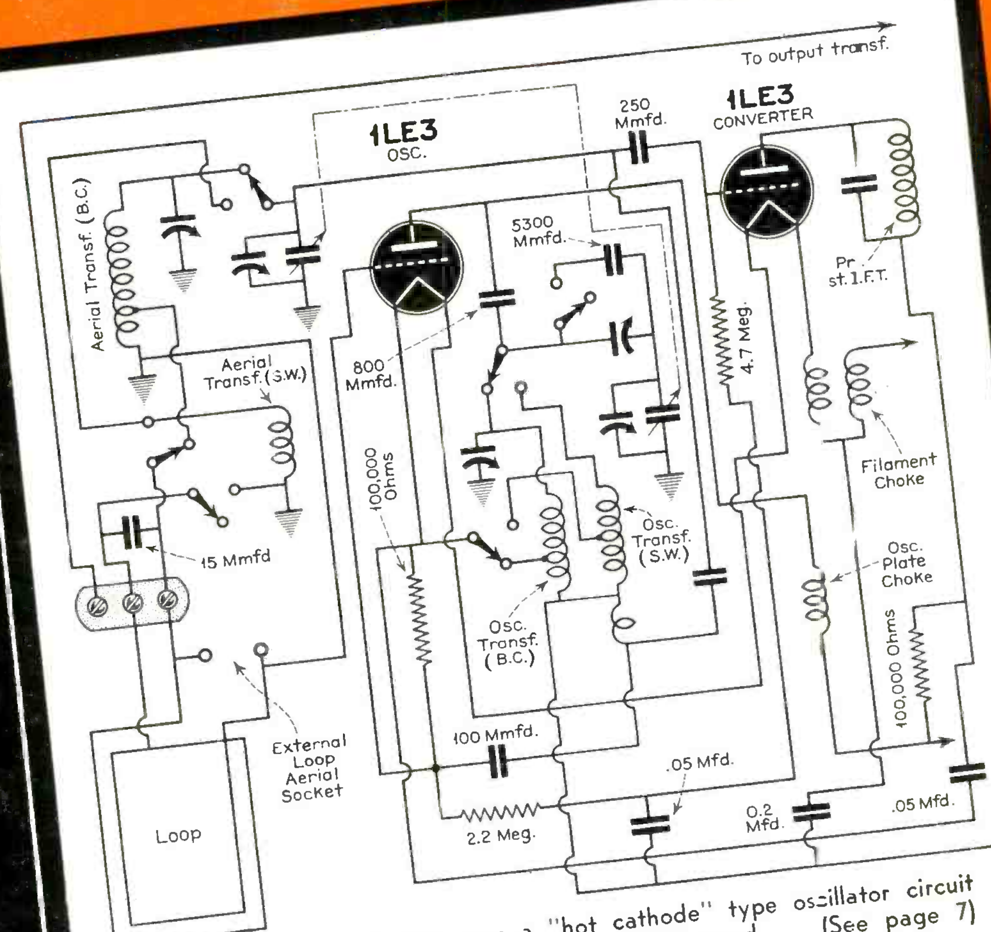
A MONTHLY DIGEST OF RADIO AND ALLIED MAINTENANCE

# SERVICE




A two-band portable that uses a "hot cathode" type oscillator circuit with filament running at r-f potential above ground. (See page 7)

October 1942

RADIO — TELEVISION


We are making more tubes than ever before in our history, but the armed forces are using almost our entire output. Under existing conditions, you may have to search for Ken-Rad Tubes, but there are some and possibly will be more for replacements. Please bear with us in the knowledge that the better job we do now, the sooner we will be able to meet civilian requirements

***Ken-Rad Radio Tubes Make Satisfied Customers***

# KEN-RAD

## *Metal Radio Tubes*

**KEN-RAD TUBE & LAMP CORPORATION, Owensboro, Kentucky**

# EDITORIAL

WITH the announcement of the strict control order curbing production of dry cell batteries and a corresponding statement that portable batteries for portable radio receivers will be discontinued, comes an interesting situation for alert Service Men. While many of the portables affected will still be useable in view of the provision for a-c or d-c power connection, there are still many portables that will have to be closeted unless something is done. That "something-to-be-done" phase is where the Service Man comes on to the scene. There are many tricks that the Service Man can introduce to reactivate these portables. Many of the conversions will demand quite a bit of ingenuity, and others will be quite simple. But regardless of the problems, Service Men should investigate this new phase and make every effort to revitalize these sets, not only for those at home, but perhaps for the hundreds of recreation centers of our Armed Forces that are in need of more radios!

THE storage of cars and the reduced use of cars has created a new servicing problem that also requires immediate attention. Storage batteries used in cars deteriorate unless charged with some frequency. There are thousands of batteries that are now idling in storage or in seldom-used cars, that must be kept "alive" or else. This can be solved by the Service Man. He can arrange for a group servicing plan, where the batteries are kept in condition and maintained over various periods of time. And where the batteries are found to be at too low an ebb, there are sufficient vital materials in the batteries to make them attractive as a contribution to either a metal or rubber salvage station. But, regardless of which step is taken, action should be immediate for the vacationing batteries that can serve no purpose while nestling in the cold cars without attention.


# SERVICE

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**ROBERT G. HERZOG,** Editor (On Leave)

**ALFRED A. GHIRARDI,** Advisory Editor


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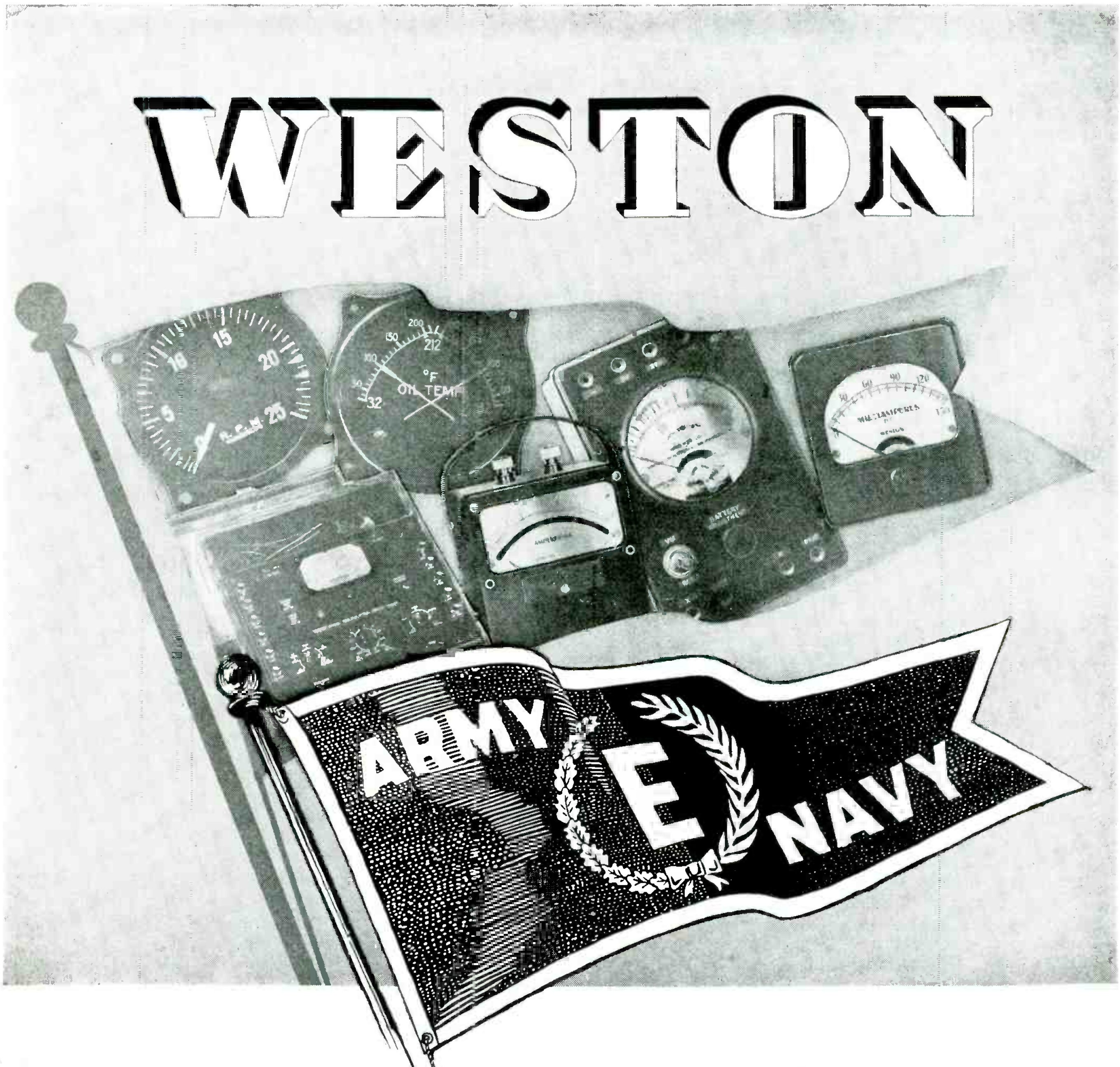



# *Receives the Army-Navy "E" Award*

*"On LEADERSHIP rests the responsibility for getting things done."*

Only short months ago, the instrument goal in this mechanized war seemed unattainable. In almost unbelievable quantities instruments were needed for our huge plane program—for a two-ocean navy—for tanks, guns and walkie-talkies — for our arsenals and factories — and for countless new devices of war.

To approach this goal meant far more at WESTON than the mere addition of factory and laboratory equipment, and the usual worker-training program. It meant imparting to untrained hands the skill and instrument sense which ordinarily takes years to acquire. For it's this rare instrument sense, backing up sound engineering, which has been responsible for WESTON's continued leadership.

This "E" award to the workers at WESTON—the first to any group in this specialized field—means recognition of their efforts in striving to attain the goal in numbers, while never relinquishing the WESTON quality ideal.

And to our courageous fighting men everywhere, it conveys the assurance that they can depend on the men and women at WESTON to continue furnishing the essential instruments in ever increasing quantities . . . *until victory is won.*

**WESTON ELECTRICAL INSTRUMENT CORPORATION, NEWARK, N. J.**

SERVICE
A Monthly Digest of Radio and Allied Maintenance

# SOUND SYSTEMS TODAY

By SIDNEY HARMAN
Sound Engineer, David Bogen Co., Inc.

THE WAR has brought many changes to many things and to the Service Man it has meant an almost complete cessation of his civilian activities and the assumption of an extremely important role in the production and maintenance of war equipment.

The Service Man who is content to seek all his business in purely civilian channels is finding it daily more difficult to operate successfully. And with the natural demands for his services which the war has created, such a man is at the very least, improvident and unwise, and is failing to make maximum use of his abilities in the war effort.

This article concerns itself with a vast new field which has grown up during the past year, a field in which the Service Man has a very definite and very vital place.

The need for large and complex sound distribution systems has grown as war plants have grown. And as the cry for more speed, more production and greater efficiency has swelled, the demand has multiplied, too.

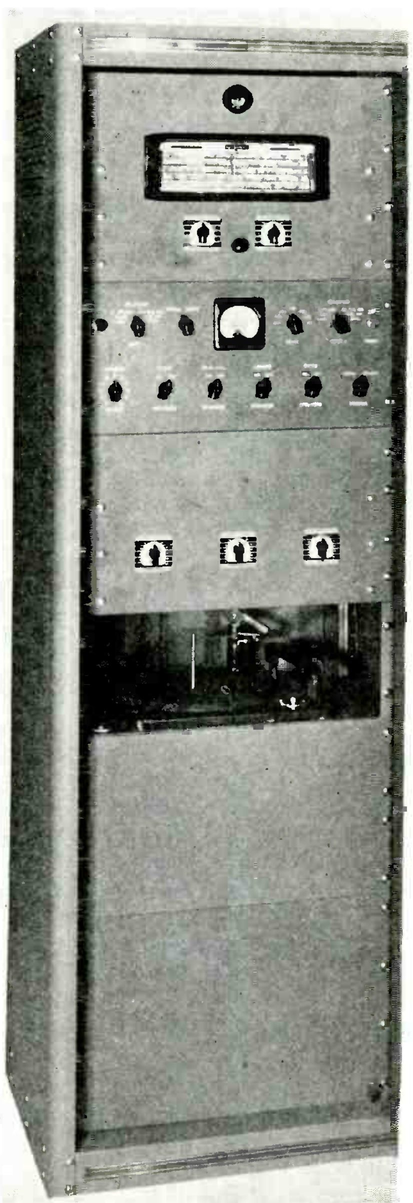
Production of the type of equipment to be described is increasing and this equipment is being shipped to every part of the country. It is almost impossible to expect the factory to maintain a personal supervision over each system manufactured, and it is in this role that the Service Man serves a very necessary function.

A number of months ago, over sixty systems were manufactured and shipped to various USO organizations throughout the country. The systems are now in use at Army camps and USO buildings.

It was essential, of course, that a competent service organization be made available, first to install, secondly to check the operation and finally to service the systems. In practically every case, a service organization was given a contract by the Area Engineer in charge, to install the system and in most cases, additional contracts were written for a year's servicing. It was very much the story of the Chinese physician who is paid a yearly fee by his client to keep the client well. The Service Man estimated a fair flat fee for taking care of the equipment and periodic trips for check-ups were the result.

It is not surprising that many Service Men have "come up" with highly important, highly lucrative jobs which have involved the surveying of plants, the recommendation of necessary equipment and the final sale, installation and servicing of the system. The regular trips to plants for check-up of systems have frequently resulted in very desirable contacts, in additional work in that plant and, most important, in recommendations to other organizations, who having seen the system in operation, realize its value and request recommendations for themselves. Many of the largest industrial systems in operation today found their origin in just this manner.

Fig. 1. A typical central control sound system rack.



It is simple to see that this type of work is not only profitable but that it also provides an extremely important service in the production for war.

What then is the equipment which is being built today for war plants and war organizations? How does it work and "what is in it" for the Service Men?

Actually, the use of public address systems was rather widespread before the war, but the tremendous new demands of war plants have proved the simple microphone-amplifier-speaker set-up to be inadequate. Industrial systems today provide microphone calls from a number of remote locations, music distribution to reduce fatigue periods, radio distribution of special programs and presidential addresses, automatic fire alarms, air raid alarms and all clear signals. All of these functions are accomplished with the same system and the signals are amplified and distributed to the same group or groups of speakers.

In Fig. 1, we see a typical central control rack for such a system. In the rear view of the rack, Fig. 2, can be seen the oscillator providing an electronically warbled 1000 cycle signal for air raid and a fixed signal, accomplished by shooting out the RC "blooper" circuit for the "All Clear" signal.

The relay panel mounts the various interlocking relays which give precedence to one type of signal over another. Thus, when an air raid alarm is issued (either by depressing a manual switch at the rack or by a control from a remote location) the relays for every circuit, other than the "All Clear," open up so that no other call can be initiated while the Air Raid signal is in progress and so that the Air Raid signal automatically locks out all others except the "All Clear." The rack shown employs five Bogen 100 watt booster amplifiers. These require 3 watts each to be driven to full output and a standard

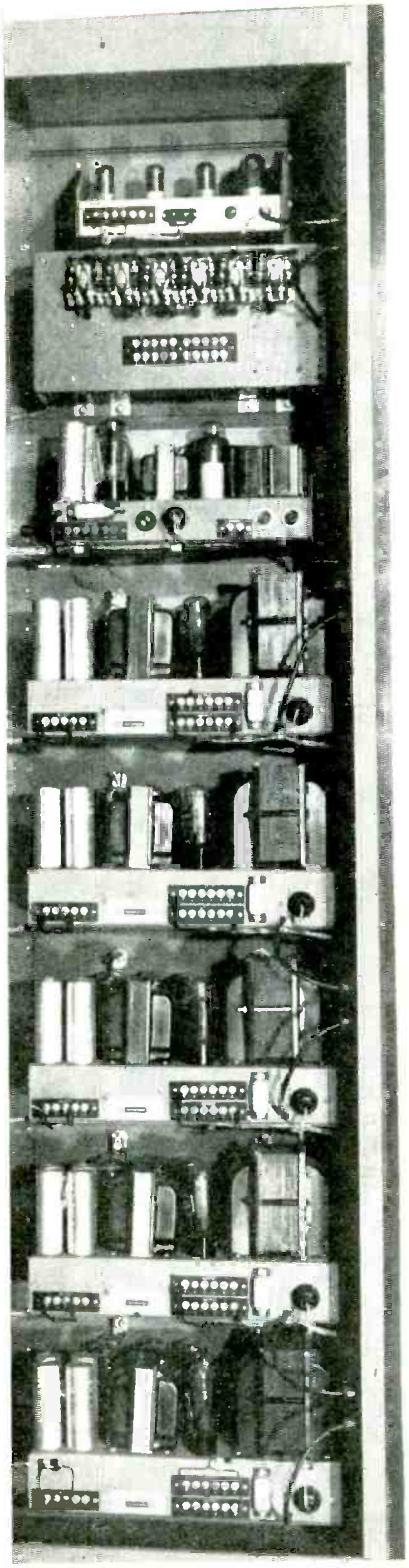


Fig. 2. The rear view of the sound system rack with the oscillator that transmits 1,000-cycle air raid warning notes.

Bogen 15 watt amplifier is therefore employed as the driver.

Each booster amplifier incidentally has a relay controlled plate supply, operating in such manner that the filaments of all tubes are always lit and maintained at operating temperature. The plate supply is closed by the relay which is in turn controlled by each input switch.

A typical remote control station is shown in Fig. 3. This consists of a metal housing with an engraved bakelite plate, a goose neck dynamic microphone, a volume level meter and telephone type switches for (a) throwing over the control of the system to the night watchman during late shift, (b) talking, (c) sending the call selectively to office speakers only, (d) sending the call to the engineering office, (e) to the production office and (f) to the plant.

Possibly one of the most important considerations in a system of this type is the selection and hook-up of the speakers. Factories have, of course, varying noise levels often as high as 90 db. (approximately the level of a New York subway), but because these levels vary and because the areas in which they exist are of different sizes and shapes, it is almost always necessary to feed different amounts of audio power into different speakers, all on the same loop.

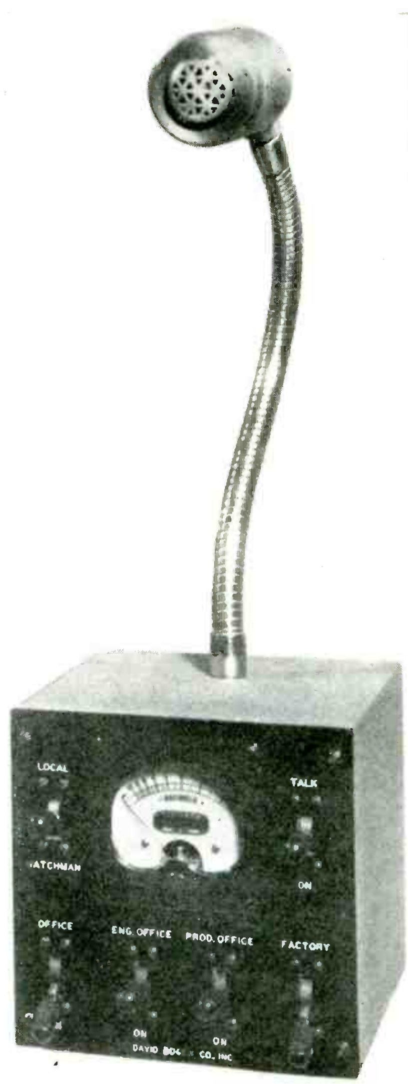
One of the most frequent problems encountered by Service Men in industrial systems arises out of the complaint that calls simply cannot be heard. Very often, it has been discovered, this is not the result of insufficient available power or a breakdown in the amplifying equipment but a failure to properly select line matching transformer primaries which will provide the correct amount of power for the speaker involved. It is the old question of correctly matching speaker impedances and properly loading the output of the amplifiers.

It is the usual practice in war plant systems to parallel the outputs of the power amplifiers and to feed their combined power to the speakers in the plant at high level. Since the normal commercial output transformer of a power amplifier employs 1000 ohms as the highest available tap on its secondary, it can be seen that five such amplifiers in parallel will provide a 200 ohm line. To obtain maximum transfer of this power to the speakers, the effective impedance of the speakers (in parallel) must equal approximately 200 ohms. It is not sufficient, however, to assume if there are 40 speakers in the system, that the primary of each line matching transformer should be tapped at 8000 ohms. It is true that such an arrangement will provide a load of 200 ohms, but the 500 watts of power will then be equally divided among the forty speakers, approximately 12 watts to each.

Measurements have been made on most commercially manufactured speakers and it is quite possible to know what "db" level can be achieved at a given distance (on the axis) from a projector type reflex trumpet when it is driven by a given amount of power. It is known, for example, that the Bogen University LH reflex trumpet, using a SAH driver unit will, when fed with 25 watts, produce a level of +120 db at five feet, and +70 db at 500 feet. It is known also that a Bogen University Radial reproducer, the type RLH, for example, when employing a SAH driver unit will provide a sound dispersion of 360° on an inclined plane 30° off the perpendicular; and when driven with 10 watts, it will produce a level of +87 db on a 120 feet center. Thus, if measurements indicate that a level of 84 db exists in a shop 300 feet wide by 660 feet long, it will be seen that for announcements to be completely audible, a level of 87 db (one audible increase) should be achieved. Knowing that 10 watts in a model RLH-SAH will provide an 87 db level when the reproducers are arranged in 120 ft. centers permits a layout as shown in Fig. 4.

A total of 18 speakers will be neces-

Fig. 3. A typical remote control station with all of the elements required to maintain effective service.



sary and a sum total of 180 watts will be required to drive them. The Service Man will know that the Bogen E 100 amplifier providing a total of 100 watts has an output transformer with a two section secondary, one having output impedances of 2, 4, 9, 15 and 72, the second 84, 100, 125, 166, 500 and 1000 ohms. In order to determine the correct impedance of the primary of the line matching transformer, the following simple formula can be employed:

$$Z_L = Zps\left(\frac{P}{p}\right)$$

where $Z_L$ is the value of the primary of the line matching transformer; where Zps is the effective value of the secondary taps of the output transformers of the booster amplifiers, arranged in parallel; where P is the total output of the amplifiers and where p is the power desired in any one speaker.

Whenever possible it is advisable in industrial systems to run speaker lines of 200 or 500 ohms. This is necessary because speaker lines in such systems are usually many hundred feet long and running a lower value line would result in losses due to the resistance of the line. Higher impedance lines would of course *result* in losses in the output transformers' secondaries.

Let us assume that a 500 ohm line will be used in the problem discussed. This will be achieved by paralleling the two 1000 ohm taps of the two E100 booster amplifiers. It will be remembered that 10 watts are required in each speaker. Applying the simple formula:

$$Z_L = Zps\left(\frac{P}{p}\right)$$

$$Z_L = 500\left(\frac{200}{10}\right) = 10{,}000$$

In order to obtain 10 watts at a reproducer then, a line matching transformer should have a primary impedance of 10,000 ohms. It will be seen that eighteen such transformers in parallel will have an effective impedance of 556 ohms, apparently not a perfect match. It must be remembered, however, that a total of 180 watts, not 200 was desired. Application of the formula will show that only 180 watts is transferred:

$$P = \frac{P(Zps)}{Z_L} \qquad P = \frac{200\,(500)}{556} = 180$$

Use of the formula will indicate the correct primaries of line matching transformers used at speakers requiring different amounts of power. Assume that it was decided to drive one speaker in

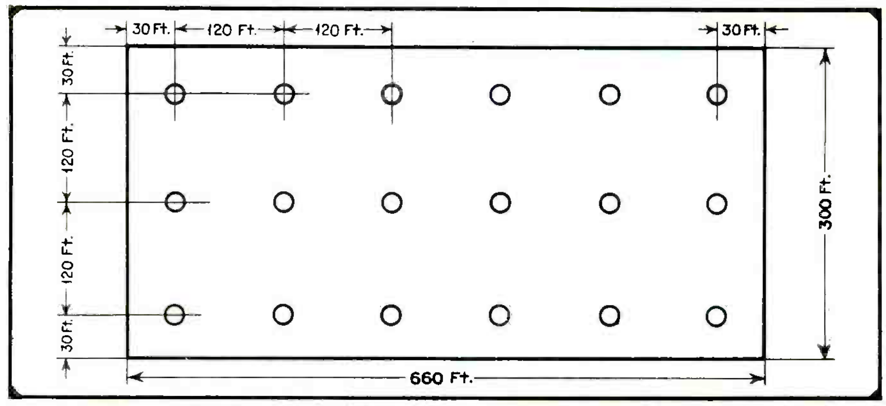



Fig. 4. A typical sound system layout with characteristic space allotments for maximum speaker reproduction.

the system outlined with 14 watts. Application of the formula:

$$Z_L = Zps\left(\frac{P}{p}\right)$$

$$= 500\,\frac{(200)}{14}$$

$$= 7000 \text{ ohms.}$$

Thus in the same speaker loop, one speaker can be driven with 10 watts (line matching transformer primary = 10,000 ohms) and another with 14 watts (line matching transformer primary = 7000 ohms).

Most commercially available line matching transformers show tapped primary values (for example: 500, 1000, 1500, 2000). These values are based on the loading of the secondary with an 8 ohm voice coil. If the speaker being used has a 15 ohm voice coil, the marked values of the primary should then be doubled so that they become 1000, 2000, 3000, 4000.

The ability to lay out an efficient speaker arrangement to determine the power required to properly cover an area and to select the correct line matching transformers can constitute an extremely valuable tool for the Service Man. There is a crying need industrially for the type of equipment outlined in this article and there is simply an insufficiency of qualified sound men to handle the demand. It is only natural that the Service Man should assume a position of prominence in this picture.

# A UNIQUE OSCILLATOR CIRCUIT

(*See Front Cover*)

IN THE PHILCO 42-853 and 42-854 seven tube, two band portables, low impedance loops and two full-gain i-f stages are used. An iron core antena autotransformer couples the loop into the first tube, the 1LE3 converter. The loop is connected across part of the winding which serves as a primary. Note the 1LE3 oscillator circuit. It is of the "hot cathode" type with the filament at a r-f potential above ground.

In the filament circuit, from the A— terminal, filament current runs through the "tickler" part of the oscillator coil, through the oscillator filament, through the converter filament, through a "T" section r-f filter to 2nd detector, i-f stages and power tube to A+. You can see that the converter and oscillator tube filaments are both above ground potential from which they are isolated by the r-f filter between the converter and 2nd detector. This is the method by which the oscillator voltage is fed to the converter stage. No other method of coupling is necessary or provided.

Another interesting relation between oscillator and converter is the source of the latter's grid bias. Note the 2.2 megohm resistor conecting the oscillator grid with the 4.7 megohm grid leak of the converter stage. A .05 mfd. bypass condenser at the junction completes a "T" section r-f filter to keep any oscillator voltage from entering the converter grid via this path which, being in phase opposition to the voltage arriving via the "hot" cathode, would subtract from this voltage. Thus, the oscillator grid developing a negative potential with respect to ground is able to provide a negative (d-c) bias to the mixer tube. "So what," did you say? Well, you know the oscillator output varies somewhat with frequency. It's a whopper of a job to keep it constant over a wide tuning range because of the varying L/C ratio and the changing "Q". When the output drops, the gain of the converter also usually decreases. However, with the foregoing bias arrangement, this need not be so. Lower oscillator potential also means less negative grid bias which increases the transconductance, or gain, of the converter. The two effects may be made to cancel, leaving the gain constant over the band. The 1st i-f stage is supplied by avc for bias while the 2nd i-f remains unbiased.

# SER-CUITS

By HENRY HOWARD

NOVEL SWITCHING, equalizing and coupling methods in a-f and r-f circuits are highlight features of circuits analyzed this month. The interesting feature of the Crosley receiver-phono combination 72CP (chassis 85), for instance, is the single switch for radio band switching and phonograph operation.

The front section is an audio switch which connects the high side of the volume control to either the detector or phono pickup in the standard manner. The rear section actually consists of four separate switches which operate in the following way: (1) The switch arm is connected to the grid of the 6SK7 rf stage and to the tuning condenser. In "broadcast" position the loop antenna is connected while on "foreign" the secondary of an antenna transformer is connected. Note the loop tap and external antenna hookup in Fig. 1. On broadcast, the outer turn of the loop acts as a primary in auto-transformer fashion. A 1000 ohm resistor tends to flatten any resonance points that may develop in the external antenna circuit. On short waves, the outside antenna is connected to the r-f transformer in the usual manner but the loop circuit is still in parallel with the primary. However, this shunts negligible energy because of its high impedance which includes that 1000 ohm resistor.

(2) Proceeding clockwise, the second switch arm is connected to the 6SA7 converter cathode which selects either the broadcast or short wave oscillator coil.

(3) The third arm is connected through a grid condenser to the oscillator grid of the 6SA7 and selects either oscillator coil. Note that the short wave oscillator trimmer is connected in series with a 100 ohm, ¼ watt resistor to broaden its action, facilitating accurate tuning.

(4) The fourth arm is grounded to the chassis and serves to short-circuit the short wave oscillator coil in "broadcast" position while also opening the primary of the antenna input transformer. This shunting circuit would detune the loop if not removed. In "foreign" position, this primary circuit is restored and the short-circuit removed from the short wave coil.

An r-f transformer couples the r-f stage to the converter, no tuning being used. The audio system contains a 6AD7 combination triode-pentode serving as a phase inverter and 6F6 equivalent output tube.

Fig. 3. The Crosley phono combination 53 TP (chassis 100). See page 26 for data.

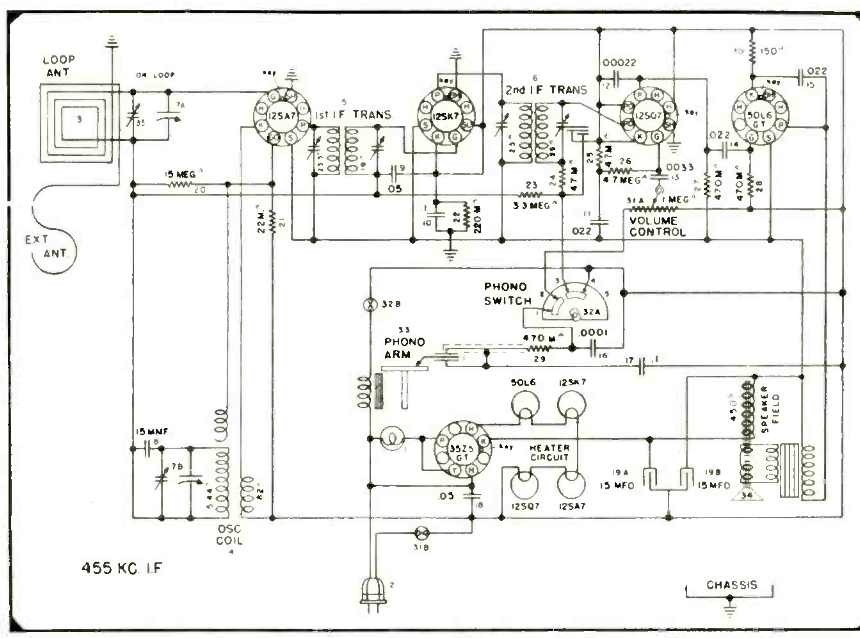
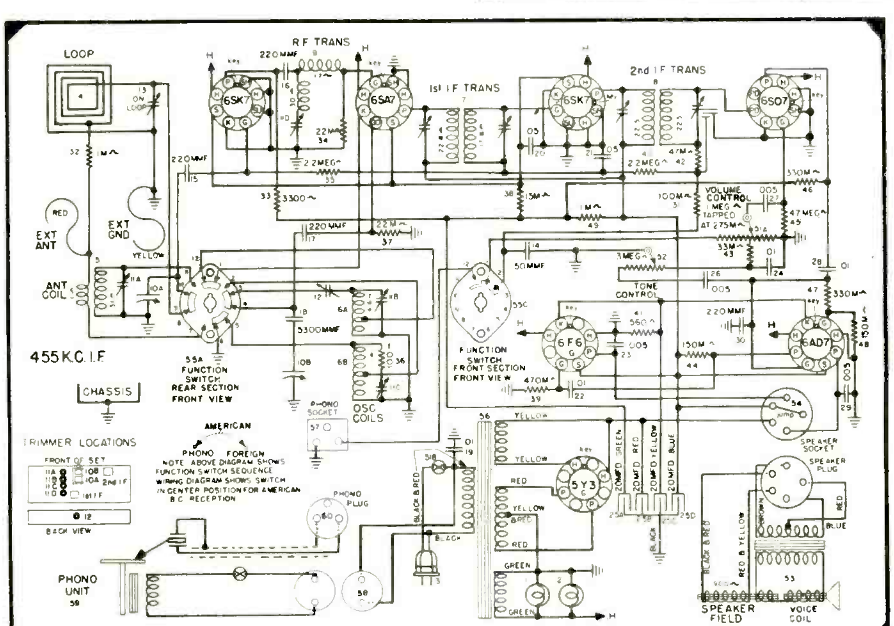



Fig. 1. The Crosley 72 CP (chassis 85) with its single switch for radio band and phono operation.




### *Crosley 63TA-63CA (Chassis 110-111)*

The Crosley six tube a-c set 63TA-63CA (chassis 110-111) features a tone control operating in conjunction with a tapped volume control, as shown in Fig. 2. The common high cutting shunt condenser forms one part of the system and a bass compensation circuit the other part of the system. The tone control per se has a resistance of 3 megohms and has the arm grounded. With the arm at the left, the .005 mfd. condenser is shunted across the first audio output, giving maximum bass and allowing the bass compensation system to operate normally.

Moving the arm to the right, the shunting effect of the .005 mfd. condenser is gradually reduced and so is the bass compensation effect which reduces the low boost. When the arm

(*Continued on page* 20)

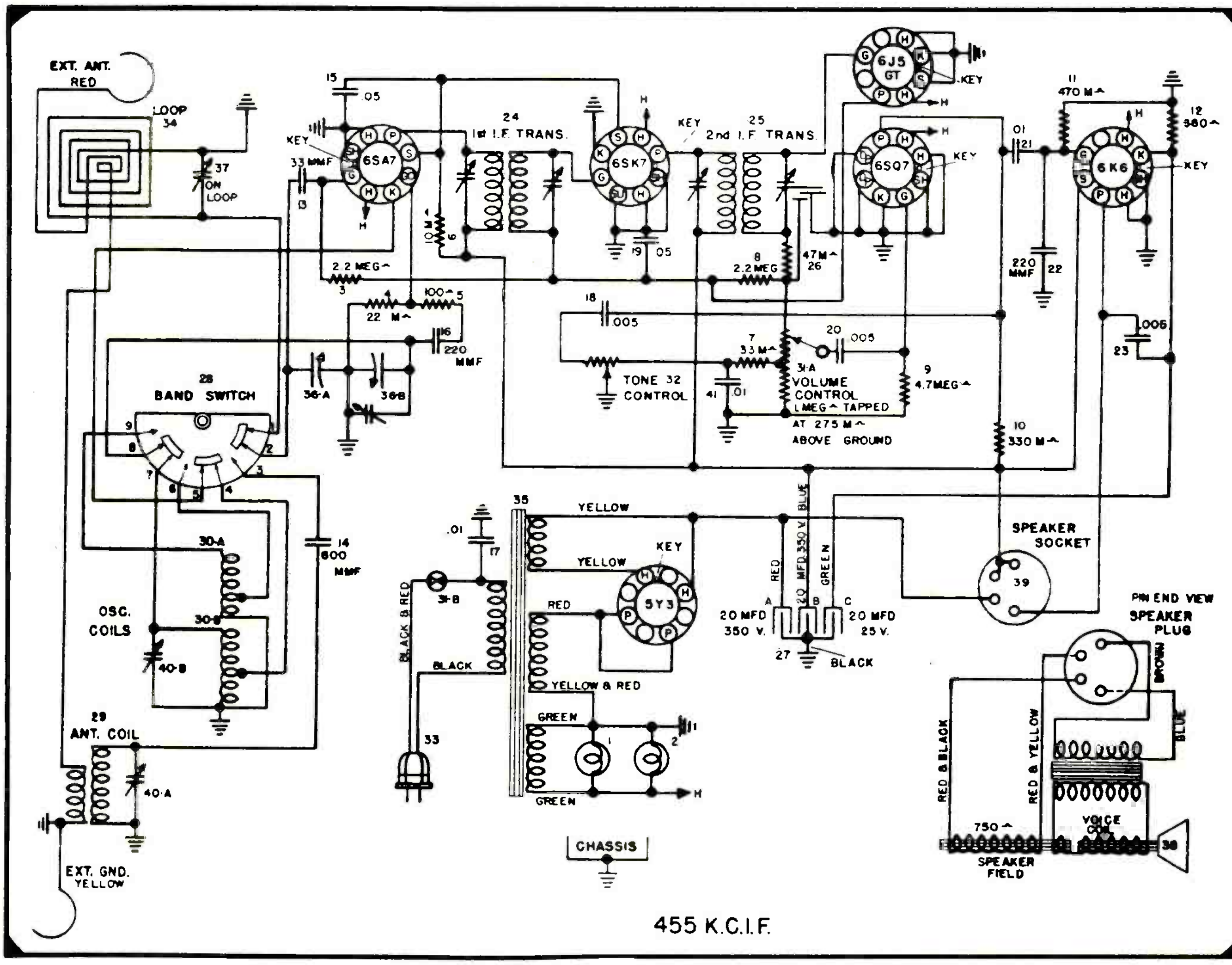
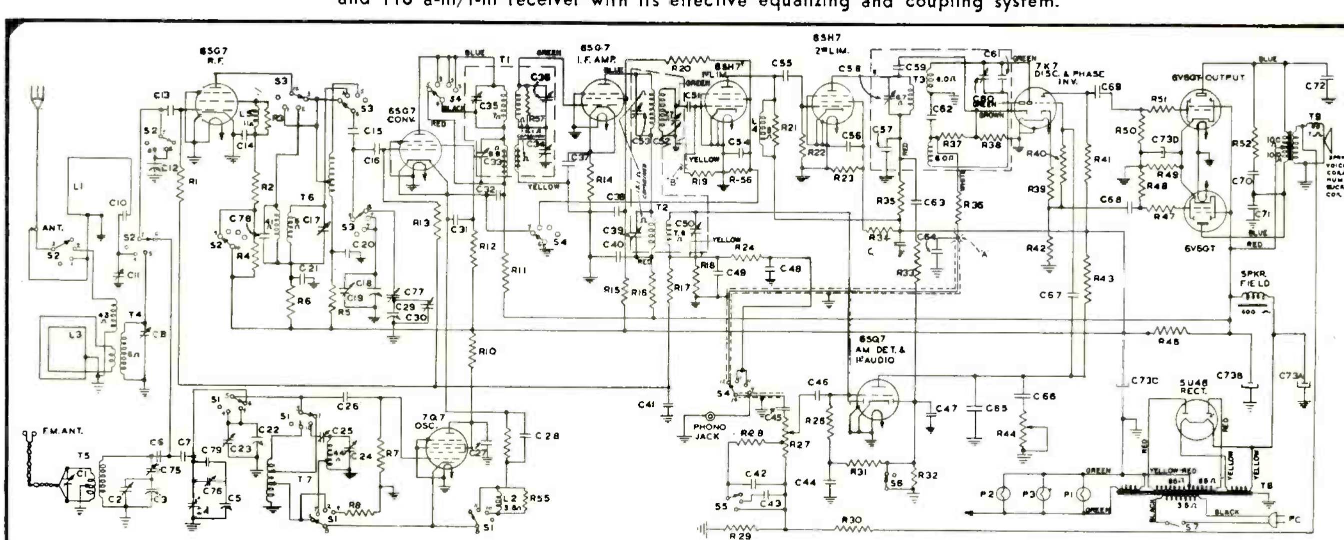



Fig. 2 (above). The Crosley 63TA-63CA (chassis 110 and 111) that features an unusual tone control system. Fig. 6 (below). The GE LF 115 and 116 a-m/f-m receiver with its effective equalizing and coupling system.




| | |
|---|---|
| C-1 | "FM" antenna trimmer |
| C-2 | "FM" RF trimmer |
| C-3 | "FM" Tuning condenser—RF |
| C-4 | "FM" oscillator trimmer |
| C-5 | "FM" tuning condenser—oscillator |
| C-6 | 47 mmf., mica capacitor |
| C-7 | 10 mmf., compensating capacitor |
| C-8 | "BC" band mmf., RF trimmer |
| C-10 | 3000 mmf., mica capacitor |
| C-11 | "SW" band RF trimmer |
| C-12 | "AM" tuning condenser—RF |
| C-13 | 220 mmf., mica capacitor |
| C-14 | .02 mfd., paper capacitor |
| C-15 | .05 mfd., paper capacitor |
| C-16 | 47 mmf., mica capacitor |
| C-17 | "B" Band trimmer |
| C-18 | "AM" Tuning condenser—converter |
| C-19 | "D" Band trimmer |
| C-20 | 3600 mmf., mica capacitor |
| C-21 | .05 mfd., paper capacitor |
| C-22 | "AM" Tuning condenser—oscillator |
| C-23 | "D" band trimmer |
| C-24 | "B" band trimmer |
| C-25 | 560 mmf., padder |
| C-26 | 65 mmf., compensating capacitor |
| C-27 | .05 mfd., paper capacitor |
| C-28 | .005 mfd., paper capacitor |
| C-29 | "FM" Tuning condenser—converter |
| C-30 | "FM" converter trimmer |
| C-31, -32 | .02 mfd., paper capacitor |
| C-37, -38 | .05 mfd., paper capacitor |
| C-40 | .02 mfd., paper capacitor |
| C-41 | .05 mfd., paper capacitor |
| C-42 | .003 mfd., paper capacitor |
| C-43, -44, -45 | .01 mfd., paper capacitor |
| C-46 | .005 mfd., paper capacitor |
| C-47, -48, -49 | 100 mmf., mica capacitor |
| C-51 | 33 mmf., mica capacitor |
| C-54 | .01 mfd., paper capacitor |
| C-55 | 22 mmf., mica capacitor |
| C-56 | .02 mfd., paper capacitor |
| C-57, -59 | 47 mmf., mica capacitor |
| C-61 | 8 mmf., compensating capacitor |
| C-62 | 220 mmf., mica capacitor |
| C-63 | .01 mfd., paper capacitor |
| C-64 | 220 mmf., mica capacitor |
| C-65 | 100 mmf., mica capacitor |
| C-66 | .01 mfd., paper capacitor |
| C-67, -68, -69 | .05 mfd., paper capacitor |
| C-70 | .005 mfd., paper capacitor |
| C-71, -72 | .002 mfd., paper capacitor |
| C-73a | 30 mfd., dry electrolytic |
| C-73b | 15 mfd., dry electrolytic |
| C-73c | 10 mfd., dry electrolytic |
| C-73d | 20 mfd., dry electrolytic |
| C-74 | .05 mfd., paper capacitor |
| C-75 | "FM" RF padder |
| C-76 | "FM" Oscillator padder |
| C-77 | "FM" Converter padder |
| C-78 | 270 mmf., mica capacitor |
| C-79 | 65 mmf., compensating capacitor |
| R-1 | 1.5 megohm, carbon resistor |
| R-2 | 3,900 ohm, carbon resistor |
| R-3 | 100,000 ohm, carbon resistor |
| R-4 | 33,000 ohm, carbon resistor |
| R-5, -6 | 2,200 ohm, carbon resistor |
| R-7 | 33,000 ohm, carbon resistor |
| R-8 | 330 ohm, carbon resistor |
| R-9 | 1,200 ohm, carbon resistor |
| R-10 | 10,000 ohm, carbon resistor |
| R-11 | 2,200 ohm, carbon resistor |
| R-12 | 22,000 ohm, carbon resistor |
| R-13 | 1.5 megohm, carbon resistor |
| R-14 | 330 ohm, carbon resistor |
| R-15 | 15,000 ohm, carbon resistor |
| R-16 | 2,200 ohm, carbon resistor |
| R-17 | 2.2 megohm, carbon resistor |
| R-18 | 150,000 ohm, carbon resistor |
| R-19 | 100,000 ohm, carbon resistor |
| R-20 | 220,000 ohm, carbon resistor |
| R-21 | 8,200 ohm, carbon resistor |
| R-22 | 180,000 ohm, carbon resistor |
| R-23, -24 | 47,000 ohm, carbon resistor |
| R-26 | 6.8 megohm, carbon resistor |
| R-27 | 2 megohm, volume control |
| R-28 | 68,000 ohm, carbon resistor |
| R-29 | 22 ohm, carbon resistor |
| R-30 | 470 ohm, carbon resistor |
| R-31 | 2.2 megohm, carbon resistor |
| R-32 | 1.0 megohm, carbon resistor |
| R-33 | 10,000 ohm, carbon resistor |
| R-34 | 68,000 ohm, carbon resistor |
| R-35 | 22,000 ohm, carbon resistor |
| R-36 | 68,000 ohm, carbon resistor |
| R-37, -38 | 100,000 ohm, carbon resistor |
| R-39 | 3,300 ohm, carbon resistor |
| R-40 | 470,000 ohm, carbon resistor |
| R-41, -42 | 82,000 ohm, carbon resistor |
| R-43 | 220,000 ohm, carbon resistor |
| R-44 | 0.5 megohm treble-tone control |
| R-46 | 2,500 ohm, wire wound resistor |
| R-47 | 1,000 ohm, carbon resistor |
| R-48 | 220,000 ohm, carbon resistor |
| R-49 | 270 ohm, carbon resistor |
| R-50 | 220,000 ohm, carbon resistor |
| R-51 | 1,000 ohm, carbon resistor |
| R-52 | 8,200 ohm, carbon resistor |
| R-55 | 100,000 ohm, carbon resistor |
| R-56 | 47,000 ohm, carbon resistor |
| R-57 | 220,000 ohm, carbon resistor |
| R-58 | 820,000 ohm, carbon resistor |
| S-1, -2, -3, -4 | Band switch |
| S-5 | Bass tone switch |
| S-6 | Squelch switch |
| S-7 | Power switch (combined R-44) |
| T-1 | 1st IF transformer |
| T-2 | 2nd IF transformer |
| T-3 | Discriminator IF transformer |
| T-4 | "BC" Band antenna transformer |
| T-5 | "FM" band antenna transformer |
| T-6 | "BC," "SW" and "FM" converter transf |
| T-7 | "BC," "SW" and "FM" oscillator transf |
| T-8 | Power transformer |
| T-9 | Output transformer |
| L-1 | "SW" Beam-a-Scope |
| L-2 | Cathode choke |
| L-3 | "BC" Beam-a-Scope |
| L-4 | Limiter plate choke |
| L-5 | Screen choke |

# INSTANTANEOUS SOUND-RECORDER WARTIME SERVICE


**By ALFRED A. GHIRARDI**

Advisory Editor


THE term "instantaneous sound recording" is used to describe the art of making reasonably durable sound recordings into, or on, a material which can itself be used for playing back the sound immediately after being recorded, without any further reprocessing. The idea of instantaneous sound recording and reproduction is far from new. As early as 1877 Edison without benefit of amplifiers and other modern equipment, crudely recorded and reproduced sound from a cylinder covered with metal foil, and within a few years he was doing the same thing on a wax cylinder. Important advances in the art of recording and reproduction made it possible to produce five instantaneous disc recordings of professional quality in broadcasting and sound studios several years ago, but the equipment used then was complex and costly.

Further refinements in instantaneous recording technique and new developments in equipment have now changed the situation. Today, with the improved yet relatively inexpensive records, motor-turntable—feed mechanisms, recording heads, styli, pickups and microphones available it is possible to achieve satisfactory quality with equipment which is simple and rugged, and at moderate cost. Instantaneous recording has gone to the public at popular prices and has met with enthusiastic acceptance.

***Semi-Professional and Home Recorders***

The commercial development of instantaneous recording equipment for use by the public has been along two distinctly different lines. On one hand we have the semi-professional type of equipment which usually consists of the complete recording apparatus (often including a radio tuner unit) of a high grade, all built into a portable carrying case for convenient use anywhere. Such equipment has opened up wide fields of use in schools and colleges in connection with the teaching of voice, dramatics, and instrumental art, public speaking, microphone technique, languages, choral and orchestral work and the solo playing of musical instruments. It has been found that these and many other subjects can be taught more effectively if the pupil is enabled to hear his own efforts faithfully reproduced as they sound to others. It is also employed in many business and professional applications such as the recording of legal evidence, "canned" sales talks, "canned" instruction talks, banquet speeches, public community events, radio programs of historical or current value, etc. For these and many other important applications the semi-professional types of portable high-quality instantaneous sound recorders fill a definite field of usefulness.

Fig. 2. The electrical system employed in a typical home radio-phono-recorder.

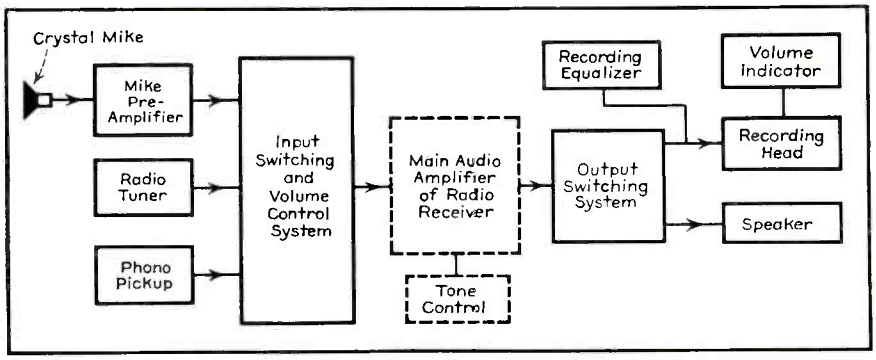
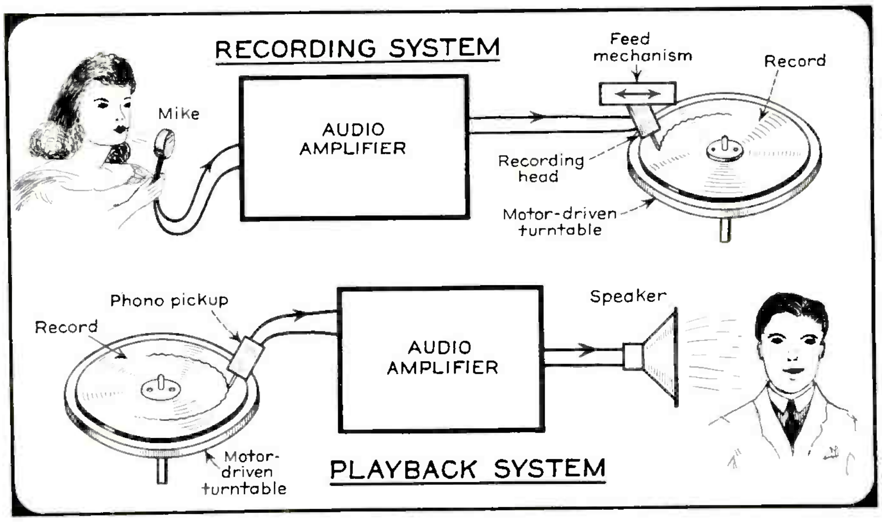



Fig. 1. The recording and playback system, in its simplest form is illustrated here.




On the other hand we have the more simple, inexpensive "home" type of instantaneous recording equipment (see Fig. 5) which has opened up the way to satisfactory sound recording in the home. This equipment may be in portable form or, more often, built in as an integral part of phono-radio-recorder "combinations." The novelty of being able to record and immediately play back one's own voice has captured the popular imagination.

***Potential Sales — Service Opportunities Large***

The tremendous increase in the use of instantaneous sound recording equip-

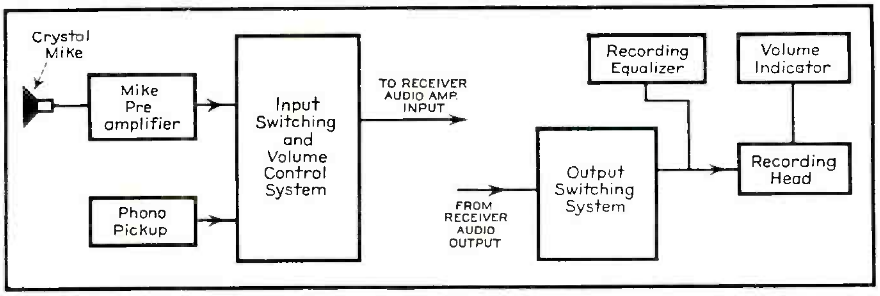



Fig. 3. The electrical system for simple recording and record player attachment to be added to home radio receiver.

ment of both the semi-professional and home types by the public has made its sale and servicing a profitable field, for most of this equipment is in the hands of non-technical laymen who cannot be expected to keep it in first class working condition themselves. Especially during the present wartime period when the existing equipment is being used more than ever, equipment servicing and the sale of such necessary accessories as blank records, cutting styli, playback needles, record albums, additional microphones, mike cables and fittings, etc., represent a sizeable business. Most of these needs are of the "must have" type, for a large part of this equipment is being used for important, useful purposes and must be kept operating.

Many smart radio Service Men and service-dealers have made the most of these opportunities by actually instituting sound-recording services in their own shops. Aside from the income derived directly from the making of recordings for customers, such services prove to be a valuable means of cementing customer good will and making new customer contacts that can be followed up for profitable sales of other services and merchandise. Even the simple servicing of recorders enables the Service Man to gain entree to public and private schools, business offices, and homes that he otherwise would never have the oppurtunity of entering. Needless to say, such contacts can also be used advantageously for follow-up for sales of other services and merchandise.

#### *Radio Service Men Logical Suppliers and Servicers*

Since all of this equipment is too thinly and widely distributed to make it financially attractive or practical for the sound recorder manufacturers to undertake its direct maintenance and servicing, it is logical that radio Service Men and service-dealers should go after, and get, this business. The component parts which go to make up instantaneous recording equipment do not involve anything that radio Service Men cannot easily learn. The electrical circuits to be analyzed are also well within their sphere.

It is the purpose of this article and the one which will appear in the next issue to present to the Service Man and the service-dealer all of the information he needs about commercial instantaneous recording equipment, good recording technique and trouble-shooting and servicing of the recording equipment, in order to enter this lucrative field.

#### *Basic Instantaneous Recording System*

Essentially, the entire instantaneous recording process on flat discs is based upon a few simple conversions and reconversions of energy that every Service Man is already familiar with in connection with radio equipment. The sound (voice, music, etc.) is converted into corresponding feeble electrical impulses by a microphone. (In the case of a radio program which is to be recorded, the output of a conventional radio tuner supplies the electrical impulses.) These feeble electrical impulses are amplified by a conventional audio amplifier which actuates a laterally-fed recording head that produces corresponding physical undulations in spiral grooves it cuts into a rotating disc of suitable metal or composition. In the reproduction process, these undulations in the grooves of the rotated disc actuate the playback needle of a conventional phonograph pickup. The pickup converts these mechanical movements of the needle into corresponding electrical impulses which are fed to the audio amplifier and then to a loudspeaker which converts them into a more or less faithful reproduction of the original sound. The recording and playback system, in its simplest form is illustrated in Fig. 1.

#### *Practical Recording Systems in Use*

In practice, additional input sources, a microphone pre-amplifier, input switching and volume controls, tone controls, output and speaker switching controls, recording equalizer, and a volume level indicator may be added to the equipment.

The actual basic electrical arrangements of recorder equipment that the radio Service Man is apt to encounter most frequently are illustrated in Figs. 2, 3 and 4. These are:

1) Simple recording mechanisms and circuits forming part of a home radio-phonograph-recording "combination." This is illustrated diagramatically in Fig. 2. Actual equipment is shown in Fig. 5.

2) Simple recording and playback mechanisms designed as a unit to be added to an existing home radio receiver for utilization of the receiver amplifier and speaker in the recording and playback of the records. This is illustrated in Fig. 3. Such equipment is not very common.

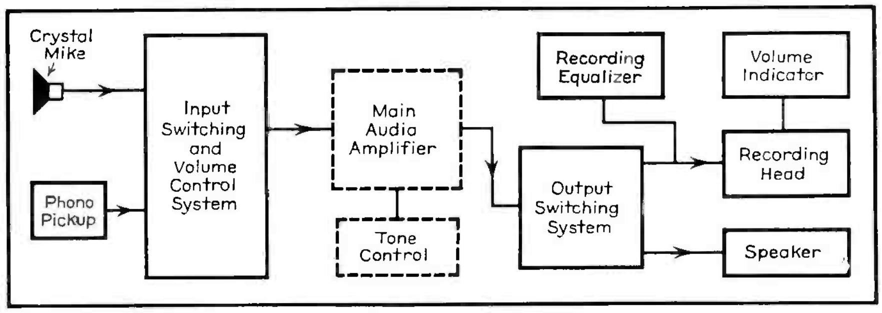
3) Portable semi-professional recording and playback mechanism complete with amplifier and speaker. This is illustrated in Fig. 4.

#### *The Recording Blank*

Several types of materials have been used for instantaneous recording discs, but some have been discarded for the "duration" because they are now unobtainable for the purpose. Among these are the aluminum discs and those having an aluminum or steel base. Pre-grooved discs are no longer popular. All instaneous recorders are now designed to cut the spiral groove and apply the recording modulations simultaneously into a blank ungrooved disc.

Present-day instantaneous recording blanks in wide use are thin lacquer-coated discs having a cardboard or glass core or base for rigidity. They are generally referred to as "acetate" discs but this is a misnomer because cellulose "acetate" is now seldom used

Fig. 4. The electrical system for a typical semi-professional portable recorder and playback unit.



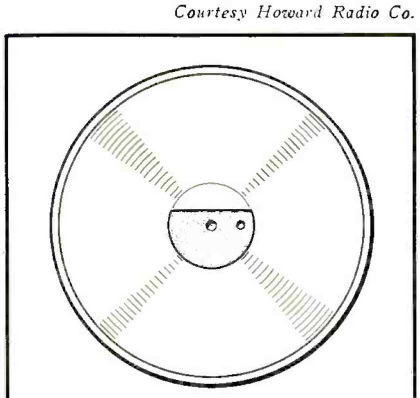
for the coating. Several other materials including nitrocellulose, ethyl cellulose, acetyl cellulose or one of several resins are employed for most discs. The material must be soft enough to be cut easily and smoothly with a cutting stylus, yet hard enough to withstand the wear of repeated playbacks without undue rapid changes in the character of the undulations in the grooves cut during the recording process. Since the coating material is a liquid resembling ordinary lacquer during the course of manufacturing the blank, it is dipped, sprayed, floated or spun on the base. Considering the fact that the total thickness of coating seldom exceeds 0.006 to 0.01 inches (of which from 0.0025 to 0.003 is to be cut out later for the groove) it is easy to understand how carefully it must be applied in order to form a smooth homogeneous layer of uniform thickness and free from air bubbles, dust, etc. After application the coating is baker to "set" it.

An off-center hole punched in the disc fits over a stud inserted in the turntable to prevent the record from slipping due to the drag of the recording stylus or the playback pickup. This may be seen in the disc illustrated in Fig. 6.

It cannot be over-emphasized here that the characteristics of any individual coated disc are of the utmost importance in making good recordings. Dust or air bubbles in the coating, or a coating of unequal thickness will play havoc with the recording. A thin spot in the coating will rapidly wear through, either during the process of recording (when it may wreck the cutting stylus) or after a small number of playings, making the record useless. The coating must not be too soft, or too hard. If it is too soft the groove walls will wear away too rapidly under repeated playing, giving rise to distortion and short record life. If it is too hard the lacquer will tend to tear rather than cut sharply. The exposed groove walls will

Fig. 6. A typical cardboard base home recording disc.

*Courtesy Howard Radio Co.*



*Courtesy Howard Radio Co.*

Fig. 5. A typical console type of "complete radio for the home." Into this single cabinet of period style is built a short-wave and broadcast band receiver for American and foreign reception. (At the top, right) and complete facilities for making and playing back home recordings of radio program, music or speech (at the upper left). The microphone shown in the person's hand at the right is for making the home recordings. Into this cabinet has gone the most advanced type of radio equipment now available.

then be rough, and a high surface noise will be evident in the reproduction. Coatings that tend toward being "soft" produce lower surface noise, but the high-frequency response as well as the durability improve with hardness.

The complete discs used for instantaneous recordings do not present any particular fire hazard, but the thin groove thread or shaving that is cut out of the nitrocellulose coating used in the majority of them is highly inflammable and should be kept away from open flames of any kind.

### *Disc Speeds*

There are two standard disc speeds now in use in all phono work: 33⅓ and 78 rpm. The 33⅓ rpm speed is used mainly for electrical transcriptions and long-playing instantaneous recordings for broadcasting stations. The 78 rpm speed (or 78.26 to be precise) is used for all commercial phonograph records and for most instantaneous recordings except those employed for broadcast purposes. The 33⅓ rpm speed was adopted originally because it gave a long playing time on the 16-inch

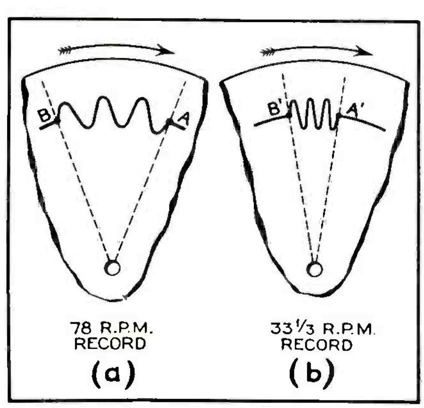



Fig. 7. Why high volume high-frequency sounds are more difficult to record on 33-1/3 rpm records than on 78 rpm records. Here are shown in magnified form 3 cycles of same sound recorded on 78 rpm record (a), and on 33-1/3 rpm record (b).

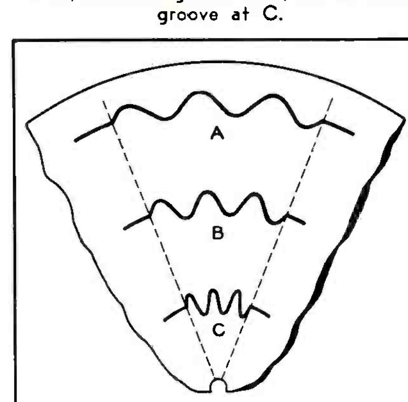
records formerly used in sound picture work.

Each of these speeds has certain advantages and disadvantages. The advantage of the slower 33⅓ speed is that the playing time of a record of given diameter is much longer, making it possible to record as much as a 15-minute program on a 16-inch record. On the other hand it is more difficult to record (and play back) high frequencies at as high a volume level at 33⅓ rpm as at 78. The illustrations of Fig. 7 show why this is so. At (a) three complete cycles of a particular sound wave recorded on a 78 rpm record are shown. They occupy the space between A and B on the spiral groove. At (b) the same sound wave (same amplitude and frequency) is recorded at the same radius from the disc center on a 33⅓ rpm record. Since this disc revolves only 33⅓/78 as fast as does the 78 rpm disc, the recording of the same 3-cycle sound wave occupies only 33⅓/78 (less than half) of the linear groove length here that it does in the 78 rpm disc (because in order to be of similar frequency the 3 full cycles must be cut during the *same interval of time* in each case and during this interval a point of the 33⅓ rpm disc moves only 33⅓/78 as far past the cutting stylus or playback needle as does a similarly located point on the 78 rpm disc). All of this will become apparent from a study of Fig. 7. In effect, the recording of the 33⅓ rpm disc has much greater wave steepness than that on the 78 rpm disc. The greater the volume level of the recording the deeper are the undulations in the groove and the more serious are the cutting and playback troubles due to this.

Another important result of this characteristic is that the inexpensive smaller size records (6" and 8") are not suitable for recording at 33⅓ rpm. The

(*Continued on page* 25)

Fig. 8. Why reproduction of the high frequencies is poorer at the inner grooves of a disc than at the outer ones. A sound wave of the same frequency and amplitude is recorded in an outer groove at A; a middle groove at B, and an inner groove at C.



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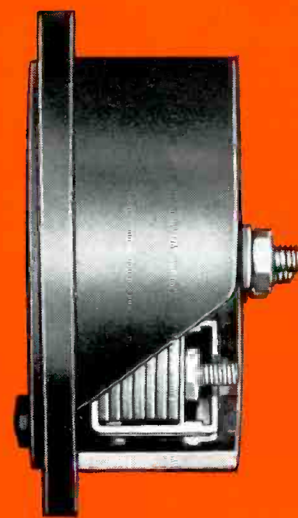

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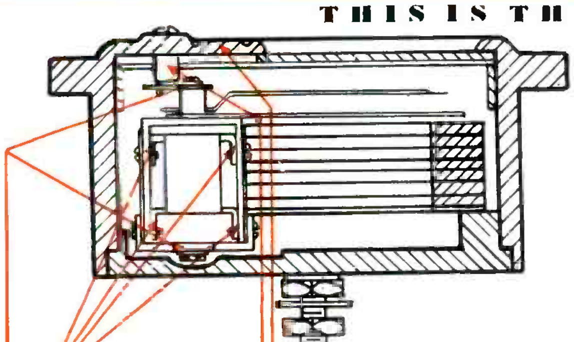

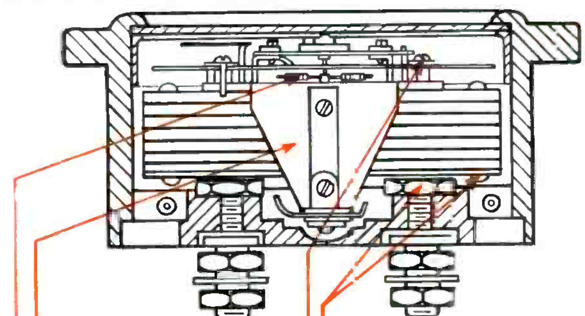

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# A STUDY OF WAVE TRAPS

**By MARK GLASER**

*and*

**EDWARD M. GLASER**

IN the old days of radio, wave traps were useful accessories to be used principally when certain types of interference were encountered from local or powerful stations. However, in the early '30's, when the industry took to superhets on a large scale, possibilities of i-f interference from direct pickup dictated the necessity for i-f traps and their application has been growing ever since.

Before getting on, we should properly define what wave traps signify to us. They are simply tuned circuits, usually consisting of a simple coil and condenser in series or in parallel, placed in the antenna or r-f circuit for the purpose of absorbing or rejecting signals at the frequency to which they are tuned. In rejecting the signal at the input to the receiver, the possibilities of the interference getting through the set are greatly reduced; the amount of attenuation, depending upon the position and design of the trap.

For those of an experimental twist, the subject of wave traps is a fascinating one, permitting a considerable amount of experimentation with only two parts—a coil and condenser. It should go without saying that all Service Men should be familiar with the theory and operation of traps.

Although wave traps are not filters in the technical sense, they are actually designed to filter out or eliminate a small band of frequencies such as the pass band of an i-f amplifier or, in some applications, only a single frequency.

The resonant frequency of either a series or parallel tuned circuit may be expressed as follows:

$$f = \frac{1}{2\pi\sqrt{LC}}$$

where f = frequency in cycles
L = inductance in henries
C = capacity in farads

Two other terms must be explained,

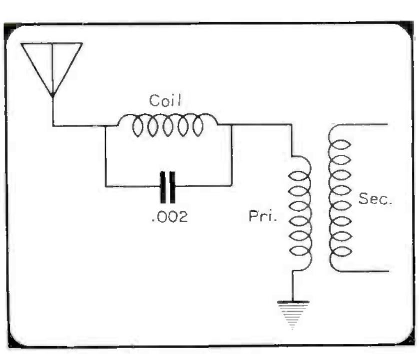



Fig. 1. The first form of i-f trap that became popular with the midget receivers.

inductive reactance and capacitive reactance. Inductive reactance is the property of a coil to prevent the flow of current through it or, in other words, the choking action, and is calculated as follows . . .

$X_L = 2\pi fL$ where $X_L$ is the reactance in ohms. This expression is usually simplified by introducing $\omega$ which is equal to $2\pi f$. Hence, $X_L = \omega L$.

Similarly, capacitive reactance is the property of a condenser to prevent the flow of current through it, and is calculated as follows . . .

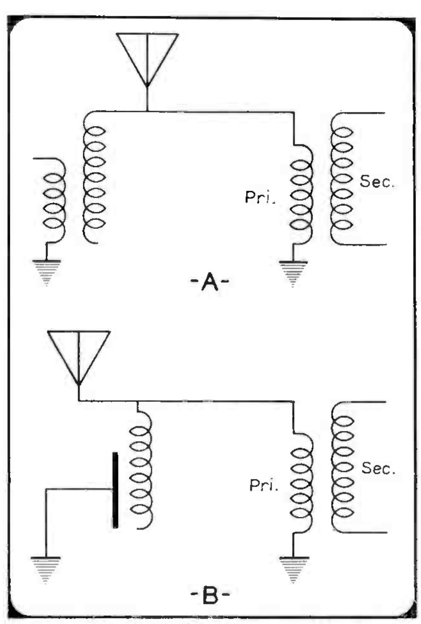
$$X_c = \frac{1}{2\pi fC} = \frac{1}{\omega C}$$

At resonance, the capacitive reactance is equal to the inductive reactance, one cancelling the other, or one tuning out the other, whichever you prefer. This is true for either series or parallel resonance.

### *Series Traps*

With that introduction, let's consider series traps which consist of an inductance coil and condenser in series. The condenser is usually the variable element, being tuned to resonance with the interfering station, as in Fig. 3 (a). The trap is shown connected to the antenna and ground so that any signal coming in through the aerial has a

Fig. 2. Shunt-type traps consisting of coil and capacity winding.




choice of two paths, one through the trap to ground and the other through the primary of the antenna transformer and on through the receiver. If the signal is of such a frequency that it resonates with the wave trap, all but a very small portion (usually insignificant) goes through the trap to ground. Why? Let's explain.

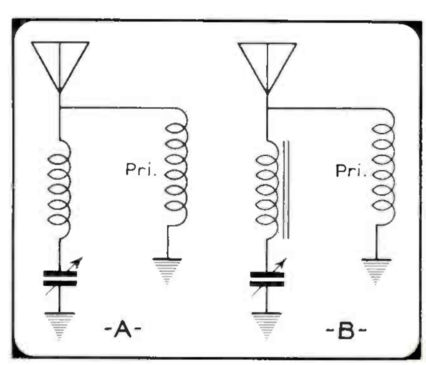
Although we can see only a coil and condenser, a certain amount of resistance is always present in every circuit element. If the condenser has an air dielectric (material between the plates) we may consider the resistance of this element negligible. If it uses mica, it is still very small. If paper, the resistance is no longer negligible. Nevertheless, coils are the big offenders, having considerably more resistance than condensers. This resistance we speak of is not the simple d-c resistance you measure with an ohmmeter, but something a lot more elusive called a-c resistance, and a lot harder to measure. The a-c resistance is always greater than the d-c resistance.

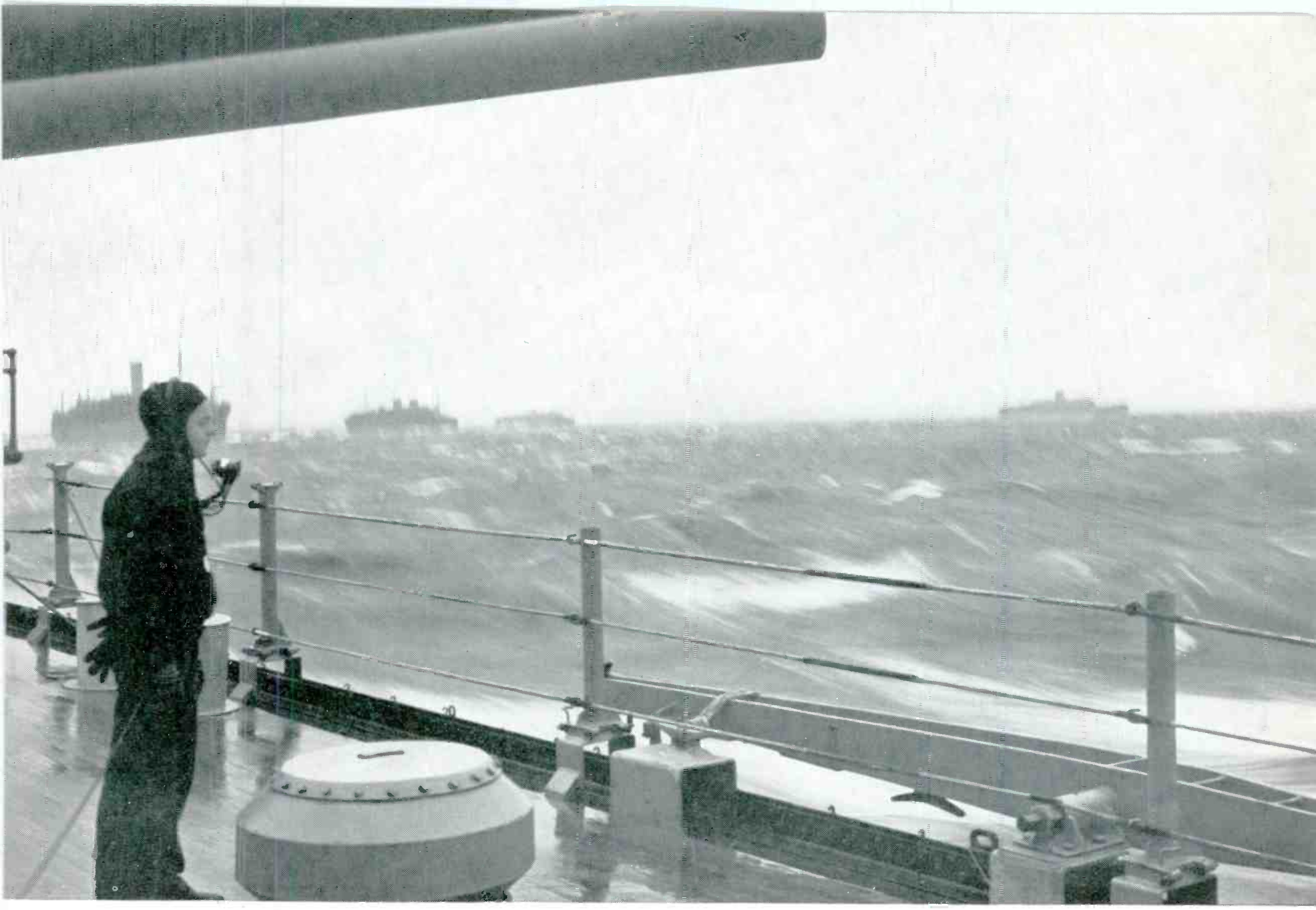
When we tune a series wave trap to a signal, we cancel or tune out the reactance, leaving only the resistance. If the resistance were zero, all the signal voltage would be short-circuited, allowing none of it to go through the receiver. Practically, of course, the resistance cannot be zero; so the trap does not represent a complete short-circuit, but its impedance (resistance) is so low compared to that of the antenna transformer that, for most practical purposes, we consider it a short.

Since the trap contains resistance, it will represent a short circuit not only to the resonant frequency but to a narrow band of frequencies above and below resonance in a direct proportion to the amount of resistance. Expressed differently, if a lot of resistance is present, the trap tunes broad; if little resistance, it tunes sharp. The sharper it tunes, the

(*Continued on page* 17)

Fig. 3. Adjustable trap, shunt type, at A; at B, an adjustable trap with iron core coils.





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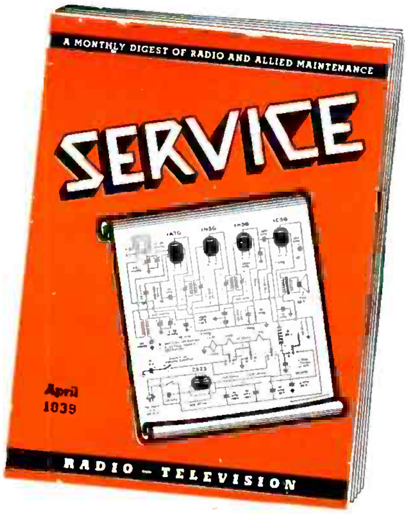


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## WAVE TRAPS

(*Continued from page 14*)

more effective it traps and this effectiveness is measured by its Q. The Q of a coil $= \frac{\omega L}{R}$.

The signal voltage drop across the coil, neglecting resistance, is its reactance drop IX. Substituting $\frac{E}{R}$ for I, the signal current, the voltage drop is $\frac{EX}{R}$ which equals $\frac{E\omega L}{R}$, or EQ. This states that the voltage across the trap inductance is equal to Q times the signal voltage. If you are located near a transmitter, the signal from this transmitter may run as high as several volts, say 5 volts. A good coil may have a Q well in excess of 100. Therefore, a voltage exceeding 500 will be set up across the coil, and across the condenser, too, because $\omega L = \frac{1}{\omega C}$ at resonance and the same current passes through the condenser and coil. In other words, the reactance drops are equal.

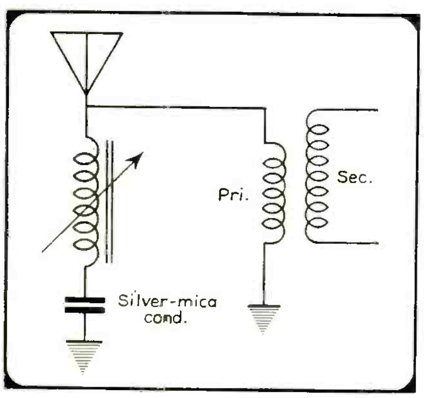
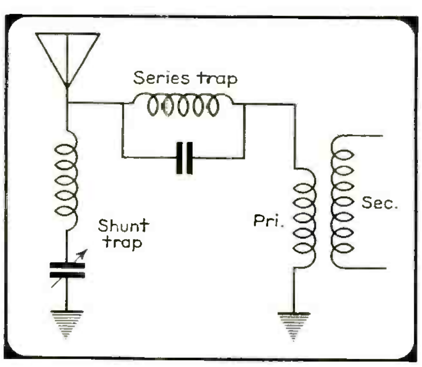



Fig. 4. Adjustable iron-core shunt trap.

Fig. 5. Elaborate i-f trap filter system using both series and shunt traps.




Note Fig. 3 (b). Here, an iron core coil is used to improve the Q. The Q of air core coils used for 455 kc i-f traps normally is in the range of from 60 to 150, depending upon the size and type of wire, number of strands if Litz, coil form, ratio of length to diameter, size and material of shield, etc. The Q of iron core coils exceeds these values. In Fig. 4 is shown a very popular type of trap in which an adjustable iron core is used for resonating, the condenser being of the fixed silver mica type. This form of wave trap is found in the higher priced sets.

Other variations of series traps are found in Figs. 2 (a) and (b). The first has two open end windings where the lower capacitor winding is interwound (bi-filer) with the low end of the upper winding, acting exactly like a condenser in series with an inductor but having no variable element. This type of trap had to be individually peaked with an "L" meter. The second type utilizes a coil wound over an open plate, the plate-to-coil capacity doing the job of a separate condenser.

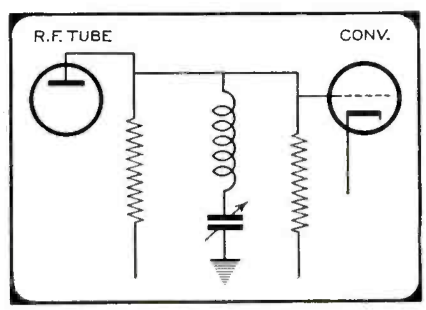
In the last few years, many sets have been designed with an r-f stage and 2-gang variable condenser, the r-f stage being resistance-coupled to the first detector. This system does not provide sufficient selectivity to preclude the possibility of direct i-f pickup, so an i-f trap is often used. One popular circuit is shown in Fig. 6. Here, the signal is shunted to ground just before reaching the converter stage.

Loop receivers, even those which connect the loop directly to the converter, are usually quite free from i-f interference because of the low voltage pickup of a loop. However, when an external aerial is connected, the chances for i-f interference are considerably aggravated. This again calls for a wave trap such as that shown in Fig. 9 which shunts the loop primary, or coupling coil.

**Parallel Traps**

A parallel-tuned circuit operates, in a sense, opposite to a series circuit. Instead of offering a low impedance to resonant currents, it offers a very high impedance, behaving as if it had an effective resistance equal to $\frac{L}{RC}$. The higher the inductance for a given resistance and capacity, the more effective the parallel trap in stopping the unwanted signal. However, there are other circuit conditions which must also be considered in establishing the $\frac{L}{C}$ ratio.

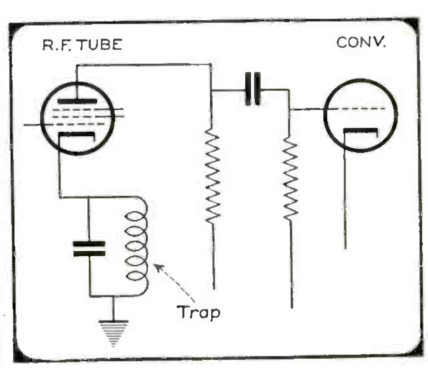
Fig. 6. Trap placed between r-f and converter.




If a very large coil and very small condenser were used, the coil might act as an r-f choke to desired signal frequencies, presenting unwanted attenuation.

A simple and cheap parallel wave trap is shown in Fig. 1. This type of trap consisted of a fixed .002 mfd. mica which was inserted inside of the coil, the coil being adjusted by moving the turns together or apart by hand until the trap resonated at the i-f (455 to 465 kc). Many of these are found in a-c/d-c midgets. This position, in the antenna lead, is the most common for shunt traps where the signal at resonant frequency is prevented from entering the primary of the antenna transformer. The better the trap, the higher the resistance offered to the unwanted station. There is a "current rise" in each branch of the parallel circuit equal to Q times the current in the antenna lead which is the counterpart of the voltage

Fig. 7. Cathode-trap degenerative circuit.



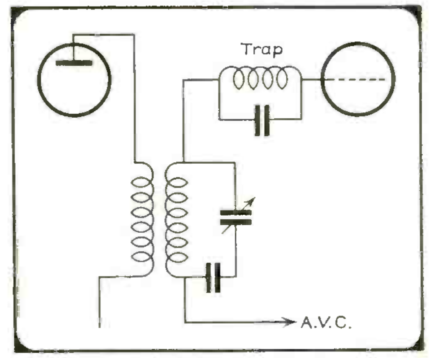




Fig. 8. Another series system for the r-f stage.

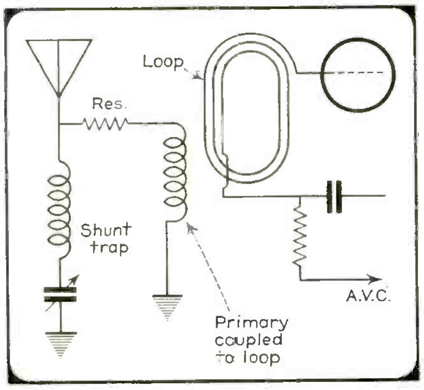



Fig. 9. The coupling and filter methods with trap circuits.

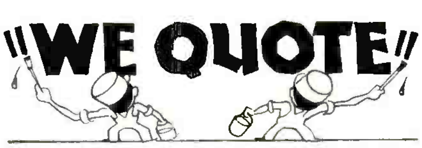
rise in the series resonant circuit previously explained.

Fig. 5 shows an arrangement using both parallel and series wave traps which is extremely effective. Such a method is desirable in cases of severe interference. In special cases of interference on two separate frequencies (such as a local broadcast station in addition to i-f pickup), one trap may be set for each frequency. In this case, though, neither trap will be as efficient a rejector as though it were used alone.

Fig. 7 shows a degenerative parallel-trap inserted in the cathode of a resistance coupled r-f amplifier, an alternate system of Fig. 6. Still another alternative is shown in Fig. 8 where a parallel trap is located in the signal grid of the converter tube. Where a tuned r-f stage is used in addition to a tuned first detector a trap is, in general, not required. This is especially true if the i-f used is in the region of 175-262 kc. In fact, traps are not often required in sets using this i-f as an r-f stage is usually provided.

As to trap construction, parts from old i-f transformers can usually be assembled into a good trap. Any good stable trimmer may be used for tuning. When small area coils are used shielding is not usually required, but should be used in all high class jobs or in severe cases. Traps used in some of the circuits presented herein will reduce the gain or signal level of the receiver at certain frequencies, so this should be kept in mind when making an installation.






*Important Leaders on*

## THE STATE OF THE INDUSTRY

"The Service Man should continue to cooperate with the distributor, as most of them have, and do his best to service as many radios as possible, with the materials at hand. He should avoid waste and improvise whenever possible. There is no reason why he should not make ample charges for his services even though he may have to skimp on parts at times.

"All this seems most unreasonable from a normal business standpoint, but this is not a "normal business," and we must do the best we can with what we have, without losing sight of the fact that "victory is our business."

George Wedemeyer,
Wedemeyer Radio Co., Ann Arbor, Mich.

"Establish, above all, a good set of contacts with war factories for maintenance work carrying good priority. This guarantees turnover of material needed. Rates of pay are good, for customers regard from $2.50 to $3.00 per hour for specialized work reasonable, as well as sensible.

"The effort to establish contacts should be made untiringly and without regard to labor or cost, so that the results can pay off.

"In our area our problem is such that I honestly think the Service Man can do but little else."

L. W. Hatry, Partner,
Hatry & Young, Hartford, Conn.

## SER-CUITS

*(Continued from pages 8-9)*

gets to the right hand stop, no highs are lost through the .005 mfd. condenser and no lows are boosted by means of a .01 mfd. unit shunting part of the volume control; hence, a treble effect is produced. By the way, the tap on the volume control occurs at 275,000 ohms above ground.

### Crosley 53TP (Chassis 100)

The Crosley phono-combination 53 TP (chassis 100) is a simple a-c job with 150 mil tubes, that uses a neat phono-radio switch as shown in Fig. 3. The volume control is switched from detector to pickup and, at the same time, the detector output is shorted. A high-cutting equalizer network consisting of a 470,000 ohm resistor as a series element and .0001 mfd. condenser as a shunt element is used on the crystal pickup.

### Silvertone 7165

In the Silvertone 7165 six tube automatic phono-combination, a capacitor wire antenna is used instead of a loop or plate for internal pickup. The antenna input circuit is quite unusual (see Fig. 4). Permeability tuning is used. Note the wave trap or equalizer connecting the antenna to the antenna tap on the short wave coil. Only the 31 meter band is covered so the tuning range need not be great. This receiver,

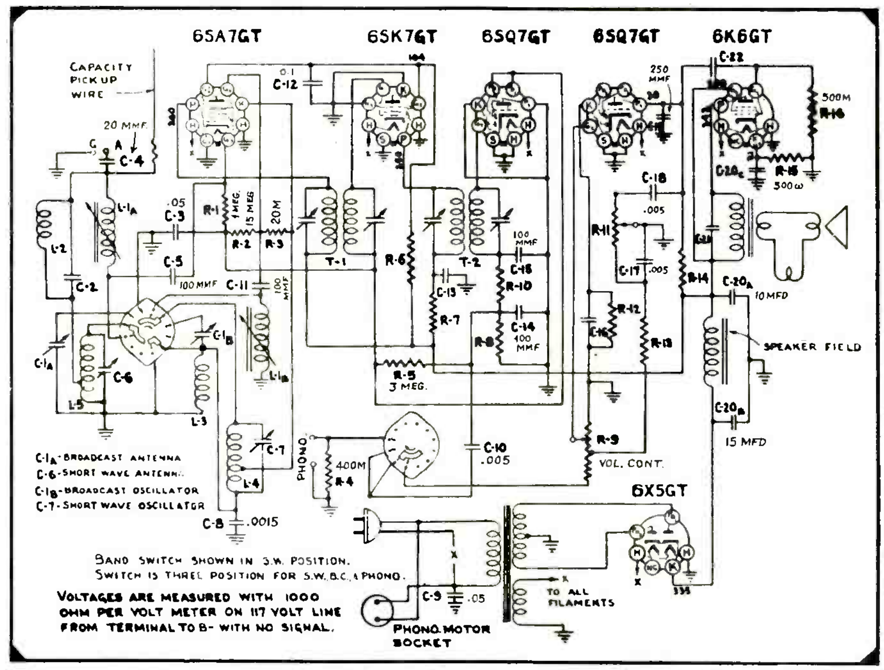
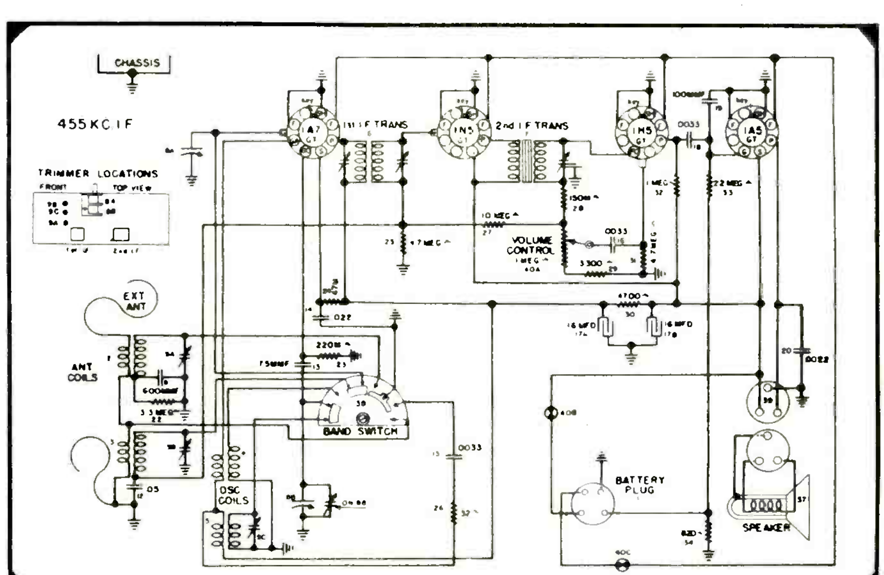



Fig. 4 (top). The Silvertone 7165 six-tube automatic phono-combination with a capacitor wire antenna. Fig. 5 (below). The Crosley 43 FB (chassis 91) with an interesting method of boosting sensitivity on short waves.



like the Crosley set above, has a single switch for wave-changing and phonograph switching.

#### Crosley 43FB (Chassis 91)

All Service Men should note the method used in Crosley 43FB (chassis 91) (Fig. 5), to boost the sensitivity on the short wave band. This otherwise standard battery set uses the conventional avc system on the broadcast band but cuts it out on short wave. Bias is supplied by a grid leak of 3.3 megohms, giving a lower voltage, thus increasing the gain of the converter stage. The avc remains on the i-f stage, however.

#### G. E. LRP 170

The service notes on the G. E. LRP-170 automatic record changer, contain four cautions on mistreatment that are worthy of attention.

(1) Never use force to start or stop motor or any part of the mechanism.

(2) The records should not be left on the record post, as they may warp, particularly in warm climates.

(3) The use of warped or damaged records may result in poor mechanical performance, and will also result in unsatisfactory reproduction since they tend to slide on one another.

(4) Warped records may be flattened by placing them on a flat surface and loading them with a heavy flat article for a few days.

#### G. E. LF 115 and LF 116

Parallel circuits consisting of a resistor shunted by an inductor are used quite generally for equalizing and coupling systems in the G. E. a-m/f-m combination receivers LF 115 and LF 116. Note the tuned-stage in Fig. 6 where the screen grid carries a potential above ground because of the choke-resistor network. By-passing to ground takes place at the low end of this combination. Again, note that the oscillator cathode is fed through a similar circuit to the converter cathode on one of the wavebands. In both these cases the value of the resistor is 0.1 megohm. Next, note the impedance coupling system between the 1st and 2nd limiter stages. In this case the resistor is of low value or 8200 ohms.

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#### NAVY WANTS TECHNICIANS

Among the most urgent needs of new officer personnel in the United States Navy is for professional technicians in engineering fields, the Director of Naval Officer Procurement, Chicago, has announced.

Perhaps first in the list are graduate electrical engineers, those mainly between 21 and 50 years who have followed electrical engineering since their graduation, and who have a knowledge of ultra-high frequencies, electronics and television. Those more familiar with power engineering likewise may find a place in the Navy which is interested in these men in ages up to 50 years. Electrical engineers are needed especially in the Navy's fields of radio and detection devices. Men with radio or communication engineering degrees may qualify for officers commissions as well. Waivers for minor physical defects often are obtainable.

A Petty Officer rating is offered to men with sufficient experience in radio to instruct classes in Radio Theory, Practical Operation, Code, or Maintenance.

The Navy has schools in several parts of the country to instruct enlisted men in radio, and it is for these schools that instructors are needed. The men that are selected will go through a refresher course at a Naval Aviation Service School in Chicago where they will be instructed in use of the radio equipment used by the Navy.

In some cases men with B. S. Degrees in mechanical or other engineering subjects and who have had experience in radio and electrical work may qualify for officer assignments in radio or electrical lines.

Another special officer procurement program under way is for college teachers of physics, or chemical, diesel, electrical, mechanical, and radio engineering at Naval Reserve Midshipman Schools. Private school and junior college teachers and others qualified to teach those subjects in colleges also are being sought.

Either Ensign W. W. Hall, Room 300 or Mr. M. G. Miller, Room 1184, both in the Board of Trade Building, Chicago, will answer all requests for information.

# Farrell Says:

## By C. H. FARRELL

### A READER DISAGREES

LAST MONTH I optimistically promised that this old typewriter of mine would grind out some data and opinions on the building and retention of good will. But that chore will have to be left for another time. A reader of these scrivenings takes issue with our contention that most of the public criticism which has been heaped upon the heads of radio Service Men was the result of penny pinching tactics on the part of receiver manufacturers.

Writes D. M. Linton of Bakerstown, Pa.: ". . . I think a man with Farrell's knowledge should be able to see to the root of the whole trouble, namely, the tube manufacturer."

He goes on, in an interesting way, to mention specific tube types, all of them multi-element types which, he claims, are "not designed to stand up."

Well, that "got me." You may recall that two years ago I made mention of what I called "Graf Spee tubes which scuttle themselves when things get too hot." Of course, I was only kidding, but perhaps some fifth columnists in tube factories took me seriously and passed some defective tubes as okay. But I don't believe so.

Another thing . . . whatever knowledge I have of the radio industry is confined to sales promotional, advertising and business administration. I have steered clear of the technical aspects of the game, but never lack for authoritative sources of any technical information I may require. So I sat down with the service manager of possibly the largest radio repair organization for a few hours. We pored over service job records and derived much knowledge therefrom. I also visited the boys in the shop and asked pointed questions. The sum total of their opinions rather leaves our reader-critic "holding the bag."

### A Good Example

For instance, a receiver on the work bench caught my eye. I wanted to know what the trouble was, for the receiver in question is one of the finest. A tube was shorted . . . one of the tubes which Mr. Linton says are not made to stand up . . . a power supply tube. And the fault did not lie with the tube manufacturer. The tube had shorted because of an insufficient power carrying capacity resistor. The trouble was corrected by putting in a five-watt resistor instead of the one-watt resister which the manufacturer's designers had figured on. Scores of this model have come in for repair to this one shop. The trouble is always the same . . . tube shorted because of that one-watt unit. And similar "bugs" crop up in many receivers and cause tube shortings. But it is still the fault of the set manufacturer . . . not the tube maker.

Here in a shop which turns out an average of 2,000 repair jobs a week, there is a minimum of replacement of tubes which have lived the good life and expired from general debility and old age. Most of the tube failures are caused by the failure of parts. And "junk" parts and poor design are the principal offenders.

I hold no brief for tube makers or

designers. I realize that the introduction of the multi-element midget tube might, conceivably, be accompanied by all of the headaches which accompany so involved and delicate a design and production problem as, for instance, the manufacture of a 6L7. When I take a "look-see" into a radio tube factory and observe the intricate operations which are necessary to produce tubes of this type and draw mental pictures of the hours spent in designing these wonderful tubes, I am amazed that the public at large does not have a greater appreciation of the genius which has made tubes like these possible.

#### *Final Testing*

This reader also states that he gets sets to repair which have never played because "the manufacturer did not take the trouble to try them out before shipping them." That is a pretty hard one to swallow, for in most cases I've observed, all receivers are subjected to a final test before leaving the factory. It is possible, of course, that some "loft" manufacturers do not have adequate testing facilities, but the number of sets produced by such manufacturers is infinitesimal and is such a slight percentage of the total receivers produced that they cannot be quoted as evidence that proper testing of receivers is neglected by manufacturers.

That many design "bugs" are present we will admit. That too many sets have been built down to a price instead of up to a quality standard cannot be denied. But I'm afraid that the reader who feels that faulty tubes are responsible for a lot of the troubles encountered in radio receivers is practically alone in his opinion.

I'll stick to my original thesis: that cheap and junky parts are the principal reason why the servicing fraternity are being made the "goats" whenever somebody polls public opinion.

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### *ADEQUATE TELEPHONE FACILITIES*

THIS actually happened. A neighbor wanted to have his radio repaired and called the dealer who had sold it to him. The dealer has a good sized service department and turns out plenty of jobs nowadays. But every time my neighbor called that dealer, the telephone was busy. He tried for three days to get telephonically connected with that dealer and finally gave it up in disgust and took the set to an independent service shop in his neighborhood.

I took time out to visit the dealer's shop and found that he had one girl to answer the telephone and only one trunk line. Although he claimed that he was working at capacity; that even if he had three trunk lines and three girls were kept busy taking orders, his full working capacity could not take care of the business which they booked.

Here was a dealer who has no more receivers to sell, but who, when set production is resumed, will be seeking new set business. At present he is kept going by the repair business he manages to turn out, and, because of inadequate telephone facilities, he is pitching his future good will to the four winds.

How much better his present servicing customers who are his future new set prospects would feel were they able to get prompt telephone connections . . . even though they could not get their receivers repaired at once!

Be sure that people are not kept waiting unduly when they call you. If your telephone seems to be kept busy all day, it is almost a certainty that scores of people are trying to get you on the phone and are getting a busy signal. Your telephone company will be glad to run a check on how many callers get a busy signal daily, and the phone companies will make recommendations regarding the proper number of trunk lines to adequately serve your customers.

Nothing annoys the average human being so much as having to call a telephone number a score of times before getting the connection.

# NEW PRODUCTS

### RECORDINGS TO BOYS-IN-SERVICE

"A record a day, keep the blues away" is the new slogan of the Wilcox-Gay organization. The company has installed recording studios to produce records for the boys now in service. Recorded messages to the men-in-service have proven very popular and the idea is growing throughout the nation. Below we see D. E. McGraw, Leo Wilcox and Don Hosmer making a few recordings for the Wilcox-Gay boys in uniform.


* * *

### NEW TYPE CALENDAR

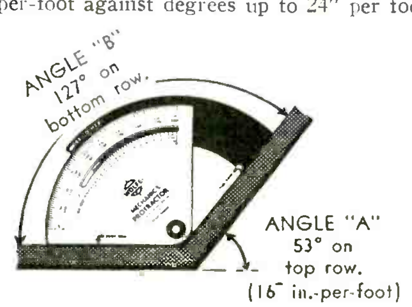
A unique 1943 calendar is being offered free by the Frederick Post Co., Chicago, Ill.

This calendar, 15¾ x 24½, has 52 weekly sheets in big black numerals that are easily read. Ask for your copy on your letterhead stationery.

* * *

### MECHANIC'S PROTRACTOR

A protractor designed for the man on the job, known as the Mechanic's Protractor, that will measure a variety of angles up to 180°, is now being made by the Interstate Sales Company, 1123 Broadway, New York City. Among the advantages that the protractor is said to offer are: readings for outside angles, readings for inside (inclusive angles), and inches-per-foot against degrees up to 24" per foot




(60° 26"). All of these readings can be taken with one setting. Difficulty angles can also be measured with this protractor in conjunction with a bevel. Calibrations are at the extreme of the radius, enabling positive readings to a fraction of a degree.

## RECORDER SERVICING

(Continued from page 12)

reason for this lies in the fact that the velocity of travel past the stylus is proportional to the radius at which cutting (or playback) is taking place at the instant, as well as to the turntable speed. Because the disc coating travels comparatively slowly past the stylus (or playback) when the stylus (or playback) is at a short-radius position from the disc center in these small discs, the groove waveform for the higher frequencies recorded here becomes so greatly compressed that distortion results for the same reasons as stated previously. This is illustrated in Fig. 8. While not as severe, this effect is also present on the inner spiral recordings at 78 rpm. Consequently there is a recommended minimum inside recording diameter for both speeds. In home recording work the recording should not be carried inside about the 2½ inches diameter mark for 78 rpm and 4 inches for 33⅓ rpm. For semi-professional and broadcast transcription work the inner diameter limits should be about 3¾ and 7½ inches. Naturally, some latitude is allowable in these limits depending upon the presence or absence of high audio frequencies in the material to be recorded.

Consequently, careful design and operating technique is required throughout with 33⅓ rpm equipment and one should never attempt to make recordings with it unless he has first mastered the technique of making good 78 rpm recordings.

### Disc Size and Playing Time

The size of blank used for a given instantaneous recording purpose is determined by the recording speed used and the playing time required. Blanks of 6, 8, 10 or 12 inch diameter are used for 78 rpm recording. Blanks of 10, 12 and 16 inches are used for 33⅓ rpm recording.

The approximate amount of recording and playing time available on the different commercial sizes of discs is as follows:

**AVERAGE PLAYING TIME PER SIDE**

| Disc Diameter | At 78 RPM | At 33⅓ RPM |
|---|---|---|
| 6″ | 1 Min. | ........ |
| 8″ | 2¼ Min. | ........ |
| 10″ | 3½ Min. | 3¾ Min. |
| 12″ | 5¼ Min. | 7½ Min. |
| 16″ | ........ | 15 Min. |

These figures are based on the popular 96 line (or groove) per inch recording. With closer groove spacing it is possible to get a greater number of grooves (and a greater amount of time) on the recording surface and these playing times can be extended. The exact playing time of a record also depends of course upon how near the record center the recording is carried to.

### Component Parts of the Recorder

In order to utilize absolutely blank recording discs it is evident that the recording machine must do three things:

1)—Revolve the blank disc at the proper continuous rate of speed (i.e., 78 rpm, or 33⅓ rpm).

2)—Cut the spiral groove or needle track into the blank.

3)—Apply the modulations to the spiral groove while it is being cut.

The recording machine must have, therefore, a motor and turntable arranged to provide the correct rotating speed. The spiral groove must be cut into the blank disc, hence a cutting tool (called the recording stylus) is essential. In addition, the stylus must be driven laterally across the blank disc at the proper rate of speed so that the groove cut will be a spiral of the desired pitch (i.e., the desired number of grooves per inch). A cutting feed mechanism is used for this purpose. Since the recording stylus applies the modulations to the groove at the time it is being cut, a device is required for

(Continued on page 26)

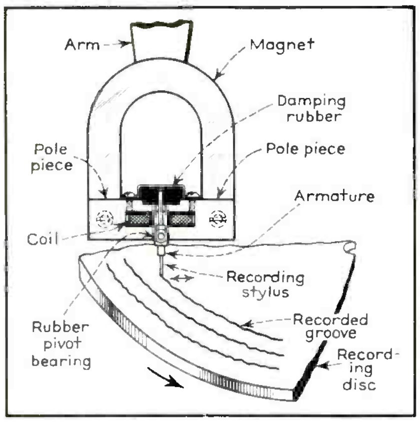
(*Continued from page* 25)

vibrating the stylus laterally in accordance with the electrical pulses produced by the amplifier. This device is known as the recording *head* or *cutter*. These comprise the electro-mechanical devices in the recorder. Each will be discussed separately.

#### The Recording Head

The two types of recording heads or cutters most widely used in instantaneous recorders are the *magnetic* and *crystal* types. A magnetic cutting head, is almost identical in construction to a magnetic phonograph pickup. Low-priced cutters usually contain an armature pivoted at its lower end and damped at its upper end by rubber blocks as illustrated in the cutter shown in Fig. 9. The higher grade of magnetic cutters use a laminated armature suspended on knife-edge bearings, with two or three balancing springs. In each case the armature is actuated by the combined effect of the strong, steady magnetic field produced by the permanent horseshoe magnet, and the varying field produced by the varying audio signal current flowing through the coil surrounding the armature. The cutting stylus is attached to the armature and vibrates from side to side with it.

Fig. 9. Internal view of a typical magnetic recording head. The head drives the cutting stylus laterally to modulate the spiral groove it cuts in the record.




A crystal recording head, illustrated in Fig. 10, operates on exactly the same principles as a crystal loud speaker, except that instead of moving a diaphragm the recording head moves a cutting stylus. The stylus is actuated by the mechanical deformation or twisting tendency of a thin, elongated section of piezoelectric rochelle salt crystal when electrical voltage is applied to it. Low priced crystal cutters are made with one "twister" plate. For higher fidelity, greater amplitude range, and smaller temperature variation two plates are cemented together to form a "bimorph" element. Foil or graphite electrodes provide electrical connection to the faces of the plates.

All recording heads with their associated arms are so heavy that if they were permitted to exert their full weight upon the recording stylus the resulting cut made in the record coating would be too deep. Consequently, an adjustable pressure spring (often called an "equalizer" spring) is usually provided to oppose this weight and so control the pressure exerted at the stylus point. The tension of this spring, which is controllable by the adjusting screw on it, is used to control the depth of the cut, which should be about 0.0025 inches. In some recorders (as the Wilcox-Gay Recordio), the actual spring tension remains very nearly the same, the angle of the axis on which it operates being changed to bring about the required adjustment in the depth of cut.

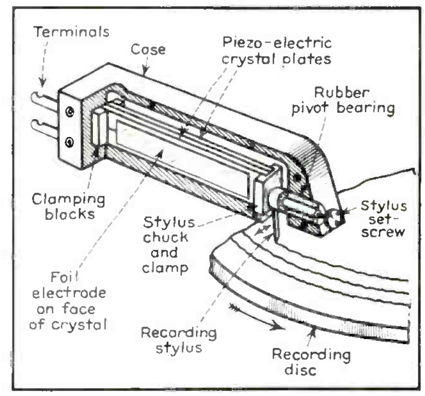
Some recent recorders have a single head which serves as both the recorder and the playback. Of course each function has its own special needle.

#### The Recording Stylus

The recording stylus is the cutting tool that is inserted in the recording head and used for the sole purpose of cutting the modulated spiral groove in the coating on the record blank. Since the quality of the reproduced sound depends largely upon the characteristics of the groove produced by the stylus, it is evident that the proper selection and use of the recording stylus is of major importance for the production of good recordings.

In making "acetate" recordings, the groove is formed by the stylus cutting a thin hair-like thread of material out of the disc coating. The groove so formed should have the smoothest possible surfaces because the surface noise level in the reproduction is proportional to the degree of groove surface polish, i.e., the rougher the groove surface the higher the surface noise level. Clearly therefore, the first requirement of a good cutting stylus is that it be ground and highly polished to a keen edge that will cut clearly without scraping or gorging out the record coating material.

Fig. 10. Internal cut-away view of a typical crystal recording head. The twisting section of the piezoelectric element drives the cutting stylus laterally to modulate the spiral groove it cuts in the record.




(*To be continued*)

***Our country is at war. On the home-front, it is your obligation, small enough surely, to keep your industry functioning smoothly "for the duration."***

# NEWS

### COLOR CODE CHART

A color code RMA Standard Resistor Chart card for technicians and radio engineers has been produced by Sylvania Products, Inc. Ohm's Law and the mathematical formulas for Ohm's Law, appear on the rear of the card.

Copies are free for the asking.

* * *

### RAULAND ACQUIRES BRITISH TELEVISION PATENTS

Title to the American patents of the Gaumont-British Picture Company of America, Cinema-Television, Ltd., and Baird Television, has been acquired by the Rauland Corporation, Chicago.

The Rauland Corporation has also taken over in its entirety the laboratory and engineering staff as well as the equipment of Cinema-Television, Baird Television and the Gaumont-British Corporation of America. This covers all of the United States interests of the parent Gaumont-British Company, Ltd., of London, England. The personnel also has been added to the present laboratory and engineering staff of the Rauland Corporation.

* * *

### GIRLS NOW ON TEST BENCH

The calibration of transmitters in the war plants of General Electric by women has become quite prevalent. For years this job was looked upon as a man's stronghold. Now, under the stress of war conditions and the consequent shortage of manpower, the famous G-E training course for graduate engineers is opening its doors to women. Test girls will replace test men on some of the work, and in other cases they will give highly skilled assistance to the engineers in laboratories and factories.

* * *

### GOVERNMENT OFFICIALS AT HALLICRAFTERS "E" PRESENTATION

At the recent "E" ceremonies at the Hallicrafters, Inc., Chicago, Colonel Thomas L. Clark, officer in charge, Chicago Signal Depot and Joseph L. Overlock, regional director of the WPB were among the government officials present.

(Left to right) J. L. Overlook; W. J. Halligan, president of Hallicrafters; Colonel Clark, and Raymond Durst, sales manager of Hallicrafters.

* * *

### SOLAR D-C ELECTROLYTIC CATALOG

A new 32 page, illustrated catalog, describing in full all of their d-c electrolytic capacitors has just been issued by Solar Manufacturing Corporation, Bayonne, N. J. The new issue is known as catalog 12, section A, and contains specifications, diagrams and other pertinent data that will be helpful to users of capacitors. Copies are available free, provided requests are made on letterhead.



### A D-C POWER SUPPLY

To provide continuous direct current for the operation of d-c or battery-operated equipment. Standard Transformer Corp., 1500 N. Halsted Street, Chicago, Ill., have developed a new type power supply.

This unit employs gaseous type bulb rectifiers, has a two-section filter and a special "built-in" automatic voltage regulating device. It delivers 110 volts d-c at currents up to 15 amperes. The input circuit is designed to permit use on a-c lines of various voltages. Its height is 48 inches, width is 19½ inches, and depth is 12½ inches.

Units of this type are available in a variety of physical mounting styles and can be made for operation on various line potentials and frequencies.

* * *

### IDEAL ELECTRIC ETCHER

A new model etcher to cover an extremely wide range of etching heats has been marketed by the Ideal Commutator Dresser Co., Sycamore, Ill.

This unit called the number 18 "machine shop" metal etcher has 14 heats from 115 to 1,300 watts.

* * *

### TUBE BASE CONNECTIONS DATA

The element connection and base layout of over 600 different types of radio tubes are shown in a new bulletin released by the Weston Electrical Instrument Corporation, Newark, N. J.

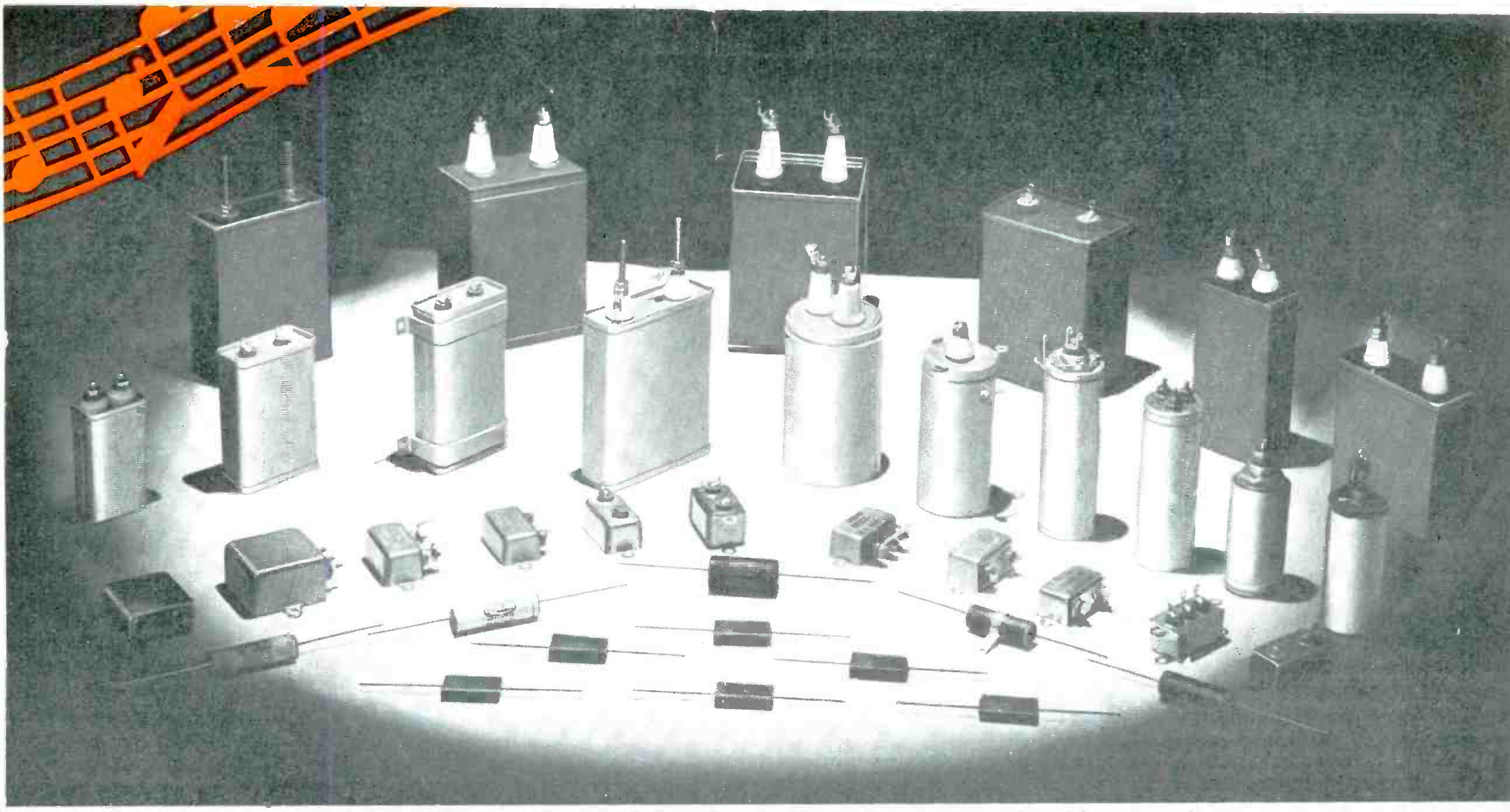
Originally designed for use with the Weston method of selective analysis, but now used with all methods of servicing, this folder permits rapid socket selection for practically any tube now in commercial use.

## JOTS & FLASHES

A timely book highly recommended . . . "The Future of Television" by Orrin E. Dunlap, Jr. . . . published by Harper & Bros. . . Army-Navy "E" to Ward Leonard Electric Co., Mt. Vernon, N. Y., and to five Pittsburgh-area plants of Westinghouse . . . congratulations. . . . Murray Dorhoffer, sales manager of Polymet Condenser Co. celebrating his 10th year with the company. . . . Annual Rochester, N. Y., Fall engineering meeting, sponsored by IRE and the engineering section of RMA, to be held at Sagamore Hotel, November 9th. . . . Ed Rehfeldt of Thordarson stopped over in New York on his way to New England. . . . An old established firm but a new advertiser in SERVICE . . . Stevens-Walden wrenches . . . are you getting THE OHMITE NEWS regularly . . . if not ask them to add your name to their mailing list . . . Jensen anti-corrosion HYPEX Projectors well received by the trade . . . Sound Apparatus Co., New York, celebrating 10 years in business . . how about the scrap drive in your town . . . are you contributing your share and more . . . U. S. Army Signal Corps needs capable technicians and radio men BADLY . . . how about investigating . . . hundreds of females now in radio service field . . . number increasing daily . . . . reports show that they are efficient servicers . . . we hear that a salvage plan covering replacement parts is being worked out in WPB's radio section . . . understand it will require return of old replacement parts in exchange for new ones . . . J. M. Tuttle appointed manager of sales for RCA Victor in Chicago . . . still wondering why makers of radio test equipment don't make special efforts to teach service men how best to maintain and repair their apparatus, now irreplacable . . . a big pat on the back to Lieut. Commander Henry Hutchins, U. S. Navy, formerly sales manager of National Union . . . Universal Microphone Co., Inglewood, Cal., employing blind men and women in certain types of precision assembly . . . Solar Manufacturing Corp., Bayonne, N. J., also using blind help on the assembly bench . . . National Union reports amplifier sales hitting new peak . . . lots of favorable comment on United Transformer's outstanding advertising . . . Army-Navy "E" to Eitel-McCullough, transmitting tube manufacturer of San Bruno, Cal. . . . once again and again BUY BONDS 'til it hurts . . . you can't make a better investment than to invest in the future of these United States. . . . Perry Saftler, well-known manufacturers' sales representative, takes larger quarters at 53 Park Place, New York. . . . Cornell-Dubilier opens fourth plant.—P. S. W.



## Index to Advertisers



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Some of us are still at your jobbers, with this same "Quality Above All" — in Service. Will be seeing you there! ★ ★

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# NATIONAL UNION *De Luxe* AMPLIFIER

**15 Watts Output . . . Less than 3% Distortion . . .**

*at rated output . . .*

**Patented Circuit . . . Permits Extreme Compactness**

**W15A–**
Amplifier includes set of 5 N U Loktal Tubes.

**W15A-C–**
Portable Case Only — Imitation Leather (space for Amplifier W15A, Two 8″ P.M. Speakers, Microphone and Cable).

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Portable Case with 2—8″ P.M. Speakers


***The Patented Circuit Provides...***

SMOOTH AND FLEXIBLE CONTROL OF BOTH VOLUME LEVEL AND TONE GRADATIONS OVER A WIDE RANGE . . . TWO MIKE INPUTS AND ONE PHONOGRAPH INPUT MAY BE SEPARATELY CONTROLLED OR MIXED FOR SIMULTANEOUS OPERATION . . . CONTINUOUSLY VARIABLE SEPARATE BASS AND TREBLE TONE CONTROLS. . . EASILY ACCESSIBLE FUSE . . . HOUSED IN COMPACT ATTRACTIVE GREEN CRACKLE FINISHED CABINET WITH PLASTIC IVORY KNOBS AND CARRYING HANDLE.

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**Rated Output:** 15 Watts.

**Peak Power Output:** 25 Watts.

**Distortion:** Less than 3% at Rated Output

**Tone Controls:** 1—Bass Boost Control.
1—Treble Tone Control

**Frequency Range:** ± 1 Db from 50 to 10,000 cycles

**Input Circuits:** Two high impedance microphones
One high impedance phonograph

**Output Circuits:** Variable Impedance Output. Two Speaker Sockets. Each Socket has Combination Voice Coil and 110 V. A.C. Terminals

**Output Impedances:** 4-8-16-500 Ohms.

**Power Considerations:** 110-117 Volts 60 Cycle A.C.

**Power Consumption:** 50 Watts.

**Circuit:** Special Patented Output and Bass Control Circuits

**Tubes:** National Union Loktal 2-7N7—2-7C5—1-7Z4.

**Size:** Extremely Compact 8⅝ x 5⅝ x 5⅝

**Weight:** 12 Pounds.

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