SERVICE

A MONTHLY DIGEST OF RADIO AND ALLIED MAINTENANCE

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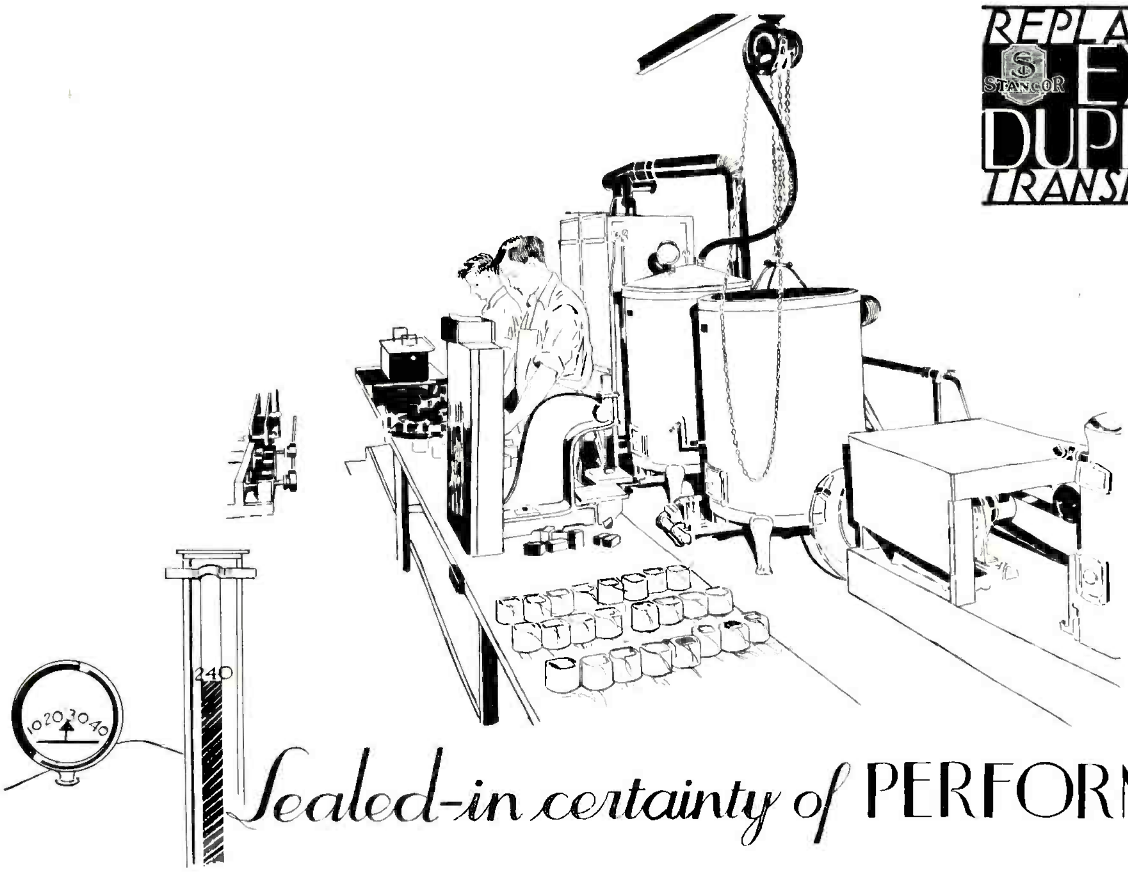
JUNE 1933

EXACT-DUPLICATE REPLACEMENT TRANSFORMERS-REBUILT SERVICE

REPLACEMENT EXACT-DUPLICATE TRANSFORMERS



Sealed-in certainty of PERFORMANCE

A 29″ point of vacuity . . . 250 degrees fahrenheit and molten wax seals your promise to your customer that the Stancor EXACT-DUPLICATE Replacement Transformer you install in his set will not only renew its performance, but will endure.

The "impregnation" process to which these transformers are subjected is a bit unusual in transformer manufacture, but Stancor methods leave nothing to chance that it is possible to avoid.

. . . the coils, having come from the first test, after pig-tailing, are arranged in big wire trays in such a manner that all sides are exposed. The trays are then lowered into the vacuum tank which is sealed . . . the vacuum pumps are started. For fifteen minutes or better the pumps draw out the air from the tank and the coils. Then the cocks are opened . . . molten wax rushes into the tank . . . into the transformers . . . filling, soaking, sealing the transformer against weather, climatic conditions and all other influences that might otherwise cause it to deteriorate.

The goodness and assured performance are hermetically sealed-in.

Added to all of this, Stancor EXACT-DUPLICATE Replacement Transformers are exactly like the originals in all electric and physical characteristics . . . developed from exhaustive study of many makes and models of chassis and transformers—"Post Mortems" that showed what happened to the originals.

THERE IS A STANCOR EXACT-DUPLICATE REPLACEMENT TRANSFORMER FOR ALL MAKES AND MODELS OF RADIO RECEIVING SETS.

Ask your distributor. He knows. Distributors of Stancor EXACT-DUPLICATE Replacement, Class "B" and Filament Transformers are located all over the United States, Canada, our island possessions and Europe.

STANDARD TRANSFORMER CORPORATION

862 BLACKHAWK STREET — CHICAGO, ILL.

The Standard Transformer Corporation also make a quality line of window-fan ventilators, fans, electric mixers and other electrical conveniences in a lower price range than is ordinarily found in the market.

UNIVERSAL REPLACEMENT · CLASS "B" & FILAMENT TRANSFORMERS

SERVICE

A Monthly Digest of Radio and Allied Maintenance

JUNE, 1933
Vol. 2, No. 6

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THE ANTENNA...

IMPORTANCE OF AUTO-RADIO

SEVERAL states are talking about enacting legislation to control or even prohibit the installation of radio receivers in automobiles; particularly short-wave receivers capable of receiving police alarm transmissions. Naturally the radio industry is against any such form of legislation. First, because it curtails radio activity, and second because the average citizen should not be made to suffer on account of the racketeer. In the third place, such legislation would be of little merit in the effort to curb the use of such receivers by men who are not supposed to be informed of the alarms.

However, our interest lies in the radio industry. It behooves every member of the radio service profession, who upon hearing or reading that his (or her) state is attempting to institute such legislation, to make every effort to forestall its enactment by communicating a protest to the various state authorities such as the Assemblymen and Senators functioning for the district of the protestant.

This is of particular importance today, when auto-radio receiver sales represent a very large proportion of radio-receiver sales. Auto-radio receivers have not reached the level of the normal home broadcast units and it is hoped that they never will.

Any action to license car radio receivers will stifle sales and as far as the readers of this magazine are concerned, will stifle installation and service. It means dollars and cents in your pockets to prevent such laws. If we knew that any such law would prevent lawlessness and would prevent the getaway of the pursued criminal, there would be some justification. We recognize that the crook derives some advantage by knowing the instructions being given to the cruising patrols. But since the criminal already has committed an offense against the law, just what importance will he place upon another law designed to interfere with his safety? Absolutely none! At the same time, such a law would stifle sales of receivers, diminish financial returns to the various states and the federal government in the form of taxes, and actually take bread and butter out of the mouths of many.

• • •

HOW about selling auto-radio receivers? There is a great push behind this type of radio receiver today. The modern receiver is much superior to the older product. It is quieter in operation, ignition noises are less because the long leads to distant batteries have been eliminated. The modern car set is self-contained. Signal sensitivity has been greatly increased. Automatic volume control has been added. Installation is much simpler. In practically every respect, it is easier to sell a modern auto-radio job and to keep it sold.

The next two months are going to find the public auto-radio conscience. An examination of national magazine advertising shows that auto-radio receivers are being pushed by the receiver manufacturers. Now is your chance to get into the swim. Don't miss the opportunity. Start selling this summer and it will continue into the fall and thereafter. The servicing jobs will come as a natural course.

ARE you considering purchasing any apparatus? Have you any purchases to make? If you have the funds to buy, or if you are able to make commitments for future delivery, make them today. Prices are on the upturn and there is no doubt about definite increases within the next 60 or 90 days—maybe sooner.

If you are entertaining any thoughts to the effect that prices will drop, even during the summer when the radio industry is at its ebb, you are destined to disappointment.

Federal legislation relating to prices and competition may cause any number of reactions, but one definite reaction, if we can judge by what information has come to hand, will be an increase in prices.

• • •

WE know of a man who has a complete service shop in a small automobile truck. On Sundays he tours to picnic grounds where there is to be found an accumulation of cars. He takes his family with him. They picnic and he seeks car radio installations and their owners, and services car sets which are not performing to perfection. Maybe it's tedious work but it displays imaginative thought and is an example of the ramifications of the mind of a go-getter. Where there's a will, there's a way. And lest you forget—his family is out in the country for the day.

• • •

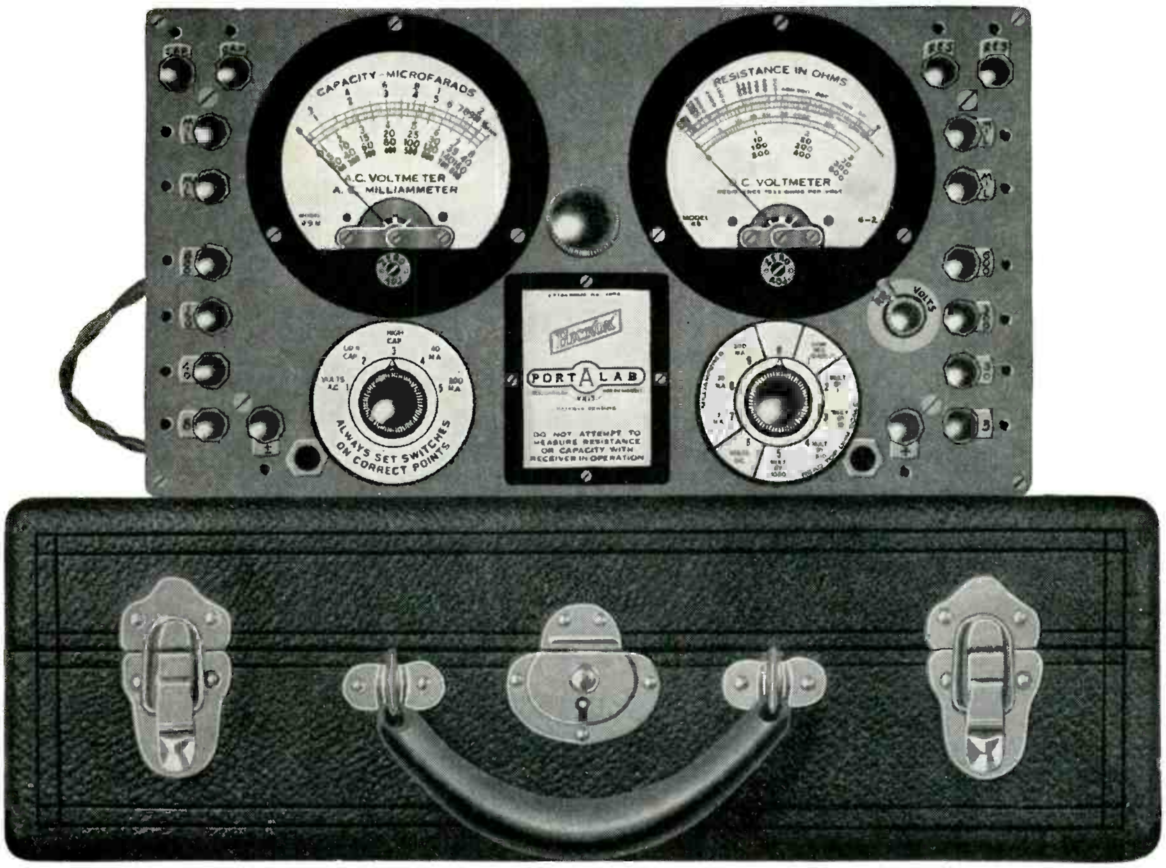
THE Century of Progress Fair at Chicago has an interesting display in the RCA Hall. It consists of a series of cathode ray oscillograph tubes connected to a radio receiver and utilized to show the passage of currents through the receiver. Is this, and the use of the oscillograph for peaking by receiver manufacturers, the forerunner of what to expect in the service business in the future?

It is not a far-fetched thought to imagine cathode ray tubes being sold for from $5.00 to perhaps $10.00 and instrument manufacturers producing oscillators for use with oscillographs. What with the multiplicity of tuned circuits in modern receivers and the necessity for accurate tuning, peaking of r-f. and i-f. circuits is daily assuming greater and greater proportions. Perhaps the day will come when checking of voltages and resistance of circuits will be just a minor detail and the greatest amount of time will be spent upon adjustments. Measurement of inductance, capacity and degree of resonance will be daily service routine.

Equipment the same or similar to the oscillograph may in the end tend to simplify servicing procedure. Any device that will provide an immediate and positive indication of just what is going on in each vacuum-tube circuit would eliminate the Service Man's curse—hunting for a hidden fault. Every Service Man would welcome a device which would inform him quickly which particular circuit was misbehaving. Once located, the rest would be easy. *John F. Rider.*

PORT A LAB
INDIVIDUAL UNIT MEASUREMENT
Patents Pending

TWENTY RANGE
POINT TO POINT
NEW---RADIO SET TESTER



All Bakelite—Walnut Panel—Chrome Trim—Size 12" x 7" x 3¼"

A PORTABLE PRECISION LABORATORY

Special Size (4¼ Dia.) Easy Reading Meters — Highest and Lowest OHM Readings
Ohmeter Not Battery Operated — No Rectifiers in A. C. Meters

A PLAIN STATEMENT OF FACTS CONCERNING THE PORT-A-LAB AND THE HICKOK METHOD OF INDIVIDUAL UNIT MEASUREMENT

This method is Imperative with today's Receivers and definitely Supersedes all previous methods of testing, requiring a Service Instrument having:

WIDE RANGE OF APPLICATION TO INDICATE HIGHEST AND LOWEST POSSIBLE OHMS — ¼ OHM TO 20 MEGOHMS—MICROFARADS—HENRIES—A. C. AND D. C. MILLIAMPERES AND VOLTS. ALSO FRACTIONS THEREOF.

The unit SHOULD NOT BE BATTERY OPERATED, NOR EMPLOY RECTIFIER TYPE METERS, as the former run down and the latter wear with use, resulting in loss of meter calibration.

The Port-A-lab employs neither. The Ohmeter operates with TUBE TYPE RECTIFIER (tube mounted inside case), NO BATTERIES. The A. C. Meter contains NO RECTIFIER TO CHANGE IN VALUE AND LOSE CALIBRATION. Attachment is made to A. C. Line. Voltage Adjuster for precise Calibration, always independent of Line Fluctuation. A HICKOK DEPENDABLE FEATURE.

Extreme Visibility and Extra Large Meters with Special Length Scales, Easy to Read — are essential, as in the Port-A-lab, to read ALL FACTORS and MINUTE FRACTIONS THEREOF, to meet TODAY'S SERVICE DEMANDS.

The Port-A-lab is the result of Extensive Research and Practical Application in the field of Service to provide:

SPEED — ACCURACY — GREAT TIME SAVING — TRUE REPAIR ESTIMATES — NO ERRORS — SIMPLIFYING OF SERVICE PROBLEMS — ENHANCED PROFITS AND INSURED CUSTOMER CONFIDENCE.

DEALERS

Write for Bulletin 27A. New important information.

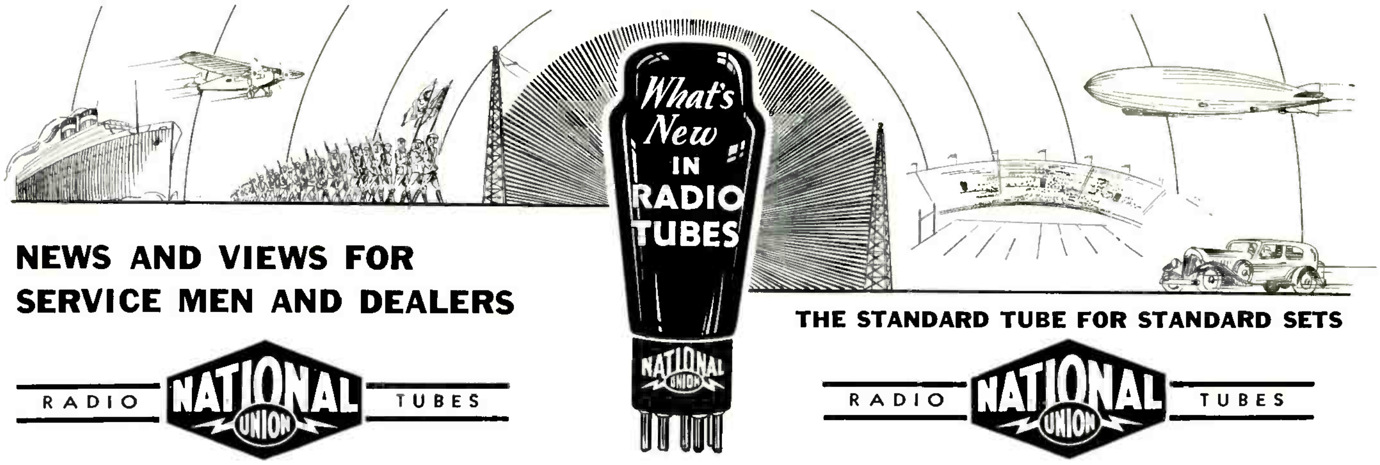
The Sum of These Facts Merits Ownership and the Immediate Adoption of the Hickok Method of Point to Point Radio Set Testing as Embraced in the PORT-A-LAB, STATI-K-TESTER and COMPACT-A-LAB

Tests All Sets — including New Seven Prong Tubes

List Price, Model 4953, Complete............$125.00
Dealers' Net Price, Model 4953, Complete.... 75.00
List Price, Carrying Case (Not Essential).... 10.00
Dealers' Net Price, Carrying Case (Not Essential) $6.00

West Coast Prices Slightly Higher

THE HICKOK ELECTRICAL INSTRUMENT CO. **10514 Dupont Ave., CLEVELAND**



NEWS AND VIEWS FOR SERVICE MEN AND DEALERS

RADIO NATIONAL UNION TUBES

THE STANDARD TUBE FOR STANDARD SETS

RADIO NATIONAL UNION TUBES

TUBE SHIELDING REVOLUTIONIZED

National Union Develops Metal Jackets for Easy Shielding

National Union Radio Corporation of New York announces an important development in tube shielding. The device, which consists of a metallic shield and a grounding clip, will find ready sale to the set owner who wishes to improve the reception of his set at a nominal expense.

SUPERIOR TO OLD STYLE SHIELDING

For years the service man has complained of cumbersome tin can shields and metallic partitions which were easily damaged and more often lost. Here is a shield which actually becomes a part of the tube and yet which can be easily detached and used again in the event of tube renewal.

This form-fitting shield jacket, which has already caused so much favorable comment, comes in two equal parts which are held snugly to the tube by a simple spring ring. Grounding for the chassis is provided by the use of the small metallic strip which runs from the cathode pin to the inside of the shield where it is pressed firmly against the glass envelope.

WIDE APPLICATION

Two shield styles are available so that all requirements of the straight-side and dome-type bulbs are provided for. One style fits the ST-12, dome-shaped bulb found on such tubes as types 57, 58, 6F7, etc.; the other style conforms to the S-14 bulb such as found on types 24, 27, etc.

The new shield jackets have a wide application and can be used on radio-frequency and detector-circuit tubes where shielding is desirable. In many cases the original shielding in a receiver may be inadequate; in still other instances, noise is excessive. The simplicity of the application of the new shield jackets makes experimentation practical, whereas old-style shielding methods required abnormal length of time to determine the results of the experiment.

SAFETY FACTORS

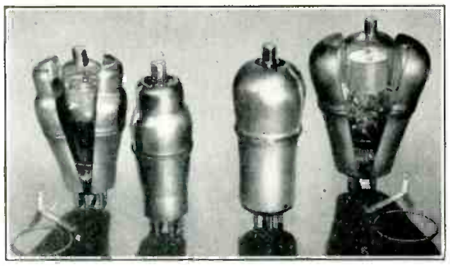
National Union shield jackets under no circumstances harm a radio set. In fact, over a wide range of experiments conducted in the laboratory a definite gain was demonstrated. They are safe; they are designed so as not to alter tube characteristics; they are snug, form-fitting, and will not vibrate; they are non-microphonic. The tone quality of the radio receiver can be improved to give the finest reception—quiet, clear, and full-tone—by combining the new shield jackets with new, quiet, rich-tone National Union tubes.

NATIONAL UNION ONLY TUBE LINE NECESSARY

Spray-shielded radio tubes heretofore presented a real problem to dealers and service men in necessary duplication of tube lines. This problem is eliminated by the introduction of new National Union shield jackets.

SHIELDS SOLD BY NATIONAL UNION JOBBERS

All National Union jobbers have the new shield jackets available in any quantity for quick delivery. The cost is low: Both styles list at 12¢ per set, complete with ring and cathode ground clamp, subject to the regular dealer discount of 40-10%. The shield jackets are packed complete in especially-designed envelopes containing complete instructions. For a limited time it will be possible to obtain the National Union shield



jackets from your jobber, without charge. Any National Union jobber salesman will give you complete details of this special offer.

NATIONAL UNION TUBE SHIELDS MARK A NEW MILESTONE IN NOISE ELIMINATION FOR RADIO-RECEIVER SERVICING. THEY ANSWER EVERY SHIELDING PROBLEM PROMPTLY.

N. U. TUBES PROVE THEY CAN TAKE IT!

"During the recent political campaign, our sound truck was in the service of the Baltimore Democratic Committee for a period of two weeks. Tubes gave us considerable trouble, causing a complete replacement three times within the two weeks period. This was an expensive proposition, as the equipment uses one '26, one '10, three 81's and six 250's.

"Immediately after this engagement our truck was leased for a six weeks period by a nationally known car manufacturer, covering the states of New Jersey, Delaware, eastern Pennsylvania and southern New York. Mr. Mattson, your local distributor, asked that we give your tubes (National Union) a trial. Up to that date, we had not tried them (National Union). In those six weeks our truck covered 2,360 miles over the roughest kind of roads, as the truck operated mostly in rural districts. The operating time for this trip was 756 hours.

"That set of tubes (National Union) functioned through the entire trip and upon checking them found that there had been no noticeable loss of efficiency.

"We may also state at this time, that we conduct the only theatre sound service organization in this city, and since the experience aboard the truck, we have been using National Union tubes in the theatre replacements, with a much greater degree of satisfaction than we had experienced before.

"With best wishes for the continued quality and success of National Union tubes, we are (Signed) NATIONAL SOUND & RADIO ENG'RS., R. C. Thamm, Jos. E. Emmer."

NO HIDE 'N' SEEK FOR NATIONAL UNION

You haven't time to play the game of "Hide 'n' Seek" . . . when you need tubes you want them without delay . . . it will pay you to ask your National Union jobber FIRST . . . all tube types kept in stock at all times for your convenience. . . .

EXTRA! EXTRA! EXTRA!

Because of the National Recovery Act all bonuses, special discounts and FREE EQUIPMENT OFFERS are liable to forced withdrawal at any minute. Act Now! Sign contracts for as many National Union Free Offers as possible.

SUPREME MODEL 333 FREE!

Extra! At Last! **Combination Set Analyzer and Point to Point Tester!**

New Supreme Model 333 compact and portable, no larger or heavier than ordinary analyzer. Will take any type receiving tube now in use. Also provides for any new tubes using present extremes of voltage drain and socket adaptation. For the service man who wants:

1. A new up-to-date analyzer.
2. A Point to Point Tester (Resistance and Voltage).
3. A direct reading capacity meter.
4. Means of reading the leakage of wet and dry electrolytic and paper condensers.
5. Universal circuit cut-in.
6. Rectifier type output meter.

All of these features and other aids to quick and reliable service work covered in Supreme Model 333.

Unbelievable but True—just one instrument compact and portable. Conforms in every way to Supreme high standard of test equipment. National Union enables you to own this fine instrument Free through the purchase of National Union radio tubes. Small Deposit—Write for full details of offer.

OTHER NATIONAL UNION OFFERS

You can also get an Oscillator and Output Meter. Three Service Manuals, Unameter (Tube Tester), Readrite Tube Tester, Bench Kit box, Hickok Ohm-Capacity-Voltmeter. Equip your shop the easy National Union way at no cost. Small deposit on some items. Write now for profit's sake!

INTERCHANGEABLE TUBE CHART

This chart gives brief descriptions of all tube types, filament voltages and comparative type numbers of National Union tubes and those of other manufacturers. It is organized in simple easily readable form. A copy will be sent free on request. Ask for the "National Union Interchangeable Radio Tube Chart."

Remember! All offers subject to withdrawal without notice. Send coupon NOW!

NATIONAL UNION RADIO CORP. OF N.Y.
400 Madison Avenue, New York City

Sirs: I am interested in following equipment: Supreme 333 ☐ Unameter ☐ Readrite Tube Tester ☐ Oscillator & Output Meter ☐ Service Manuals ☐ Ohm Capacity ☐ Bench Kit ☐ S6

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ADDRESS ....

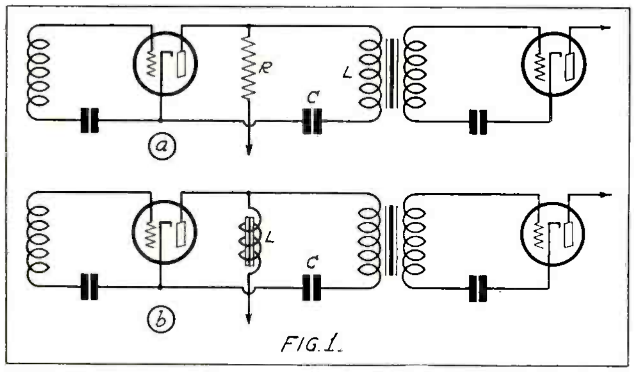
CITY .... STATE ....

Jacking Up Tone Quality

NUMEROUS old radio receivers suffer from "tone disability" and many of the newer receivers, though having fair or good quality, can be improved in one manner or another by the addition of a few extra parts.

Of course, the matter of tone depends a great deal on the owner of the receiver. As an example, the older one gets the less his ability to hear the high notes. His ability to hear the low notes remains fairly constant. This would mean, then, that an old person, or a young person with impaired hearing, might well wish to have the higher frequencies boosted above the normal delivered by the average radio set. For all of this, however, it appears that in most cases people are more anxious to have the lows boosted, for, unlike the human ear, radio sets are poor in lows.

We are better adapted nowadays to control audio frequencies than we were some years back. It is therefore possible to effectively tamper with the frequency response of both old and new receivers and get desirable results. This business of frequency compensation is well worth thought and the average Service Man should be able to provide in this manner a unique service to his customers.



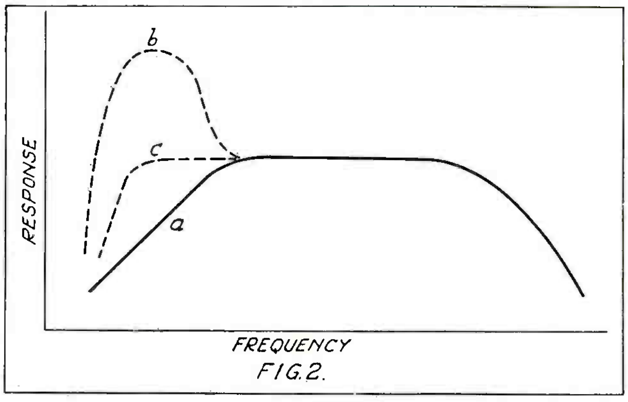
Method of resonating the primary of an a-f. transformer to increase the lows in two typical circuits

Automatic Tone Control

How many of you remember every bit of the original data given out on the type 58 tube? It was mentioned at the time this tube was released that it would provide a sort of automatic tone control. This point has not exactly been overlooked, but very few set manufacturers have used the tube for this purpose.

Now, the type 58 tube can be employed for either automatically boosting lows or cutting highs. Thus, if a type 58 tube is used in the first audio stage of a receiver in place of the '27, 56 or 57 type tube used, it will provide a better gain at low frequencies without materially attenuating high notes. Being a variable-mu tube, it will also tend to take the edge off sharp noises such as produced at times by man-made static. A bias resistor of about 500 ohms should be used.

We are used to employing the 58 tube in i-f. amplifiers. If we provide a means of varying the negative voltage on the suppressor grid from zero to about 40 volts, we can at will alter the plate resistance of the tube. In doing so, we change not only the selectivity of the particular i-f. stage so controlled, but also alter the tone. In effect, this arrangement cuts the highs at maximum selectivity, and thereby reduces



"Humping" the characteristic—the result of resonating at low frequency

background noise, and gives best frequency response at minimum selectivity. This provides a "local-distance" feature not present in most sets. It is suggested that this form of selectivity and tone control be incorporated in the circuit of the last i-f. tube.

It might be both interesting and valuable to fuss around with these two schemes.

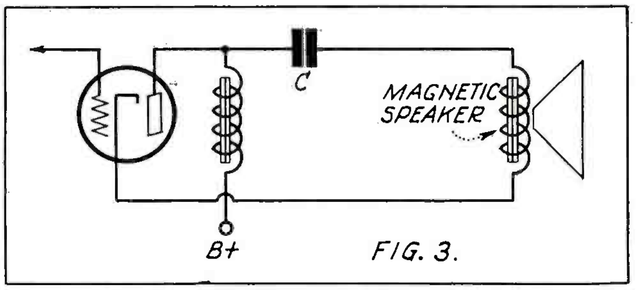
Low-Frequency Compensation

It is more often desirable to introduce low-frequency compensation in old audio amplifiers in order to get improved response of the low notes. This may be accomplished by either of the circuits shown in Fig. 1. Such arrangements are most successful with low impedance tubes, such as the '27 and 56 or their equivalents.

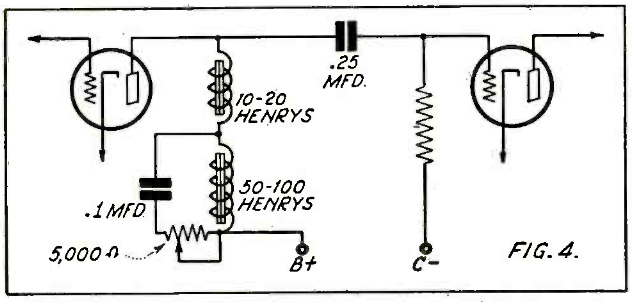
Compensation in these circuits is obtained by series tuning of the primary of the interstage transformer. Thus, in Fig. 1 (a) the plate potential is fed to the tube through resistance R, and condenser C is adjusted to tune the primary of the interstage transformer L to series resonance at the desired low frequency. Suppose the primary inductance of the transformer were 100 henrys and we wished to peak the response curve at 50 cycles. Here's the way it works out:

$$C = \frac{1{,}000{,}000}{4\pi^2 f^2 L} = \frac{1{,}000{,}000}{4 \times 9.86 \times 2500 \times 100} = 0.1 \text{ mfd.}$$

In the above we have first 4 times pi squared, ($4\pi^2$) which is 9.86. This is a fundamental part of the formula. Next we have frequency squared (f^2). Since we picked 50 cycles, we square that, which gives us 2,500. Next is L, the inductance, which we already know to be 100 henrys. The



The coil of a magnetic speaker may be resonated so as to respond to low frequencies



An impedance-coupled amplifier may be tuned to some low frequency to increase response, in the manner shown. The variable resistor functions as a tone control

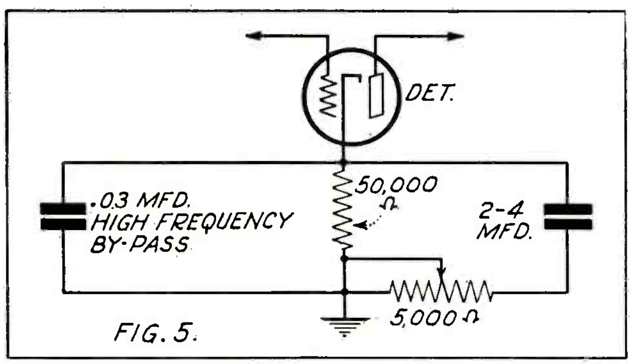
rest is multiplication and division. In the end we find that for the condenser C in either Fig. 1 (a) or (b) we want a value of 0.1 mfd. if the circuit is to resonate at 50 cycles. Had we wished to peak the response at 100 cycles a capacity of .025 mfd. would be required.

The curves of Fig. 2 indicate the type of characteristics which result. Since the tube plate impedance is in series with the series-tuned circuit, the higher the plate impedance of the tube the lower the peak will be, as a result of which these two particular circuits are not very satisfactory with screen-grid or pentode tubes.

Referring to Fig. 2 curve (a) is the normal amplifier characteristic, (b) is the characteristic with a fairly low-impedance tube, such as the '27, '37, '30 or 56, and (c) the characteristic with a higher impedance tube. These characteristics would apply to either circuit (a) or (b) of Fig. 1, the only difference between the two being the use of an audio choke rather than a resistance in the circuit of (b).

This same procedure may often be applied to battery and other sets operating magnetic and other speakers. Some of the older sets employ choke coil and condenser coupling to feed the magnetic speaker, as shown in Fig. 3. Usually a 2-mfd. or 4-mfd. condenser is used. It is frequently possible to use a 1-mfd. condenser in such combinations and increase the low-frequency output considerably. In many cases the overall fidelity will actually be improved while in some cases the fidelity will suffer appreciably although the low-frequency output will be materially increased. These results are due to series resonating the windings of the magnetic speaker—in a manner similar to the two arrangements shown in Fig. 1.

Of course, a switch with a number of condenser combinations may be used for any of the above arrangements so that the characteristic may be peaked at any one of a number of low frequencies. This results in a variable low-frequency



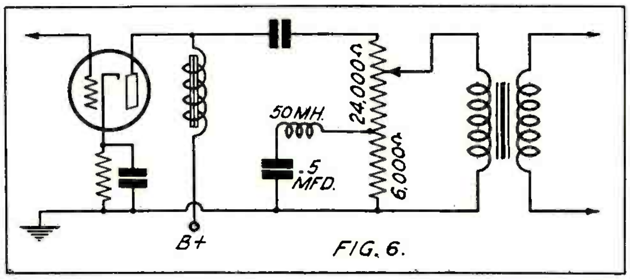
A method of boosting the lows and at the same time providing tone control, in the cathode circuit of a detector

tone control. It should not be confused with the usual form of tone control which cuts the high notes and thereby gives the impression of increased low-frequency response.

The choke used to couple impedance-coupled amplifiers can be tuned to low frequencies and if desirable the low frequency hump can be varied by means of a variable resistor, as shown in Fig. 4. The 10- to 20-henry choke in this circuit prevents high-frequency loss due to tuning and the 5,000-ohm variable resistor permits of broadening the hump due to tuning the larger choke.

Detector Frequency Control

In receivers using self-biased detectors of either the single grid or multigrid type of tubes, audio degeneration will center around the bias resistor. If a large resistor and large bypass condenser are used, degeneration will be negligible and low frequency response will be normal; if the effective shunt capacity is reduced, low frequency response will be reduced. This may be accomplished as shown in Fig. 5. A high-frequency bypass condenser of small value, say .01 to .03 mfd., must of course shunt the bias resistor so that detector efficiency will not be affected by varying the audio



Circuit for acoustically-compensated volume control—the lows build up as volume is decreased

degeneration. Now, with this arrangement, the 5,000-ohm resistor increases or decreases the ability of the 2- or 4-mfd. condenser to bypass audio frequencies. The resistor in itself therefore functions as a tone control.

We will not cover the usual forms of tone control here, as they are well known.

Acoustically-Compensated Volume Control

Some receiver manufacturers have recently gone in for acoustically-compensated volume controls which will permit an increase in the response of low frequencies as the volume is reduced. This permits the set owner to hear the low notes when the volume control is set low. A circuit of this sort is shown in Fig. 6 and the necessary values given. The tapped variable resistor shown is being marketed by a number of companies.

What really happens in this circuit is that as the volume is decreased, the resonant circuit, composed of the air-core inductance and series condenser, starts taking effect, because as the volume is decreased the resistance in the resonated circuit is decreased. The result is that a low-frequency hump appears, similar to the ones shown in Fig. 2. As the volume is increased, the hump is leveled off due to the resistance added between the resonant circuit and the grid of the a-f. tube.

This arrangement is best placed in the output of the detector circuit but can also be used in the intermediate audio stage. The same circuit will work effectively in connection with an electric phonograph pickup.

General Data . . .

channel control circuit must be tuned for a dip or decrease in the output meter reading, either side of which output increases.

It is important that the input from the 175-kc. oscillator be kept as low as possible all during the aligning operation, and volume control turned all the way on, as this permits the most accurate adjustment.

All-American Model SA-130

The All-American (Lyric) Model SA-130 is a 13-tube superheterodyne employing a stage of r-f., first detector, oscillator, two stages of i-f., second detector, one stage of intermediate a-f. and two power pentodes in push-pull feeding dual-dynamic speakers. An 82 mercury-vapor rectifier is used.

In the lower part of the diagram are the control tubes, the first tube to the right of the oscillator being the automatic volume control and the next two tubes are for silencing and channel control. The locations of these tubes on the chassis are shown in the sketch accompanying the diagram.

Channel Control

The outstanding feature of the channel control system of noise suppression is the fact that in addition to eliminating all static and other noises while the set is being tuned from one station to another, it makes it impossible to tune the set to anything but exact resonance with the desired signal. A variable control for the noise suppression system is placed toward the rear on the left side of the cabinet. This permits compensation for all conditions of static and other interfering noises. With the set tuned between stations so that no signal is received, this knob should be rotated counter-clockwise to the point where the static and other noises are just silenced. The set may then be tuned in the ordinary manner without further attention to the channel control. On channels where no station is operated or where the station is weaker than the static or interfering noise level nothing will be heard; however, on all channels where the received signal is above the noise level, the signal will be released when the set is tuned to exact resonance.

The requirements of circuit alignment in this receiver make necessary extreme care when ganging either the r-f. or i-f. systems. For this reason detailed instructions will be given. Unless these are followed precisely, it will be impossible to obtain proper channel control operation.

Circuit Alignment

For aligning the tuned circuits, the following equipment will be necessary: Calibrated r-f. oscillator with range of 550 to 1500 kc., accurately calibrated 175-kc. oscillator, output meter, insulated screwdriver and three 20,000-ohm ½-watt resistors.

During all ganging operations, the channel control knob must be in full-on (extreme clockwise) position and the channel control tube removed from socket.

The I-F System

The i-f. system of the receiver consists of two stages peaked at 175 kc. The sketch of Fig. 2 shows a bottom view of the rear edge of the chassis pan and indicates the points at which the 20,000-ohm resistors are to be connected during alignment, and also the adjusting screws of the i-f. transformer condensers.

Energy from the 175-kc. oscillator is fed into the set by removing the grid cap from the first detector tube and connecting the oscillator between the grid cap of the tube and the chassis pan. As weak a signal as possible should be used in order to eliminate the apparent broadness of tuning caused by the automatic volume control.

Now, proceed as follows:

(1) Attach one 20,000-ohm resistor across points 1 and 2, as shown in Fig. 2. (This is done by bending ends of resistor leads to form plugs and inserting one lead into one of the small eyelets of 1 and the other into the large eyelet of 2.)

(2) Adjust screws "A" for maximum output.

(3) Remove resistor from 1 and 2 and connect across points 3 and 4.

(4) Adjust screw "B" for maximum output. (Resistor must be left connected across points 3 and 4 while adjusting second and third stages and r-f. circuits.)

(5) Adjust second i-f. transformer as described above, placing a second resistor across points 5 and 6 when adjusting "C" and transferring it to points 7 and 8 when adjusting "D." (The second resistor must be left connected across 7 and 8 while adjusting third stage and r-f. circuits.)

(6) Adjust third i-f. transformer as described above, placing a third resistor across points 9 and 10 when adjusting "E" and transferring it to points 11 and 12 when adjusting "F." (The third resistor must also be left across 11 and 12 while adjusting r-f. circuits. Also, be sure to leave these three 20,000-ohm resistors connected across the i-f. transformers at points 3 and 4, 7 and 8, 11 and 12 while ganging them in place, also while ganging the r-f. circuits. It is impossible to align these circuits if this is not done.)

(7) Tune channel control circuit (adjusting screw "G") for dip in output reading. Since the circuits of the three i-f. transformers are tuned for maximum output, the

The R-F. System

Viewing the variable condenser gang from the front (see chassis sketch), the first two sections tune the antenna pre-selector system, the third tunes the oscillator and the fourth tunes the r-f. interstage transformer.

In this receiver an adjustable padding condenser is used to obtain the difference of 175 kc. between the tuning of the oscillator and remaining r-f. circuits. The adjusting screw for this condenser is accessible through a hole in the chassis pan between the partitions of the oscillator section of the variable condenser.

Before attempting to gang the r-f. circuits, be sure that the i-f. and channel control circuits are accurately tuned to 175 kc. as heretofore described. Then proceed as follows:

(1) Adjust dial mechanism so that when the gang condenser is turned to maximum capacity with plates against stop the dial reads 525 kc.

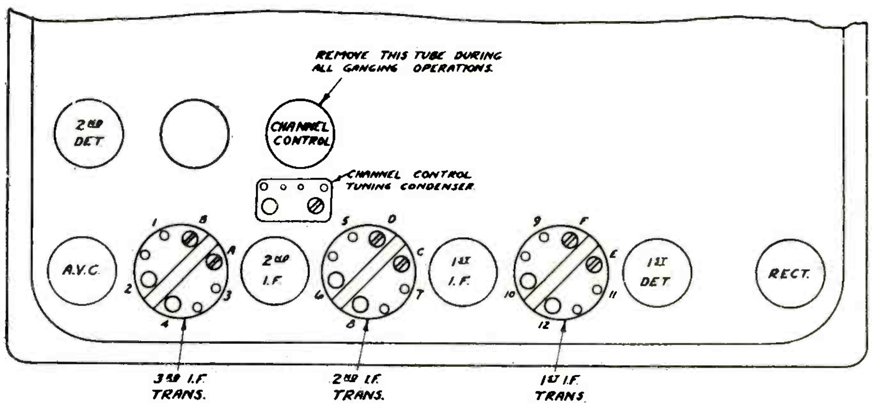


Fig. 2. Bottom view of rear edge of All-American SA-130 chassis

(2) Set test oscillator to some known frequency between 550 and 600 kc. Tune variable condenser so that pointer indicates this frequency on dial scale and adjust padding condenser for maximum output.

(3) Set test oscillator to some known frequency between 1,400 and 1,500 kc. and tune variable condenser for this frequency on dial. Adjust trimmer condenser of oscillator section (third trimmer from front of chassis) until signal provides maximum output. Be careful in this adjustment as there are two possible settings of the oscillator trimmer condenser at which the signal will provide maximum output. The proper setting is that at which the trimmer is set to minimum capacity. The trimmer condensers of the first, second and fourth variable condenser sections should then be adjusted for maximum output.

(4) Align circuits at known frequencies of approximately 1,200, 900, 700 and 550 kc. as follows: Set test oscillator to some known frequency, approximately 1,200 kc., tune set so that dial indicates this frequency, then bend adjustable sections of rotor and

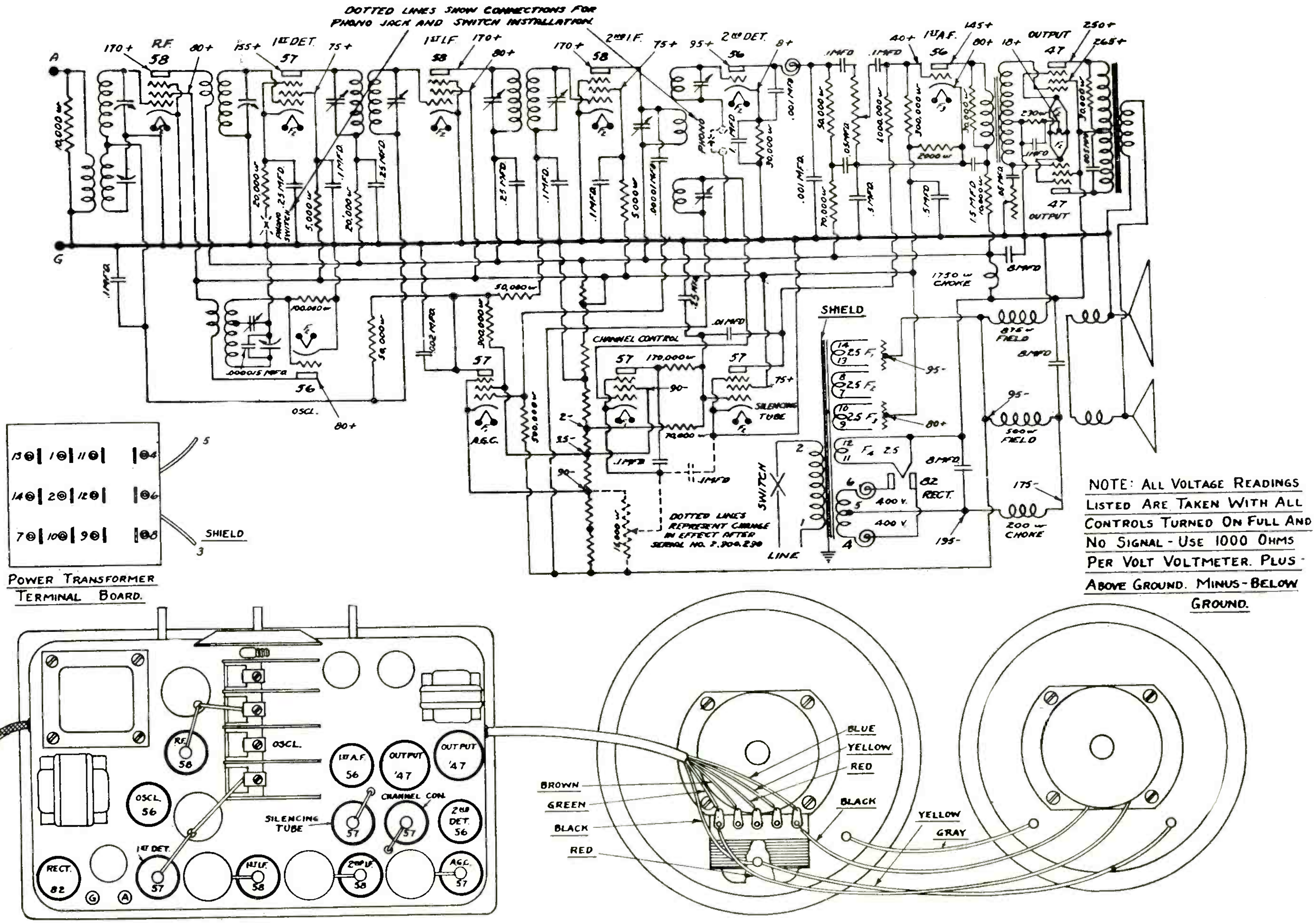


Fig. 1. Schematic diagram of the All-American Model SA-130; also chassis layout and power-transformer connections. This diagram includes the voltage data. Note that this receiver employs a channel-control tube and a silencing tube. The operation is explained in the text

plates of oscillator condenser for maximum output. Then bend adjustable sections of first, second and fourth variable condenser sections for maximum output. Repeat process at some known frequency, approximately 900, 700 and 550 kc. in order given.

With i-f. transformers set to exactly 175 kc. and r-f. circuits aligned according to these instructions, the dial calibration should be accurate at all points of the dial to within one or two kc.

All resistance and capacity values are given in the diagram. A glance will show that the diagram also includes the operating voltages.

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Brunswick D and AVC-D Chassis

On page 355 of the December, 1932 issue of SERVICE was published the circuit and data on the Brunswick AVC-D chassis. This chassis is very similar to the D chassis except that it is equipped with automatic volume control.

The circuit diagram of the original D chassis is shown on this page. Any chassis with a serial number of 25,000 or above is the AVC-D chassis previously described.

The D chassis, the circuit of which is shown here, differs in the following respects from the AVC-D chassis: Has no AVC, has no local-distance switch in the antenna circuit and employs a type '24 tube as second detector instead of a type '27. The latter difference is the quickest way to determine which chassis you are working on.

Changes in Model AVC-D

Referring to the diagram of the AVC-D chassis in the December issue, most of the sets have a 3,000- or 5,000-ohm resistor in series with the .01-mfd. condenser shunting the primary of the output or speaker transformer. Also, in many of these sets the 30,000-ohm resistor and .01-mfd. condenser connected in series and running from the 40 mh. r-f. choke in the plate circuit of the second detector to ground, is omitted. The cathode or biasing resistor for the second detector tube is usually 30,000 ohms instead of 15,000 ohms as shown.

The socket voltage data included with the Model AVC-D diagram should really apply only to the circuit of the Model D shown on this page. The correct voltages for the Model AVC-D are given in the accompanying table.

A glance at the diagram in the December issue will show that there is a mistake in the wiring. It will be noticed that the screen of the first detector tube as well as the plate and screen of the oscillator tube do not connect into the high voltage lead supplying the plates and screens of the other tubes.

The i-f. amplifier in both the Model D and AVC-D is peaked at 175 kc.

All the data given was kindly supplied by Schafer and Bowman, 7649 South Wabash Avenue, Chicago, who are the distributors for Brunswick and Bremer-Tully replacement parts.

BRUNSWICK MODEL AVC-D VOLTAGES

Tube	*Plate*	*Plate MA.*	*Grid*	*Screen*	*Heater*
1st R-F.	220	3.4	0.1	70	2.4
1st Det.	220	0.4	1.1	62	2.4
Osc.	35	1.2	0.0	22	2.4
I-F.	220	9.0	0.1	60	2.4
2nd Det.	194	0.8	10.8	. .	2.4
Power	220	35.0	1.0	220	2.4
Rect.	530	26.0 (each plate)			5.0

Readings taken with volume control full on.

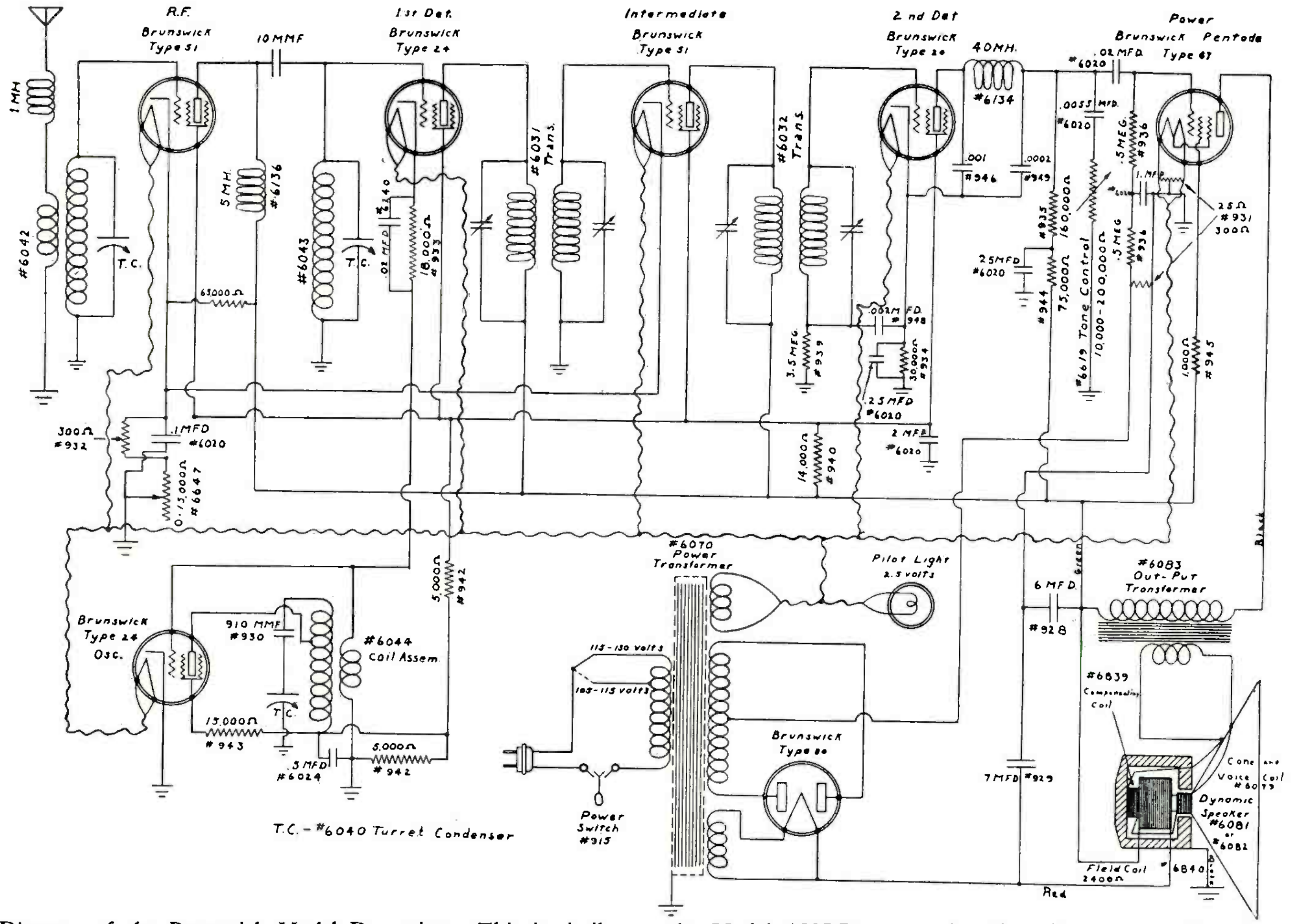

Diagram of the Brunswick Model D receiver. This is similar to the Model AVC-D except that there is no automatic volume control and a type 24 is used as second detector

RCA Victor R-27

This receiver is of the universal type and will operate from d-c. or 105-120 volts, 25 to 133 cycles a-c. The total power consumption is 40 watts and the frequency range is from 540 to 1,700 kc., thus taking in police signals.

The Model R-27 first type employs a magnetic speaker. The complete diagram is shown in Fig. 1. The Model R-27 second type employs a permanent-magnet dynamic speaker. The diagram for this receiver is shown in Fig. 2.

Except for the speakers, the diagrams of both types are practically the same. It will be seen that there is a stage of tuned r-f. feeding a straight detector. The detector is resistance-capacity coupled to a type 38 pentode.

The heaters of all tubes, including the heater of the type 37 tube used as half-wave rectifier, are connected in series. The series connection includes the voltage-reducing resistor R1. The high-voltage supply is taken off the cathode of the rectifier tube which is not connected to the heater. The filter is composed of the choke L7 and the condensers C4 and C5.

Volume is controlled by varying the bias on the r-f. tube by a change in the value of the variable resistor R2. Note that the coupling between circuits is principally capacitative, the coupling units being the open-end coils L3 and L6.

RCA VICTOR R-27 VOLTAGE DATA

Tube	*Grid*	*Screen*	*Plate*	*Plate MA.*	*Heater*
R-F.	3.0	105	105	7.0	6.0
Det.	0.75*	11	60*	0.025	6.0
Pwr.	11.0	100	95	5.0	6.0
Rect.	. .	. .	115	15.0	6.0

Screen, control grid and plate voltages should be measured between cathode or heater and the elements.
* Impossible to measure on ordinary voltmeter.

When the receiver is tuned to a strong local station with the volume control fully advanced, a condition may be observed where a certain amount of counter-clockwise rotation of the control will improve the quality of reproduction and actually increase the volume. This condition is caused by overloading and may be corrected simply by setting the volume control below the readily-apparent critical point.

The antenna provided with the set is a coil of wire about 20 feet long. If this wire is bunched or coiled too near the set, oscillation may occur. The position of the wire should be changed. This condition may also be corrected by reducing the volume control setting. When operated at or near the point of oscillation, however, the sensitivity of the set will be greatly increased—ordinarily to a point in excess of that required for normal reception.

Point-to-point resistance measurement may be carried out quite easily on this set. All the values of resistance are given in the diagram. The voltage data is given in the accompanying table. The figures are based on a line voltage of 115 for a-c. All values will be slightly lower when the set is being operated on a d-c. line.

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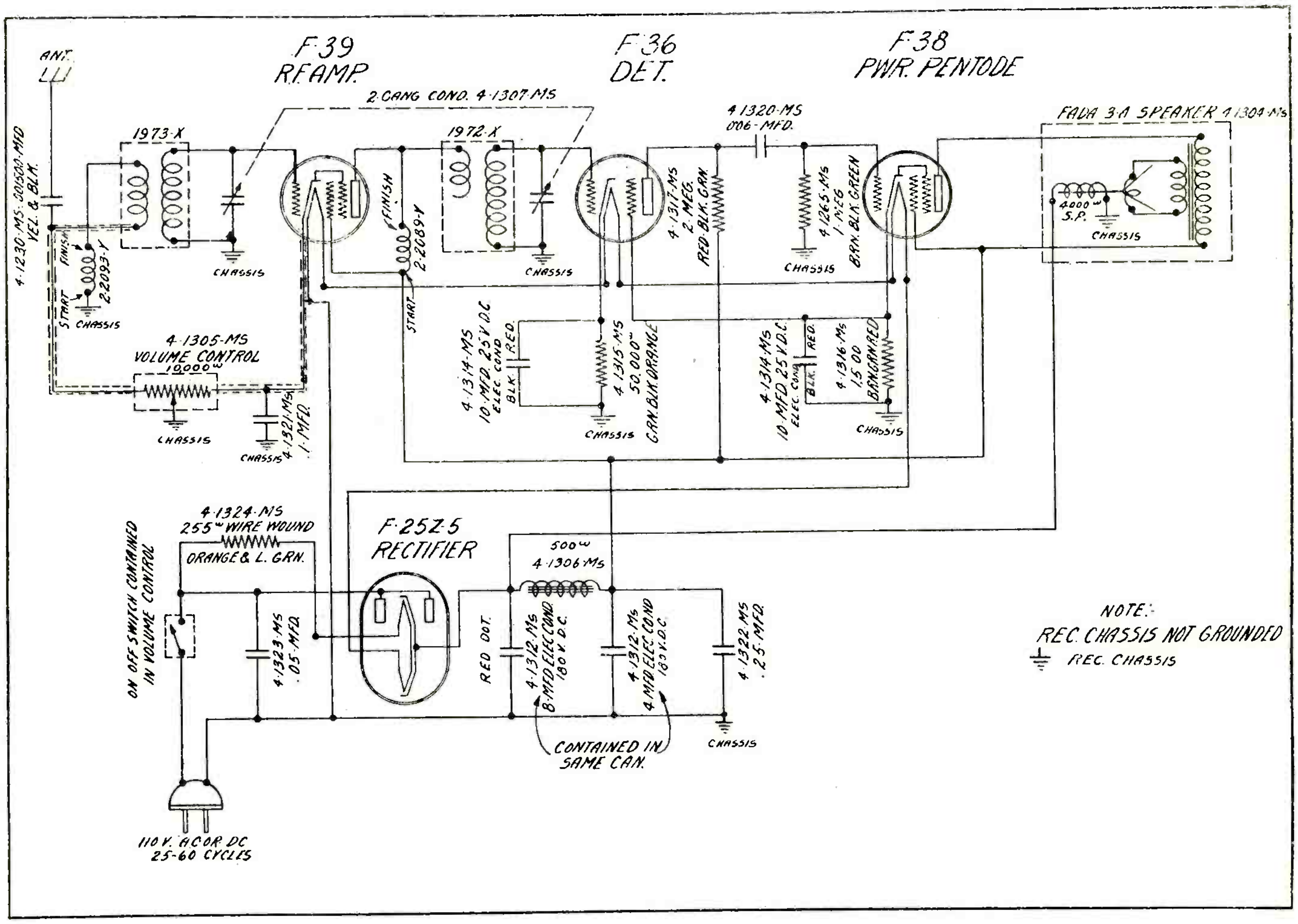
Fada Model 103 "RL" Fadalette

The schematic diagram of this receiver is shown herewith. Resistance and capacity values are included. Note that the chassis of the receiver is not grounded.

This midget receiver is designed for a-c. or d-c. use and the heaters of all the tubes are connected in series through a limiting resistor connected in the line circuit.

The 25Z5 rectifier tube is used in a half-wave connection with the usual form of filter.



Circuit diagram of the Fada 103 "RL" Fadalette for a-c., or d-c.; series heater connection. This is a tuned r-f. job with capacity coupling between r-f. and detector

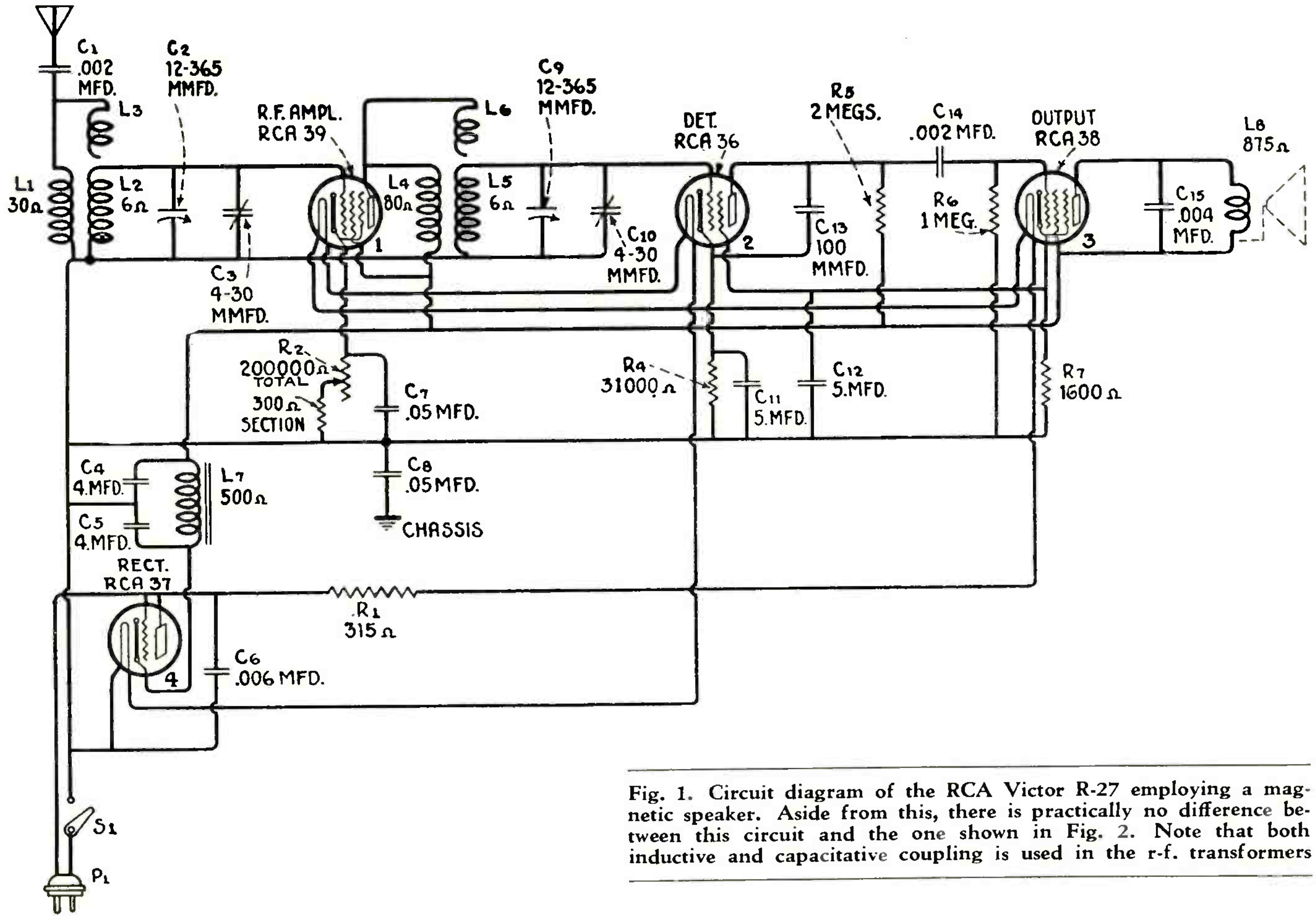


Fig. 1. Circuit diagram of the RCA Victor R-27 employing a magnetic speaker. Aside from this, there is practically no difference between this circuit and the one shown in Fig. 2. Note that both inductive and capacitative coupling is used in the r-f. transformers

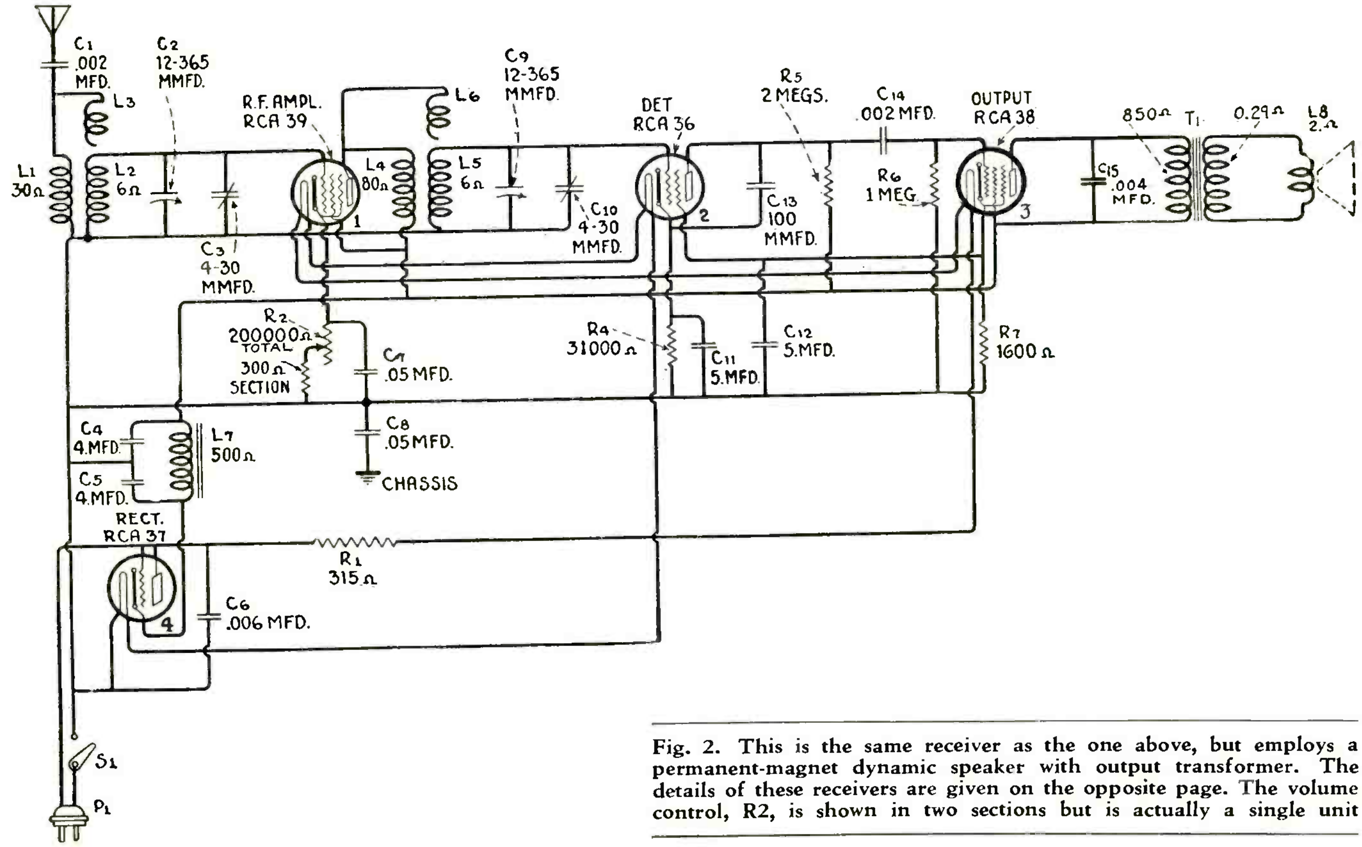


Fig. 2. This is the same receiver as the one above, but employs a permanent-magnet dynamic speaker with output transformer. The details of these receivers are given on the opposite page. The volume control, R2, is shown in two sections but is actually a single unit

THE STORY OF RECEIVER DESIGN

Part IV

THE detector is probably the most important component of the present-day radio receiver, since in addition to detection it is usually also employed for automatic volume control (AVC), delayed automatic volume control, or quiet automatic volume control (QAVC) with an additional tube. Moreover, unless the detector has a linear characteristic, distortion is produced which is amplified by the audio amplifier. Thus, a square-law detector produces so-called "even order" distortion, meaning second, fourth, sixth, etc., harmonics, as well as sum and difference frequencies. The latter are probably more annoying than harmonics since they bear no harmonic relation to the other parts of the signal and may therefore be said to be in entire discord with the mathematics of the signal.

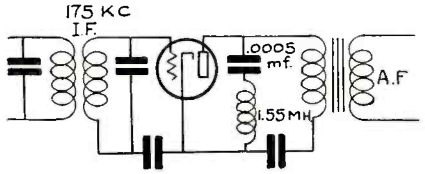


FIG. 2

Circuit showing the manner in which the filter in the output of the second detector can be resonated at the intermediate frequency

To get a clear picture of this, suppose the incoming carrier were modulated with 100 cycles and 250 cycles—then the output of a square-law detector would contain frequencies of 100, 200, 400, 600, 800 cycles, etc., 250, 500, 1000, 1500 cycles, etc., as well as (100+250) 350 cycles, etc. Third and other odd-order harmonics are produced in some types of detectors in which a part of the operating characteristic is cubic. However, these terms are seldom of enough magnitude to cause noticeable distortion.

The linear or straight-line detector on the other hand is practically free from distortion.

SQUARE-LAW DETECTORS

Fig. 1 illustrates a typical triode detector circuit. This is usually called a square-law detector which is true for small inputs, but it does not apply for large inputs at which such a tube acts almost as a linear device. In such a tube the bias would be chosen as —10 or —12 volts. It will be noticed that the positive half cycles of the input are amplified and the negative half cycles are attenuated. This inequality produces an increase in direct current and even-order harmonics of the audio signal in addition to the fundamental notes with which the input is modulated. As mentioned before, the output of this device is proportional to the square of the input. In such a case therefore it is more important to add amplification ahead of the detector than after it. Thus, one db. of gain at radio frequency produces the same effect or sensitivity as 2 db. at audio frequency, whereas with a linear detector it makes no difference so far as sensitivity is concerned whether the gain is added at radio frequency or audio frequency.

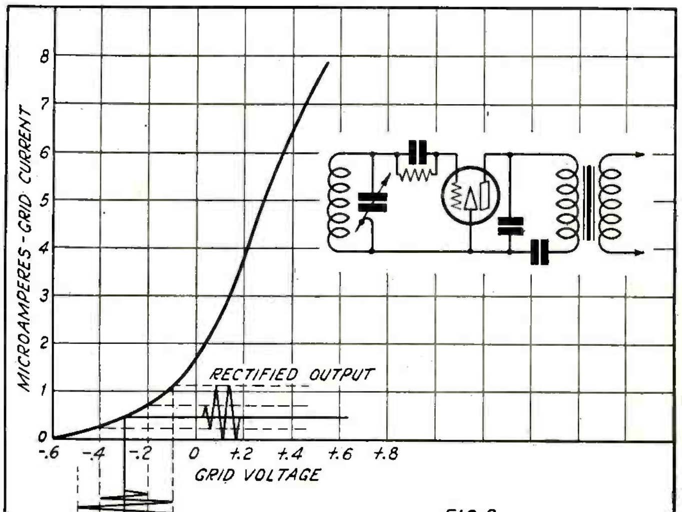


FIG. 3.

Here is illustrated the operation of a grid leak and condenser detector, or grid circuit detector. This is also a square-law detector, and has greater sensitivity than the bias detector

Another characteristic of the detector shown in Fig. 1, which is also called a plate circuit detector, lies in the fact that it draws no grid current unless overloaded, and in addition has a high output impedance. The significance of the former is that good selectivity may be had from the tuned circuit preceding the detector. The significance of the latter is that the input impedance of the transformer or choke in the plate circuit must be high to insure good fidelity at low frequencies. If this necessary condition is met with a transformer then very little step-up may be had in the transformer itself, as there is a limit to the size of the secondary. Step-up voltage ratios of 1 to 1 or 1 to 1.5 are usual for this transformer if good fidelity is to result.

The r-f. choke is usually 1 to 3 millihenrys and if good high-frequency fidelity is to result the bypass condenser is usually no more than .0001 to .0005 mfd. When this detector is used at only one carrier frequency (as in a superheterodyne) the detector efficiency may be materially improved by placing the choke and condenser in series and adjusting them to resonate at the intermediate frequency, as shown in Fig. 2. This was sometimes done in superheterodynes of several years ago before AVC became common. Some receivers of the same vintage (1930, 1931) which did not use this circuit can be materially improved by the addition of the arrangement. Thus, for an intermediate frequency of 175 kc. (1715 meters) a .0005-mfd. condenser will resonate with a 1.55-millihenry choke. To work out values for other intermediate frequencies, refer to the chart on page 305 of the November 1932 issue of SERVICE.

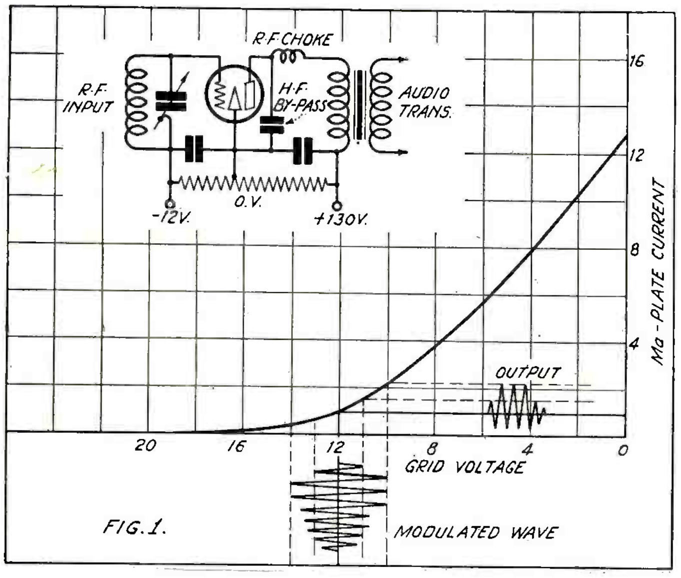


FIG. 1.

Illustrating the operation of a square-law detector of the biased type. The output is proportional to the square of the input, except for large inputs when the device becomes linear in operation

GRID CIRCUIT DETECTOR

A more nearly square-law detector is the grid leak and condenser type. This is shown in Fig. 3. It is also referred to as a grid circuit and grid current detector because it operates by virtue of the grid current rather than the plate current. The chief characteristics of this device are high sensitivity, low overload level, low input and output impedance. It is essential therefore that it be followed by considerable audio gain compared to the bias detector. A high step-up may be obtained from its plate circuit to the grid of the first audio tube because a high-ratio transformer can be used. The tuned circuit on its input will have very poor selectivity because the tube draws grid current under normal operation. Very often the high audio frequencies are attenuated by the wrong grid leak and stopping condenser combination. Usually the grid condenser is 250 mmfd. and the grid leak one to two megohms. This gives high sensitivity and poor fidelity. With such a combination attenuation of the audio frequencies starts at about 1000 cycles. If the leak is reduced to about one-half megohm, the sensitivity

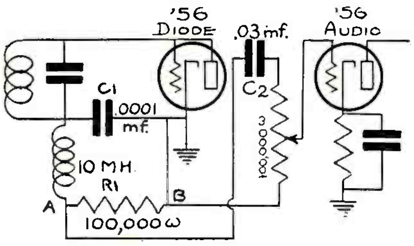


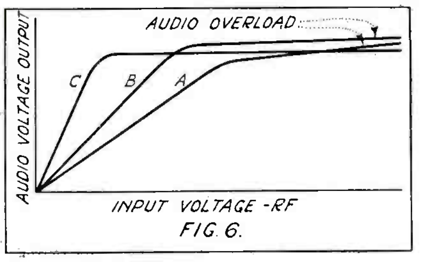
FIG. 4

Typical circuit of a diode detector, which has a linear characteristic. Note the location of the i-f. choke

will be reduced proportionately but attenuation of the audio frequencies will begin at about 3000 cycles. If the condenser is reduced to, say, 100 mmfd. and the leak remains one-half megohm, excellent fidelity results, only frequencies above 7,500 cycles being noticeably attenuated. Therefore for high-fidelity broadcast reception the latter combination is to be preferred, whereas if sensitivity is of paramount importance the former may be used to advantage.

So called power grid circuit or grid leak detectors have been used for various purposes, but there has been little or no use of this arrangement in broadcast receivers, therefore we will not discuss them here. Suffice it to say they consist of power tubes operated with high inputs and reduced plate voltage.

Screen-grid tubes are also frequently used as plate circuit or biased detectors. Their



Typical AVC curves. Curve A is for maximum control voltage, B for partial voltage, and C for delayed AVC

action is similar to that of the circuit of Fig. 1 except they have even higher output impedance and are considerably more efficient. On account of their high output impedance, they are nearly always coupled to the audio amplifier by chokes or resistances. If choke coil coupling is used, the fidelity of the receiver at low frequencies will usually suffer considerably because the impedance of a choke coil is directly proportional to frequency. As a result resistance coupling is nearly always used.

Diode Detectors

Diode detectors are now almost universally employed as second detectors in superheterodyne receivers. There are five good reasons for this:

(1) They are almost exactly linear and therefore introduce negligible distortion.

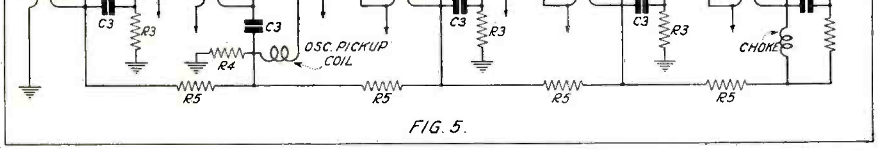
(2) Their direct-current output is proportional to carrier alone and they may therefore be used as a perfect volume control.

(3) Modulation products resulting from interference by strong unwanted signals is minimized.

(4) The signal to a-c. hum ratio originating in the detector circuit is minimized.

(5) No bias is required for normal operation.

Fig. 4 illustrates a simple diode detector obtained by paralleling two elements of a three-element tube. The grid and plate are in this instance used as one element of the diode. This gives a slightly more linear characteristic than paralleling the plate and cathode. The latter is often used however to reduce noise pickup by grounding the plate which surrounds the other elements. The cathode is heated in the usual manner and current flows from grid (or grid and plate) to cathode. As a result an increase in input voltage causes point A to become more and more negative. It will be noticed that the audio voltage is obtained across an r-f. bypass condenser in series with the diode. Typical values are given in the diagram for



Circuit with automatic volume control. The resistors R5 and the condensers C3 compose the resistance-capacity filter network. Such filters have definite time constants

the circuit constants which may vary considerably in different receivers. Some care must be exercised in the choice of circuit constants for this device. Thus, the i-f. bypass condenser C1 must be sufficiently large to bypass the i-f. but not so large that it will discriminate against the higher audio frequencies. Moreover, if resistance R1 were increased, C1 must be decreased in the same percentage. Now the higher R1 the larger the delivered audio voltage. Consequently it becomes necessary to supplement the filtering action of C1 with a choke of 10 to 20 mh. inductance. These two elements effectively prevent the i-f. voltage from entering the audio amplifier where it might contribute to overload and distortion. Examples of this form of filtering will be found in some circuits appearing in this issue.

The value of condenser C2 in the circuit of Fig. 4 should only be large enough to prevent undue loss at low audio frequencies. Thus, the reactance of a condenser of .03 mfd. (the value given) at 50 cycles is 100,000 ohms. Therefore the loss at 50 cycles will

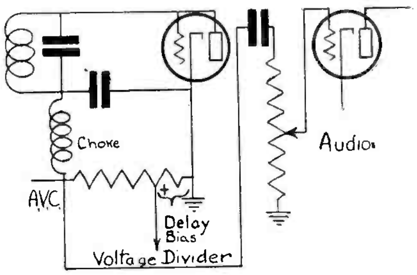


FIG. 7

Circuit using a triode for detector and delayed automatic volume control to obtain a characteristic similar to curve C in Fig. 6

be 3 db. more than if this condenser had been infinitely large.

Automatic Volume Control

Now suppose we wish to add automatic volume control to the circuit of Fig. 4. Since point A is negative with respect to ground, we may connect it to the grids of as many tubes as we wish to control, the cathodes of which are at or near ground potential. This is illustrated in Fig. 5. Sometimes all the tubes except the oscillator and audio amplifier are so controlled. It is not uncommon to include the first audio amplifier if it is a variable-mu tube. This is not considered good practice however. Sometimes the last i-f. tube is omitted from control to prevent it from overloading. However, if r-f. pentodes are used in the i-f. the last stage may be controlled without much danger of overload. To prevent regeneration between stages, resistance-capacity filters are used as indicated in Fig. 5 by the resistors R5 and the condensers C3. Usually R5 is 100,000 to 500,000 ohms and C3 about 0.1 to 0.25 mfd. Now the action of the AVC is such that when the carrier is impressed on the set the gain is instantly reduced. If the carrier is suddenly removed however, the set will return slowly to full gain—for the case in Fig. 5 in about .25 second. This time of return to full gain

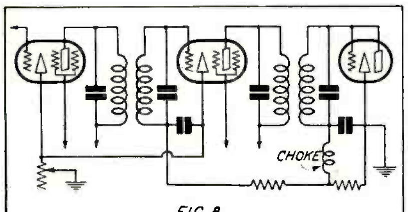


FIG. 8.

Means of altering bias so that sensitivity just reaches noise level for the AVC operation

is determined by the values of R5 and C3 or by what is known as the time constant of the circuit. The time constant of the circuit in seconds is equal to the product of filter resistance in ohms into capacity in farads. It is the combined time constant of the entire resistance-capacity filter with which we are concerned and which determines the effective time constant. In general a time constant of 0.1 to 0.25 second is used.

Typical AVC curves are shown in Fig. 6. Curve A is for maximum control voltage; i.e., with the control filter attached to A of Fig. 4. In considering these curves it should be remembered that AVC action simply amounts to reducing the sensitivity of the receiver further as the signal increases. Therefore the input-output curve (which is usually called the AVC characteristic) of the set will rise more slowly than without AVC until it reaches a certain point, after which it becomes nearly horizontal. Curve B shows a similar characteristic in which only a part of the voltage available for AVC is used. That is to say, the control filter is connected to some point between A and B of Fig. 4.

It will be noticed that since less control voltage is used the output rises somewhat faster as the input is increased, and as a result the point at which the audio amplifier overloads is reached sooner. Usually the maximum control voltage is employed. When the receiver is being tuned the gain will rise to maximum between stations. If the receiver has sufficient sensitivity a great deal of noise will be heard between stations. It would therefore be highly desirable if an AVC system could be developed which would rise instantly to full output and remain in that position.

Delayed AVC

This state of affairs can be approached very closely as shown by curve C of Fig. 6, through the use of delayed AVC. This is accomplished by placing a fixed biasing voltage in series with the diode. If this bias is poled oppositely to voltage developed by a rectified carrier, no signal will be heard until the bias is exceeded and the sensitivity of the set will not be reduced until the voltage is reached. Now the reason for the knee in each of these curves is that the gain of present-day tubes decreases rapidly until a certain point on the characteristic is reached, usually called cutoff, after which the gain decreases more slowly with control grid bias. Therefore if the delay bias is made equal to the so-called cutoff voltage, the desirable curve C of Fig. 6 will result. Obviously a signal of such value that its peaks operate the AVC will be distorted. This can be remedied by using a separate diode for detector and for control. Thus, a three-element tube may be used as shown in Fig. 7, or a tube such as the 2B7 may be employed which has two rectifier plates near the cathode. If desired, the maximum sensitivity of the set can be made variable as shown in Fig. 8. This is obviously very desirable since the maximum sensitivity of the set can then be adjusted until the sensitivity just goes down to the noise level. In such a case the noise between stations is small or entirely absent. Such controls have been used on a few receivers and you will probably see more of them as time goes on.

QAVC Circuits

QAVC or squelch circuits have also been used to some degree to eliminate undesirable inter-station noise. These circuits function by placing such a large blocking bias on the control grid of the first audio tube that no output results until there is sufficient rectified current to remove the blocking bias. Thus in Fig. 9, tube K is biased beyond cutoff, as indicated. The volume control rectifier removes this blocking bias when the rectified voltage across R1 is greater than the blocking bias. The chief disadvantage of this circuit lies in the fact that signals which are barely strong enough to remove the bias will obviously be badly distorted. To relieve this it has recently been proposed to employ a neon tube which will break down and remove the squelch bias only when sufficient voltage is developed to restore the audio tube to a bias sufficient to prevent distortion. These tubes are not on the market as yet but will probably be used shortly.

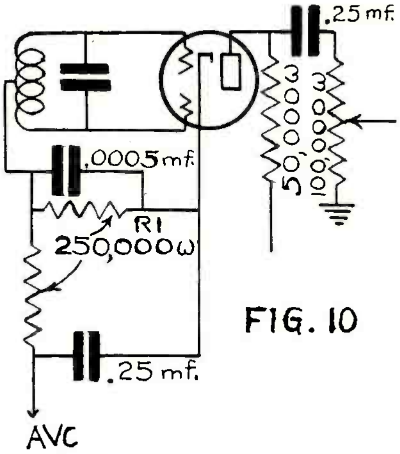


FIG. 10

Circuit for balanced input detector and automatic volume control

Balanced Input Detection

Fig. 10 shows the circuit of the Wunderlich tube which has a balanced input circuit. This tube performs the normal functions of detection, AVC and in addition contains the first stage of audio. One of its outstanding advantages lies in the fact that the incoming carrier is balanced out and the tube is not overloaded so quickly. The tube may be made to function as a power grid leak detector and as a result has high sensitivity as well as high output level. Full wave rectification takes place between the two control grids and cathode, the resulting voltage being impressed across R1 which usually has a value of about 100,000 to 250,000 ohms. This is shunted by a condenser of .0001 to .0005 mfd. The d-c. acts as an AVC source and as a bias for the triode audio amplifier. The audio is impressed on the two control grids in parallel and is thus amplified in the normal way.

G. S. Granger.

(To be continued)

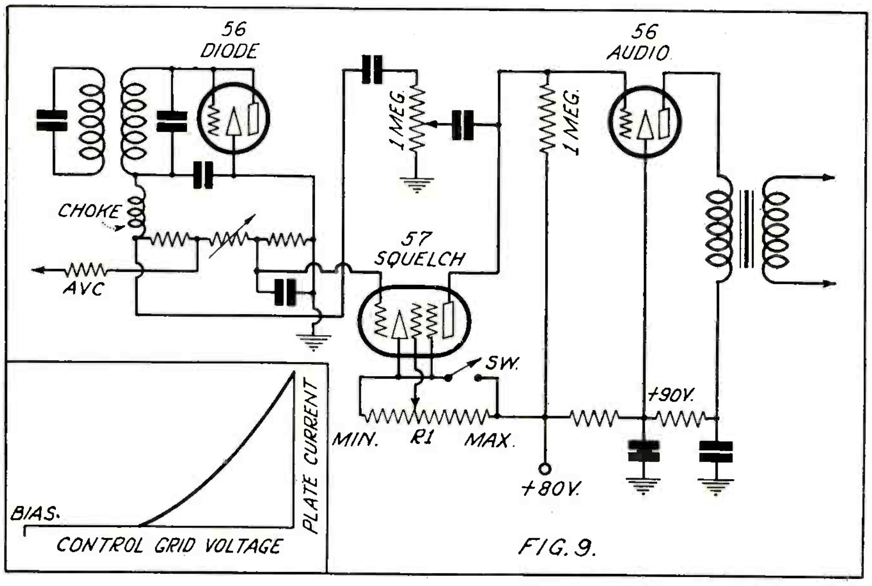
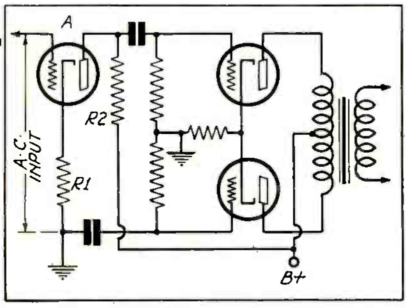


FIG. 9.

Typical QAVC circuit, with AVC diode detector and a squelch tube

Bridge-Type Push-Pull Amplifiers

Resistance-coupled push-pull amplifiers provide compactness and if properly designed have excellent frequency characteristics and can be made to function in true push-pull fashion.



Circuit of one bridge-type, resistance-coupled, push-pull amplifier

In the accompanying diagram, the voltage developed across the cathode series resistor R1 is practically 180 degrees out of phase with the voltage across the plate load resistor R2. By suitably proportioning the two resistors, voltages equal in magnitude but 180 degrees out of phase will be delivered to the grids of the push-pull tubes. Although tube A is shown as a triode in the diagram, a tetrode or pentode may be used with even greater advantage. Likewise, the output tubes may be triodes or pentodes working as Class A amplifiers.

It is pointed out that in general the heater of tube A must be connected to a separate winding on the power transformer.

In the circuit shown, the voltage applied to the grid of each push-pull tube was only one-half of the total voltage developed by the phase splitting tube. This means that the total audio-frequency gain is reduced by one-half, which may be insufficient amplification for some purposes.

Three other circuits are shown in the article, two of which employ output transformers with special windings.

(*L. Tulauskas, Electronics, May, 1933*)

New Tubes

As anticipated, there has been a general slowing-up in the release of new tubes. This has given the manufacturers as well as the Service Men a bit of breathing space.

Type 230 Special

Triad has taken the type 230 tube and changed the connections in order to reduce the inter-electrode capacity. It is known as the Triad Type 230 Special and has the plate of the tube connecting to the tube cap rather than to one of the prongs.

This tube is for use principally in short-wave transmitters and receivers, particularly around 5 meters, where the tube shows considerable improvement over standard tubes, due to its lowered inter-element capacity.

Raytheon Type 2A3

The Raytheon Type 2A3 is similar in characteristics to the standard 2A3 and is completely interchangeable with other makes. The difference lies in the emitter, which is of the indirectly-heated type. The standard 2A3 employs a multiple filament while the Raytheon 2A3 uses three heaters, three cathodes and three grids within a formed plate structure common to all three sets of elements—each cathode being tied to the mid-point of each heater. These elements are connected in parallel.

The connections to the tube prongs are, of course, the same as in the standard tube.

Raytheon Type 12A5

The 12A5 is a power pentode with a two-section heater. It is designed for two services. One is operation in a universal receiver operating on 110 volts a-c. or d-c. and also on a storage battery. In the case of 110-volt operation the two sections of the heater are operated in series and when used on a six-volt storage battery they are shifted in parallel.

The output of this tube on 110 volts is considerably greater than with any conventional 6.3-volt heater tube of the power type. With plate and screen voltage of 100 the output is 0.70 watt. With 180 volts the output is 2.8 watts.

Three of the tube prongs are used for the heater so that either a series or a parallel connection may be made. With series connection, the heater draws 0.3 ampere at 12.6 volts. With parallel connection the heater draws 0.6 ampere at 6.3 volts.

The other use for the tube is in automobile or home receivers, where about 200 volts are available for the total B supply. In the case of automobile receivers where efficiency is of paramount importance a self-bias resistor of about 850 ohms, together with a load resistance of about 6,000 ohms, are recommended. In the case of an a-c. receiver where ample d-c. power is available, a cathode resistance of 600 ohms and a load resistance of 4,500 ohms are recommended. In the first case mentioned the output power is approximately 2.2 watts and in the case of the home receiver, about 2.7 watts.

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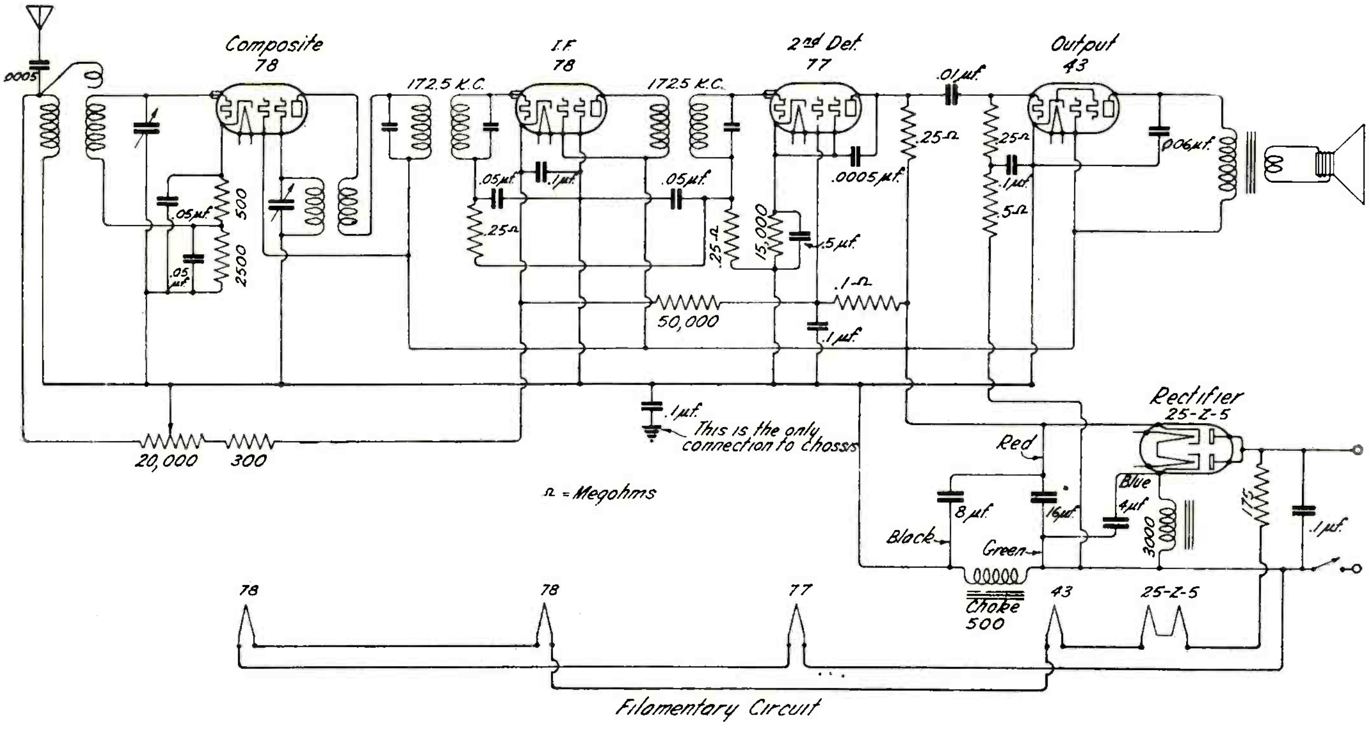
Emerson Model H-5 Super

The Model H-5 is a superheterodyne of the universal type employing a combination oscillator and modulator, one stage of i-f. peaked at 172.5 kc., a high-mu second detector and a power pentode in the output.

The heaters of the tubes are connected in series in the usual manner. The cathodes of the 25Z5 rectifier tube are used separately, one for supplying the 3000-ohm field of the dynamic speaker and the other for tube volt-

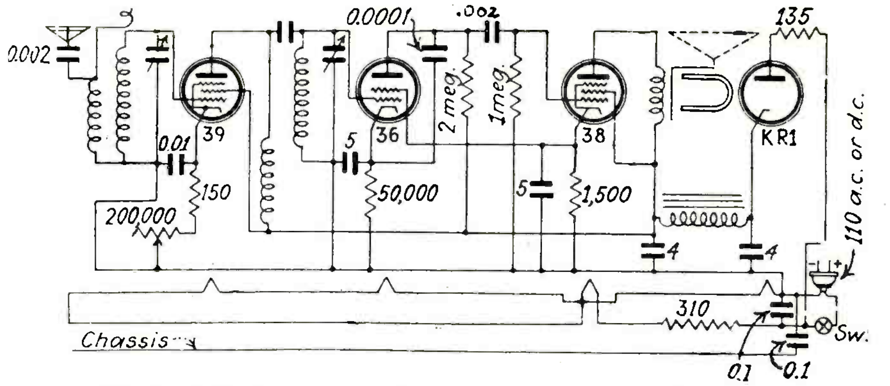
Schematic diagram of the Emerson Model H-5 super for a-c. or d-c. operation. The type 77 tube is a diode and pentode combined



ages. Note that there is a 500-ohm choke in the negative leg of the power supply.

Both inductive and capacitative coupling are used between the antenna and the antenna transformer.

The volume control is in the cathode circuit of the i-f. tube and in the antenna circuit. Its effectiveness is increased by bleeding more current through it than it would normally pass for the cathode of the i-f. tube. This additional current is fed to the volume control through the 50,000-ohm resistor connected in to the high voltage circuit. Other diagrams in this issue show the same or a similar arrangement.



Circuit of the International Kadette Universal tuned r-f. receiver

International Kadette Universal

The schematic diagram of the International Kadette universal receiver is shown on this page. It is a tuned r-f. job with both inductive and capacitative coupling in the antenna transformer, and capacity coupling in the r-f. transformer. All heaters, including that of the KR1 rectifier, are connected in series.

Volume is controlled by a 200,000-ohm variable resistor in the cathode circuit of the r-f. tube. This varies the bias on that tube.

Resistance and capacity values are given in the diagram.

Majestic Model 390 Super

The Model 390 chassis is used in the Model 393 receiver. It is a superheterodyne with a stage of r-f., separate oscillator and modulator, one stage of i-f., full-wave diode detector supplying automatic volume control and a triode section providing a-f. amplification. This tube (type 55) feeds a type 56 driver for the type 53 double Class B amplifier in the output.

The i-f. amplifier is peaked at 175 kc. The oscillator, r-f. and first detector trimmers are located on top of the condenser sections of the gang condenser. They are in the order mentioned when looking from the front of the chassis.

The 970-ohm speaker field is used as the filter choke. The filter condenser C1 has a rating of 305 volts, while the filter condenser C2 has a rating of 265 volts d-c.

The color coding for the power transformer is as follows:

Primary . . . . Stranded Yellow
Primary . . . . Stranded Yellow
High Voltage . . . . Stranded Red
High Voltage C. T. . . . . Stranded Black
High Voltage . . . . Stranded Red
Heater . . . . Solid Black
Heater . . . . Solid Black
Rectifier Fil. . . . . Solid Yellow
Rectifier Fil. . . . . Solid Yellow

The voltage data is given in the accompanying table. The readings are based on a line voltage of 115 and the readings should be taken with the volume control set at maximum.

MAJESTIC 390 VOLTAGE DATA

Tube	*Fil.*	*Plate*	*Screen*	*Cathode*	*Suppressor*
R-F.	2.3	265	95	6.5	6.5
Mod.	2.35	265	95	9.5	9.5
Osc.	2.38	98	. .	13.5	. .
I-F.	2.28	265	95	6.5	6.5
Det.	2.4	50*	. .	3.0	. .
Driver	2.41	262	. .	12.5	. .
Output	2.42	262**	262***	. .	. .
Rect.	4.9	320 A-C.			

* Triode plate only.
** Plate No. 1.
*** Plate No. 2.

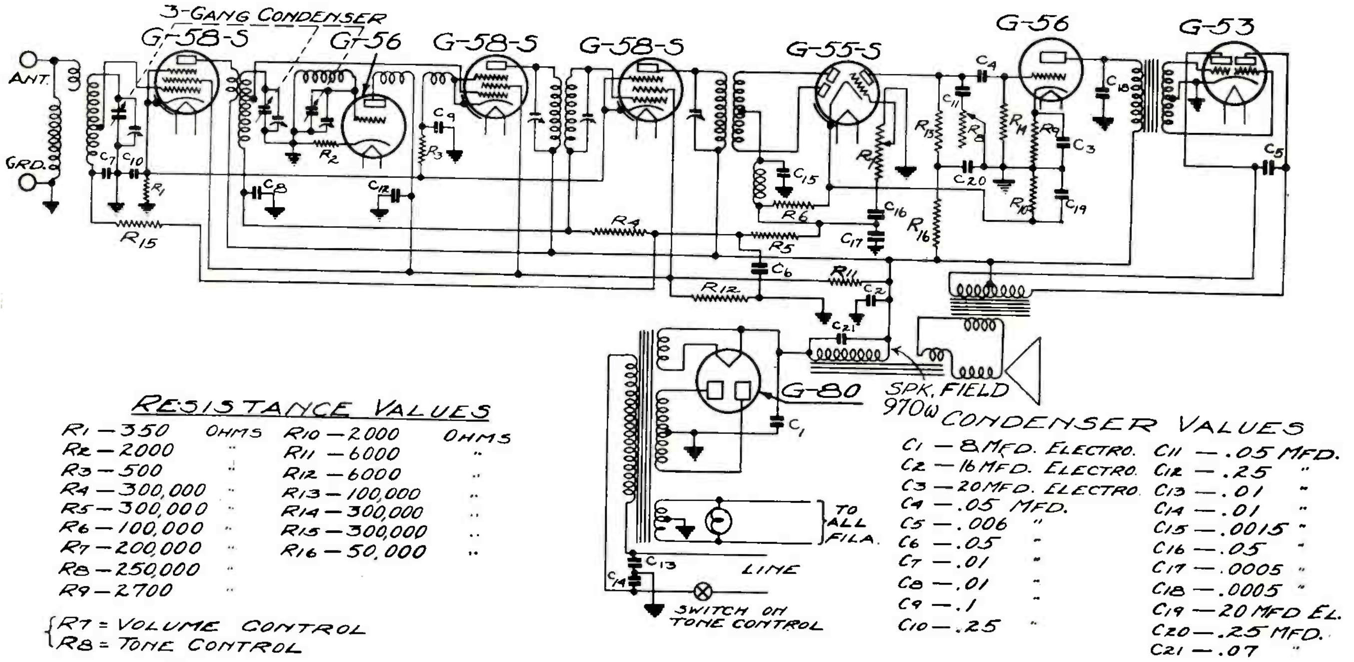


Diagram and values of the Majestic Model 390 super with a type 53 tube for Class B output

Public Address . . .

Grid Filters and Ripple

On page 63 of the February issue of SERVICE, your attention was directed to the use of grid filters for saving in the amount of capacity required to bypass the grid bias resistor in order to prevent degeneration. When this circuit is used with filament type tubes, proper adjustment of the condenser and resistor of the grid filter may often be used to appreciably reduce the a-c. hum introduced into the grid circuit by the filament. Let us take as an example a single type 45 power tube connected up as shown in Fig. 1. Since a center-tapped filament transformer is used, 1.25 volts of a-c. ripple is introduced into the plate circuit and a like amount into the grid circuit. Now if C1 is very large in capacity or if a suitable resistance is introduced at X, this ripple will be appreciably reduced. However, whatsoever ripple appears across C1 will be amplified by the tube and appear in the plate circuit. Since there is a phase reversal through the tube, this amplified ripple from the grid will partially or wholly subtract the existing ripple in the plate circuit.

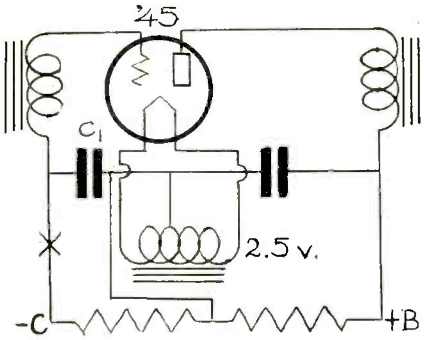


FIG. 1

A resistor inserted at point X will reduce ripple caused by the effect of the filament

It would appear then that if just the right amount of ripple were introduced into the grid circuit, complete cancellation of ripple would occur. Actually, just this can be done but there is a fly in the ointment—if the ripple is balanced out in this manner, the ripple from previous stages may not be. However, proper choice of circuit constants will often result in large reductions in ripple and if grid filters are to be used, we might as well use the best values of condensers and resistors in the first place.

Consider the circuit of Fig. 2. Here we have a single '45 tube with a grid filter. Now the relation between the circuit constants for ripple cancellation is:

$$C2 = \frac{\mu\, R2\ C1}{R2 + R3}$$

We know that the amplification factor of the '45 tube is 3.5. Suppose R2 is 1,000 ohms. C1 will necessarily be determined by the lowest frequency it is desired to amplify.

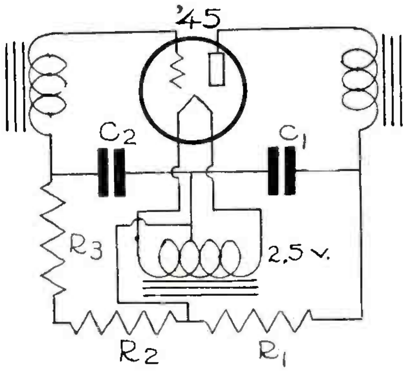


FIG. 2

The resistance R3 is for the purpose of reducing ripple. The value has a definite relation to the value of C2

A common value for C1 is 2 mfd. We can assign R3 any convenient value although it is evident that the larger R3 the smaller C2 will be. There is little to be gained by making C2 smaller than 0.1 mfd. and we must not make it too small or we may introduce a loss to low frequency signals in the grid circuit. Let us choose R3 as 100,000 ohms. We then have:

$$C2 = \frac{3.5 \times 1000 \times 2}{1000 + 100{,}000} = \frac{7000}{101{,}000} = \frac{7}{101} = .07\text{mfd.}$$

If R3 had been 200,000 ohms, C1 would be about .035 mfd. Now it usually happens that the values of C1 and R3 vary somewhat from the rated values due to manufacturing tolerances, and since it is hardly worth the while to carefully select either one exactly, it is usually best to try a number of condensers of approximately the right value for C2 until the one is found which gives the lowest ripple output. Thus if .07 mfd. were the calculated value, we might try several 0.1 mfd. and 0.05 mfd. condensers until the best results are obtained. The 0.1 mfd. condenser may be anything from .08 to 1.2 mfd. and the 0.05 mfd. condenser may be anything from .04 to .07 mfd.

Unfortunately we do not know the phase of the hum from previous stages of amplification introduced through the interstage transformer and even when the hum due to the power stage is reduced to a negligible value, this may mask the results or require some value other than that calculated for C2. If this is the case, it is often helpful to try reversing the primary of the interstage transformer.

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Calculation of Parallel Impedances

The chart shown here permits of rapid calculation of parallel impedances of like kind or of the effective capacity of series condensers. Thus the effective resistance of two or more parallel resistors or the effective inductance of two or more parallel chokes or the effective reactance of two or more parallel capacities, or the effective capacity of two or more series condensers may be estimated from this chart.

To use this chart, lay a straight-edge on the two resistor values, on say (a) and (c) and read on scale (b)—or on (d) and (b) and read on scale (c).

The dotted lines drawn in represent a calculated problem of three resistances of 4 ohms, 6 ohms and 8 ohms in parallel. Thus 4 ohms on (a) is joined with 6 ohms on (c), which indicates a parallel resistance of 2.4 ohms on (b). This value is in turn joined with 8 ohms on (d) which gives 1.85 ohms on (c). If the values had been 40, 60 and 80 ohms, then of course the answer would have been 20.4 ohms.

Now suppose we had two condensers in series, of 2 mfd. and 4 mfd. Then we would join 2 on scale (a) with 4 on scale (c) and read 1.33 (mfd.) on scale (b). This process can be continued indefinitely for any number of capacities or resistances.

All scales are divided into 100 parts to facilitate computation to three figures. If you wish to use a similar chart for more accurate calculation you can construct a large chart for the purpose and with a pair of dividers divide each scale into any equal number of parts. The scales should be laid out at angles of 60 degrees with each other.

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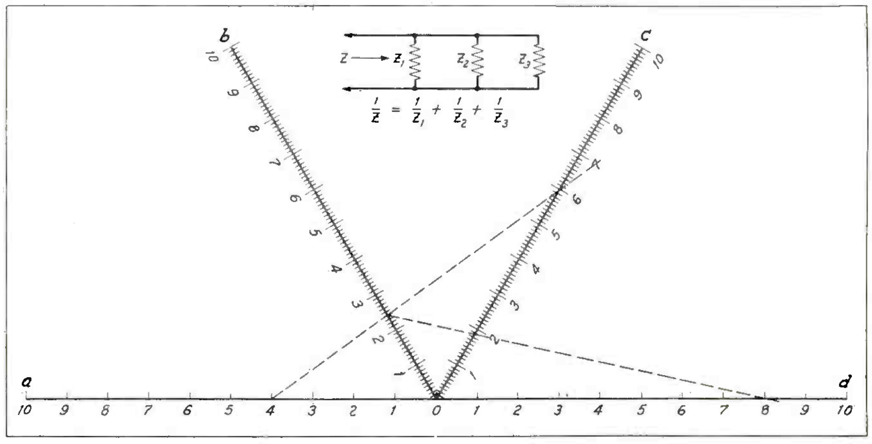
Petting Carbon Mikes

It frequently happens that a double-button carbon microphone becomes unbalanced due to mishandling, packing of grains, etc., so that the current through the two buttons is



With this chart it is a relatively simple matter to determine the resultant values of parallel resistances, series capacities, etc., as described in the text

widely different. If this difference is greater than about 30 per cent the quality is likely to be effected adversely. Sometimes unbalance is only apparent when the microphone is not in use, in which case the currents through the two buttons will be approximately equal when in use. If this is the case, there is no particular harm in the unbalance since it does not exist during operation. If an unbalanced condition is allowed to continue for any appreciable length of time, burning of the carbon grains may result which will necessitate the replacement of one or both buttons.

This condition may be remedied by petting the microphone after it has been disconnected from battery or power supply. This consists of gently tapping the edges of the microphone with one hand as it is slowly rotated with the other hand. Gentle shaking may also help to relieve the unbalance. Care must be taken not to tap the bridge or diaphragm at any time since this may result in a permanent injury to the microphone.

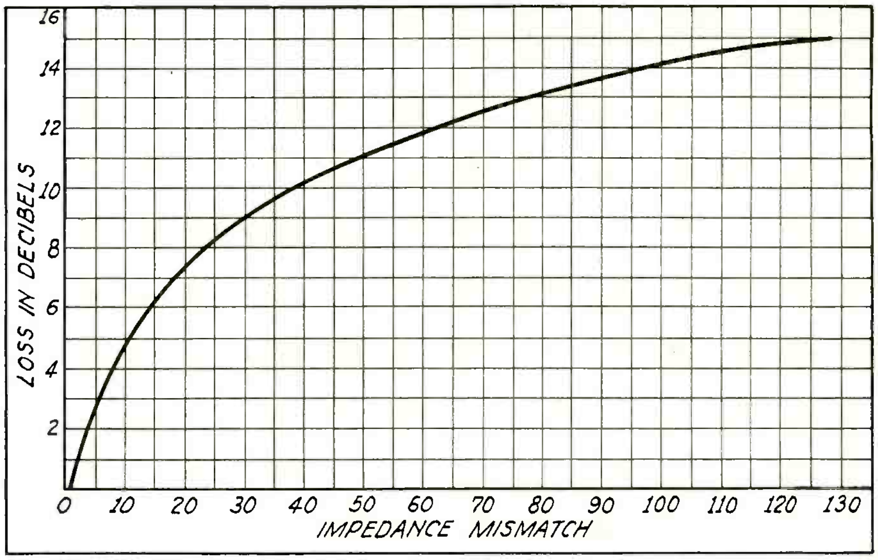
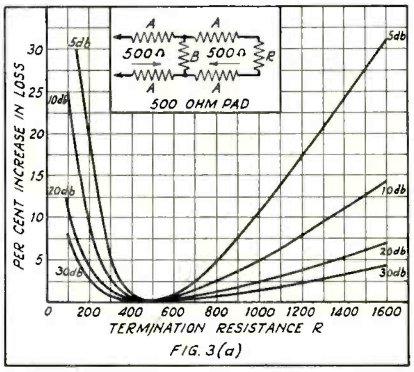


Fig. 2. (Above). A curve giving the relation between power loss and impedance mismatch. Fig. 3, a and b. (Below). Two charts indicating the losses in pads with various values of termination resistance

More on Resistance Pads

In the March issue (page 103) we told you how to design resistance pads both when the impedance on the two sides of the pad were equal and when they were different. The Table of Fig. 1 gives the resistance values for 200- and 500-ohm pads as derived from the curves previously given.

Now let us consider what would happen if we used a 500-ohm pad between say 500 ohms and 200 ohms. We know that if a 500-ohm amplifier is terminated in 200 ohms a loss will result, due to impedance mismatch. The magnitude of this loss is given by the curve of Fig. 2. Thus, we see that a loss of something over 1db. results from this mismatch. It would vanish of course if the proper impedance-matching transformer were used. However, it is evident that other errors will be introduced when a pad is mismatched, due to a larger or smaller current flow at the pad output terminals.



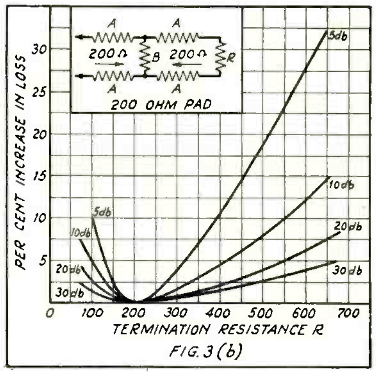


Fig. 3 shows the combined effect of these two losses which obviously depend on the loss of the pad. Thus, if a 500-ohm pad having a loss of 5 db. is terminated in 200 ohms, the loss will be increased 20 per cent, or will be 6 db. Had the pad a calculated loss of 30 db., however, the error would have been only 2.5 per cent and the total error would have amounted to about 1 db.

LOSS DB	VOLTAGE RATIO	500 OHM PAD		200 OHM PAD	
		A	B	A	B
1	.89	10	2000	5	720
2	.79	25	1750	10	650
3	.71	45	1400	18	560
4	.63	55	1050	24	440
5	.56	70	800	30	320
10	.32	140	350	54	140
15	.18	175	175	72	66
20	.094	215	100	82	40
25	.056	220	60	88	25
30	.032	240	40	95	15
35	.018	245	20	97	6
40	.01	250	12	100	2

FIG. 1.

Here is a chart giving the values of resistance for 200-ohm and 500-ohm pads with losses in decibels from 1 to 40

The curves of Fig. 3 illustrate the effect of impedance mismatch on both 500-ohm and 200-ohm pads. It is interesting to note that the loss of the pad is always increased by a mismatch termination regardless of whether the termination is too large or too small. In general such increases in loss will be negligible. However, in special cases they might be serious.

We normally think of lines or trunks as having an impedance of 500 ohms, but for short lengths, say up to 1,500 feet or so, this is not the case. The impedance of such short lines is determined entirely by the termination impedance. Thus, we may have 5-ohm and 50-ohm lines terminated in the voice coils of dynamic speakers, etc.

Now, the number of connected speakers determines the trunk impedance. If such a trunk is padded and the number of speakers changed, then the loss to the remaining speakers is proportionately increased. It is for this reason that the curves of Fig. 3 are given. In general, the increase in loss due to mismatch can be minimized if it is taken into account in design.

Auto-Radio . . .

Philco Models 6, 6F and 9 Supers

The circuit diagram and under-chassis layout of the Model 6 are shown on this page. The Model 6 with latest improvements becomes the Model 6F. The Model 6F is now a two-piece unit instead of having the customary three pieces. The new full-wave EF Vibrator is attached to the side of the receiver housing. Connections for this unit are given on page 182 of the May issue of SERVICE.

The Model 9 receiver is also similar to the Model 6, one exception being that the Model 6 employs a single type 41 power pentode in the output while the Model 9 receiver uses a type 79 double Class B tube in the output. There are other minor changes.

All three models employ an intermediate frequency of 260 kc. and the adjustment data given below applies to all three receivers.

It will be noted from the schematic diagram of the Model 6 shown in Fig. 1 that this receiver does not use the type EF Vibrator, but rather the Model EB Dynamotor. There have been a few complaints regarding receivers not operating, which, when investigated were found to be due to the dynamotor battery connections being reversed. The label pasted on the dynamotor base clearly shows the polarity of the "A" terminals.

The ground connection on the terminal panel must be connected to the terminal that corresponds with the polarity of the ground side of the battery. The battery lead must be connected to the terminal that corresponds with the live (non-grounded) side of the battery.

If connections are reversed at the battery, the shield lead will short the battery. If connections are reversed at the dynamotor, the polarity of the output (high voltage) side will be reversed. "B+" becomes "B—" and vice-versa and the receiver will not operate.

ADJUSTING I-F. STAGES

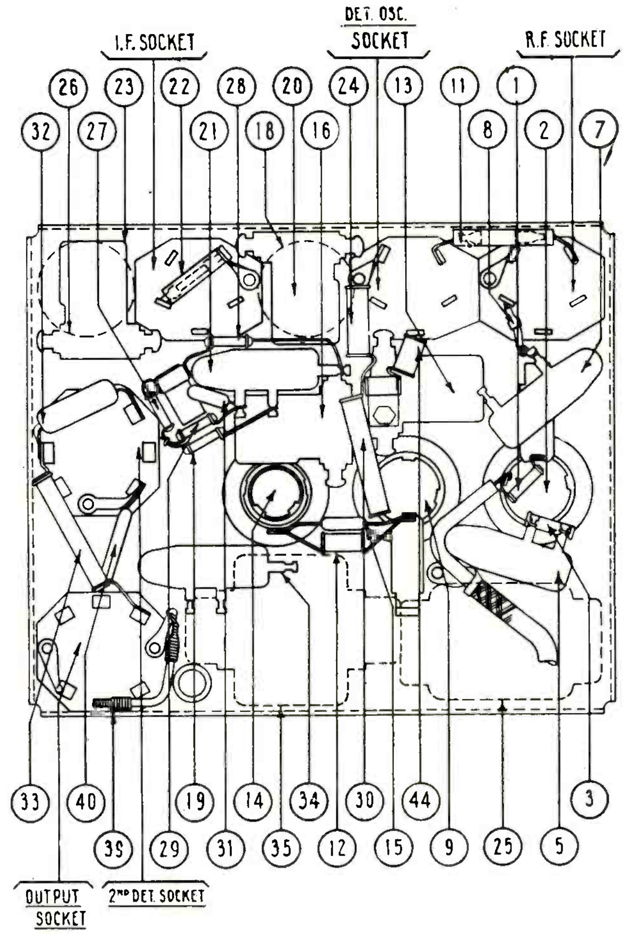
Remove the grid clip from the detector-oscillator tube and connect the output of the oscillator to the control grid.

With the receiver and oscillator turned on, set the oscillator for 260 kc. and adjust the oscillator attenuator so that the signal is barely audible with the receiver volume control turned on full.

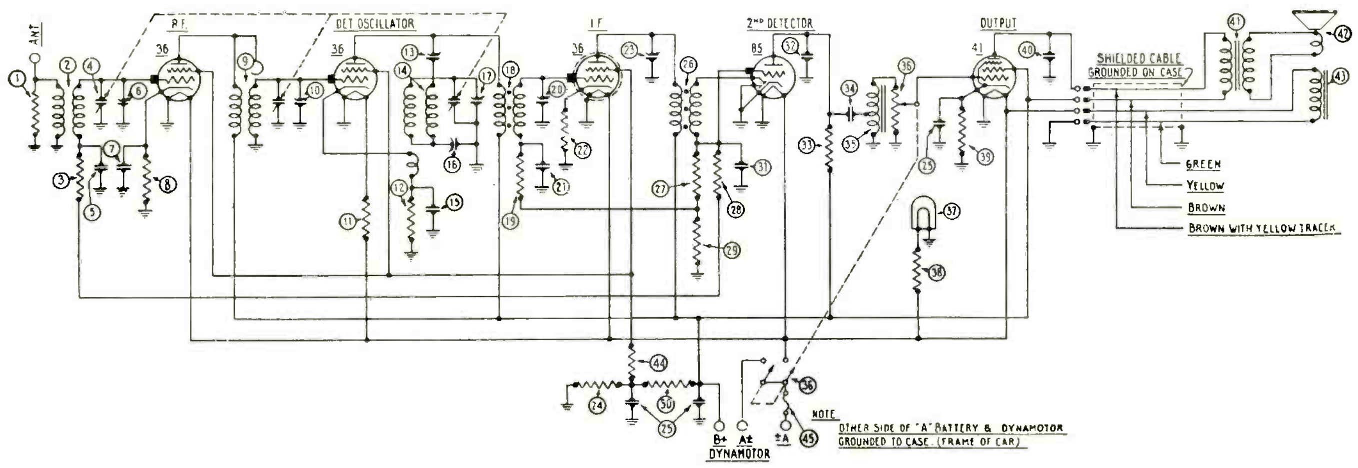
Now adjust the second i-f. condenser. This is numbered 23 in Figs. 1 and 2. The correct adjustment is obtained when the strongest signal is heard or when maximum output is obtained on the output meter.

Next adjust the secondary and primary i-f. condensers. These are 20 and 13 in the diagram and chassis layout.

Fig. 1, below, is the schematic diagram of the Philco Model 6 Superheterodyne. This circuit is similar to that of the Model 9. Fig. 2, right, is an under-chassis view of the Model 6. See legend below for values of parts



(1) Resistor, 5,000 ohms
(2) Antenna Coil
(3) Resistor, 100,000 ohms
(4) Tuning Condenser
(5) Bypass Condenser, 0.05 mfd.
(6) Compensator Condenser
(7) Bypass Condenser, 0.05 mfd.
(8) Resistor, 500 ohms
(9) Detector Coil
(10) Compensator Condenser
(11) Resistor, 2.7 ohms
(12) Resistor, 8,000 ohms
(13) Compensating Condenser
(14) Oscillator Coil
(15) Condenser, 0.007 mfd.
(16) Compensating Condenser
(17) Compensator Condenser
(18) First I-F. Transformer
(19) Resistor, 500,000 ohms
(20) Compensating Condenser
(21) Condenser, 0.05 mfd.
(22) Resistor, 500 ohms
(23) Compensating Condenser
(24) Resistor, 20,000 ohms
(25) Condenser, 0.25 mfd., 0.5 mfd., 8.0 mfd.
(26) Second I-F. Transformer
(27) Resistor, 100,000 ohms
(28) Resistor, 500,000 ohms
(29) Resistor, 100,000 ohms
(30) Resistor, 20,000 ohms
(31) Condenser, 0.00025 mfd.
(32) Condenser, 0.0002 mfd.
(33) Resistor, 50,000 ohms
(34) Condenser, 0.09 mfd.
(35) A-F. Transformer
(36) V. C., 500,000 ohms
(37) Pilot Lamp
(38) Resistor, 7 ohms
(39) Resistor, 700 ohms
(40) Condenser, 0.002 mfd.
(41) Output Transformer
(42) Cone and Coil
(43) Field Coil
(44) Resistor, 25,000 ohms



Disconnect the oscillator and reconnect the clip to the control grid.

High-Frequency Compensators

Connect the output of the oscillator to the antenna lead and the housing of the receiver. With the receiver turned on and the oscillator set for 1,400 kc., tune the receiver to 1,400 kc. (or set the oscillator for 175 kc. as the eighth harmonic of this frequency is 1,400 kc.). Now adjust the third padder on the tuning condenser for maximum signal or output. This is the one on the extreme left of the housing. The purpose of this adjustment is to line up the condenser so that 1,400 kc. is tuned in at 140 on the scale when the scale is set properly.

It may be necessary to adjust the first two compensators on the tuning condensers at 1,400 kc. in order to get a strong enough signal through.

After the detector-oscillator has been padded at 1,400 kc., adjust the first and second r-f. condensers on tuning condenser at 1,400 kc.

Now tune the receiver to 700 kc. and adjust the condenser 16 in Figs. 1 and 2. During this operation the tuning condenser must be shifted and the compensator must be adjusted to bring in the maximum signal.

After this has been done, check the adjustment of the high-frequency condenser at 1,400 kc. again.

Fada Model 101 (RK) "Motoset"

The "Motoset" is a superheterodyne employing seven tubes in the receiver proper and one tube in the "B" power unit, as indicated in the accompanying diagram. The receiver and power unit are contained in the same case, the speaker and tuning control being separate.

It will be seen that there is a stage of tuned r-f. in front of the first detector. A separate tube is used as the oscillator. The first detector feeds into a stage of intermediate frequency, the transformers of which are peaked at 175 kc.

A type 85 tube is employed in the composite functions of second detector, automatic volume control and intermediate a-f. amplifier. The triode portion of the 85 feeds two type 89 pentodes in push-pull and function as Class A amplifiers. The output feeds a dynamic speaker which obtains its field supply from the storage battery.

Power Supply

The power supply is interesting in that it is composed of a vibrator and transformer to provide a simulated alternating current. That is to say, the operation of the vibrator alternates the direction of storage battery current flow through the primary of the transformer. The transformer in turn provides the necessary voltage step-up and the resultant high-voltage alternating current is rectified by the type 84 rectifier tube. The output of the tube is then filtered. The power supply is turned on and off by means of a relay connected into the circuit of the set on-off switch.

Servicing Data

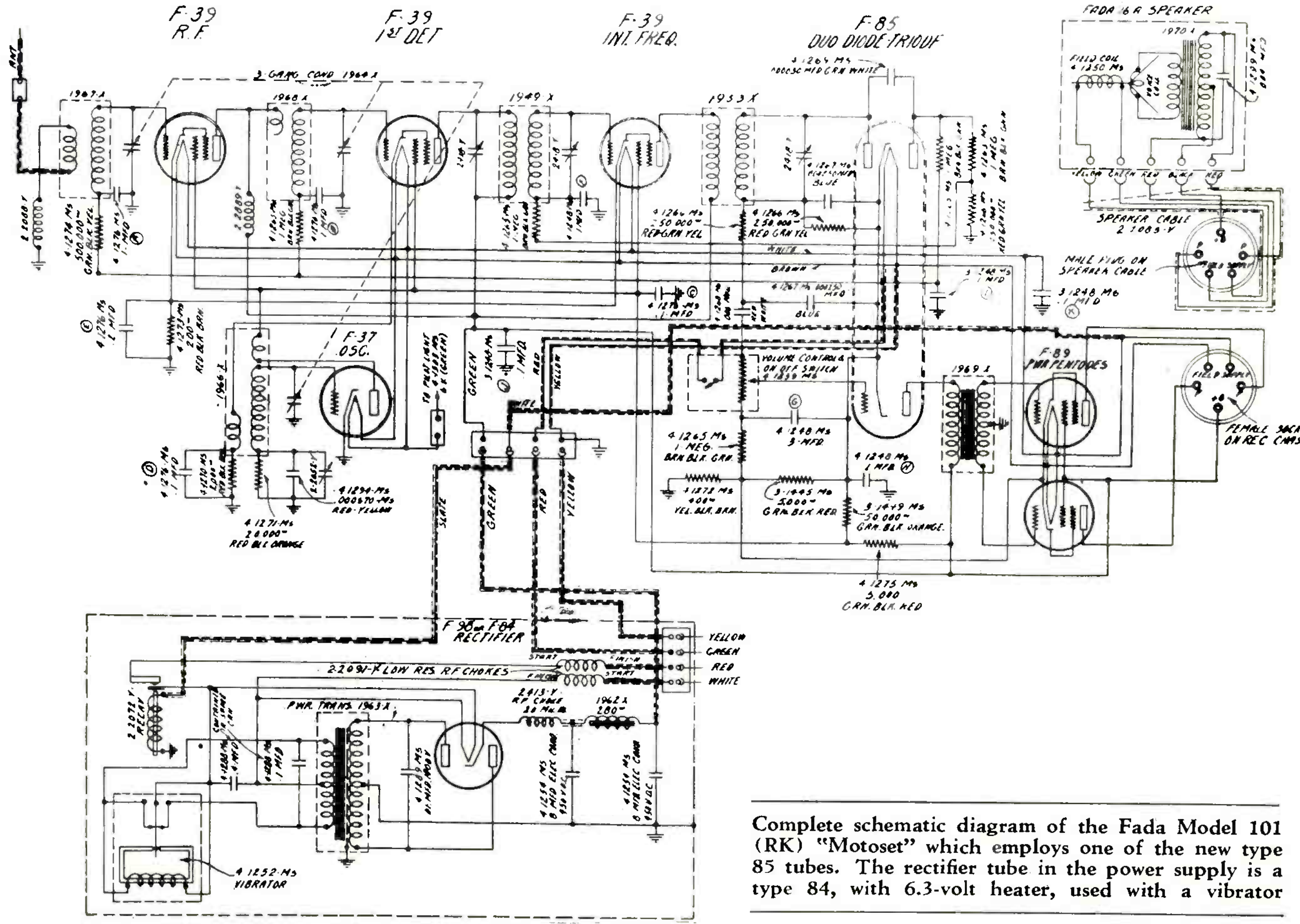
Unfortunately, no voltage data is as yet available, but the values of all parts are included in the circuit diagram. Take note of the fact that the fixed condensers marked A, B, C, D and E are in the same can, as are condensers F, G, H, I, J and K.

All shields in the set are grounded.

Motorola Models 88 and 61

The Galvin Motorola receivers Models 88 and 61 are identical up to and including the second detector. The audio systems differ however. The Model 88 employs a type 37 tube in an intermediate stage of a-f. and two type 38 tubes in push-pull in the output stage. The Model 61, the circuit diagram of which is shown herewith, has no intermediate audio stage and the type 85 second detector feeds directly into a single type 41 power pentode.

With the exception of the audio channels, the servicing data, parts used, etc., apply equally as well to both the Models 88 and 61. There is one other exception; the fourth tube or second detector in the Model 88 is interchangeable with the 6-prong automotive type Wunderlich tube, Sylvania 69 or 85 tube, or any other make of duo diode triode. When the Wunderlich tube is interchanged



Complete schematic diagram of the Fada Model 101 (RK) "Motoset" which employs one of the new type 85 tubes. The rectifier tube in the power supply is a type 84, with 6.3-volt heater, used with a vibrator

with the 85 the grid clip which is normally connected on the top of the 85 tube can be ignored by merely taping it up and tucking it behind the tube, so that it will not become grounded. In the Model 61, however, the type 85 tube is interchangeable only with tubes of corresponding numbers. The method of controlling volume in the Model 61 limits the adaptability of other types of detector tubes.

In either model the substitution of a type 36 tube in the oscillator-modulator socket will result in a five per cent decrease in sensitivity but a corresponding decrease in oscillator hiss. A further increase in sensitivity to make up for this may be gained by replacing the type 36 tube in the i-f. stage with a type 39 tube.

An Elkonode "B" Eliminator is employed in both Models 88 and 61. Upon removal from the set it can be tested by applying 6 volts to the large terminals with positive polarity to the brown wire and applying a 5,000-ohm resistor across the red (or green) and black wires, an 8 mfd. electrolytic condenser and a voltmeter. With this setup the Elkonode unit should consume not more than 2.25 amperes and the voltage drop across the 5,000-ohm resistor should be between 160 and 170 volts, provided the battery voltage is exactly 6.3 volts. Further data on the Elkonode, including internal diagram, will be found on page 146 of SERVICE for April.

If the buffer condenser across the secondary of the power transformer should be open it will be indicated by the failure of the BR tube in the Elkonode to stay ionized. Ionization is the bluish-red glow always characteristic of these rectifier tubes. A shorted .05 mfd. condenser will be indicated by a spasmodic operation of the Elkonode, as well as failure of the BR tube to glow. As a general rule in all power packs when spasmodic operation of the Elkonode is observed, it is always an indication that the Elkonode is not feeding into the proper load. It is either unloaded or overloaded and such a condition should not be permitted to continue as it will damage the unit.

If tests are to be made on either the Model 88 or 61, do not remove the chassis until the set is turned off. This also holds true for the BR tube.

The "A" supply is polarized, therefore fasten the red wire to the positive terminal and the white wire to the negative terminal. Check the polarity of the storage battery with a voltmeter.

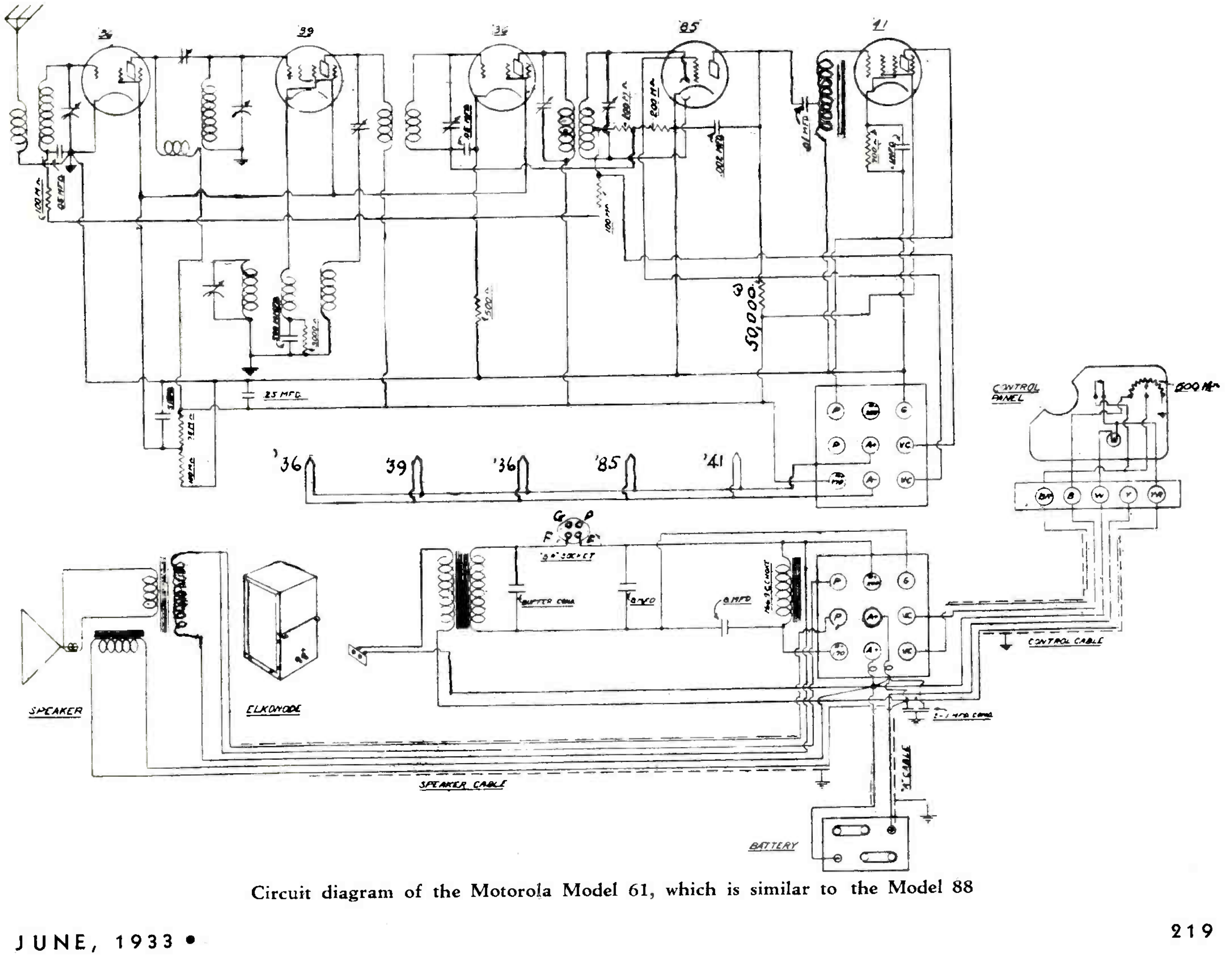
Do not operate the set with the "A" leads reversed as this will damage the Elkonode beyond repair. A reversal of the polarity of the "A" leads will indicate itself by low "B" voltage, spasmodic hum of the Elkonode or erratic flashing of the BR tube.

The voltage data in the accompanying table applies to both Models 88 and 61 with the exception of the audio end. In the Model 61 the type 41 pentode will draw somewhere around 17 ma. plate current and 3.0 ma. screen current.

VOLTAGE DATA FOR MOTOROLAS 88 AND 61

Tube	*Htr.*	*Plate*	*Grid*	*Screen*	*Cathode*	*Plate MA.*	*Screen MA.*
1st R-F.	5.8	180	0	60	3.4*	2.5	0.7
Mod.-Osc.	5.8	180	6	60	1.8*	2.0	0.3
I-F.	5.8	180	1	60	2.8*	2.5	0.3
Det.	5.8	30	0	..	..	1.8	..
2nd A-F.	5.8	38	2	..	..	0.7	..
'38 Pwr.	5.8	200	20	200	10.5*	8.5	2.0

Voltages given are average.
* With no signal.



Circuit diagram of the Motorola Model 61, which is similar to the Model 88

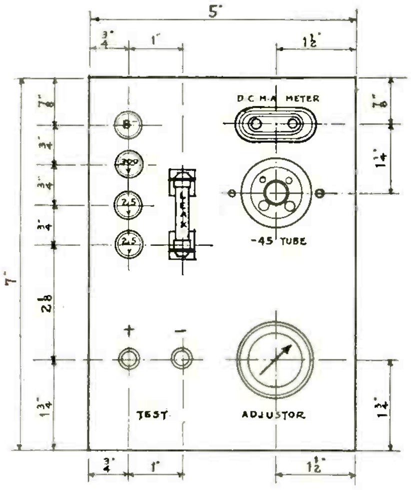
ON THE JOB . . .

Condenser Leakage Tester

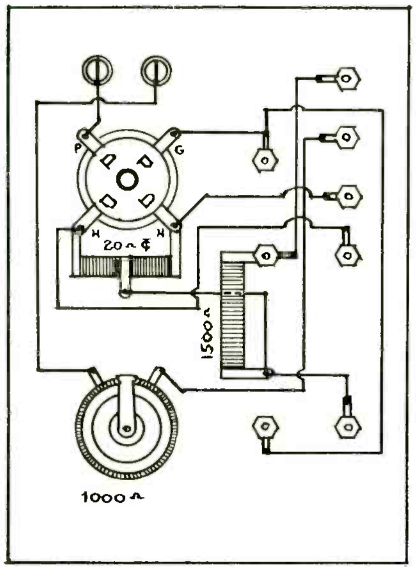
In the May issue of SERVICE, I was particularly interested in the Condenser Tester described by Carl Keppler, Jr. I have been using a similar device since last August and have found it to be A-1. In hopes that you may care to pass it along, I am giving the complete details on the unit I am using. There is nothing original about this as far as the writer is concerned, as I first saw the data in the August 20, 1932 issue of *Radio World*.

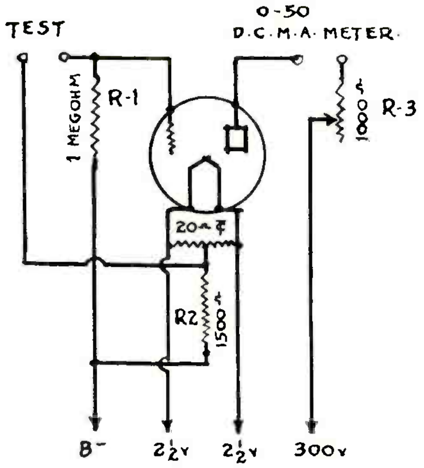
My own unit is built on a bakelite panel and mounted in a meter box. The box had enough space left for me to put a capacity meter alongside the Leakage Tester. You will note on the drawings of the unit that I do not use a separate meter but plug in the milliammeter of my set analyzer. The potentials for heater and plate I obtain from a power pack built by me for test purposes.

The panel is of 3/16" bakelite from which the shine is removed with fine steel wool and then rubbed to a satin finish with



Panel layout and wiring diagram for the Condenser Leakage Tester





Schematic diagram of the Condenser Leakage Tester, using a type '45 tube

powdered pumice stone and water. The lettering is done with white show card ink thinned with water to a consistency sufficient for it to run from the pen. After the ink is dry, go over the lettering with clear lacquer so that it becomes permanent.

John J. O'Mara.

(*The following abstract from* Radio World *explains the method of operation.—Eds.*)

With the tube operating, R3 is varied until the plate current meter needle comes to rest on any meter division, for easy reading. The test leads are then clipped to the terminals of the condenser to be tested. A sudden rise in plate current will ensue. This rise indicates that the condenser is not open and that it *is* a condenser and will accept a charge.

If the plate current rises to a very high value and stays there, the condenser is shorted. If the condenser is not open and not shorted the plate current will subside slowly, approaching the point of previous setting. The increase in plate current above the setting point, after stability has been attained, is a direct indication of the leakage current through the condenser.

Electrolytic condensers may be tested for uniformity and leakage just as outlined above for paper and mica condensers. Proper polarity connection must be made and recognition taken of the fact that electrolytics have a definite and rather large leakage. Electrolytics must be tested with much smaller values of R1.

•

Keeping Resistors in Order

Service work can often be speeded up by keeping resistors in an orderly file instead of piling them in a box or some other place where it takes much of your time to fish out the desired size.

A method which I find very handy is to place the resistors in rows, with their values ranging in order, on a large piece of cardboard, the size of which depends on the number of resistors put on. Holes are punched through the cardboard for the wire leads of the resistors to go through, and the leads are bent over toward each other behind the card.

Take a pen and mark on the cardboard the value of each resistor opposite its end. In most cases two columns of resistors on the cardboard will suffice, in which case the values can be written in two columns, one down the left edge of the cardboard and the other down the right edge.

Then when you want a certain value resistor, just scan the columns until you strike the right figure.

Incidentally, this method makes it easy to determine which sizes are out of stock by noting the values opposite the empty spaces.

U. V. Blake.

•

Adapter Marker

After straining my eyes and my patience in an attempt to find the holes in adapters and put them on the proper prongs on the analyzer plugs, I put a strip of paint a half-inch wide all the way up and down the adapters in line with the paint marker around the latch on the analyzer plug. Now it is easy to take hold of the analyzer plug with my thumb on the latch, turn the adapter around until the marker is uppermost—then snap, and they're together.

Robert G. Gedye

•

Source for D-C Sets

There is quite a good deal of direct current in our vicinity and consequently a considerable number of d-c. sets to be serviced from time to time.

We have a 220-volt, a-c. line coming into our building, that is, 110 volts each side of the neutral wire. I have rectified this with a type 83 full-wave mercury rectifier tube and secure a little over 90 volts d-c. under load. This is sufficient to operate very nicely the d-c. sets we get in for servicing, which are mostly A-K's with the tube heaters connected in series.

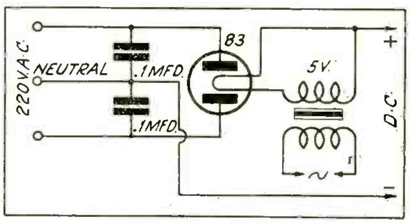


Diagram of type 83 rectifier used on a 220-volt a-c. line for supplying high current

In order to cut out radio-frequency interference from the type 83 tube, it is necessary to connect 0.1-mfd. fixed condensers between each plate and B—, as shown in the accompanying diagram of the complete arrangement.

I have used this layout for some time and it has worked out fine. It is surprising how much current the 83 will handle and how little voltage drop there is.

Ralph L. Bowers.

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Address ....

City .... State ....

THE FORUM . . .

Welcome!

Editor, SERVICE:

I was reading in the May issue that a Service Man of North Dakota wanted to know if you all had ever heard of a Radio Service Girl, since the girls seem to be doing everything else.

Well, I think they are few and far between, but I thought I would write and tell you that there is a Radio Repair Girl down in the state of old Virginia.

My husband runs a radio repair shop and when he gets extra busy with outside calls, I repair some of the sets he brings to the shop.

I have worked on a few sets such as Sparton, Philco and Majestic and have found the work very interesting.

I hope if other girls read of this they will take up radio repair, as it is very fascinating.

MRS. G. F. WALTON,
Norfolk, Va.

(*Many thanks for the nice letter, and welcome to the fold. If we hear from any girls interested in radio servicing, we'll give 'em your address, which we don't dare publish for fear "you all" would start getting fan mail from the boys.—The Editors.*)

•

From Mr. Freedman

Editor, SERVICE:

I certainly would have answered earlier, but couldn't spare the time between school and work.

I see absolutely no reason in going from the ridiculous to the grotesque! In the letter I recently wrote, I made no mention of the fact that your magazine catered to a flock of screw-driver mechanics. In my opinion, this type of mechanic merely makes the repair twice as long. You positively misunderstood my message and attacked it from the remotest angle in your editor's note.

In almost every edition of SERVICE, I can point out at least a half column where certain symptoms or peculiarities are found with some particular set now on the market, and its subsequent remedy. And all I suggested was that this particular feature be expanded to at least two pages! And in making this suggestion, I see no change in your policy! This suggestion was merely made to save the professional Service Man time on each one of his calls.

Coming in contact with many of these Service Men daily, I know that they are continually looking for the shortest and best way to repair a radio set to the satisfaction of the customer. The reason why this particular repair is so effective is merely secondary in their thoughts, whereas satisfaction to the customer is primary. Yes, this is the way the Professional Service Man looks at it!

Summarizing the results:

(1) Increased number of sales.

(2) Give a badly needed radio education to many Service Men, by reading the remainder of the issue.

(3) Save much time for the Professional Service Man in diagnosing certain peculiar symptoms.

(4) And make the name of SERVICE actually mean service in every sense of the word.

In closing, I wish to state that the only reasonable and sensible motive for your not wanting to expand this feature could only be in the fact that you do not wish to increase the scope of SERVICE, and wish to keep it within its confined bounds.

MONROE M. FREEDMAN,
New York, N. Y.

(*It is possible that we did misunderstand the main idea behind your original letter, just as we might misunderstand your statement, "I made no mention of the 'fact' that your magazine catered to a flock of screwdriver mechanics," which, of course, it doesn't. We recognize the value of such items as may pertain to faults characteristic of specific receivers. Naturally, we publish these. They are, as you say, time-savers . . . even for the trained man, though it would not take the trained man long to find the difficulty without the "tip." There is a limit to the number of such tips a man can keep in mind. Therefore their value is somewhat limited. Often it would take less time to locate the fault by test than it would to hunt (possibly in vain) for the data in a file. We publish these items, nevertheless, and may publish a greater number in the future providing the necessary space is available. Our readers have made it quite plain that the other data published is of more value to them. This, therefore, cannot be sacrificed.* —THE EDITORS.)

•

About Licensing

Editor, SERVICE:

I have been reading with much interest the letters and editorial remarks appearing in the last few issues of SERVICE, regarding the future of the Service Man.

The letter by Mr. J. G. Horsford, in the May issue, gives to some extent the writer's opinion. At present the Authorized Service Shop is required to have enough licenses to do business without having to obtain a permit or license from the Government.

On page 23 of the May issue of *Radio Retailing* appears an article regarding this same subject, together with an advertisement which the bona-fide Service Men of Houston, Texas, are running in their local papers. This, in my opinion, is the better plan to use in helping to educate the public to the view that there is a difference between the Professional Radio Technician and the "Gyp Radio Mechanic."

Another reason why I believe this plan to be a better one is due to the fact that a certain plan used might work out very well here, but not in some other city.

I do believe in the Service Men organizing and bringing to the front the fact that a radio tinkerer or any one who can read a tube tester is not a Professional Radio Technician.

Any practical plan which will benefit the Professional Service Man will receive my support.

H. H. TAYLOR,
St. Joseph, Mo.

•

About Ohmmeters

Editor, SERVICE:

No doubt most Service Men are in possession of a good voltmeter, both a-c. and d-c., of flexible enough ranges to obtain the various voltages encountered in servicing; but, as to a good ohmmeter, I wonder if some Service Men aren't still hoping that some manufacturer will put on the market an instrument flexible enough to cover the entire range of resistors encountered, possibly something on this order: One large type meter, scale 0 to 10 with selector switch to increase values in even decimals. For example, the various positions as follows: 0 to 10, 0 to 100, 0 to 1,000, 0 to 10,000, 0 to 100,000, 0 to 1 meg., 0 to 10 megs. The voltage to be obtained from the wall socket and some means provided for keeping or adjusting this voltage at a fixed value before entering the ohmmeter circuits would likely have to be adapted.

Of course, the price would have to be within reach of the average man.

I believe an instrument of this type would be attractive for its flexibility and simplicity. Of course, there are ohmmeters on the market today of very good design, but it seems that either the reading becomes very crowded on one end or they do not read in even decimals and require two or more scales, or that batteries must be carried around.

MAGNUS NORGREN,
Barksdale, Wis.

•

With Mr. Anderson

Editor, SERVICE:

I cannot say that I am in accord with Mr. Freedman regarding his letter published in the March issue, but I do most certainly agree with the viewpoint expressed by Mr. Anderson.

Mr. Anderson appears to me to be the only one with nerve enough to admit that he does not understand *all* that is published in SERVICE. Perhaps some of your correspondents are like "Andy" of "Amos 'n' Andy" . . . Oh, sho, sho! they understand it all—until they are asked to explain some of it.

It is my opinion that SERVICE should be written so that *all* of it can be understood by the average Service Man. Perhaps not Mr. Freedman's average Service Man, but the type who reads and wishes to learn. I admit (without shame) that I do *not* understand *all* that is published in SERVICE.

What we need is education and still more education. *That is why we buy* SERVICE.

CHARLES F. MACHIN,
Windsor, Ontario, Can.

(*Right you are. We have already admitted our fault and expect to reform.*—THE EDITORS.)

HIGHLIGHTS . . .

Radio Language

Some months back we mentioned a few of the definitions being employed by some Service Men, such as "flat tube." Now comes John A. Mayr, of Oakland, Calif., with a couple of good ones which he says are used by the fellows in his locality. This gang uses the word "thermovariant" for a tube with an intermittent heater. They refer to the measurement of resistance as "ohmalize" and the measurement of capacity as "faradize."

And read this, from M. K. Barber, of Fort Ethan Allen, Vermont: "The word 'flat,' whether used with tube or tire, is indeed short and suggestive, but does not indicate why it is flat as the words 'deactivated' tube or 'punctured' tire would do. There are a number of other defects which will prevent a tube from oscillating, as for example, loose heater contact (*flasher*), free grid (*floater*), poor vacuum (*gasser*), exhausted cathode (*sinker*), plate-to-grid short (*wrecker*), filament sag to grid (*sagger*), inter-element leakage (*leaker*), etc."

The above is a swell collection in itself, but Mr. Barber is not so sure that it is a good idea to use slang. Personally, we like it.

As a mimicry of medical terms he offers among a number the following: Laryngitis—off-center or open voice coil; Acidosis—electrolytic corrosion. And we like these, too. It's all a matter of opinion, we guess. Just the same, one of these days the Service Man is going to have a special vocabulary all his own. Wait and see. . . .

•

Tube Designations

Mr. J. R. Williams, Chief Engineer of Apparatus Design Company, has been good enough to call our attention to a discrepancy in the short note on tube designations appearing on page 152 of the April issue of SERVICE.

This particular item would lead one to believe that in the new method of tube numbering the last digit designated the number of terminals on a tube, whereas this digit designates the number of useful elements. For a full explanation, see the article on page 101 of the March issue of SERVICE.

•

W. U. Service

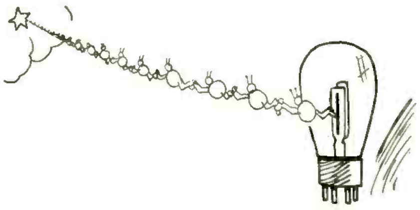
In New York City (certain parts, anyway) a set owner can call Western Union when his set goes gaflook and the first thing he knows a Service Man pops up at the door. Western Union takes care of all the details.

May we suggest that local associations throughout the country get in touch with Western Union about this for their own locality. It should help business.

•

Chicago Fair

We hear that the Century of Progress Fair is in full swing. It was started off, you know, by the light from the star *Arcturus*. Since it took the light 40 years to get here, it was kind of old, but still had



enough of the old "go" to stimulate a photo-cell into action.

George Lewis of the Arcturus Radio Tube Company doesn't think so much of this feat. He points out that, incredible as it may seem, much greater distance than this is attained by the electrons flowing inside a type '27 tube. Says he, "By computing the flight of these electrons it is found that in the period of one hour the distance covered, if placed end on end, would reach the star *Arcturus*."

Think of it! . . . and go nuts.

•

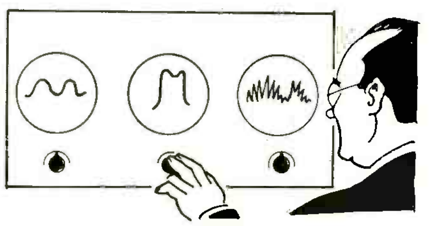
Bell Tel Dial Stunts

One of our scouts (yea—we got scouts) came back from the Chicago Fair and relates how Bell Systems is demonstrating the operation of dial phones to the visitors. You can put a call through to most any place free of charge—talk to the people at home—if you don't mind having half of the Fair listening in to your conversation. It's a big eavesdropping game and our scout says Chicago is still laughing over the guy who called his wife and got a bawling out for forgetting something or other. Half the Fair heard it—and another red face bit its lips.

•

Oscillograph Mysteries

One of the big features of the RCA-Cunningham exhibit at the World's Fair—we can't seem to get away from this thing—is a visual demonstration of what actually takes place in a radio set. With the aid of cathode-ray tubes, one may actually see the wave form as it enters the set, as it emerges from each radio-frequency stage, as it is



transformed by the detector, as it is built up by the audio-frequency amplifier, and as it finally emerges from the speaker. What a picture!

Well, this may be something like the servicing equipment you fellows will use in the future. Instead of reading voltage and resistance values, you'll read waveforms. Maybe we will be stating that an i-f. stage should have a 5-degree hump and the a-f. compensator a 10-degree valley. Who knows? By gar—we don't!

•

Comes the Revolution

There has been so much talk recently to the effect that speakers must have good sized baffles and will more than likely always require them, that we should like to let drop a little tip about a sort of revolutionary design in dynamic speakers. Seems that one of the smart boys decided some time ago that if a dynamic speaker were made right it could "grip" as much air as needed to transmit the low notes to the surrounding territory. This fellow has since developed a speaker which has plenty lows and no baffle to help it along. So small it can be moved around at will . . . put it where you

want it and let 'er rip. Hold it in your hand and hear the kettle-drums.

Some day soon you'll know all about it.

•

Police Calls

We hear from Philco that enterprising garage owners are installing short-wave receivers so they can pick up the police and airplane calls. When an accident occurs and is broadcast by headquarters, the garage owner already has a wrecking-car speeding to the scene to pick up a bit of business.

We have heard from another source that lawyers who make their living out of accident cases are doing the same thing.

Though not the same idea—why not keep a check with garages on accidents? Some of the cars are bound to have bashed radio sets needing replacement or repair.

•

Thar She Blows!

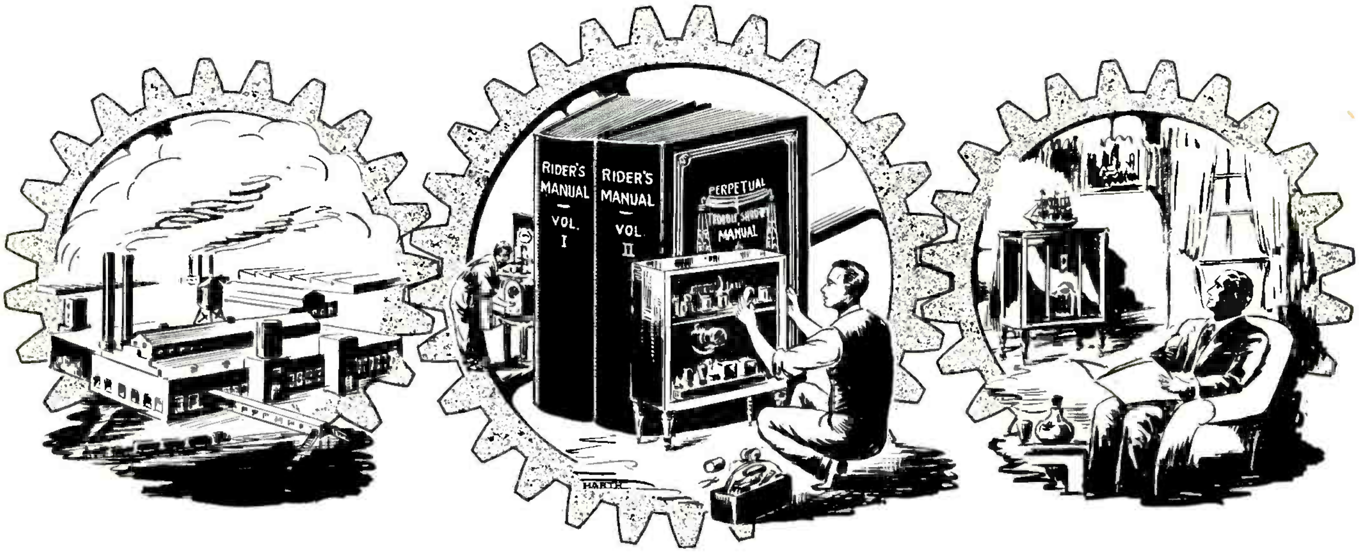
A set owner jumped from his car in front of my shop and asked me if I had a tube for his auto-radio.

Upon asking him what tube he wanted, he replied, "It's the one farthest south in my set."

My amusement was heightened when, upon testing, I found it to be the "north" tube.

—*C. L. Darner.*

(And was *his* face red.—Eds.)



ESSENTIALS IN THE RADIO INDUSTRY

THE SERVICE TECHNICIAN

is essential to progress in the radio industry. He safeguards the reputation of the radio receiver manufacturer and protects the investment of the receiver owner.

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RIDER'S MANUALS are as important to you as your testing equipment. Irrespective of what system you use—resistance analysis or continuity testing or voltage measurement, you require accurate service information in the form of wiring diagrams and service data. Your reputation as a Service Man depends upon how accurately you service a receiver. In order to work quickly and accurately you must have the correct service information as a guide. If this information is lacking, you cannot tell whether the units used in the receiver are correct—if the resistance values are correct—if the condenser values are correct or if the voltages at the tubes are correct.

THE INFORMATION YOU NEED—resistance values—condenser values—voltage values—wiring diagrams, etc., is found in RIDER'S MANUALS. The accuracy of this information—the great number of receivers included—the clarity of the presentation—are the factors which have made RIDER'S MANUALS the standard service reference guides in the industry.

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1100 Pages in Volume III

ONCE again we demonstrate to the Service Industry that when Rider prepares a service manual, presentation of the required information is most important.

The Service Man must be served. . . . Price is a secondary consideration. Detailed—accurate—up-to-date service information is what the service field wants and that is what you obtain when you buy a RIDER MANUAL.

The original announcement stated that Volume III would contain about 830 pages. When that number of pages had been printed, it was found that additional valuable information was available.

This additional data was included and the second announcement advised that Rider's Volume III would contain between 880 and 900 pages. . . . Investigation then showed that even this number of pages did not offer complete coverage of old and right up-to-the-minute receivers . . . because manufacturers had furnished more new information.

For example, Grigsby-Grunow forwarded information on their 116 auto radio receiver—Philco developed their AC-DC receiver—the 54. Atwater-Kent announced the 155, 636, 756 and 756-B. . . . RCA had announced the M-34 . . . etc., etc. "EVERY BIT OF UP-TO-DATE DATA MUST GO IN" was the verdict!

The result is 1100 pages in Volume III!

These 1,100 pages make Volume III the most up-to-date manual available and makes the grand total to be found in Rider's Volumes I, II and III about 3,000 pages!

These 1,100 pages in Volume III also contain the old receivers not shown in Volumes I and II, and contain such names as Radiotrope and the Sonora line available since the old Sonora Phonograph Co. ceased functioning.

WE PLANNED 830 PAGES AND DELIVER 1,100 PAGES! . . . EVERY PAGE VALUABLE—JUST WHAT YOU NEED AND WANT. . . . NO PADDING. . . . NO TEXT. . . .

Point-to-point and continuity test data with specific values of resistance are included for many manufacturers—many more than in Volume II.

Rider's Volume III is the *only* manual to contain a Chronological Catalog and Index of radio receivers manufactured and sold in the United States between 1921 and 1933. . . . This data is of tremendous value to the service field.

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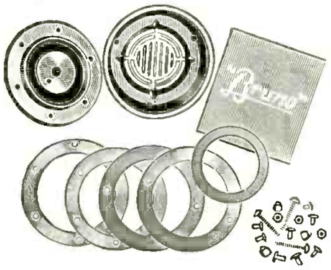
THE MANUFACTURERS . . .

Bruno Condenser Microphone Kit

Bruno Laboratories, 20-26 West 22nd Street, New York, N. Y., are marketing a complete kit of parts for the construction of a condenser microphone. It is claimed that the parts constituting this kit are made with micrometer accuracy and tested thoroughly before shipment.



This kit of parts can very easily be assembled into a microphone with only the use of a screw-driver. It is packed complete with instructions and also the hook-up for an efficient two-stage amplifier to provide the proper gain.

•

Shallcross A.C. Utility Meter

The Shallcross Manufacturing Company, 700 Parker Ave., Collingdale, Pa., have brought out a very interesting A.C. Utility Meter (No. 685) which will provide a-c. voltage measurements and a wide range of impedance measurements using the 110-volt, 60-cycle commercial power line. In order to make the instrument of maximum value, the impedance ranges are calibrated in inductance, capacity and resistance. As a result, it is claimed that any of the following voltage, capacity, inductance and resistance ranges can be obtained.

A-C. Volts (1,000 ohms per volt), 10-125-500-1,000; Resistance, 25-50,000-500,000-5,000,000 ohms; Capacity, 0.0005 to 0.1-1-10 mfd.; Inductance, 0.5 to 100-1,000-10,000 henrys.

The No. 685 A.C. Utility Meter can be purchased complete or in kit form for those who wish to do their own building.

•

Acratone Auto Amplifier

Federated Purchaser, Inc., 23 Park Place, New York, N. Y., have developed a triple push-pull auto amplifier known as the Acratone Model 770. It is designed to operate directly from any 6-volt storage battery and has the motor-generator incorporated right in the amplifier unit. This machine supplies 320 volts at 100 milliamperes to the amplifier.

The first push-pull stage uses two '36 tubes, the second stage two '37 tubes, and the last stage two '42 pentodes. The undistorted output of the amplifier is given as 7 watts.

The amplifier is equipped with a built-in microphone and phonograph matching transformer which matches any single or double button mike. It is also possible to match the impedance of most any type pickup.

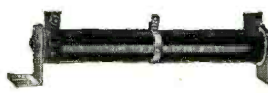
The output of the amplifier is tapped for connection to a 9-ohm voice coil, a 15-ohm voice coil, a 500-ohm line or to a 4,000-ohm magnetic speaker.

•

Aerovox Adjustable Pyrohm Resistors

Aerovox Corporation, Brooklyn, N. Y., announces a new Adjustable Pyrohm Resistor especially designed for use as a transmitting grid leak in connection with standard tubes, and also in other circuits wherever adjustable heavy-duty resistors or voltage dividers are required.

These resistors are the wire-wound type, on porcelain tubes, the wire being coated



with a vitreous enamel. A strip of the wire windings is left exposed along the length of the unit so that contact may be made by means of an adjustable slider to obtain any resistance value from minimum to maximum value. A scale marked on the side of the unit permits setting the slider to any desired resistance tap without having to take meter readings for resistance values.

Standard resistors are made in values ranging from 5,000 to 100,000 ohms and rated at 200 watts. All units are 1 3/16" in diameter and 8½" long.

•

Continental Auto Suppressor Kit

Continental Carbon, Inc., of 13,900 Lorain Avenue, Cleveland, Ohio, is now supplying replacement auto-radio ignition suppressor kits for 4-, 6- and 8-cylinder cars, complete —including one Continental "Certified" Suppressor for each spark plug lead and for the

high tension lead from the ignition coil to the distributor. Each suppressor is individually packed in cellophane for the sake of protection.

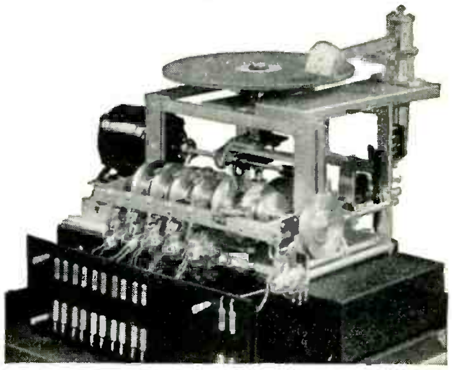
A metal-enclosed generator filter condenser, especially designed to withstand heat and vibration, is also included in each kit.

The resistance element of Continental Suppressors is pressure molded and fired at high temperatures to assure permanence of resistance value. An Isolantite housing for the resistance element is used in place of the usual form of molded unit. This serves as a protection against heat, oil, moisture, etc.

•

Operadio Automatic Synchronizer

A new automatic phonograph and synchronizer, called the Operadio Talk-A-Lite, is announced by the Operadio Manufacturing Company, St. Charles, Ill. This device automatically synchronizes voice and sound effects on a phonograph record with changing lights, mechanical movement, or other electrically-controlled animation.

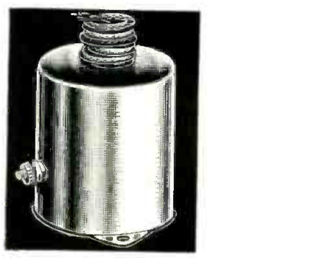


The Model 53-6 Talk-A-Lite can be ordered to play 3-, 4½-, 6-, 9-, 12- or 15-minute recordings. The pick-up arm, actuated by the turntable mechanism, restores itself to the starting point after each playing.

•

Eljer "No-Tenna"

The Eljer Manufacturing Co., 212 W. Kinzie Street, Chicago, have developed an inexpensive substitute for indoor or outdoor antennas, utilizing a ground connection foi reception. This unit is called the "No-Tenna."



A glance at the accompanying illustration shows that the unit is well shielded and therefore is not apt to pick up local man-made interference.

Index of Monthly Literature

All articles listed on this page are cross-indexed for your convenience. Titles given are not necessarily the titles of the original articles, but in each case serve to determine the substance of the article. Listings marked with an asterisk (*) are abstracted in this issue. The material in each issue of SERVICE is alphabetically indexed on the Contents Page.

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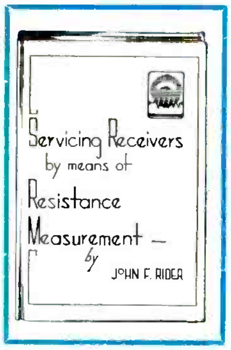

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More and more of the radio service managers and engineering staffs in the large receiver manufacturing plants concur in the statement made by Rider that modern receivers with their tricky circuits require resistance measurement method of servicing.

Servicing Receivers by means of Resistance Measurement by Rider is the only clear and concise exposition of this method of servicing. It was the first to discuss point-to-point methods and is the best.

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Not only is *Servicing Receivers by means of Resistance Measurement* a clear explanation of actual application of the point-to-point system, but it also gives you a clear insight into resistance problems as experienced in radio receiver design.

A thorough understanding of this book will not only give you the information you require about today's receiver, but you will be prepared for whatever changes are made upon future receivers.

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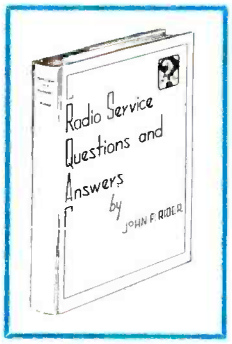
Now is the time! . . . Send for your copy today.



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