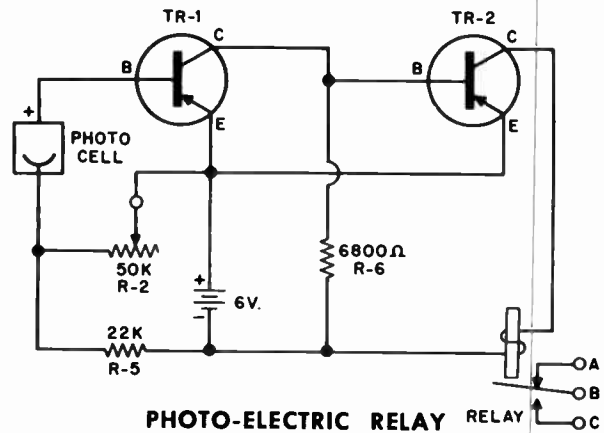
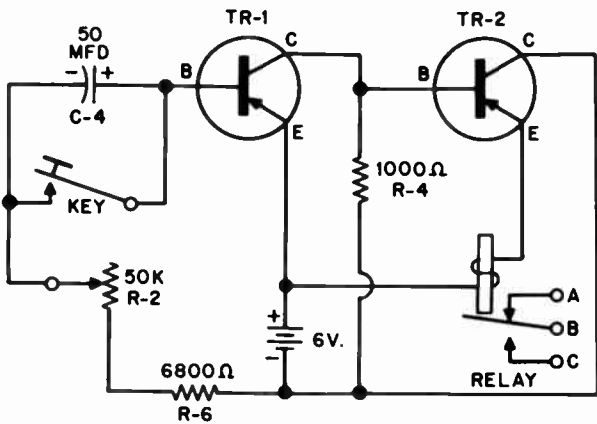
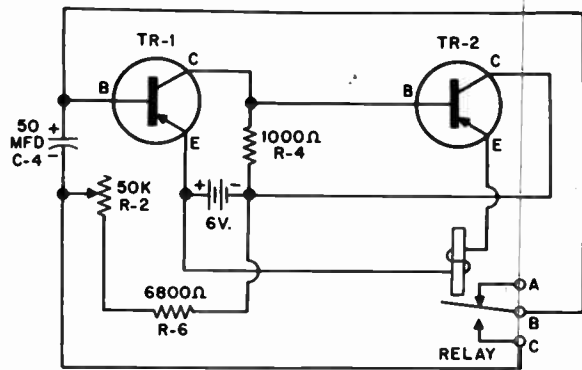


PHOTO-ELECTRIC RELAY



ELECTRONIC TIMER



ELECTRONIC FLASHER



2-Transistor Pocket Radio

knight-kit 2-Transistor Pocket Radio

THIS circuit combines the space and power-saving advantages of the transistor with the efficiency of "reflex" circuitry to provide excellent reception for a radio of its size.

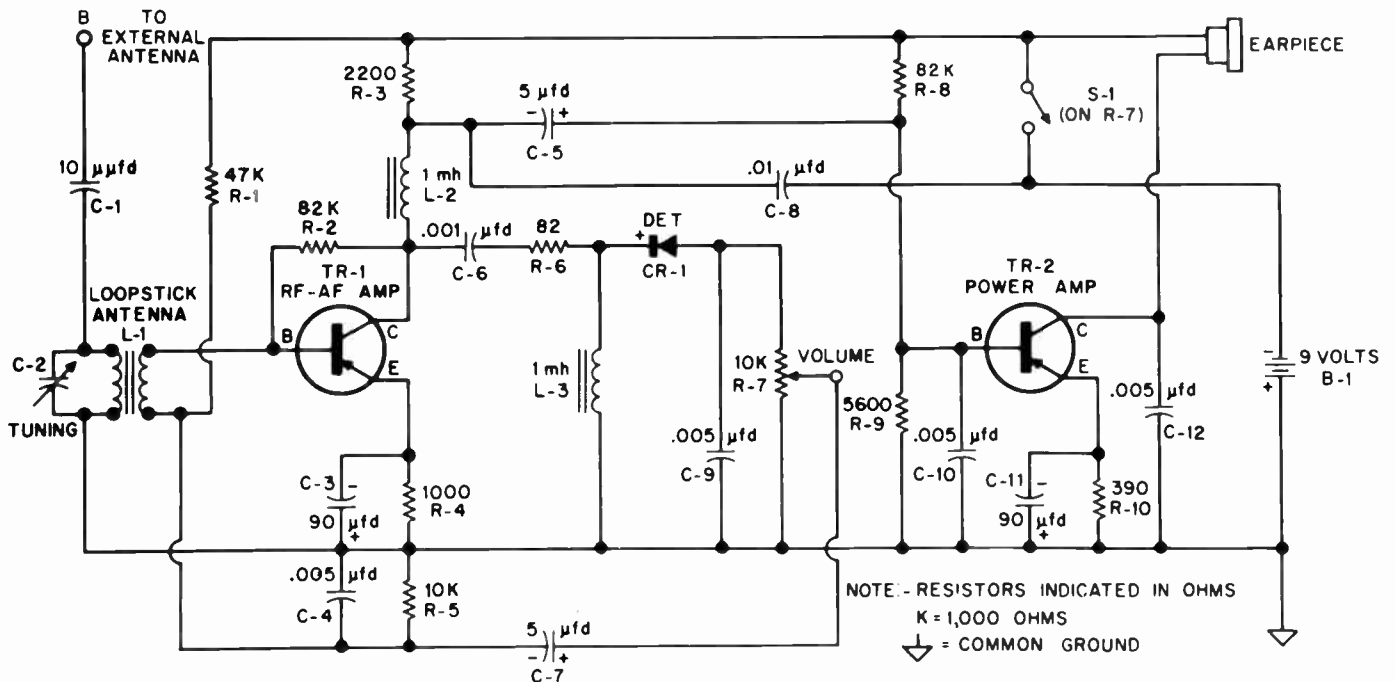
Transistor TR-1 amplifies the RF and audio signals simultaneously. The loopstick antenna and tuning capacitor C-2 act as a tank circuit to present a low impedance to signals of undesired frequencies, shunting them directly to ground. The desired RF signals are amplified by TR-1.

The amplified RF signals are coupled through C-6

and R-6 to CR-1, the crystal diode detector. This separates the audio signals from the RF signals. The audio signals are returned through C-7 to TR-1 which amplifies them. The amplified audio signals are coupled to TR-2, passing through L-2 and C-5 which block the flow of RF but pass audio signals.

TR-2 is a P-N-P transistor in a grounded-emitter circuit. The output of TR-2 is used to actuate the earphone which acts as the collector load.

The Knight-Kit 2-Transistor Pocket Radio is listed in the kit section of the Allied Radio Catalog.


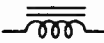
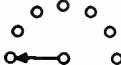

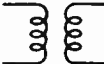





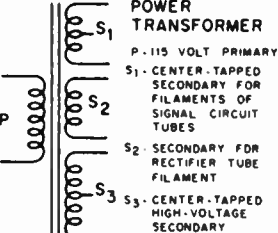










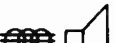




















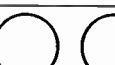



SCHEMATIC SYMBOLS USED IN RADIO

The symbols below are standard in radio, TV and electronics diagrams. Popular components are represented. An industry-wide attempt is being made to standardize schematic diagrams. All current diagrams will be enough like these to easily identify the components. Note the two methods used to indicate a wire connection and a crossover. Both are in common use, but the

curved wire crossover and dotted connection is preferred.

The symbol for a ground point may indicate an actual connection to the metal chassis, or a connection to a common lead, usually the B- voltage point. All ground points may usually be assumed to be connected together electrically.

| | | | | | |
|---|--|--|--|---|--|
|  | ANTENNA (AERIAL) |  | IRON CORE CHOKE COIL |  | SWITCH (ROTARY OR SELECTOR) |
|  | GROUND |  | R. F. TRANSFORMER (AIR CORE) |  | CRYSTAL DETECTOR |
|  | ANTENNA (LOOP) |  | A. F. TRANSFORMER (IRON CORE) |  | ADJUSTABLE CORE COIL |
|  | CONNECTION |  POWER TRANSFORMER P-115 VOLT PRIMARY S ₁ -CENTER-TAPPED SECONDARY FOR FILAMENTS OF SIGNAL CIRCUIT TUBES S ₂ -SECONDARY FOR RECTIFIER TUBE FILAMENT S ₃ -CENTER-TAPPED HIGH-VOLTAGE SECONDARY |  | FUSE | |
|  | NO CONNECTION | |  | PILOT LAMP | |
|  | NO CONNECTION (WHEN CONNECTIONS ARE INDICATED BY DOTS) | |  | HEADPHONES | |
|  | CONNECTION (WHEN NO-CONNECTION CROSS-OVERS ARE INDICATED BY HALF- CIRCLES) | |  | FIXED CAPACITOR (MICA OR PAPER) |  |
|  | TRANSISTORS |  | FIXED CAPACITOR (ELECTROLYTIC) |  | LOUDSPEAKER, ELECTRODYNAMIC |
|  | |  | ADJUSTABLE OR VARIABLE CAPACITORS |  | PHONO PICK-UP |
|  | ONE CELL OR "A" BATTERY |  | ADJUSTABLE OR VARIABLE CAPACITORS (GANGED) |  | VACUUM TUBE HEATER OR FILAMENT |
|  | MULTI-CELL OR "B" BATTERY |  | I. F. TRANSFORMER (DOUBLE-TUNED) |  | VACUUM TUBE CATHODE |
|  | RESISTOR |  | POWER SWITCH S. P. S. T. |  | VACUUM TUBE GRID |
|  | POTENTIOMETER (VOLUME CONTROL) |  | SWITCH S. P. D. T. |  | VACUUM TUBE PLATE |
|  | TAPPED RESISTOR OR VOLTAGE DIVIDER |  | SWITCH D. P. S. T. |  | 3-ELEMENT VACUUM TUBE (TRIODE) |
|  | RHEOSTAT |  | SWITCH D. P. D. T. |  | ALIGNING KEY OCTAL BASE TUBE |
|  | AIR CORE CHOKE COIL | | | | |

