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IN THIS ISSUE

True Adventures of a Spare-Time Serviceman

Questions and Answers for Radio Operator Examinations

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This Christmas Season, we direct our Greetings to the N. R. I. Students, Graduates, and former Employees who are now serving in the Armed Forces of the United Nations.

To each and every one of you, our Christmas Wish is: strength and success in your undertakings—and a speedy, safe return to your home.

The deeds *you* have done and will do . . . .

The great personal sacrifices *you* have made and will make . . . .

The service *you* are rendering to your Country, to your people, and to all humanity . . . .

. . . . will make it so that at some future, happier Christmastime, all people of the world can again sing PEACE ON EARTH, GOOD WILL TOWARD MEN.

J. E. Smith, President
E. R. Haas, Vice President

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CIRCUIT ANALYSIS OF MODEL 908 PHILCOPHONE INTERCOMMUNICATOR

By J. A. DOWIE
N.R.I. Chief Instructor

AN intercommunicator is a two-way device for voice communication between two or more points. For short-distance work, its superiority over the telephone is unquestioned. No switchboard or special operator is required, and reproduction is from loudspeakers rather than an earpiece. Switches at both master and remote stations enable either to talk or listen at will.

There are hundreds of uses for intercommunicators. To name a few, doctors and business men can use them to connect their private offices with the reception desk. Stockrooms, hospitals, factories, schools, etc., can make good use of these inexpensive systems.

Today, with the present shortage of labor, any device which cuts down on extra steps, extra help and wasted time is welcomed by all as an aid to our war effort. If you want to make extra money selling, installing and servicing intercommunicators, you should have no trouble getting all the business you can handle.

Although radio sets are fast vanishing from show rooms, ample stocks of Philcophone intercommunicators are still available to radio servicemen for resale at attractive profits. The Model 910 Philcophone is a complete system consisting of the master station, one remote speaker-microphone station and 50 feet of connecting cable, and has a retail selling price of only $29.95. The Model 908 is identical except that the master station has push-button switching to accommodate up to 5 remote stations. The selling price is $34.95 for the master station and one remote; extra remote stations are $8 each. All distributors of Philco radio parts carry these units, and will grant a discount of 35% on them to N. R. I. graduates and students.

The Philcophone Model 905A portable 15-watt complete public address amplifier system is another profitable item still available at Philco distributors. It lists at $90 complete with desk microphone and two loudspeakers and carries a discount of 40%.

Fig. 1—Close-up of Philcophone with one remote loud speaker.

The following statement by Mr. C. E. Gerhard, Manager of Parts Sales for Philco, is of interest to N. R. I. men:

"Several industrial publications have approached us on the subject of running full length articles on intercommunicating systems and amplifiers for use in industrial plants. We plan to tie in with some of these articles with advertisements on Philco equipment. We know from past experience that many inquiries will be received as a result of this publicity, which in the ordinary course of events are forwarded to Philco Distributors in the proper territories. We can now recommend to our Philco Distributors that the prospects be referred to N. R. I. members wherever possible."

By all means get acquainted with your nearest Philco distributor, for he may be able to give you some hot prospects for this Philco equipment.

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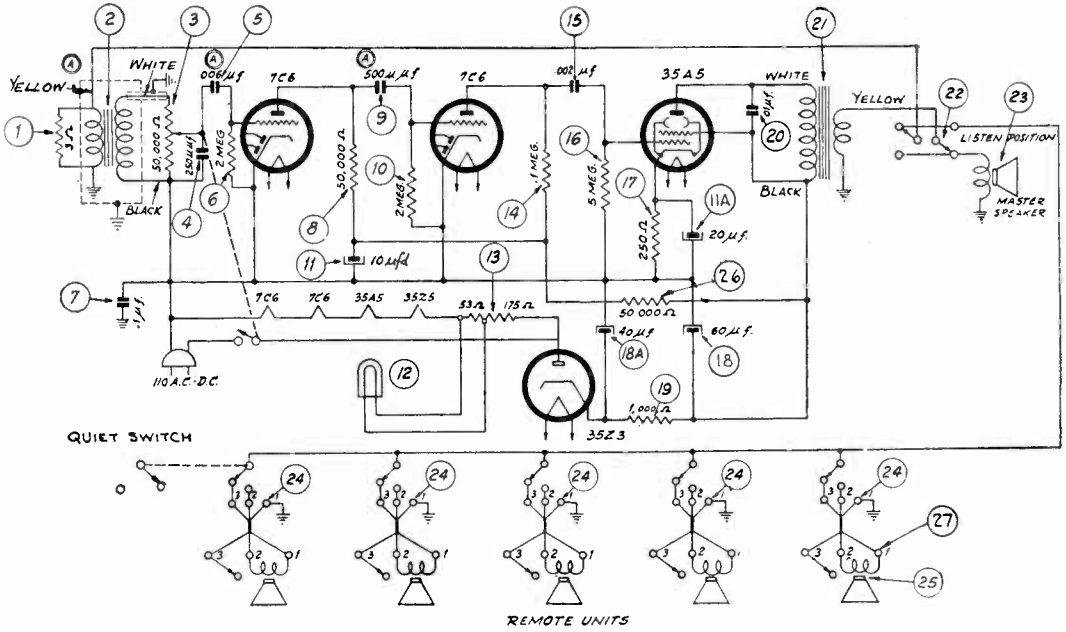

Fig. 2

PHILCOPHONE ANALYSIS

The diagram of the Model 908 Philcophone is shown in Fig. 2. The set consists of a three-stage amplifier and built-in power supply. Between two and six loudspeakers can be used, one at the master station and one at each of the five remote stations. Three-wire cables connect push-button switch 24 in the master station to each of the remote units. (The cable terminals are numbered 1, 2 and 3 respectively at each end.)

Notice that with the push-buttons in the positions shown, none of the remote loudspeakers are connected. However, if the button which is located at the back of a remote loudspeaker is pushed, terminals 3 and 2 on that remote speaker are connected together. This connects the remote loudspeaker across the primary of the audio input transformer (2), with the circuit being completed through the chassis.

The remote loudspeakers are of the permanent magnet dynamic type, so any movement of the cone causes the voice coil to cut through the flux produced by the permanent magnet. As a result, there is induced in the voice coil a voltage which is proportional to the strength of the sound wave causing the cone movement. Thus these loudspeakers also act as microphones and feed the input of the a.f. amplifier.

The audio current flowing through the primary of the input transformer induces a voltage in the secondary. This voltage is applied across the 50,000-ohm volume control (3), and a portion of it (depending on the volume control setting) is fed through condenser 5 to the control grid and cathode of the 7C6. The amplified signal voltage of this tube appears across plate load resistor 8 and is transferred across grid resistor 10, through coupling condenser 9 and decoupling condenser 11. This signal, being in the input circuit of the second 7C6 tube, is amplified by it and appears across plate load 14. By way of condensers 15 and 11, the signal is developed across grid resistor 16. The signal is now at the input of the 35A5 power tube, and this tube delivers sufficient power through output transformer 21 to drive master loudspeaker 23.

When the operator at the master station desires to talk to one of the remote stations, he pushes the button for that station. This throws the push-button switch to terminal 2, connecting straight through to the loudspeaker of that station only. He then sets switch 22 (on the master station panel) to the "talk" position, so the left-hand section of this switch connects the master loudspeaker to the input of the amplifier, and the right-hand section connects the remote loudspeaker to output transformer 21. By throwing his switch back to "listen," he can hear the reply

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of the party at the remote loudspeaker when the button on the back of the remote loudspeaker is depressed.

There is, as you can see from the schematic, a "quiet" push-button. When this is depressed, the lead from talk-listen switch 22 to all the push-buttons is grounded. The remote stations cannot then interrupt conferences by calling the master station.

Fig. 3—This illustration shows the Philcophone in use. Since in most cases the master and remote stations are fairly close together, fifty feet of cable is supplied with each remote unit. Extra lengths of cable are available for special installations.

The amplifier is of straightforward design, and there are no trick circuits employed to make servicing difficult. Anyone who understands and has serviced a.c.-d.c. receivers can easily maintain these outfits in first-class condition.

One point of interest is the 3-ohm resistor (1) shunted across the primary of the input transformer. This resistor acts as a load on the transformer at all times, particularly when the speakers are entirely disconnected while switching from talk to listen. If the resistor were not there, howling would occur each time the talk-listen switch was thrown.

Bias for the 7C6 tubes is provided by the voltage drops due to convection currents through 2-meg. grid resistors 6 and 10. The 50,000-ohm plate load for the first 7C6 tube is used instead of a larger resistor, to improve tone quality and prevent hum.

The decoupling filter network consisting of resistor 26 and condenser 11 is rather unusual in an a.c.-d.c. device, and shows that the manufacturer has taken every precaution to prevent hum from getting into the amplifier. The weakest points in this or any a.c.-d.c. device are the tubes and the electrolytic condensers.

In making point-to-point voltage measurements, do not be confused in locating B-. This, contrary to most a.c.-d.c. receivers, is not the on-off switch. A glance at the schematic shows this switch to be in the rectifier plate supply line. Therefore, B- is the other power cord lead, and this goes to the low (a.f.) potential side of the volume control as well as to the cathodes of the 7C6 tubes. Thus, any of these points may be used as B- when making point-to-point voltage or resistance measurements.

n r i

New Radio Beam System

A new two-course ultra-high-frequency radio range development is expected to replace the radio beam system now in use on the airways of the United States.

The new development operates on 125 megacycles, a wave length 400 times shorter than the wave length in use at present. Experimentation indicates that this ultra high frequency system eliminates static entirely and greatly diminishes the danger of multiple courses and the distortive effects which mountains, rivers, ore deposits and other influences of terrain exert upon radio beams, factors which have been held responsible for airline accidents. The new system provides precise and complete information to the pilot. It shows him whether or not he is to the left or right of his correct line of flight and whether he has flown beyond the radio range station or has not yet reached it, an extremely important point of information in bad weather.

In addition to its safety factors and more complete information for the pilots, the new development points the way much further toward the automatic gyroscopic control of the plane. The instrument indicator actuated by the ultra high frequency range transmitter may in the future be used to direct the automatic pilot and thus keep the plane on its course automatically.

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How Recordings Are Made

By CLINTON B. DE SOTO

Executive Editor, QST

The Editor is very grateful to QST, the publication devoted to Amateur Radio, for permission to reprint this interesting article which originally appeared in QST, August, 1942.

FUNDAMENTALLY, a recorder is nothing more or less than a precision lathe. It consists of a true-running, perfectly-balanced turning head, a cross-feed mechanism and a cutting tool.

Of course, in the recorder the headstock is called a turntable and the cutting tool is a stylus, but the difference in names doesn't alter the kind of work performed.

Equally important are the associated motor and drive mechanism and the audio power amplifier. In fact, each element of the recorder has an important role to play in the ultimate performance as a unit. We shall consider each in turn.

CUTTERS

The recording process begins with the cutter. This is the instrument that translates dynamic sound into static grooves in the wax (or equivalent) disc. The part that actually does the engraving is the stylus, while the associated mechanism that drives the stylus is called the cutting head.

As with microphones and headphones, both electromagnetic and piezoelectric crystal cutters are currently used. In the past, magnetic cutters have been preferred, especially for high-quality professional work, but the crystal cutter has become a strong competitor in recent years. Among the low-cost types, particularly, the crystal cutter excels in the handling of wide variations in sound level, and usually gives better results in the hands of the less-skillful operator.

The stylus in a magnetic cutter is attached to an armature suspended vertically between field coils which are energized by the output from an audio power amplifier. Audio variations in the fields of these coils cause the armature to vibrate from side to side. The rate of vibration varies with the power delivered to the field coils.

Low-priced cutters resemble converted pick-ups, as shown in Fig. 1-A. High-grade magnetic cutters use a laminated armature suspended on knife-edge bearings, with two or three balancing springs, as in Fig. 1-B. The pole pieces are made of high-permeability alloy.

The precision with which the armature bearing is made largely determines the minimum power required for satisfactory engraving, while the maximum power that can be used is limited by the level at which magnetic saturation of the field occurs. The range between these points establishes the amplitude or volume range of the cutter.

The stylus in a crystal cutter is actuated by the mechanical deformation or twisting tendency of a thin, elongated section of piezoelectric crystal when electrical voltage is applied to it. There is no mechanical action except the stresses in the crystal itself. Since the structural details are therefore less critical, crystal cutters capable of good performance can be manufactured more cheaply than the magnetic type.

Rochelle salt (sodium potassium tartrate) crystals are used because of their greater activity (nearly 1000 times that of quartz, according to the Brush Development Co.). This activity is greatest at room temperature (72° F.), decreasing in either direction until with extreme heat or cold it is very low. If placed in a temperature

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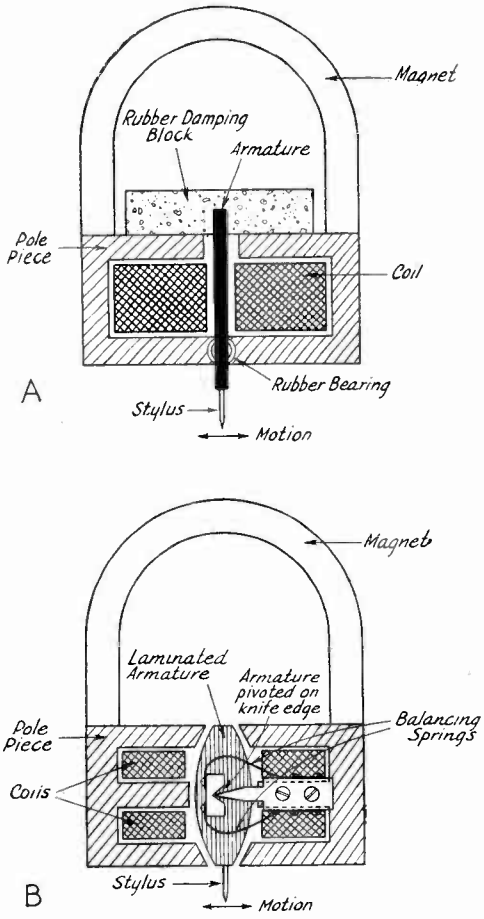

Fig. 1—Typical magnetic recording heads.

(A) Simplest type of magnetic cutting head. The armature is suspended in rubber, with a stiff bearing at bottom and flexible damping block at top. Armature vibrates between upper faces of pole pieces in response to alternating current in coils, pivoting on lower bearing. Resulting motion is imparted to stylus, which engraves the record. Damping pad overcomes natural resonance of cutter, flattening unwanted peaks but also limiting high-frequency response.

(B) Typical form of balanced-armature cutter. Laminated armature is pivoted in the center with a knife-edge bearing on a milled V block, centered by light balancing springs. Magnetic action occurs between both upper and lower faces of pole pieces. Armature pivot block is suspended in axial bearings of rubber, viscoloid or other mechanical resistance material, providing damping which limits excessive low-frequency amplitude without injuring high-frequency response.

greater than 130° F., the crystal permanently loses its activity.

Typical crystal cutters require voltages of 75 to 120 volts across an impedance of perhaps 50,000 to 100,000 ohms. This compares with the peak power of 1 watt or so required for driving magnetic cutters (the impedance of which may be anywhere from 8 to 500 ohms).

Stylus motion must be restricted to one plane. It is common practice, therefore, to incorporate a vibration damper on high-grade cutters, to suppress vertical motion. This is usually some form of dash-pot filled with oil or glycerin, or a counter-balanced weight or spring device, which serves to damp out vertical vibrations without introducing unwanted stiffness or friction.

THE STYLUS

The cutting tool, or stylus, may be made of several materials. Steel, stellite and sapphire are commonly used. At least one manufacturer offers a special alloy of precious metals in the platinum group. The inexpensive stylii ordinarily used in home recorders are made of steel, carefully cut, rounded and polished. Stellite, a cobalt-chromium alloy used in machine tool manufacture, is widely employed for instantaneous work. The better cutting heads used in making electrical transcriptions are equipped with polished-jewel stylii, usually made of sapphire which, being next to the diamond in hardness, is highly wear-resistant.

A steel cutting needle ordinarily has a useful life of about one-half hour, during which time it will cut a groove over a mile long. Stellite can be used from 2 to 10 hours (depending on the record coating used and the permissible distortion) and platinum alloy 3 to 5 hours, while sapphire is good for from 5 to 25 hours. Steel stylii, costing only a few cents, are replaced when they are worn out. Stellite and sapphire can be resharpened (a critical job usually left to the manufacturer). The maximum number of resharpenings depends on wear and the condition of the point, of course, and may be anywhere from 2 to 10 times.

Not only do the more costly stylii have a longer life but they make better recordings. A good sapphire cutter is quieter than steel by 6 db or more.

Regardless of the material, the tip of the stylus must be carefully shaped, rounded off to the correct radius and given a high polish. The degree of this polish controls the smoothness of the groove walls, which in turn determines the amount of surface noise in playback. The shape and polish of the stylus also determines the degree of friction encountered in engraving, and

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therefore affects the fidelity.

As shown in Fig. 3, a correctly-shaped stylus is a round-nosed cutting tool with an included angle of 88-90°, the nose radius averaging 0.0015-0.002 inches. The use of a back rake angle of from 2 to 5° (usually negative, although positive rake occasionally works out best in individual instances), is preferred practice to prevent tearing or hogging.

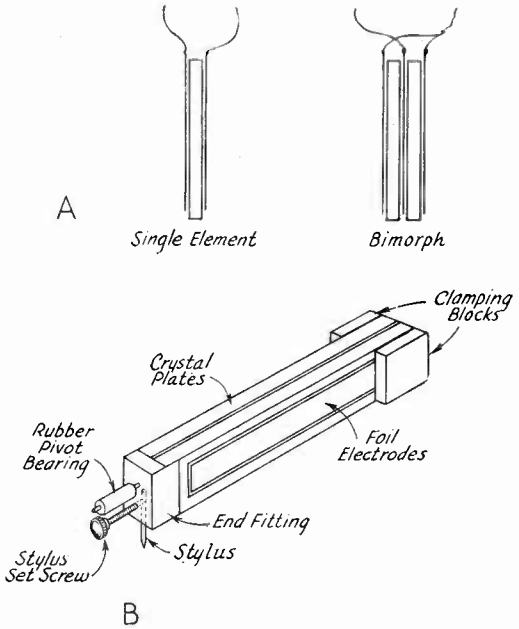

Fig. 2—(A) Low-priced crystal cutters are made with one "twister" (shear) plate, as at left. Higher fidelity, greater amplitude range and smaller temperature variation result from cementing two plates together to form "bimorph" element, at right. Foil or graphite electrodes are used to provide electrical connections to plates.

(B) Typical crystal cutter assembly with bimorph element. Twister plates are clamped with stiff pads at support end. The free end pivots in the flexible bearing along the twisting axis. Voltage applied across the plates causes mechanical deformation at 45° to mechanical and optical axis, moving stylus from side to side (for lateral recording).

In setting the rake angle, it must be remembered that it is the angle of the cutting face of the stylus to the blank that is important—not that of the cutting head. Most heads have provision for setting this angle, in the form of a hinged pivot or slotted bracket with setscrews. In cheap recorders it may be necessary to bend the stylus shank to get the correct angle. The angle can be checked by aligning the face of the cutter and its reflection on a smooth blank; the two will, of course, form a straight line when the cutter face is exactly vertical.

The depth of cut is an important adjustment. The customary groove depth is 0.002-0.003 inches. It may be checked either by measuring the thread or chip from a test cut with a micrometer, or by observing the relative area of "land" and groove under a microscope, using a standard feed. The proportion should be as shown in Fig. 3. If the cut is too shallow poor tracking will result, the pickup tending to slide across the record, while a cut that is too deep will increase the danger of over-cutting and breaking through the walls of an adjacent groove on loud passages. The stylus may even break through the coating on the blank into the hard base. The deeper the cut the greater the surface noise.

The depth of cut is adjusted by a device regulating the height of the cutting head. This may be either a spring or a movable counter-balance, adjusted by a thumbscrew or setscrew on the head.

TURNTABLES AND MOTORS

Since sound is based on frequency and frequency is directly related to speed, it is vital that the record be turned at a fixed, unvarying, known speed in both recording and reproduction. Because of the greater load encountered when engraving than during playback, it is even more important that the recorder turntable and its associated drive have a uniform, steady speed. If the motor slows down when the stylus bites into the blank, for example, the actual recording speed will be somewhat less than the standard. Then, when the recording is played back, the motor will speed up under the lighter drag of the pickup, and all of the frequencies will be higher than in the original. Even slight variations in speed during recording due to variations in stylus loading with frequency and amplitude will cause distortion and result in reproduction that is not true in certain frequency ranges.

The speed regulation must be better than 0.3 per cent or the variation will be apparent to the trained musical ear in the form of "wows" (audible changes in pitch resulting from momentary changes in speed). Good instantaneous recorders are constant to 0.2 per cent or better, while the proposed "wow factor" standard for electrical transcriptions for broadcasting is 0.1 per cent. Good speed regulation is particularly important at 33 r.p.m. because of the decreased groove speed.

Another factor of importance, particularly in broadcasting where actual program time must be known to a few seconds, is that of speed ac-

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curacy, or total playing time. The recommended standard is 0.5 per cent. A typical medium-priced recorder is guaranteed for 0.4 per cent, while the best professional outfits achieve about 0.2 per cent, or less than 2 seconds error in 15 minutes playing time.

Turntable vibration causes an objectionable low-frequency noise or rumble with a dominant frequency under about 500 cycles. It is often this factor that limits the amplitude range of the cheaper recorders, since the vibration noise or flutter amplitude may be only 40 or 45 db below average signal level. In good-quality portable units such noise is held to —50 db or better, while with heavy professional installations it is down 60 db or more. Turn-table vibration also causes cross-modulation effects on the higher frequencies, contributing to waveform distortion.

A good turntable is a massive circular plate, usually made of cast aluminum, with a heavy steel shaft running in a bronze sleeve bearing and a ball thrust bearing. The turntable is covered with a thin rubber pad, and has a center pin (diameter 0.2835 inches) to locate the blank.

The turntable itself should be carefully cut and balanced to run true and level. Generally speaking, the bigger and heavier it is the better the performance. Massiveness implies freedom from warping and mechanical distortion, while weight provides the flywheel characteristic necessary for constant speed.

Basically, of course, the turntable speed depends on the driving motor, and it must therefore be of a constant-speed type. Since most recording motors run on a.c., the synchronous type seems a logical choice. In practice, however, the fact that a synchronous motor is inherently a "hunting" device that oscillates around a mean frequency with torque variations within each cycle makes it undesirable for the purpose, unless a very heavy flywheel or elaborate damping methods involving elastic (spring) couplers are used. Synchronous motors are now found only in the most expensive machines, where there is no objection to the auxiliary equipment required, or in the cheapest outfits where the smallest possible motor must be used.

Most present-day recorders make use of ordinary induction-type motors of sufficient power (1/20 to ¼ h.p.) so that the regulation is virtually unaffected by the cutter load. Speed is held relatively constant by a mechanical fly-ball governor or equivalent device.

TURNTABLE DRIVES

A variety of methods may be used to couple the motor to the turntable. Commercial equipment is usually built around either of two methods: friction rim-drive with or without idler wheels, and gear drive. Direct drive from special low-feed motors is used in a few professional assemblies, while belt drive, although rarely used in manufactured recorders, is a favorite of the home constructor.

A well-made gear drive is among the most satisfactory. With carefully-cut helical gears, preferably made of fibre or laminated bakelite, running in an oil bath, excellent performance can be obtained, especially during the early life of the machine. A disadvantage of gear drive is that when the gears wear, the turntable will take advantage of the resulting play and tend to lag or lead the motor, but in a well-made assembly this doesn't occur until after hundreds of hours of successful operation. Another disadvantage is transmission of motor vibration to the turntable, resulting in the troubles discussed above. The actual coupling to the drive must be "soft" and the turntable bearing solid and carefully suspended.

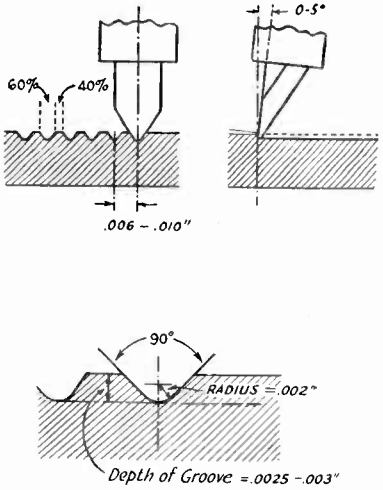

Fig. 3—Illustrating correct groove formation, stylus cutting angle, and stylus tip outline. Good stylii, when examined under the microscope or "shadowgraph," have carefully-ground points shaped as shown. Stylus material must be very hard and highly polished to cut cleanly without tearing, producing a smooth groove with low surface noise. Tip pressure when cutting may reach 20 tons per square inch.

Next in popularity—and increasingly used, even in the best professional apparatus—is the rubber-wheel rim drive. The simplest application of this method is a small rubber wheel, mounted on the motor shaft, which bears against the turntable

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rim. The advantages are extreme simplicity and economy; the disadvantages a tendency toward slippage, flattening of the rubber wheel where it rests against the rim when not in operation, and the difficulty of regulating pressure for reliable driving. Some of these disadvantages can be minimized by equipping the turntable with a rubber rim and using a steel motor wheel. Still another variation is the introduction of a rubber idler pulley between the motor wheel and rim, which helps to iron out vibration and speed irregularities. This method is commonly used on 2-speed turntables, where the simple shift of a lever reverses a large and a small idler wheel to give either 78 or 33 r.p.m. Where no idler pulley is used, a steel step pulley may be employed.

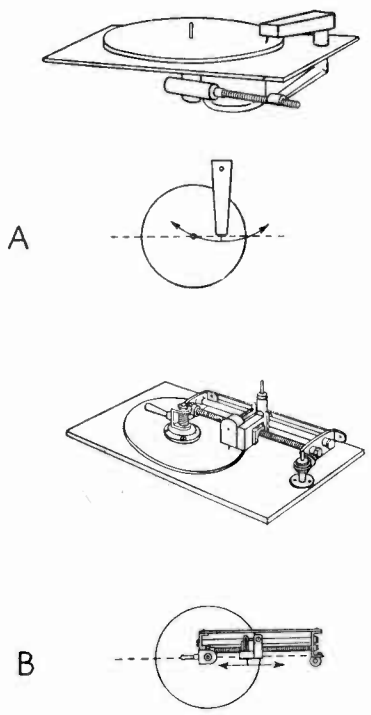

Fig. 4—Basic feed mechanisms.
(A) Underdrive tangent type, in which the cutting head is attached to a follower arm driven by a long leadscrew geared to the turntable shaft. Stylus cutting face is at correct angle with respect to groove direction only at center of recording space. Tangent error can be minimized by using long arm to increase radius.

(B) Straight-across overhead feed with leadscrew driven by spindle through worm and gear. Cutter riding on guide rail and driven by half-nut on leadscrew travels in straight line across record, maintaining constant angle and eliminating tangent error.

All of the friction-drive systems require careful adjustment of driving pressure to minimize slippage, speed changes, "wows" and transmission of motor vibration.

In operation, turntable speed must be carefully adjusted to the prescribed standard. This is customarily done with a stroboscopic card, obtainable from almost any radio dealer or music store. It is marked with rows of lines or dots so arranged that, when placed on the revolving turntable and viewed under a neon or fluorescent lamp with a 60-cycle a.c. supply, or even under ordinary house lights, the dots appear to stand still if the turntable is rotating at the correct speed, or seem to advance or retreat slowly if the rotation is too fast or too slow. The speed adjustment should, of course, be set so that the dots appear to stand still. Failure of the pattern to remain stationary over a long period of time indicates that the motor speed is not constant and the apparatus will not record properly.

Lacking a stroboscopic card, an approximate check of speed can be obtained by placing a mark or indicator on the rim of the turntable and counting the revolutions over a period of several minutes. This is done more readily at 33⅓ r.p.m. than at 78, of course. At best, however, it is a laborious and unsatisfactory method.

In playback, the friction of the disc against the turntable pad suffices to turn the record. In cutting, however, additional "hold-down" pressure is required to avoid slippage. The pressure need not be great; a pound or two is usually enough. With overhead feed this pressure is provided by the leadscrew spindle plate which rests on the record. In home recorders a spring pin is mounted in the turn table. This pin engages a hole in the blank, providing a positive drive. If the same turntable is used in playback with an ordinary pressing, the spring pin merely depresses below the turntable level.

One difficulty with the spring-pin drive is that the pin does not always engage the hole tightly, particularly with thin cardboard blanks. This results either in a slight but troublesome vibration or in "climbing" of the disc on the pin. In that case, either a screw-down clamp (a large thumb-nut on a threaded center pin) or simply a weight made of a round chunk of iron or lead faced off and drilled with a hole for the center pin may be used.

FEED

To make the cutting head trace the prescribed number of grooves per inch—80 or 96 or 120 or whatever the number may be—it is necessary to provide a mechanism for moving the cutter

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slowly across the face of the blank. This mechanism is called the feed.

To avoid crossovers and erratic cutting, and yet allow maximum playing time, the feed must move the cutter in exact ratio to the speed at which the turntable revolves. For example, to cut 96 lines per inch at a speed of 78 r.p.m. the cutter must traverse 0.812 inches per minute, with a groove pitch of 0.0104 inches per revolution.

The construction of a satisfactory feed mechanism is obviously no simple job. It requires a highly-accurate gear train, usually of the worm and gear type. In the more advanced professional equipment, a leadscrew and carriage similar to those on machine lathes are used.

Most ordinary home-recording outfits use a cutter head mounted on a swinging arm in the same manner as the pickup on a conventional phonograph, with a fan-type feed mechanism as shown in Fig. 4-A. This system is comparatively inexpensive and simple to operate. It has two disadvantages. First, there is the inherent lack of precision and accuracy of the gear system, particularly if ordinary spur gears are used as is common in the less expensive recorders. Second, there is the change in cutting angle of the stylus face as it progresses across the record, so that at only one point does it cut a theoretically perfect groove. At other points the tangent error results in unsymmetrical groove shape.

In the simple fan-drive mechanism shown in Fig. 4-A, a follower arm terminating in a half-nut rides on a horizontal screw geared to the turntable. Lowering the cutter head on the record automatically engages the drive.

Intermediate-grade recorders use a variation on this method wherein the follower arm is replaced with a fan-shape rack or quadrant gear which is worm- or spur-gear driven. With carefully-machined gears of fine pitch this system can be made to have high accuracy.

The other major feed classification is the straight-across carriage type of feed, in which the cutter is attached to a carriage which travels across the record in a straight line, as shown in Fig. 4-B. Occasionally, the feed screw and drive are mounted under the turntable to protect them from dust and damage, the cutter being suspended from an extension arm carried on guide rails, with its vertical support outside the turntable radius. This underdrive system shares the neat appearance of the concealed-mechanism fan drives, but for maximum precision and performance the direct overhead drive is preferred.

In the overhead assembly the cutter is suspended from a carriage riding on a single guide rail and a threaded half-nut which engages the leadscrew. The leadscrew is driven either through a spindle resting on the turntable driving a worm and gear (the arrangement is shown in Fig. 4-B), or through an external gear-train or belt-and-pulley drive direct from the motor or turntable shaft, with the worm and gear in the outer support of the leadscrew.

Courtesy RCA Mfg. Co., Inc.

Fig. 5—Topview of RCA Model VHR-207 Automatic Record Changer and Recorder. Cutting head at upper left is in operation, with outer portion of blank disc already cut. The cutting head feed mechanism is underneath in this model.

Regardless of the method used, the parts must be finely made and accurately fitted if satisfactory recording is to be accomplished. Gears, worms and feed screws must be carefully cut and mated to mesh perfectly. Screw threads must be deeply formed so that the arm or follower does not tend to climb or lift itself out under load, yet the tooth shape must be such that the clearance with normal alignment is sufficient to allow tight meshing without backlash. In standard practice the tracking error should not exceed 5 per cent of the mean groove pitch; e.g., the actual pitch must not deviate more than 0.002-inch from true pitch at 96 lines per inch.

On professional recorders accurate scales are provided, showing the exact line at which recording begins or ends and giving total playing time. This facilitates accurate playback of transcriptions, dubbing, etc. In commercial transcription work, a handwheel is provided for manual feed, supplementing the automatic feed. This handwheel is used to make the standard starting and stopping spirals—two to four grooves (8 grooves per inch) in the starting spiral before modulation occurs, and a locked concentric stopping circle at the end.

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The standard feeds for transcription work have been established as 96, 104, 112, 120, etc., in increments of 8 grooves per inch. The actual feed to be used in a given case will be a compromise, with the desired maximum playing time weighed against the accuracy of the feed system in the recorder, the maximum amplitude to be recorded, etc. In commercial transcription work, 120 lines per inch is common and up to 160 may be used. The home recorder is usually limited to around 96 lines, with 112 or 120 as maximum.

The final important consideration in feeding is whether the stylus is to move from "inside-out" or "outside-in." Many recorders are provided with reversible gears in the feed-screw drive to permit feeding in either direction at will. The record should always be labeled with the method used, to avoid confusion in playback.

As far as quality is concerned, there is no particular choice. Outside-in recording is often preferred because it corresponds with the commercial pressings and most transcriptions, and is essential for use with automatic record-changers. Inside-out recording has the advantage that the thread or chip which comes from the stylus in an endless string tends to wind up around the center of the record, automatically freeing itself from the outward-traveling stylus. With outside-in recording the operator must keep the thread brushed away from the stylus to prevent it from tangling and pulling or making the cutter jump. In commercial equipment, this problem is eliminated by a thread control device. This may be either (1) a mechanical "chip chaser" with a rubber wiper blade which trails the cutter, sweeping the thread toward the center where it winds around the pin or spindle, (2) a pneumatic device employing a stream of forced air, or (3) a miniature vacuum-cleaner which disposes of the thread by suction.

Our Cover Photo

The photograph on the front cover of this issue, through courtesy of RCA Mfg. Co., Inc., shows an RCA Model VHR-207 Radio-Phonograph Home Recording Combination in use. Christmas poems and songs are always favorites among home-recording enthusiasts.

n r i

Definition

A committee is a meeting of important people who, singly, can do nothing, but together can decide that nothing can be done.—Anon.

N.R.I. Salutes - - - - -

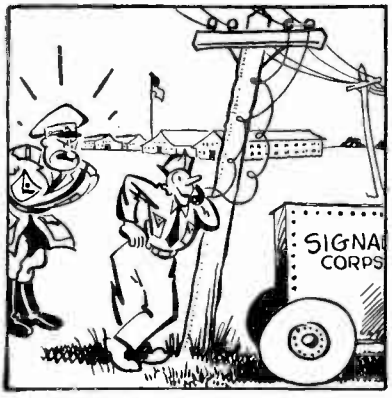
DAVID H. SMITH

Latest member of the N.R.I. Staff to join the Armed Forces, is David H. Smith, head of our Lesson Examining Section, and brother of President J. E. Smith.

"Dave," as we all call him here, has been with N.R.I. since 1927. His ability as an executive is best proved by the fact that he leaves an able, well-trained group of people to carry on the work of his Lesson Examining and Grading Section "for the duration."

Although a former Radio Operator in the U. S. Navy, Dave has been interested in aviation for many years and holds a private Pilot's License. So today he is in an Aviation Engineering Battalion, and is attending non-com school.

To put it very, very mildly, we all wish Dave the very best of luck—and feel sure that many hundreds of N.R.I. students and graduates join us in these good wishes to P.F.C. David Smith!!!



Hello! Is that you, honey? Sure it's O.K. to phone you from this line. The Captain and I are pals—just like that!

n r i

He Spoke Too Soon

The defendant stood before the judge's bench, charged with bootlegging.
Said the judge, "I am going to fine you $100.00 and—"
"I've got it right here in my pocket" broke in the prisoner.
"Good," said the judge, "now look in the other pocket and see if you can also find 100 days."

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TRUE ADVENTURES OF A SPARE-TIME SERVICEMAN

EDITOR'S NOTE: *Somewhere in Virginia, an N. R. I. student finished Lesson 33FR-2 this fall and decided to begin spare-time servicing. Now, in addition to the lessons he's sending in for grading, Chief Instructor Dowie is getting regular reports on his servicing experiences.*

This student's experiences are so interesting and so full of practical advice that we're using them as the basis for this article. Of course, names and places have been changed, to avoid any possible embarrassment to the student and his customers. BOB JONES is as good a name as any for our student, and JENNIE will do for his red-haired wife and unofficial partner.

Beginning students will find here a true picture of what spare-time servicing is like, and will get many ideas for their own radio business. You who've already started radio servicing will enjoy reading about Bob's intermittent headaches, about customers who know it all, and about wartime servicing problems. And now, for the first time in any publication, we present: The True Adventures of Bob Jones, Spare-Time Radio Serviceman.

WITH about half of the N. R. I. Course mastered and with radio servicemen very much in demand in my Virginia locality near Washington, Jennie and I decided to start spare-time servicing. She'd keep the records straight and handle the phone calls during the day while I was at work, and I would handle the radio jobs on evenings and week ends.

Immediately a question came to mind: "*What should we call the business?*" After much discussion, the name "Jones Radio Service" evolved as a dignified and self-identifying title. Anyway, it sounds impressive when I lift the telephone receiver and answer in a deep bass voice, "*Jones Radio Service—Bob Jones speaking.*" Also, it saves prospective customers from asking, "*Is—this—the man—who fixes radios?*"

But phone calls won't come until you tell the world about a new-born business. With none too much cash on hand, we decided to run the following classified ad for 12 weeks in the local weekly newspaper, at a cost of exactly 36 cents per week:

EXPERT RADIO SERVICING

GUARANTEED repairs, professional methods. Pick-up-delivery service for Glenn Heights, Cloverdale and Elmwood sections. Bring set yourself, save $1. Jones Radio Service, 1437 Maple St. (two blocks west of Courthouse). Phone Madison 9436.

In preparation for the coming avalanche of business (I can dream, can't I?), we worked up an arrangement of five printed forms on an 8½" x 11" sheet of paper without a bit of waste space, and Jennie used mechanical lettering guides and drafting instruments to make a master drawing 1½ times the final size. (She's handy with these tools, and does drawing jobs now and then for radio firms.) From this, we had a lithograph plate made in final size for about $3, and had 500 impressions of this plate run off on 24-pound rag bond paper, with a Multilith machine. A printer can do a job like this, but doing it this way saved some money over printing rates in a large city. In small towns, however, it might be cheaper to have the forms printed.

The final result, in somewhat reduced size, is shown in Fig. 1. Four strokes of the printer's power shears along the dotted lines divided the 500 sheets into 2500 separate forms, at a total cost well under $10.

Being always attracted by flashy colors, I was fortunate in being able to pick up a honey of a Philco Model 050 Tube Tester. Not exactly a portable model, but has a flashy black, red and nickel panel which should catch customers' eyes the way it caught mine. You can see this tester in Fig. 2.

No cut-rate prices—that was to be the policy of Jones Radio Service right from the start. Located a schedule of professional charges which seemed about right and which were being used by other servicemen during March, 1942, when price ceilings for service work were fixed. Decided to adhere to them as much as possible, until

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NAME OF CUSTOMER _____ JOB NO. _____

ADDRESS _____

PHONE _____ DATE RCD. _____ DATE RET. _____

DESCRIPTION OF RADIO _____

COMPLAINT _____

ESTIMATED CHARGE _____ FINAL CHARGE _____ EXPENSES _____

REMARKS _____

JOB NO. _____ DATE _____

DESCRIPTION OF RADIO _____

OWNER _____

Received for repair by _____

JONES RADIO SERVICE

1437 MAPLE ST.

PHONE : MADISON 9436

MINIMUM CHARGE FOR CHECK-UP AND TEST:

When set is brought to shop and taken away ..$1.50

When one trip is made to customer's home 2.50

When set is picked up and delivered 3.50

TERMS: CASH IN FULL AT TIME REPAIRED SET IS RETURNED.

JONES RADIO SERVICE

1437 MAPLE ST.

MADISON 9436

TO _____ Date _____

Job No. _____

Check-up and test { set brought to shop ☐ / one call to home ☐ / set picked up and delivered ☐ } _____ $

Professional Services: _____

New Parts: _____

TERMS: CASH TOTAL ____ $

GUARANTEE: The materials and services listed above are guaranteed for thirty days, provided the charges have been paid in full. All parts covered by this guarantee will be replaced free within this time limit if they become defective, provided set is not abused.

GUARANTEE STARTS ON: _____ By _____

JONES RADIO SERVICE

PLACE THIS CARD INSIDE YOUR RADIO SET

JONES RADIO SERVICE

1437 MAPLE ST.

Two blocks west of Courthouse

MADISON 9436

BOB JONES

Guaranteed repairs of all radio receivers by professional methods. Pick-up and delivery service for Glenn Heights, Cloverdale and Elmwood sections only. Bring your radio set in yourself and save one dollar.

THIS RADIO SET WAS REPAIRED

_____

JONES RADIO SERVICE

1437 MAPLE ST.

Two blocks west of Courthouse

MADISON 9436

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I found what my own overhead expenses were. With three smooth tires on the car and only an A gas ration card, we also decided that if people demanded pick-up and delivery service, they would have to pay a fair price for it. So, on each phone call we explained the minimum charges and secured an okay on them before accepting the job.

For check-up and test at the shop, when the customer brings the set in and takes it away, our charge is $1.50. This covers testing of tubes, a general check-up of the set and any quick tests needed to determine the approximate nature and extent of the trouble. A check-up and test at the customer's home is $2.50, to cover one round trip. A check-up and test at the shop, including pick-up and delivery of the set, is $3.50 because it covers two round trips.

Time and again, radio servicemen have said you just cannot get minimum charges like these from customers, so it was not without a bit of fear that we awaited our first calls.

To our surprise and pleasure, however, not a one of the three customers replying to our ad the first day objected to the minimum charges. Since then, only two customers out of thirty have offered any objections, and we lost only one of these. Good riddance anyway, because a customer who objects to a minimum charge will very likely object to all other charges as a matter of principle. Many customers actually say that our minimum charges are quite fair in view of the serious transportation problems here in the East.

► The first job was a cinch—a little Arvin table model with a slipping tuning dial and a broken power cord plug as its only troubles. The customer was a charming young lady married to an Army man now somewhere in Australia. She lives just a block away, so walked over to pick up the set. Used furniture polish vigorously on the cabinet after making the repairs, and she did notice it when I installed the set again. Charged only the minimum of $1.50, and it was paid with a smile. (As a neighborly gesture, we decided there would be no delivery or pick-up charges for customers in our subdivision.) We called this job No. 101—why advertise the fact that I'm a beginner unless someone asks outright?

► This first job begot another in the same house. Her brother had a swell Silvertone R1161 table model which was just plain dead. Examination at the bench revealed a tricky voltage-doubling circuit with highly questionable filter condensers. Since voltage-doubling condensers have to be matched exactly for best results, I replaced all three electrolytics. Temporary connections showed satisfactory operation, so quoted a price of $8.60 for the job, as follows:

Pick-up and test	$1.50
Installation of three electrolytic condensers	3.50
Reset 4 push-buttons	.80
Two 40-mfd., 150-volt electrolytic condensers	2.00
One 30-mfd., 200-volt electrolytic condenser	.80
Total	$8.60

Phoned the estimate to the customer, and encountered objection. They wanted to think it over, the price being way higher than they had anticipated. Got an okay a week later to go ahead, so put in the new parts permanently and checked performance. It was terrible now—intermittently dead. More trouble-shooting revealed a grounded Candohm, for which no replacement could be found. Its two sections had values of 87 ohms and 22 ohms respectively, neither of which were available in single wire-wound resistors. Finally had to get two 10-ohm resistors and connect them in series for the 22-ohm section, and place a 150-ohm and 200-ohm unit in parallel to give 86 ohms. Would have been happy with anything from 75 to 100 ohms for this section, though.

The four resistors cost me $1.08, which made a

Fig. 1 (on opposite page.)—Reduced-size reproduction of the five-form layout Bob Jones ran off on 8½" x 11" bond paper. Dotted lines did not appear on original drawing, and are shown here only to indicate the size of each form.

Upper Left: Job Record Card, made the same size as a 3" x 5" index card. Jennie fills in all data received over phone; card stays with job until finished, with Bob jotting down additional data on both front and back as he works on set. Final charges are listed on back, to show what the guarantee covers, as no carbon is made of the bill given to the customer.

Upper Right: Receipt given to customer when set is left for repair or taken from home.

Lower Left: Bill statement, planned so a lump-sum charge for professional services can be made, with no extra charges for parts, or so each item of parts and services can be priced separately. The method of billing varies according to the job. Advantage of lump-sum billing is that it does not give customer chance to argue about entire bill if he thinks some one little charge is too high (like charging 15c for a pilot lamp when customer says he paid a dime last time).

Center Right: Calling card and advertising leaflet combined, handy to pass out to customers who mention having friends in need of radio service, and also useful for slipping under doors or posting on bulletin boards in stores. A bit light for formal calling cards, but regular cards are used so seldom that their cost is not justified yet in this spare-time business.

Lower Right: Label to be attached to inside of cabinet of each repaired set with scotch tape, thumbtacks or staples, to promote repeat business.

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selling price of $2.00 (doubling the cost and taking the nearest round figure gives us the selling price when there is no list price to go by). Their installation came to $4.25 at the schedule of professional rates I was using, but all this was my loss because I had already quoted a definite price to the customer. Knowing how I felt the time a plumber charged me more than he'd originally quoted, and being desirous of keeping on good terms with a neighbor, I stuck to the first estimate.

A partial solution to this problem of unexpected trouble lies in using a schedule of charges high enough to take care of *contingencies* like this in the long run. The other part of the solution, as I see it, is to do the complete repair job, at least with temporary connections, before phoning the estimate. Enough troubles will develop even after this to use up the contingency part of your regular charges.

Snapped a photo of the final job for my album, this being the first really tough job (see Fig. 3). I mounted insulated terminal lugs in the old Candohm holes to support the four resistors. You can also see the three individual electrolytic condensers used to replace the original aluminum can unit mounted above the chassis.

► The next job started out like a serviceman's dream, but ended up more like a nightmare. A 10-tube Kadette table model, with an obviously noisy volume control and a defective type 6A7 tube. Made a tentative quote of $9.25 for repairs ($3.50 minimum, $1.25 tube, $1.50 volume control and $3.00 installation of control). Also suggested that they get an entire new set of tubes in view of possible future trouble in securing them. The wife propositioned the husband—she'd pay for the repairs if he bought the new tubes. He agreed, so I departed with the set after quoting a final price between $15 and $18 (figuring about $8 for six more tubes, since three were plug-in resistors which need not be replaced till they fail).

In my enthusiasm at securing such a big job, I asked if they'd like to use my little Zenith Wavemagnet set while theirs was being fixed. This was mistake No. 1, as Jennie pointed out quite vigorously when I got back home. The Zenith was worth more than their set, so if any later arguments arose, they might say, *"All right, you can have our set, and we'll keep your Zenith!"*

Examination of the set at the bench indicated that hum was high and output voltage low, so put in three 8-mfd., 450-volt electrolytics. Had to get an ON-OFF switch with the new volume control, at a net cost of 90 cents. Tubes came to $1.50 less than I'd estimated, so figured I could charge for the condensers I hadn't known about in the customer's home. The set worked perfectly, so I made out a bill as follows:

Check-up and test, including pick-up and delivery	$3.50
Installation of three filter condensers	3.50
Installation of combination volume control and ON-OFF switch	3.00
One combination volume control and switch	1.80
Three 8-mfd., 450-volt electrolytic condensers	$2.70
One 6A7, two type 41's, two type 76's, one type 6D6 and one type 25Z5 tube	6.50
Total	$21.00

Here's where mistake No. 2 came up. Phoned these items to her, and quoted the total of $21 without mentioning my original top price of $18. She remembered, though, and I saw visions of losing the whole charge when she said, "I'll talk it over with my husband tonight."

After a miserable half hour, called her back and admitted I was in wrong. Asked if she'd let me omit the condenser installation charge of $3.50 because I hadn't secured her okay before putting them in, and suggested she could save a dollar by coming to get the set. Felt greatly relieved when she agreed. Collected $16.50 for the job, and felt that I'd bungled it pretty badly. To make matters worse, got a call from her the other day saying set wasn't working right, having a terrific noise. Will have to do some more gratis work on that set, likely as not.

Moral—if you ever give a top price, even if only a rough estimate, be sure it's high enough to cover all possibilities. Tell the customer quite frankly that it's humanly impossible to quote a definite price until you've given the set a thorough check-up at the bench. If he questions this, just show him the maze of parts underneath the chassis of his set.

Late news flash—made a call-back and found set working perfectly, with owner most reluctant to let me take it back. Strongly suspect the noise was just someone starting up an oil burner, though she wouldn't admit it. One call wasted, but at least I don't have to do any free work on their set.

► Had one very sad job—haven't collected yet on it. A lady across the street from another customer wanted her radio checked in the home. Resoldered an obviously broken loop antenna lead, then checked tubes. Found a bad rectifier tube, and quoted her $1.25 for it in addition to the check-up and test fee of $1.50. That was too much! She was having medical treatments, her husband was not earning much as a retail clerk, and anyway he could get the tube at a discount where he works. That was okay with me, so indicated that the only charge would be $1.50. She didn't have the money, but promised to pay three days later.

Went around then and received another story of trouble, along with another promise to pay. Went back once more, but nobody home, and they don't have a phone. Haven't gone back since—special

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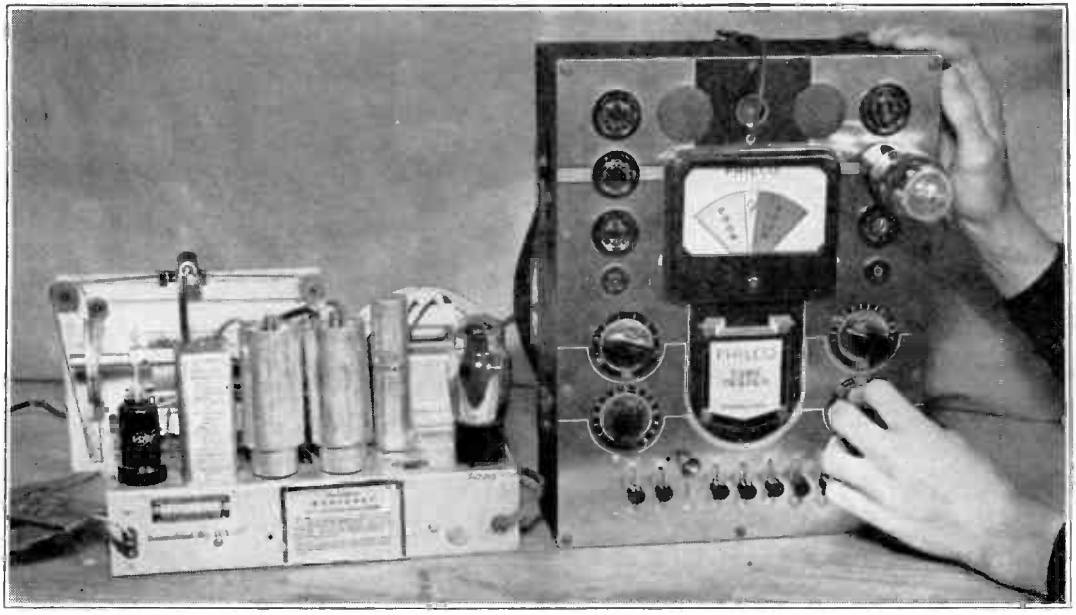

Fig. 2—Even without a cover or a carrying compartment for the line cord, this Philco Model 050 is working out nicely as a portable tube tester for either bench or home use. Here's a tip—when testing tubes, take out only one at a time as shown here, so you can replace them correctly. Sometimes sockets are marked, or a tube layout diagram is posted inside the cabinet, but even then it takes time to refer to these.

trips to collect a sum like this waste more time and transportation expense than the job is worth. May drop in some time when I'm in her locality and have another try at it.

► The next three jobs brought in some much-needed cash to cover heavy getting-started expenses, without any particular headaches.

One of these was my first record-changer job—a 1940 Philco model which the owner had tried to fix herself after a downtown radio shop gave it up as a bad job. Result—thoroughly jammed levers and teeth stripped from fiber gear. Quoted $12 to $15 sight unseen, and landed the job. Got a new fiber gear for 35c. Found I'd have to wait till the war was over for a new cam lever to replace the bent one, so had to straighten it myself. Spent two solid evenings studying the mechanism, one section at a time, and studying general principles of record changers in John Rider's new book on Record-Changers, then went to work on it.

Must have taken that lever out at least 20 times, bending it a little this way or that way each time, before it would work right. Replaced two missing springs after a few more hours of figuring where they belonged. After all this brain work, the final adjustments of needle-landing position and trigger action at the end of the record were a cinch.

The changer job took over two weeks, since other sets were coming and going all the time, but proved to me that record changers *can be fixed* if you are only willing to study them long enough.

Re-installed the unit in the customer's home. demonstrated that the mechanism worked, and collected $15.00 in cash. But they'd forgotten to tell me that before the changer had jammed, record volume had been way low. Leakage in the shielded cable due to action of excessive oil on the rubber insulation is the probable cause, but the crystal cartridge could be bad too. Didn't have test equipment along to check it, so will have to make another call there Sunday. She is willing to pay extra for it, too.

P.S. She called two days later saying everything was working swell, and I wouldn't have to come. Heat in house must have dried up the leaky in-

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sulation. Noted all facts on Job Record Card, so can take a new shielded cable over next spring when dampness does its work again and she gives me a call.

Took a licking on this changer job at $15, because I had to spend so much time studying it, but fixed the next changer in about four hours for exactly the same price. Came from a huge Stromberg-Carlson Combination but was almost identical with the Philco job (both were made by Webster-Chicago). People seem more willing to pay fair prices like these for changer repairs than for comparable work on a complicated receiver. Why? I don't know!

My first field coil repair job was a complete success and netted $8.50, with not a cent of outlay for parts. It was an RCA Model U-125 Radio-Phono Combination, dead in customer's home, so took out chassis and loudspeaker, leaving cabinet and changer there. Best not to take cabinet of a console, because they're hard to get into car and you risk scratching them.

Circuit disturbance test gave no indications at all, and loudspeaker was completely silent, so went right to work on it with an ohmmeter and found the open field coil. Removed it, cut away outer insulation, and luckily found the break right on the outside where it could be fixed easily. Taped it up with black scotch tape after repair was made, then put on a coating of polystrene coil dope to keep out moisture (loudspeaker service cement would have been just as good).

► An elderly customer brought to the house an RCA table model set with an intermittent frying noise. Spent 2½ solid hours one afternoon working over it, pushing on every loose wire and part I could find, and the trouble seemed to be cleared up. When he came around that evening to pick up his set, I admitted quite frankly that I had not found any serious defect, but that the trouble had not occurred for the last hour. Asked $4.50 for the job, which he paid with an expression that said as plain as day, *"Too high, too high!"*

Two days later he was back, quite disgruntled by now and complaining of motorboating so loud he couldn't stand it. Discussed headaches of intermittent troubles with him for ten minutes, calming him down somewhat, and promised to do what I could on the set. Ran it for three solid days with not a single motorboating pop—perfect performance all around.

Finally gave the set back to him when he came around again, and suggested he might be in a low-voltage locality, or that some electrical appliance in the vicinity had caused the noise. He seemed satisfied with these suggestions, and haven't seen or heard from him since. Moral—make your charges for intermittents high enough to take care of several call backs, unless you are absolutely sure you've cured the trouble. My charge definitely was not high enough to cover all the time I'd spent already on this man, and I expect to see more of him yet.

► Here's a job where the bill was $9.15 but I collected only $6 cash, with both parties thoroughly satisfied:

Check-up and test	$1.50
New output transformer	2.25
1 type 80 tube	.75
Mounting of transformer	2.00
Installation of filter condenser	1.75
New filter condenser	.90
Total	$9.15

The story here is an allowance of $3.15 for a 5-tube Silvertone table model in black plastic cabi-

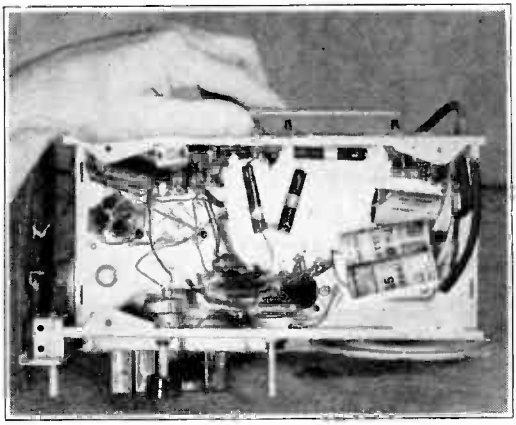

Fig. 3—A completed repair job. New parts are outlined in white so they show clearly, and the defective Candohm is held just above the wire-wound resistors which replace it.

net, which had been dropped on one corner but still had five good tubes. Will fix it up for loan purposes when I take out the customer's only set.

► A radio set which catches mice—that's what I ran into just half a mile down the road, at the home of a typical Virginia pioneer with drooping handlebar mustache, clear bright eyes and a sprightly walk despite his age.

His G-E console was taking upwards of two hours to get going after he turned it on. We moved the cabinet away from the wall, and there before me was a barrier of heavy eighth-inch wire mesh, thumb-tacked around the entire back of the cabinet.

Noting my bewilderment, he offhandedly mentioned that the screen was used to keep mice out.

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Seems as how mice had decided the top of the chassis was a nice warm location for nest building, and consequent families of baby mice had sent radio repair bills sky high by eating insulation off all accessible wires and parts.

The screen proved effective in keeping out the mice, except that one time he left a corner of the screen loose after moving the set. The next day there was a live mouse dashing around wildly inside his radio cage.

Acting as if all this was quite the thing in my work, I proceeded to remove the chassis and take it to the shop. Rest of job was routine, except that the charges proved too high. Finally satisfied him by leaving out the new tuning eye, which I can certainly use on future jobs anyway, and omitting resetting of push-buttons. Fortunately, I hadn't touched them yet at the time of phoning the estimate.

► Here's a job left at my house and picked up, which was fixed quickly without any brainwork, and hence brought in very little profit:

Check-up and test	$1.50
Resetting 5 push-buttons at 20c each	1.00
One type 6J5GT tube	1.10
One pilot lamp	.15
Total	$3.75

Actual cost was $.55 for tube and $.06 for pilot lamp, but when you assign to the job its share of time needed to get these parts, and the time used in talking to the lady and her 7-year-old boy on her two trips here, plus the actual time spent on the job, plus its proportionate share of overhead expense (telephone, heat, advertising, test equipment, stationery, etc.), these small, easy jobs really won't show much (if any) *true* profit. Don't get into the rut of thinking you're doing good if a flock of easy jobs come your way: it's the tough ones which pay because you can then charge for *professional services*. Even a dime store clerk can check tubes and install a new one, but it takes a thorough knowledge of radio to *locate* defective parts.

Sample Questions and Answers for Radio Operator License Examinations

By WM. FRANKLIN COOK
N.R.I. Technical Consultant

The following questions are taken from the book "Study Guide and Reference Material for Commercial Radio Operator Examinations" published by the Federal Communications Commission. This Study Guide gives a general idea of the questions which may be asked in the Commercial Radio Operator Examinations.

The following material answers particular questions found in the Study Guide, but all students and graduates should study these questions and answers. Of course, it is not expected that the beginner will understand all of the points brought out, as much of the material will be advanced in nature.

Remember, the following answers are far more detailed that would be required for an operator's license examination. The questions are theoretical, so the answers go more thoroughly into the basic theory in order to permit similar questions to be answered.

ELEMENT II

Basic Theory and Practice

(2-68) The voltage drop across an individual condenser of a group of condensers connected in series across a source of potential is proportional to what factors?

Ans. The answer to this question is going to depend on whether the voltage is d.c., a.c. or a combination of a.c. and d.c.

If the voltage is a d.c. voltage, then the actual voltage division in a group of series condensers is going to depend upon their respective d.c. leakages. You can consider a condenser to be an actual capacity in parallel with a rather high value of resistance. This resistance is the leakage through the condenser.

However, if the source of voltage is d.c., the actual voltage across any one condenser in the group will depend upon its d.c. leakage resistance and upon the leakage resistance of the other condensers. Actually,

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the proportion of the total voltage which is across that particular condenser will be equal to the source voltage multiplied by the resistance of that condenser, which in turn is divided by the total leakage resistance of all the condensers in series.

If the source of voltage is a.c., the voltage division will be according to the reactance of the condenser, which is inversely proportional to the capacity. This means that the larger the condenser, the lower the reactance and hence the lower the amount of voltage across the condenser. The voltage will divide according to the ratio of the condenser reactance to the total reactance. In other words, multiplying the applied voltage by the condenser reactance, then dividing by the total series reactance will give the amount of voltage across the condenser.

If the voltage is a combination of a.c. and d.c., it will divide according to both the resistance and reactance and in proportion to the relative amounts of d.c. and a.c.

(2-69) What factors determine the charge stored in a condenser?

Ans. The charge stored in a condenser is, of course, dependent on the voltage. In addition, it is dependent on the capacity of the condenser. In fact, the charge in coulombs is equal to the capacity in farads multiplied by the voltage in volts. ($Q = C \times V$).

(2-70) You are given two identical mica condensers of .1-mfd. capacity each. One of these is charged to a potential of 125 volts and disconnected from the charging circuit. The charged condenser is then connected in parallel with the uncharged condenser. What voltage will appear across the two condensers connected in parallel?

Ans. The condenser which was charged has a certain quantity of electricity stored in it. When we connect another condenser to it, we have two capacities in parallel and hence, twice as much capacity. Since the quantity of electricity is just that in one condenser, and since the capacity is doubled, the voltage must be cut in half. This comes from the formula stating that the charge is equal to the capacity multiplied by the voltage. Here, to get the same quantity, doubling the capacity means that the voltage must go to one-half.

Hence, the voltage across the parallel combination will be one-half of 125 volts, or will be equal to 62.5 volts.

It is interesting to know that one-half the energy stored in the charged condenser will be dissipated in the rush of electrons from the charged condenser into the uncharged condenser. In other words, the energy is equal to:

$$\tfrac{1}{2}\ CE^2$$

As a result, when the capacity doubles and the voltage is cut in one-half, the total energy is only half of what it was before because the energy varies as the square of the voltage.

(2-71) State the formula which is used to determine the reactance of an inductance.

Ans. The formula is:

$$X_L = 2\pi fL$$

where X_L is in ohms, 2π is equal to 6.28, the frequency is in cycles and the inductance is in henrys.

(2-72) What will be the inductive reactance of a 30-henry choke coil at 100 cycles?

Ans. Here, we must use the formula given in Question 2-71. Inserting the values, we will have the inductive reactance equal to:

$$6.28 \times 100 \times 30$$

Multiplying these numbers together will give an answer of 18,840 ohms.

(2-73) What is the effect of adding an iron core to an air core inductance?

Ans. The use of an iron core will increase the inductance of a coil. This is because the higher permeability of the iron allows more flux to be developed for the same magnetomotive force. Since the ability of a coil to produce flux is a measure of its inductance, this means that the inductance has increased. The actual amount of increase will depend upon the permeance of the core, its type and arrangement, and how near it is to saturation.

(2-74) What will be the effect of a shorted turn in an inductance?

Ans. The primary effect of a short-circuited turn will be a reduction in the inductance of the coil. In a coil designed for high-frequency work, this will also affect the Q and the distributed capacity. However, considering inductances generally, the reduction in inductance is the most important factor.

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A short-circuited turn will act like a short-circuited secondary winding. In other words, if alternating current flows through the coil, there will be a voltage induced in this short-circuited turn. Due to the relatively low resistance of the short-circuited turn, the current flow in this turn may be rather high and may burn out or open the turn.

(2-75) What is the relationship between the number of turns and the inductance of a coil?

Ans. The inductance of a coil varies with the number of turns. This means that if the number of turns is increased, the inductance of the coil will be increased.

Considering a single-layer solenoid, the inductance will vary with the square of the number of turns providing the coil diameter and length are not changed.

If you increase the number of turns by adding more turns to one end of the coil, so that the coil size changes, the relationship is not exactly as a square. For example, if you double the number of turns on a coil and at the same time double its length, the inductance is about 2.5 times that of the original coil. On the other hand, if you use smaller wire to get twice as many turns in the same length, the inductance will vary as the square of the turns, or be four times as much.

(2-76) Define the term "reluctance."

Ans. Reluctance is opposition offered to the flow of magnetic lines of force in a magnetic circuit. This is the equivalent of resistance in an electrical circuit. In other words, it is the ratio between the magnetizing force and the flux in a magnetic circuit.

(2-77) What are some of the factors which determine the "figure of merit" or "Q" of an inductance?

Ans. Refer to Question 2-25, which gives essentially this information. Briefly, the Q factor of a coil is determined by dividing the coil reactance by the a.c. resistance.

The inductive reactance is determined by the frequency and by the coil inductance in henrys.

The a.c. resistance, which is sometimes called the r.f. resistance, is determined by the d.c. resistance, the skin effect, dielectric losses in the coil form, shield losses, and in the case of a coil with an iron core, by losses in the core itself.

(2-78) State the formula for determining the resonant frequency of a circuit when the inductance and capacitance are known.

Ans. The formula for determining the frequency is: $f = \frac{1}{2n\sqrt{LC}}$

In this formula, f is in cycles per second, 2n equals 6.28, L is in henries and C is in farads. (Divide a value in micro-farads by 1,000,000 to change it to farads.)

(2-79) What is the formula for determining the power in a d.c. circuit when the voltage and resistance are known?

Ans. The formula is: $P = E^2 \div R$, where P is the power in watts, E is the voltage in volts and R is the resistance in ohms.

As additional information, you will undoubtedly remember that the basic formula for power is $P = E \times I$. From Ohm's Law, you know $I = E \div R$. Therefore, substituting this in the basic power formula, we have $P = E \times E \div R$. Since voltage times voltage is voltage squared, we obtain the first-mentioned formula.

(2-80) What is the formula for determining the power in a d.c. circuit when the current and resistance are known?

Ans. This formula may be derived in a manner similar to that mentioned in Question 2-79. Again, $P = I \times E$. From Ohm's Law, $E = I \times R$. Hence, our formula is: $P = I^2 \times R$, where P equals the power in watts, I is the current in amperes and R is the resistance in ohms.

(2-81) What is the formula for determining the power in a d.c. circuit when the current and voltage are known?

Ans. This is our basic power formula, which states that the power is equal to the current multiplied by the voltage. Hence, the formula is: $P = I \times E$, where P is the power in watts, I is the current in amperes, and E is the voltage in volts.

(2-82) What is the formula for determining the wavelength when the frequency in kilocycles is known?

Ans. For practical purposes, the following formula is most generally used:

$$\text{wavelength} = \frac{300{,}000}{\text{frequency in kc.}}$$

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The above formula gives the wavelength in meters when the frequency is in kilocycles.

(2-83) What is the frequency corresponding to a wavelength of 375 meters?

Ans. In this question, we are to find the frequency, having been given the wavelength. We use the same formula given in Question 2-82 by changing it around as follows: Frequency in kc. = 300,000 ÷ wavelength in meters. Therefore, dividing 300,000 by 375 gives 800 kilocycles.

(2-84) Define the term "apparent power."

Ans. Ordinarily, we think of power as being the product obtained by multiplying the voltage by the current. This is true in a d.c. circuit or in an a.c. circuit containing only resistance. In an a.c. circuit having inductance or capacity, however, phase relationships must be considered. Therefore, the product of a voltmeter reading multiplied by the ammeter reading may not be the real power in the circuit. To distinguish between the real power and this product, the voltage multiplied by the current in an a.c. circuit is called the apparent power. This must be multiplied by a correction number known as the power factor, to obtain the real power.

Refer to Question 2-38, which gives further information on this subject and on power factor.

Note that if the power factor in an a.c. circuit is 1, indicating a pure resistive circuit, then the apparent power will be equal to the real power. In an a.c. circuit, the apparent power is ordinarily greater than the real power.

(2-85) State Ohm's Law for a.c. circuits.

Ans. Ohm's Law for an a.c. circuit is exactly like the law for a d.c. circuit, except that instead of resistance, we deal with impedance. In other words, the voltage is equal to the current multiplied by the impedance of the circuit; the current is equal to the voltage divided by the impedance; the impedance is equal to the voltage divided by the current. ($E = I \times Z$; $I = E \div Z$; $Z = E \div I$)

The impedance of an a.c. circuit is the result of combining resistance in the circuit with the reactances of the coils and condensers, in the proper manner so that phase can be taken into account. For your information, $Z = \sqrt{R^2 + X^2}$, where Z is the impedance, R is the resistance in ohms, and X is the reactance in the circuit.

(2-86) Draw a simple schematic diagram showing a tuned-plate, tuned-grid oscillator with series-fed plate. Indicate polarity of supply voltage.

Ans. Refer to Fig. *2-86.*

As you will note from an examination of this figure, there is a tuned circuit *L1-C1* in the grid circuit and another tuned circuit *L2-C2* in the plate circuit. This kind of oscillator depends upon grid-plate capacity within the tube for feed-back purposes. The tuned circuit *L1-C1* is adjusted to the desired frequency, then the tuned circuit *L2-C2* is adjusted until the plate load is sufficiently inductive to give sufficient feed-back through the tube to produce oscillations.

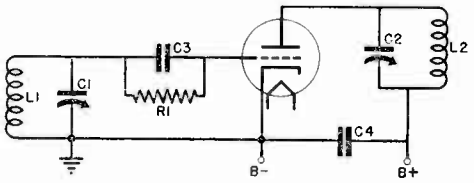

Fig. 2-86

Condenser *C3* and resistor *R1* provide automatic grid bias voltage.

Condenser *C4* is a by-pass condenser across the plate supply. Note the polarity of the plate supply, which is requested in the question.

Some misunderstanding seems to exist about series-fed and shunt-fed circuits. This is a series-fed circuit, because the d.c. plate current flows through the a.c. load device in the plate circuit. In other words, on tracing the circuit from the B supply, we go through coil *L2* in order to reach the plate of the tube. This is a series-fed arrangement because the plate supply and the a.c. load are effectively in series.

A shunt-fed circuit, on the other hand, is a circuit which has a separate path for the plate current. For example, we might have our tuned circuit connected to the plate of the tube through a blocking condenser, with the opposite end of the tuned circuit connected to chassis. Then, we would have the plate voltage fed to the plate of the tube through a choke coil. The choke coil will prevent the alternating current from flowing through the plate supply, so this is a d.c. path only. Alternating current must then flow through the blocking condenser and through the tuned circuit path to chassis. This kind of circuit would be called a shunt-

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fed circuit. Several examples of shunt-fed circuits will be given later.

(2-87) Draw a simple schematic diagram showing a Hartley triode oscillator with shunt-fed plate. Indicate power supply polarity.

Ans. Refer to Fig. 2-87.

The essential feature of a Hartley oscillator circuit is that tuned circuit *L1-C1* is made common to both the plate and grid circuits by using a tapped coil. In Fig. 2-87, the lower section of the coil is in the grid circuit (between grid and cathode), while

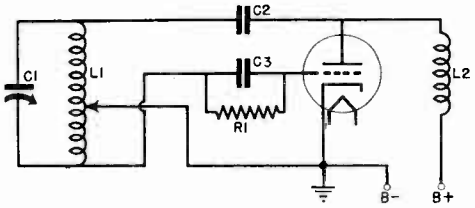

Fig. 2-87

the upper section is in the plate circuit (between plate and cathode). Feed-back thus occurs right in the tuned circuit.

Note the shunt feeding of supply voltage in this circuit. As mentioned in Question 2-86, this is accomplished through the use of a choke coil and blocking condenser. In other words, the plate supply voltage is applied to the plate of the tube through choke coil *L2*. The purpose of this choke coil is to force the a.c. to go through condenser *C2* to the tuned circuit, so nothing but d.c. current flows in the supply circuit.

With some rearrangement of parts, it is possible to use series feed on a circuit of this kind. Therefore, series feed and shunt feed may be used with any kind of oscillator, but it is sometimes more convenient to use one or the other. Also, the use of shunt feed keeps high d.c. potentials off tuning condensers, and usually allows one end of the tuned circuit to be grounded. These advantages may outweigh the increased cost of the extra choke and blocking condenser.

(2-88) Draw a simple schematic diagram showing a tuned-grid Armstrong type triode oscillator, with shunt-fed plate. Indicate power supply polarity.

Ans. There are several different circuits known as the Armstrong circuit. The tuned-plate tuned-grid oscillator is an Armstrong development. However, since this question asks for a tuned-grid oscillator, the circuit shown in Fig. 2-88 is probably the one desired.

Here, tuned circuit *L1-C1* is in the grid circuit, with feed-back from the plate circuit being obtained from coil *L2*.

This is a shunt-fed plate circuit, as the d.c. plate current path is through *L3* from the B supply, while the a.c. path is through condenser *C2* and coil *L2*.

This circuit is basically the same as the ordinary regenerative circuit with a tickler coil feed-back, except for the use of a shunt-fed plate circuit.

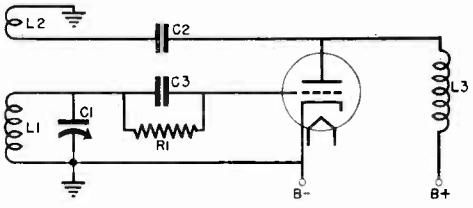

Fig. 2-88

Note that some of these questions ask for the polarity of the power supply and for particular tube types. If you are asked to draw such a diagram for the examination, be sure you answer all portions of the question.

(2-89) Draw a simple schematic diagram showing a tuned-plate, tuned-grid triode oscillator with shunt-fed plate. Indicate polarity of supply voltages.

Ans. This circuit is basically the same as the circuit asked for in Question 2-86 except for the shunt-fed plate. Fig. 2-89 indicates the circuit.

Again, *L1-C1* is the tuned-grid circuit, while *L2-C2* is the tuned-plate circuit. Con-

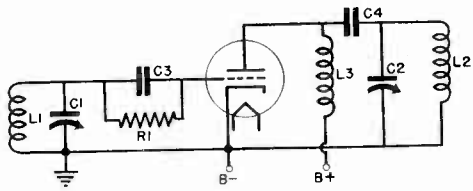

Fig. 2-89

denser *C4* is a blocking condenser, so the a.c. signal path is through *C4* and the plate tuned circuit. The d.c. path from the plate is through choke coil *L3* and through the B supply.

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Resistor *R1* and condenser *C3* are again the grid leak-condenser combination for automatic bias purposes.

(2-90) Draw a simple schematic diagram of a crystal-controlled vacuum tube oscillator. Indicate power supply polarity.

Ans. Refer to Fig. *2-90*.

The quartz crystal is connected between the grid and cathode of the tube. A tuned circuit is used in the plate circuit of the tube. Feed-back is obtained through the grid-plate tube capacity to keep the quartz crystal oscillating. When the crystal starts to oscillate, it vibrates at its natural frequency, which is determined by its physical size and temperature. The crystal thus tends to control the output frequency to a high degree of accuracy.

As the frequency depends on the temperature of the crystal, with some types, special ovens keep the crystal above room temperature, so that variations in temperature will not be effective. Also, by cutting the crystal in a special manner with respect to the optical axis, the temperature will have very little effect.

Automatic grid bias is developed by grid current flowing through resistor *R1*. Note that the circuit uses a series-fed plate supply.

A meter is not shown in this circuit, nor in previous circuits. This is apparently not being asked for. If they do ask that you indicate a plate current meter, just put it in series with the B supply. Meters are used either in the positive or negative side of the plate supply circuit, depending on the lay-out of the transmitter. Typical positions are indicated in Fig. *2-90* by the "X" marks. The meter must be by-passed by a condenser to keep r.f. currents out of the meter. By using the meter in the negative side of the circuit, it is closer to ground potential and there is less danger of accidents.

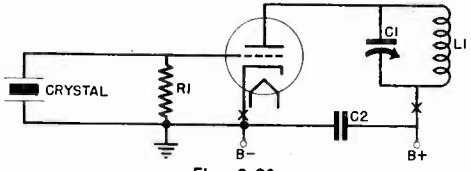

Fig. 2-90

(2-91) Draw a simple schematic diagram showing a Colpitts-type triode oscillator, with shunt-fed plate. Indicate power supply polarity.

Ans. Refer to Fig. *2-91*. The Colpitts oscillator is somewhat similar to the Hartley, inasmuch as the tuned circuit is common to both plate and grid circuits. However, instead of having a tapped coil, the Colpitts circuit makes use of a dual tuning condenser. The cathode circuit connection is made at the common junction of two variable condensers. *C1* and *C2*. The ratio of the capacities of these condensers will determine the percentage of the tank circuit voltage which is in each circuit.

Note that the tuning condensers have two functions. They must be adjusted so that the proper amount of feed-back can be obtained, and at the same time they must be adjusted to such a point that their series capacity will be proper for tuning the tank circuit to the required frequency. This type of oscillator is therefore a bit more critical to adjust than some of the others.

Note that this is a shunt-fed circuit, as the d.c. plate current path is through choke coil *L2* while the a.c. path is through condenser *C3* to the tank circuit.

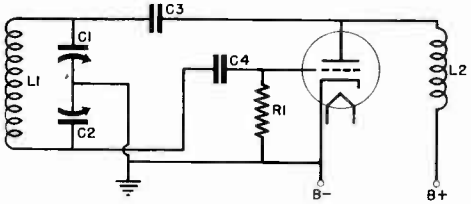

Fig. 2-91

Note that grid resistor *R1* is returned directly to the cathode, as there is no d.c. path through the tuning circuit. Condenser *C4* is the grid condenser. It may be eliminated on some circuits, in which case the tuning condensers serve this additional function as well.

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RESISTORS for REPLACEMENTS

This practical discussion of present-day resistor problems affecting Radiotricians is reprinted (with minor editing) from an IRC resistor advertisement, through the courtesy of the International Resistance Company.

THE Army, the Navy, and the Air Force have first call on all the radio parts and equipment made today. Their requirements are vital.

Realizing the importance of maintaining and servicing home radio sets, at least one resistor manufacturer (IRC) is making available for service men large stocks of the same dependable resistors the armed forces are using (but in ranges and tolerances not called for on war orders) and are offering the following suggestions to enable service men to obtain greatest possible use of resistors in these times.

½-, 1-, and 2-watt Resistors. The resistors in home and automobile sets are almost invariably of the so-called "Preferred Number" or "RMA" standard resistance values, and are color-coded accordingly.

Jobbers have, in the past, carried in stock the ½-, 1-, and 2-watt resistors only in "nominal" or round figure ranges such as 1,000, 5,000, 10,000 and 25,000 ohms, etc.

Now, however, many jobbers are stocking resistors in RMA ranges. These resistors are being furnished by the factory from stocks originally accumulated for the set makers before the manufacture of home sets was discontinued. They are of exactly the same quality previously used in the finest radio sets, but as they are not the ranges and tolerances required for military equipment, they can be supplied without interfering with the all-out war program.

A defective resistor in a set can always be replaced satisfactorily by a new resistor within 20% of the color-coded resistance value of the original unit.

In rare cases, where close tolerance units are used as original equipment, they are usually identified by a gold or bronze band for 5%, or a silver band for 10% tolerance. If a close-tolerance unit is required for replacement, two resistors, one higher and one lower than the required range, may be used in series or in parallel when matched for their combination resistance value.

If a 2-watt resistor is required and none is available from the jobber, two 1-watt units in series or in parallel will do the trick. Similarly, two ½-watt units can be used instead of one 1-watt. Any low-wattage unit can, of course, be replaced satisfactorily by any higher-wattage unit of the same range.

Correct ohmic values for combinations can easily be figured. Remember that when resistors are in series, their ohmic values add. When resistors are in parallel, the combined resistance is less than that of the lowest ohmic value in the group. For *equal-value* resistors in parallel, the combined resistance is the value of one resistor divided by the number of resistors in parallel. The formulas are:

$$\text{In Series: } R = R_1 + R_2 + R_3, \text{ etc.}$$

$$\text{In Parallel: } R = \frac{R_1 \times R_2}{R_1 + R_2}$$

Power Wire-Wound Resistors. All wire-wound resistors above the 2-watt size are becoming scarce because they are made of critical materials which must be conserved for war requirements. Fortunately, however, they are seldom required for service except in A.C.-D.C. sets. If a wire-wound resistor of the required wattage rating is not available, a combination of any types of lower-wattage units, either in series or parallel, may be substituted.

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N.R.I. ALUMNI NEWS

Edward Sorg .....President
John Stanish .....Vice-Pres.
Peter J. Dunn .....Vice-Pres.
Louis J. Kunert .....Vice-Pres.
Chas. J. Fehn .....Vice-Pres.
Earl Merryman .....Secretary
Louis L. Menne .....Executive-Secretary

NOMINEES FOR OFFICE DURING 1943

FIRST of all, we want to thank those of our members who were good enough to vote, for their time and trouble in mailing their ballots. Now that the candidates for office for 1943 have been selected, we hope you will again express a voice in the affairs of our Alumni Association by voting for the men of your choice. A convenient ballot will be found on the next page.

For President, we have two good men in F. Earl Oliver of Detroit and Allen McCluskey of Birmingham, Alabama. Mr. Oliver served our Alumni Association as Vice-President for several terms. Last year, he was a candidate for President but ran a close second in a two-man race. Mr. Oliver accepted the result, like the good sport he is, with the remark "I know it is only a friendly contest. It is honor enough just to be nominated. There is plenty of time for me to try again." And, just so, Mr. Oliver is this year again a candidate for President.

Allen McCluskey, the other half of our ticket for President, also is an old-timer in point of service in our Alumni Association. He was first elected a Vice-President in 1938, and re-elected in 1939 and 1940. This year he has bounced back as a candidate for the top office.

For President then, make your choice between F. Earl Oliver of Detroit, and Allen McCluskey of Birmingham—two good fellows who, win or lose, will always give their best to the N.R.I. Alumni Association.

Eight candidates have been nominated for Vice-President, four to be elected. The nominees are Charles J. Fehn of Philadelphia, Peter J. Dunn of Baltimore, John Stanish of Detroit, Louis J. Kunert of New York, E. W. Gosnell of Baltimore, Sgt. John Stein of Union City, New Jersey, Earl Bennett of Chicago and Oliver B. Hill of Burbank, California. The first four named are at present serving as Vice-Presidents and have been re-nominated.

Charley Fehn is a power in Philadelphia-Camden Chapter where he has held office for many years. Peter J. Dunn is a past President, having served four consecutive terms, when he proposed a resolution to limit the office of President to one year in order that more men may have an opportunity to hold this Honorary Office. Mr. Dunn has since served two terms as Vice-President. He is a prime mover in Baltimore Chapter and because of being located close to Washington, he is frequently personally consulted on matters pertaining to the Alumni Association.

John Stanish is Chairman of Detroit Chapter, which office he has held for several consecutive years. Stanish holds meetings in his own establishment, rent free to the Chapter which gives you an idea of the type of fellow he is.

Louis J. Kunert, for many years has served New York Chapter as Secretary and recently has been pinch-hitting for the Chairman who has accepted a Government position in another locality. Kunert is a loyalist all the way through and gives much of his time in the interests of our Alumni members.

E. W. Gosnell was a candidate for Vice-President last year. He was well supported although he did not receive a sufficient number of votes to be

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elected. Mr. Gosnell is completing his second year as Chairman of Baltimore Chapter and he is destined to hold a high office in our National Organization as his good work becomes better known to the members at large. Sgt. John Stein of Union City, New Jersey is nominated for the first time. He is connected with the Police Department in his city and has been a member of our Alumni Association for several years.

Oliver B. Hill of Burbank, California, also a first-time candidate, is holding an important defense job with Uncle Sam. He formerly was one of the outstanding Radio servicemen in his home town, Moscow, Idaho.

Mr. Earl Bennett is well known to our members. For several years he served as Chairman of Chicago Chapter, was elected a Vice-President of our Alumni Association in 1935, re-elected in 1936, 1937, 1938 and in 1939 was elevated to the office of President. He operates a successful Radio servicing business in Evanston, Illinois, a suburb of Chicago. He has always been ready to extend a helping hand to an Alumni brother, and his splendid technical talks to the members of our Chicago Chapter are well remembered by those who have had the good fortune to hear him.

Earl Merryman is a Charter Member of our Alumni Association. He attended the first meeting when our Alumni was organized in 1929, was then elected Secretary, and has held the office ever since. Mr. Merryman is connected with the Federal Communications Commission, where he is doing a remarkably fine job. John W. Nally, the other candidate for Secretary, is Radio Operator for the Washington, D. C. Police Department. He, too, is a top-notch man.

L. L. Menne, of National Headquarters, is again a candidate for Executive-Secretary. He is Editor of National Radio News, has frequent contacts with our members by correspondence and through visits to local Chapters and therefore, his work is well known to our members. Robert Maney is nominated for office for the first time. He has been a member of our Alumni Association for a number of years and is a high-class men in every respect.

It will be greatly appreciated if every member of the Alumni Association will cast his ballot as early as possible. The polls close December 30, 1942. All elected officers will serve for a term of one year.

The results of this election will be announced in the next issue of the News. Mr. C. Alexander, Bookkeeper at N.R.I., has been appointed Teller to count the votes. Kindly fill in the ballot on this page and mail it to Mr. C. Alexander, Bookkeeper, National Radio Institute, 16th and U Sts., N.W., Washington, D. C.

Tear or cut carefully along this line

Election Ballot

Fill in this ballot carefully, and mail it to National Headquarters immediately.

FOR PRESIDENT (Vote for one man)

☐ F. Earl Oliver, Detroit, Mich.

☐ Allen McCluskey, Birmingham, Ala.

FOR VICE PRESIDENT
(Vote for four men)

☐ Louis J. Kunert, Middle Village, N. Y.

☐ Peter J. Dunn, Baltimore, Md.

☐ Chas. J. Fehn, Philadelphia, Pa.

☐ John Stanish, Detroit, Mich.

☐ John Stein, Union City, N. J.

☐ Oliver B. Hill, Burbank, Calif.

☐ E. W. Gosnell, Baltimore, Md.

☐ Earl R. Bennett, Chicago, Ill.

FOR SECRETARY (Vote for one man)

☐ Earl Merryman, Washington, D. C.

☐ John W. Nally, Washington, D. C.

FOR EXECUTIVE SECRETARY
(Vote for one man)

☐ L. L. Menne, Washington, D. C.

☐ Robert Maney, Washington, D. C.

SIGN HERE:

Your Name .....

Your Address .....

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

Polls close December 30, 1942

Mail Your Completed Ballot to:
C. ALEXANDER, BOOKKEEPER
NATIONAL RADIO INSTITUTE
16th and U STREETS, N. W.
WASHINGTON, D. C.

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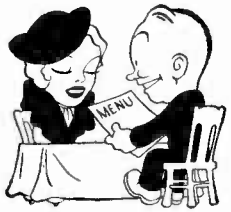
Here And There Among The Alumni Members



Just before Dave Smith of Headquarters joined the Army he and Mabel Ennis were married. Mabel is one of the most popular girls in our office. Good luck, Mr. and Mrs. David H. Smith!

n r i

L. D. Louton graduated from the Signal Corps School with one of the highest grades in his class. He was timed on five trouble shooting jobs and his average was ten minutes per set—the best average in his class.

n r i

Karl Kelly is now manager of The Radio Shop, El Dorado, Ark. He is doing a great deal of business and working long hours due to the shortage of available good radio men. Kelly was formerly project supervisor for the N.Y.A., DeQueen, Ark.

n r i

B. J. Griffin of Coral Gables, Fla., has received a Navy Commission of Senior Lieutenant, EV-(S). The E means engineering, the S means specialist. Mr. Griffin does not say what the V means but from our own point of view it means Victory.

n r i

W. E. Martin is an instructor in the San Antonio Aircraft School teaching a Mechanic Learner Radio Class.

n r i

Harvey Morris, Chairman of Phila-Camden chapter not only is a good leader in meetings but he knows how to relax during rest periods. Harvey has a lot of interesting stories regarding his experiences in the Radio servicing business.

n r i

C. W. McDormand of Washington, D. C., who frequently made the trip to Baltimore chapter meetings with Menne, Straughn and others, has joined the Navy. The picture in this issue of Baltimore chapter meeting was taken by McDormand, his last for the duration.

n r i

Ernest Amundrud of Lloydminster, Alta. Canada, has been operating his own shop since March and is doing very well. Recently was married too. Congratulations!

n r i

E. E. Hamrick of Houston, Tex., has enlisted in the Air Force and is getting his basic training to serve as an Aircraft Radio Mechanic, ground crew.

n r i

Russell A. Thatcher, Radio Operator, State Highway Control, Cambridge, Ohio, says he likes the Questions and Answers for Radio Operators license, which have been running in the last several issues of the NEWS *because "they are easy to understand." That's what we like to hear!*

J. M. Gantt, who is a charter member of the N.R.I. Alumni Ass'n, and who attended our convention in 1929 when the Alumni was organized, is now a Sergeant in a Fighter Control Squadron on foreign duty.

n r i

Dale C. Conger is a F.C.C. Radio Operator in South Dakota.

n r i

F. E. Fischer of Middle Lake, Sask., Canada, says he worked for Mr. and Mrs. J. W. Meadwell of Saskatoon, both N.R.I. graduates, until he had to return to his home to take the place of his father, who is in the Army. Fischer has much praise for the Meadwells, who have a fine Radio store and shop.

n r i

Dan C. Yates is remote control and amplifier man for the Albany Amusement Co., Albany, Ga. He has been getting a salary of $40.00 a week and will be raised to $50.00 the first of the year.

n r i

Art Miller of Chicago Chapter writes us occasionally to tell us how much he enjoys the meetings and of the good work the officers are doing. A fine spirit, Art.

n r i

A. M. Michaels completed a preparatory course at the University of Houston and has been assigned to duty with the Naval Aviation Radio Materiel School at a base in Texas. Says his N.R.I. Course gave him the necessary foundation to successfully complete the preparatory course.

n r i

John Servas of Akron, Ohio, continues to build up a thriving spare time business. He does no advertising but his satisfied customers get him more business than he can handle.

n r i

W. W. Collier of Ohio is a Midshipman, having just completed his first year at the U. S. Naval Academy. There's a bright young man who knows how to take advantage of an opportunity.

n r i

Quinton Dixon is teaching Radio in a Signal Corps School and doing fine. He is filling a big job in a very big way.

n r i

E. Fonseca of Union City, N. J., is another fellow who is finding business unusually good. He is getting a lot of new customers on his list.

n r i

J. E. Brunel of Ramsayville, Ont., Canada, says Radio Servicing business with the firm by which he is employed is good. His own work has received generous appreciation by the company.

n r i

F. F. Fouts is teaching Radio to a class of men who are preparing for work in the Signal Corps. His students are sent to the school by the U. S. Civil Service Commission. The school is located in Lousiana.

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Baltimore Chapter

Going strong with regular meetings every second and fourth Tuesday of the month at Red Men's Hall, 745 W. Baltimore St. Most of the old timers are meeting with us and a number of fine new members are turning out regularly. They are getting a lot of information and inspiration through our meetings.

Chairman Gosnell purchased a new Signal Tracer for use in his own Radio Servicing, which he brought down to one of our meetings. He demonstrated signal tracing from antenna post to speaker and we had a merry time taking a turn at operating the instruments. Those of us who were familiar with it passed on some tips to those who have had less experience.

Pete Dunn has been missed at our last several meetings. Pete is busy in city affairs as one of Mayor Jackson's staff but we expect him back with us as regularly as ever as soon as his evenings are free again. We miss Pete. He is always so alive—so inspiring.

Instead of reading a re-hash of what we have been doing at our interesting meetings, Chairman Gosnell prefers to have all former members or any students and graduates of N.R.I. drop in on us to see for themselves what they are missing. The bigger our attendance the better our meetings will be. You will receive a warm hand-clasp of welcome at Baltimore Chapter.

PERCY MARSH, *Secretary.*

New York Chapter

We opened our fall season with a meeting at which Donald Hildesheim gave us a fine talk on "Fundementals of Electricity and Magnetism as applied to a Radio Receiver." At that meeting we also started the construction of a complete superheterodyne receiver. Mr. Hildesheim was assisted by Mr. Ralph Baer. About thirty-five members were present at this meeting.

At our following meeting we took up the building of a receiver, where we had left it previously. Every step is explained in detail—just what goes on in that part of the circuit. When we complete this job every member who has attended all of the meetings should know all about the superheterodyne receiver.

We are losing some members to the Army, Navy, and Marines—more power to them—but we are also getting new members right along so that our attendance is always thirty-five or more.

We continue to meet at Damanzek's Manor, 12 St. Marks Pl. (between 2nd and 3rd Ave.), New York City. Do not confuse this street with a similarly named street in Brooklyn.

Meet with us on the first and third Thursday of the month. New members are always cordially received.

LOUIS J. KUNERT, *Secretary.*

Officers and some new members of Baltimore Chapter pose before one of the beautiful paintings which adorn the walls of their meeting place. Chairman Gosnell is seated, second from right. At the close of this meeting all went to one of Baltimore's best restaurants where the gang made merry.

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Chicago Chapter

In our last report which appeared in the NEWS, we were a bit too late to give mention to Mr. L. L. Worner who spoke to us on Electronic Controls. This was a splendid talk and we are deeply grateful to Mr. Worner for it.

It should also be mentioned that, at both our party and picnic, our Mr. Edward Oshinski entertained us with a humorous imitation act which was roundly applauded. Mr. Edward Kulpa donated his amplifier for the occasions.

Thanks is also given to the Illinois Bell Telephone Co. for exhibiting four films, namely, "The Telephone Arsenal," "Safeguarding Military Communications," "Modern Aladdin's Lamp," and "Coaxial." These interesting pictures were shown to our members under direction of Mr. Campbell and Mr. Kurent of the telephone company.

At one of our meetings we were stymied by a practice blackout in the city but we must get used to that sort of thing and carry on nevertheless. Chairman Cada took over this meeting and lectured on a test speaker for panel mounting. Then the meeting was opened to questions and we had a lively discussion which brought out a lot of good information.

Art Miller, one of our regulars, should be mentioned for an excellent talk on Radio Mathematics with ample blackboard illustrations.

Mr. J. Leeson and Mr. C. Adamson are two of our newest members. We welcome them to the chapter.

Our last outdoor activity for the 1942 year was a picnic which was held in Caldwell Woods. Unfortunately it rained for half the day but in the afternoon the sun broke through the clouds and we then had a good time until dark. The committee of Edward Oshinski, Frank Strong, Leonard Senglin and Frank Borzewski arranged a fine program for our members, their wives and children and all had a fine time. Our thanks to this hard-working committee.

Our chairman, Mr. Cada has prepared a map of Chicago with a pin to indicate the location of every member. The key to this map is as follows: a white pin for regular attending members, yellow for those who come frequently but not regularly, and green for those who come infrequently. The object is to organize groups of five or six living in close proximity to one another with a captain for each group to stimulate greater interest among our members and establish closer contacts. This will be an interesting experiment.

It will be appreciated if any member, who has changed his address recently, will notify the Secretary at 3317 N. Albany Ave., Chicago. Also information regarding meetings may be had by communicating with the Secretary or Chairman James Cada, 2511 S. Highland Ave., Berwyn, Ill.

HARRY ANDRESON, *Secretary.*

n r i

Phila-Camden Chapter

A full winter schedule with meetings on every first and third Thursday at Emerald and Atlantic Sts., Philadelphia. Any N.R.I. students and graduates who have not attended meetings here should drop in on us. We use the same quarters which are occupied by the Air Raid Warden Service. It is a nifty, All-American layout which gives spice to our meetings.

Harvey Morris, our chairman continues to give us bang-up meetings. They seem to be getting better right along which is saying a great deal.

Our picnic, which was scheduled to be held at Past-President Clarence Stokes' place at Neshaminy Falls, Pa., was rained out. So we held over the pretzels, potato chips, ginger ale and other beverages until our next regular meeting. Our Executive Secretary, L. L. Menne, came over from Washington to join us. We had a big time, thanks to the antics and remarks by Vice President Charley Fehn, Chairman Morris, and the old reliable entertainers such as Bert Champ, Herman Doberstein, M. H. Coulon and former chairman, Norman Kraft.

Kraft and your humble secretary, continue to make the trip from Perkasie, Pa., to meetings—a distance of some 35 miles—with regularity. We like to meet with the boys and will continue to do so just as long as we can save enough gasoline for the old puddle-jumper.

In these times when Radio men have such great opportunities for service in both the armed forces and in civilian life, personal contacts often can be a big help. We welcome all N.R.I. men in this locality. Take the elevated train to Tioga station, walk a block or two to Atlantic Street, then turn right for a few short blocks to Emerald Street. Remember, every first and third Thursday at 8:15 P.M.

HAROLD STRAWN, *Secretary.*

n r i

Detroit Chapter

We have changed our program and are now holding meetings at the homes and shops of various members, alternating one meeting on the West side then one on the East side. At these meetings we have talks on various service problems, types of equipment and their uses, demonstrations on the use of certain equipment and various servicing techniques. Attendance is very good.

Information regarding these meetings may be had by phoning the Secretary, Lenox 4768 or writing to me at 3999 Bedford, Detroit.

F. EARL OLIVER, *Secretary.*

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Novel Radio Items

-BY L.J. MARKUS-

Dogs howling at the moon have been silenced effectively by a Zenith Radio Nurse. With one end of the Nurse (a simplified two-way intercommunicator) installed in the dog pen and the other in his bedroom, the owner of the dogs could tell them to be quiet without shouting or getting out of bed.

n r i

Radio eyes which penetrate darkness, fog and smoke will guide ships in coastal waters after the war, according to William C. White, head of General Electric's electronic laboratory. High-frequency radio beams will locate obstacles which cannot be seen by human eyes, in much the same manner that aircraft are detected with Radar equipment.

n r i

An electronic fish-finder is being used by the U. S. Bureau of Fisheries on the Pacific Coast to locate marked salmon bearing metal identification plates. Catches of salmon are quickly "scanned" by this inductor detector device, and marked fish are quickly isolated for recording of their number and later study of their movements.

n r i

The ability to distinguish between 2,000,000 different shades of color is the outstanding feature of a new electronic instrument developed by General Electric engineers. The Materiels Laboratory of the Army Air Forces is studying the possibilities of using this new *photoelectric spectrometer* for standardization of colors used in camouflage, in luminescent materials and in the transparent plastics used for airplane windows and turrets.

n r i

To prevent submarine-attracting smoke plumes, ships are using photoelectric smoke indicators mounted inside the funnels. These warn the engine room whenever poor combustion allows smoke to form.

n r i

The "pulse" of a steam turbine was taken by electronic equipment during a study of vibration in the high-speed-turbine buckets. The output of a General Radio audio oscillator was fed into a 1,000-watt a.f. amplifier, and the resulting tremendous audio output was changed into mechanical movement by a loudspeaker-like driving unit. With this set-up, the buckets were made to vibrate at all frequencies between 30 and 20,000 cycles, and a crystal pick-up and cathode ray oscilloscope then indicated the frequencies at which vibration was dangerously excessive due to natural mechanical resonance.

Photoelectric block signals control train movements on the single-track railroad in the 13-mile long irrigation tunnel now being drilled through the Continental Divide in Colorado. Accumulations of water and dirt make impractical the usual block system which depends upon mechanical or electrical switches connected to the rails. Furthermore, electric current in the rails might cause premature ignition of blasting charges. The tunnel line is divided into blocks about 6,000 feet long, with a pair of General Electric photoelectric relays placed about 30 feet apart at each end of the block to control the red and green signal lights in that block. This is said to be the longest tunnel in the world protected by photoelectric block signals.

n r i

Meteors and shooting stars produce short-wave radio signals which begin with a shrill note and rapidly decrease in pitch and loudness, according to reports from short-wave stations in India. Calculations based upon the time for the whistle to disappear indicate that the moving objects attain velocities as high as 40 miles per second, and the only known objects which travel that fast through the air are meteors. Observers have actually seen meteors in the sky at the same instant that the peculiar whistle was heard.

n r i

War-scarce sapphire jewels for radio and electrical meters are being replaced by fused glass substitutes which can be turned out by mass-production methods at the rate of several million per year. These pinhead-size jewels are known as "Vee" jewels, for in the flat top of each one is a V-shaped depression in which the cone-shaped pivot of the meter rotates. The accompanying illustration shows 450,000 glass Vee jewels made by General Electric Company for meter bearings. The uncertainty of wartime shipping and the absence of mass-production methods among Swiss jewel-grinding craftsmen has made existing sources of sapphire jewels hopelessly inadequate.

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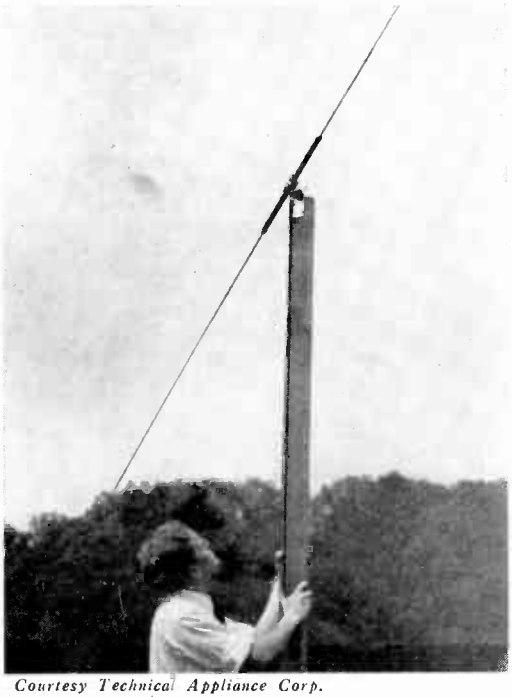
Installing Television Antennas

With two or more television transmitters on the air in any one city, the installation of a satisfactory television receiving antenna requires a bit more care. In general, the antenna should



Courtesy Technical Appliance Corp.

This television receiving antenna with universal joint mounting permits adjustments in all directions.

be in the clear wherever possible, high and far back from the street, so as to minimize both auto ignition interference and that from electrical equipment. When the television stations are nearby, however, a surprisingly simple antenna in the attic or mounted outside a window will often be entirely satisfactory.

Although the total length of the two sections of the dipole antenna *should* be equal to one-half the wavelength of the signal to be received, a satisfactory signal can be picked up from as many as three different stations with a single antenna if it is tuned to the middle frequency of the stations. Large buildings in the path of the signal will reflect transmitted waves and cause multiple images or "ghosts" on the televisor screen. These "ghosts" can be quite annoying, and should be eliminated by rotating the antenna, changing its location, or using reflector rods.

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Index

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