May 1940

Radio SERVICE DEALER

SOUNDMAN ★ JOBBER

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Radio SERVICE-DEALER

SOUNDMAN AND JOBBER

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VOL. 1 No. 2 ★ MAY, 1940

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Transients

PORTFOLIO . . . There appears in this issue the first section of our newly-instituted Technical Service Portfolio. An additional section will be published each month.

The purpose of the Portfolio is to promote better servicing. Through its text will be presented such subjects as, the most practical and efficient methods of testing, alignment and measurement, and pointers on the use of servicing equipment to the best advantage.

In another sense, it may be said that the purpose of the Portfolio is to increase the profits in servicing. Nowadays, a profit on a repair or alignment job often hinges on the rapidity with which the serviceman can trace faults or balance circuits; and future business on his ability to be precise in his work. These capabilities, in turn, are dependent upon method of attack, the precision and flexibility of the servicing equipment employed, and how intelligently the serviceman uses the equipment.

What the field obviously needs, and will eventually get, is something akin to production testing and alignment—equipment and methods that will provide a rapid detection of faults, and equipment and methods that will insure speedy and precise overall circuit adjustments, with the slow, step-by-step measurements eliminated.

In line with the foregoing, this month's section of the Portfolio deals exclusively with a new approach to the technique of trouble shooting—servicing by signal tracing. Though the system was introduced some time ago, it has not been given the attention nor the coverage to which it is entitled. It is of definite importance to every serviceman and should be given his serious consideration.

★

SOUND JOBBERS . . . Commercial Sound is a highly specialized business. Sound and intercommunication equipment cannot be sold with the same ease as radio receivers and components, nor on the same basis. Its distribution can be carried out successfully only through organized effort. To move sound equipment, one must move himself, for the potential buyer seldom seeks the supplier.

Moreover, selling the equipment is only half the deal; the other half involves the technical aspects, which are equally as important. The sound system must be properly installed, have adequate coverage, be free of distortion. These are responsibilities the supplier must assume.

To sell sound effectively, then, the supplier himself must be a crack salesman and a sound expert, or he must employ the services of men who have these abilities. It is highly improbable that he will be able to do all the work himself in any event, unless his business is confined to a small town.

In cities, where opportunities are more favorable, it is difficult to escape the opinion that, if the most is to be made of the commercial sound business, it should fall to the Parts Jobbers, who are in a position to set up well-organized Sound Departments, with sales and technical staffs. A few have tried it, and have been highly successful, but there has been a natural hesitancy on the part of many to go into Commercial Sound since it has been the province of the serviceman. That's a nice sentiment, and we'd support it fully if we thought for a moment that it was the most profitable arrangement for everyone concerned—especially the serviceman. But we don't.

The fact remains that the average serviceman is *not* a crack salesman, and even if he were, the time and effort required to sell a few sound jobs is more than he can usually afford to devote to it, if servicing is his bread and butter. So long as he remains a professional serviceman, he cannot do full justice to the potentialities of the sound-equipment market in his locality.

However, the Parts Jobber can, and if he devotes his efforts to selling and cooperates with the serviceman to the extent of turning over to him the installation and maintenance of the sound systems he, the jobber, sells, then both parties will make more in the long run. Or, if the serviceman is to sell, why not the jobber carry the stock, and the two share profits on any business the serviceman brings in?

★

PREFERRED TUBES . . . Comparing RCA's "Preferred Tube Types" program to the successful standardization programs of other fields, including automobile headlamp bulbs, spark plugs, batteries, etc., the RCA Manufacturing Company has prepared a booklet explaining to jobbers, dealers and servicemen the long-term benefits to them of the program to standardize receiving tube types.

The plan is to reduce the 470 existing types to a mere 36 basic types which will fill the need of design engineers for practically every type of radio that can be built. The results of a survey indicate that 90 per cent of all tubes sold are included in only 90 of the 470 types now extant and, further, that only 20 basic functions are performed by these 90 types.

Concentration of tube types to a preferred list will enable jobbers, dealers and servicemen to realize greater profits from a faster turnover resulting from a larger movement of fewer tube types. It will mean that customers who buy radios using them will be building a renewal market around a small group of tubes that will be much more profitable to handle and sell than the present large inventories.

The fate of the plan rests in the hands of the tube companies and the set manufacturers, but we wish to throw in our moral support for what it is worth. We trust our readers will do likewise, for if the plan becomes effective, it is sure to be of benefit to all of us.

★

DRY CELLS . . . It would be equally as beneficial to the jobber, the dealer and the servicemen if something were done about the A and B battery situation. Here, as in the case of tubes, there are far too many types, and the seller is forced to carry large inventories of a product that has a definite shelf life.

Of course, portables are a new venture, so there is some excuse; until set manufacturers are able to stabilize designs to the point where some degree of dry-cell standardization is feasible, there is not a great deal that can be done. In the meantime, all we can do is hope that the set makers will offer to cooperate on some plan similar to the preferred tube-type scheme.

However, the matter is inexcusable when a set manufacturer deliberately adds to the confusion of types for no other purpose than to hog replacement battery sales. Since this is a free country, the plan is not altogether effective, and one can purchase standard makes of replacement dry cells that will fit the Philco portables. But it would be nice if this company would cooperate for a change. There is such a thing as carrying the Lone Wolf idea too far.

EDITOR

INSTANTANEOUS

PART I

★ The serviceman can no longer afford to ignore instantaneous recording. It's big business today and will be bigger tomorrow. Most of the equipment is in the hands of laymen who can't be expected to keep it in first-class order. That's where you come in. There's also money in a sound-recording service. Don't skip that either. Here's the first of three articles.

THE perfection of instantaneous recorders of the professional, semi-professional and home types, has opened up a new field for the application of sound-recording devices. Because of the immense proportions of the potential market, the question, "Who's interested in recording?" has become, "Who isn't?"

It is natural that the serviceman and the service-dealer should have a stake in this field, and for the same reasons that he has a stake in the public-address business. The identical sales, rental and maintenance opportunities are presented, with the additional possibility of instituting a sound-recording service, which many servicemen have already done.

But decidedly more to the point is the fact that the serviceman and the service-dealer are important to the business if the equipment in the hands of laymen in schools, voice-culture and music studios, police departments, hotels, night clubs and homes, is to be properly maintained. The equipment is too thinly and widely distributed to make it feasible for the sound-recorder manufacturers to undertake its direct servicing.

It is the purpose of this series of articles to present to the serviceman and the service-dealer the fundamentals of good instantaneous recording, and data on the trouble-shooting and servicing of the recording equipment.

THE RECORDS

A discussion of recording may well have what seems to be a backward approach. In other words, the result is considered before the elements of the recording system that produce the results. The result is, of course, the record and unless sufficient attention is paid to it, the perfection of the equipment that produces it will be for naught. It should be noted here that instantaneous records differ from commercial phonograph records in several respects. Phonograph and other commercial recordings are shellac compound pressings made from chromium or nickel matrices in hydraulic presses under careful control of pressure and heat. The resulting record is quite hard and extremely resistant to wear. Although it is hard and durable, it is extremely brittle and easily cracked or broken. Instantaneous records are quite soft in comparison, but their durability is at least as good as the cheaper grade of phonograph record when treated with proper care, and are not easily broken. The comparative tone quality depends almost entirely on the recording equipment used and the intelligence that is devoted to the technique of recording.

Fig. 1. Steel styli cut V-grooves, as shown at A. The sapphire and alloy styli cut U-grooves, as shown at B. Both are good.

One very disagreeable characteristic of the phonograph record has been its high scratch or surface noise level. The consumer has had little or no control over this and has been forced to accept it as one of the penalties of listening to "canned music." Such is not necessarily the case with the instantaneous record. By careful attention to a few details when the record is being made, the surface noise can be reduced to a negligible quantity, and with a little extra care in storage of records, this lack of background noise can be preserved indefinitely. Because of the reduced scratch with all of its unpleasant characteristics, tone quality may be said to be improved, although its frequency response may show little, if any, improvement.

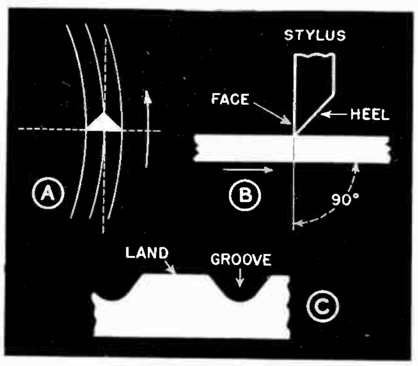


Fig. 2. (A) Position of stylus in relation to groove. (B) Angle of stylus in relation to record surface. (C) The groove and the land should be about the same width.

Recorded volume in commercial recordings is extremely variable. Although it is not practical to cut instantaneous records at the volume of dance records made for the "Juke Box" or coin-operated phonograph, the volume is under the control of the operator at all times and can be standardized or varied to meet his own taste and requirements.

RECORD MATERIAL

Previous to the consideration of the mechanics of recording, it is well to consider the type of recording material that is available for instantaneous use. The term "acetate" has been kicked around from pillar to post and back again. There is no true acetate disc on the market, to the writer's knowledge. Cellulose-nitrate sounds dangerous and it is. Yet it is the basic ingredient for all except a very few of the discs offered for public use. The records themselves are not actual fire hazards, but the shavings or threads that are cut out when the record is made are highly inflammable. An air-tight container should be provided in which to place the thread immediately after a record is cut. A few fires caused by carelessness can do much to discourage instantaneous recording.

All recording discs are not inflammable, and it is important to know which ones are and which ones are not. At the present writing, most non-inflammable records are not quite as good as the nitrate types in several respects, but have the virtue of being safe. The best grade of nitrate record will not dry out with age, has practically no surface noise and can be recorded and played back several hundred times without excessive wear. Its frequency response characteristic is good to at least 8000 cycles.

With all records, dust and careless handling have been the greatest enemies. Instantaneous records are more easily scratched than pressings and collect dust and dirt more readily. It is important that they be treated with the same care as a roll of film.

THE RECORD "CUT"

A record blank is cut by engraving a continuous spiral groove with a stylus that is shaped quite similar to the cutting tool on a machine lathe. The record groove is in general V-shaped and is quite minute in its proportions. The width of the "V" is never more than

Sound Recording

By F. H. GOLDSMITH

six-thousands of an inch and there are usually about 100 grooves to the inch. That means that on a 10-inch record there are approximately 350 concentric spiral grooves that, if stretched out, would be about 596 feet long.

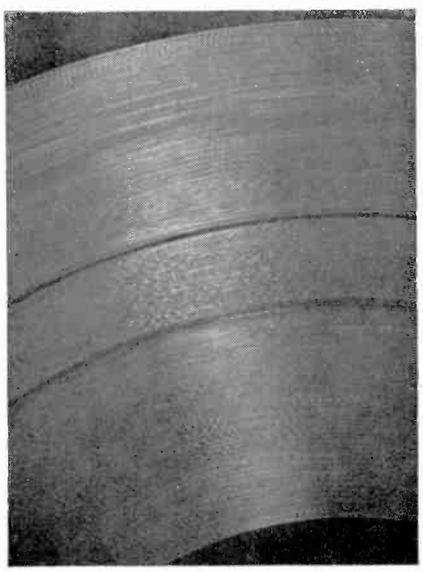
A properly shaped groove, instead of being a true V, as shown in Fig. 1A, has a radius on the bottom to properly fit the radius of the reproducing needle, as shown in Fig. 1B. This is only true of the grooves recorded with the sapphire or one of the alloy styli. The steel recording stylus has no "point" radius because it must be made cheaply so that it can be discarded after its useful life is exhausted by becoming dulled. The sapphire and alloy styli may be re-sharpened many times before they must be discarded and are probably cheaper to use in the long run. The V-shaped groove that is cut by the steel stylus depends for its lack of surface noise on the fact that, although the reproducing needle does not fit the groove exactly, it is securely held at the intersection of the "point" radius of the needle and the sides of the "V".

STLYUS ADJUSTMENTS

In order to fully realize the possibilities of instantaneous records, too much attention cannot be paid to the correct recording stylus adjustment. There are three primary adjustments; horizontal and vertical angles and cutting depth.

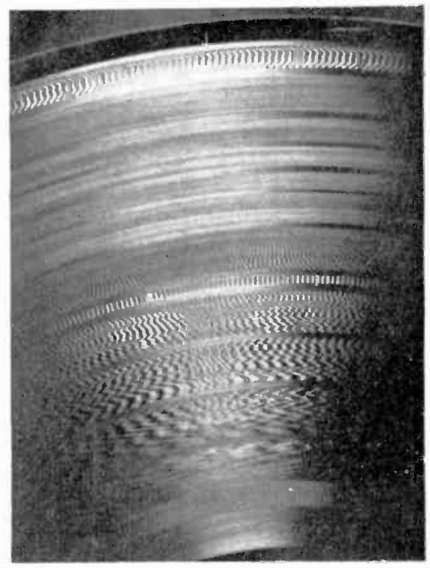
The horizontal angle is the angle between the face of the recording stylus and the imaginary center line of the record groove. When it is properly set the face of the cuttinfg stylus is in direct line with a radius of the record blank, as shown in Fig. 2A. The manufacturers of recording heads and styli attempt to make this adjustment automatic by securely clamping the flat on the front of the stylus shank in a position to insure the thread being thrown clear when a record is being made. The thread must always be thrown toward the center of the record and not to the outside.

Outside band: Modulated grooves of music recording. Center band: Pattern created by excessive 120-cycle amplifier hum. Inside band: Pattern caused by 60-cycle hum in amplifier.



Appearance of "twinning". Instead of being evenly spaced, the grooves occur in pairs with little wall between them. Grooves are apt to cut over at first playback, causing a "repeat".

The vertical angle between the stylus and the record is controlled by the operator and is the included angle between the record surface and the edge of the stylus facing in the direction in which the record is rotating, as shown in Fig. 2B. This is the cutting edge of the stylus. The purpose of varying this angle is to reduce surface noise and to prevent the cutting tool from "chattering" instead of cutting a clean groove. The most useful range of adjustment lies between vertical and 10 degrees less than vertical for a steel stylus, and from 5 degrees greater than vertical to 10 degrees less than vertical for the sapphire and alloy stylus, both of which have a bottom radius. The sapphire can be allowed to "dig in" slightly because its cutting face offers a more uniform resistance to the record material, due to the radius on its "point" which offers a greater surface area.



A frequency record viewed under an ordinary light. The width of the pattern is determined by the efficiency of the recording head at any frequency. Frequencies recorded here, 50 to 7000 cycles.

The cutting edge of a recording stylus is extremely sharp and should not be mishandled. A dull recording stylus makes a good recording impossible of attainment with the best of recording equipment.

The depth of cut on most present-day recorders is controlled by spring tension on the recording head bracket which counterbalances the weight of the assembly. The correct depth of cut is important to insure maximum record life and quality. The best way to insure proper cutting depth is to examine the record grooves and the thread that is cut from the record. Inasmuch as a calibrated microscope is seldom available, it is necessary to depend on visual observation of the ratio of the groove width to the wall or "land" remaining between grooves. With no sound applied, the groove and the land should be about the same width, as shown in Fig. 2C. A ratio of 60 percent groove to 40 percent land is the ideal maximum. With this adjustment, the thread cut from the record will be of about the same thickness as a coarse human hair.

The foregoing stylus adjustments have been discussed individually, but they do not so operate. Each one depends on the other, and if one is changed, the others change with it. Changing the vertical

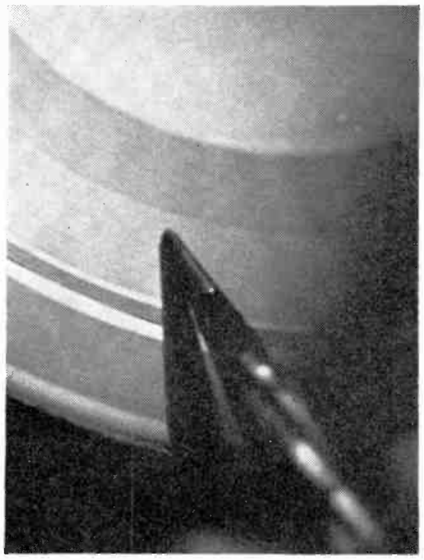
Well-spaced grooves except where they are cut too deeply, as in darker band in second group where spiral shadow appears. Shadow would show as series of coarse spirals if continued across entire record. This is indication of turntable rumble that reproduces as a low-pitched hum.

angle necessitates a change in the depth adjustment, and changing the depth adjustment may call for the selection of a new vertical angle to prevent chatter or to reduce surface noise.

PROPER AND IMPROPER CUTS

Disc recording is not an embossing process, and for that reason the cutting stylus must remove material cleanly and uniformly. The cleaner the groove, the quieter the record. When record grooves are good and the disc is held under a light, the recorded portion of the record has a greater lustre or brilliance than the uncut portion. When the grooves are below standard, the recorded portion will be dull, and in the case of the familiar black records will have almost a "gray" appearance.

Thus far only "silent" grooves have been discussed. The recorded volume on instantaneous records should be limited to a point well below the possibility of causing over-cut grooves. The most popular record for home use is very soft and is subject to a "cold flow." The stylus, in addition to cutting this type of material, *pushes* the material in the direction it is moving laterally. If two grooves run too close together so that there is insufficient wall between them, this "push" of material occurs from one groove to the other. This develops an "echo" if the sound is pushed into the succeeding groove or a "ghost" if pushed into the preceding groove.



Another photo of record having considerable turntable rumble.

No standards have ever been set to express the volume of a record electrically, so it can only be determined by observation or playback. There are definite advantages in having a maximum of sound volume on the record to the extent where it can be properly reproduced. The louder the sound is recorded, the lower the apparent surface noise.

In tone quality comparison there must be set up some standard. The commercial phonograph record should serve the purpose very well. Then it can be said that a record has commercial quality or is superior, or inferior, to it. This comparison can be further sub-divided into classifications as to tone quality, signal-to-noise ratio and durability.

There are further considerations that have to do with record quality that deserve attention. None of them necessarily are evident in examination of a record, but are functions of the operation of a complete recording device. To be complete a recorder must make the record and play it back. Its speed must be *absolute* and at either 78.26 r.p.m. or 33 1/3 r.p.m.

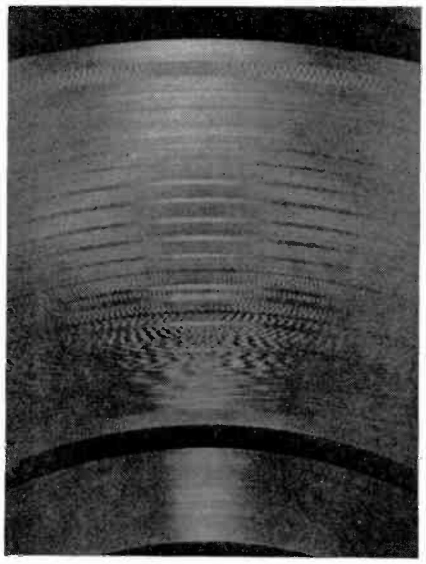
MAKING RECORDINGS

Making a good record is not all mechanics. In the home, certain problems are prevalent; in the schoolroom, others, etc. A recording machine cannot be considered as a single piece of apparatus as it utilizes the same equipment as the public-address system except that the sound is fed into the recording head instead of the loudspeaker. Microphones must be placed with the same, if not more care, and intelligently operated. No microphone can produce any semblance of tone quality if it is placed closer than two feet from the voice or music being recorded. The acoustic conditions of the

(Turn to page 21)

FAULT-TRACING CHART

FAULT	VISUAL TEST	OTHER TESTS
Speed Fluctuation	None	Record and play back sustained piano tone. Trace source of "wow." Play phonograph record to determine whether wow is in recording only
Hum	Record pattern of low freq. sounds	Isolate amplifier hum from recorder hum by removing cutter head leads and recording "silent" record
Turntable Rumble	Record pattern can be same as above. Usually pattern shows herringbone or similar type of varying groove depth	Repeat tests as above to be certain turntable is at fault. Look for slippage of drive wheel if rim-drive. Be sure cutting head is free to move on its pivots without excessive play or binding
High Surface Noise	Record grooves dull in comparison with uncut portion	Install a new stylus and correct adjustments
Low Volume Records	Low amplitude of sound grooves	Make usual tests on audio equipment. Some types of recording heads will deteriorate with age



Appearance of good recording. Inside band, silent grooves. Outside band, 50 to 7000 cycles.

TECHNICAL SERVICE PORTFOLIO

SECTION I

SERVICING BY SIGNAL TRACING

THE efficiency of signal tracing as a means of localizing obscure faults in radio receivers has now been firmly established. Yet we doubt very much if the full advantages of this new test method are generally realized, much less utilized. In part this is due to a somewhat hazy knowledge of the manner in which signal tracing instruments function, in part to insufficient knowledge of what constitutes normal performance in the circuit under test and finally, inadequate comprehension of the test method itself.

As a method, signal tracing is based upon the hypothesis that the only conclusive test of any tube or circuit is one which is made under the actual operating conditions present in the receiver when a signal is being received. To make the necessary tests, signal tracing instruments have been designed which enable the signal to be checked at any desired point in the receiver without interfering with the performance of the circuit under test. Normally these tests are made by feeding a signal to the antenna and ground posts of the receiver and by examining this signal as it progresses circuit by circuit, stage by stage, through the receiver. If at any point along this path the signal becomes noisy, takes on hum, is weaker than it should be, or is distorted, then the fault is immediately localized to some component which affects the performance of that particular stage, since stages which follow will merely amplify the trouble. Means are also provided in signal tracing instruments to check the d-c voltages and power consumption of the receiver. The circuits employed in all channels are conventional and are designed to enable all necessary tests to be made with the utmost possible speed, accuracy and convenience.

The channel layout of a typical signal-tracing instrument is shown in block diagram form in Fig. 1. This may be considered as being representative of a number of types of different manufacture. Some have fewer channels, some employ a built-in speaker, one uses meters in all channels while another employs electron-ray tubes as indicators. No matter what departures from the channel layout shown are incorporated in any particular instrument, the purpose and the application are the same as the one shown.

THE R.F.-I.F. CHANNEL

As shown in Fig. 1, this is essentially a three-stage tuned r-f "receiver" covering a range of from 95 to 1700 kc in three bands. The average gain of this channel is about 100,000 so that a 50-microvolt signal at the input grid will produce a 5-volt signal at the diode detector, sufficient to operate the indicator and to enable the use of phones when a listening test is desired. It is also possible to plug an oscillograph in the output jack so that distortion in any r-f or i-f circuit may be visually observed.

The input circuit is provided with a capacity attenuator, so that the relative signal levels at any points under test may be compared. The gain of the signal from one point to another may then be directly determined. This attenuator functions in connection with a special capacity probe, which will be described later, and operates in conjunction with a calibrated level control which varies the cathode bias of the first amplifying tube. Though the average gain of the amplifier may vary normally about 2 to 1 as the frequency to which the channel is tuned is varied, the fact that the cali-

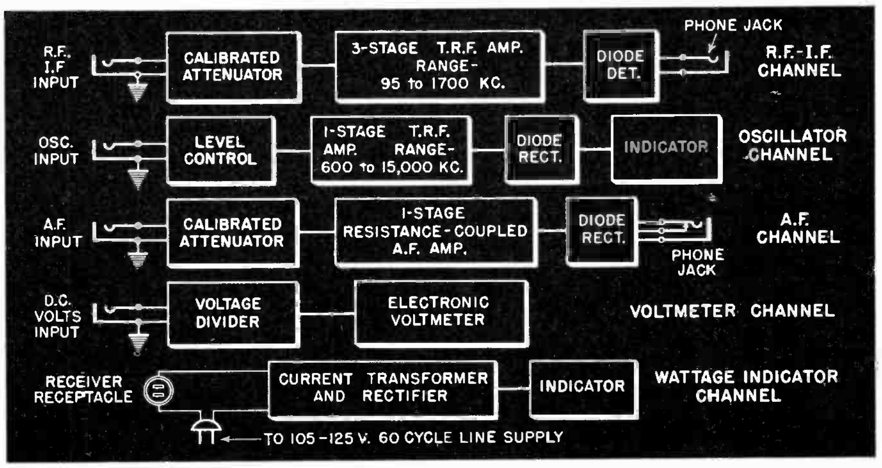


Fig. 1. Block diagram of composite signal-tracing equipment.

brated controls are in the input circuit makes the gain measurements at any one frequency independent of the variations in gain of the amplifier. The only effect of a decrease or increase in gain at any one frequency is that a stronger or weaker reference signal level will be required when making gain tests between any two points. When making measurements in circuits where two differing frequencies are present, such as in conversion gain checks, variations in gain at the two frequencies being checked will affect the readings but this variation, in carefully-designed instruments, is not of sufficient magnitude to affect the usefulness of the channel for the purpose intended.

THE A-F CHANNEL

This consists essentially of a high-gain, single-stage resistance-coupled amplifier which feeds a diode rectifier. When an a-f signal is applied to this channel, the amplified signal across the tube plate load is capacity-coupled to the diode rectifier and a rectified d-c voltage is developed across the diode load. This rectified voltage is used to actuate the channel output indicator.

Phones or an oscillograph may be plugged into the output jack provided, so that any distortion present in the signal being checked will be heard or seen. When so used, the diode load is cut out of the circuit to avoid introducing distortion because of the loading effect of the diode on the positive half of the wave.

A calibrated control and multiplier is employed in the input circuit, enabling audio voltages over a range of from 0.1 to 1000 volts to be checked. By this means, the gain in any a-f circuit may be measured.

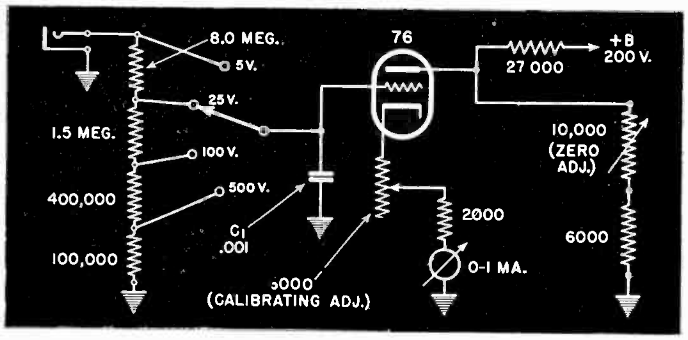


Fig. 2. Diagram of a typical electronic voltmeter such as used in conjunction with signal-tracing equipment.

THE OSCILLATOR CHANNEL

The oscillator channel is not an oscillator; it is a tuned r-f receiver similar to the r.f.-i.f. channel, but employing a single-stage amplifier rather than a three-stage amplifier. It is not as sensitive as the r.f.-i.f. channel since high sensitivity is not required. The purpose of this channel is to enable a check of the operating frequency of the local oscillator in a superheterodyne receiver, which normally supplies a strong signal.

This channel operates over a frequency range of from 600 kc to 15,000 kc. When its probe is connected or placed adjacent to an oscillating circuit and the channel dial tuned to the frequency of the oscillating circuit, an indication is obtained. If the oscillator drifts, this is manifested by a change in the indication. The frequency to which the oscillator has drifted, and thus the magnitude of the drift, may be determined by retuning the channel dial to the point where the original indication is restored.

A level control, which varies the cathode bias of the amplifier tube, is incorporated to reduce the sensitivity of the channel when the oscillator signal voltage is more than suffiicent to provide a maximum indicator reading.

THE ELECTRONIC VOLTMETER CHANNEL

This device has aroused much discussion, since it presents in its simplest form, a means of measuring actual d-c voltages without appreciably loading the circuit under test.

A triode is employed with a 1-ma meter in the cathode circuit, as shown in Fig. 2. A resistance in series with the meter is adjusted until the cathode current indicated on the meter is 0.5 ma. When a positive voltage is applied to the triode grid, the meter reading increases. When a negative voltage is applied, the reading decreases. Thus either positive or negative voltages may be measured without the need for any switching.

A voltage divider having a total resistance of 10 megs is employed in the input circuit, enabling full-scale deflections of from 5 to 500 volts in four ranges. A special probe, fitted with a 1-meg resistor in series with the probe point, serves to isolate the capacity of the shielded cable from the circuit under test, thus enabling measurements of d-c voltages even in tuned circuits.

Since the total input resistance is 11 megs (10 megs + probe resistance) corresponding to 2,200,000 ohms-per-volt on the 5-volt scale, measurement of avc and bias-cell voltages may be made without appreciably loading the circuit under test. On the higher ranges, high-resistance control-grid and screen-circuit voltages may likewise be checked accurately.

THE WATTAGE INDICATOR CHANNEL

This device consists essentially of a current transformer which feeds a diode rectifier. The primary of the current transformer is in series with the power line so when a receiver is plugged into the receptacle provided, the current taken by the set passes through the primary of the current transformer. This induces a high secondary voltage which is applied to a diode rectifier and load circuit. The resultant rectified voltage appears across a calibrated control and is applied to an indicator. The control is calibrated in watts, based on an average power factor of 80% in the receiver power transformer.

The purpose of this channel is to provide a quick means of indicating any major short or open circuits in the receiver under test which might interfere with the process of signal tracing. Thus, if the power consumption is two or three times normal, a severe short circuit is to be looked for, while if the wattage indicated is very low, an open circuit in the power-supply system is indicated.

THE PROBES

The r.f.-i.f. and oscillator channel probes and cables are constructed as shown in Fig. 3A. The tiny capacity, *C1*, is formed by separating slightly the probe tip from the shielded conductor which terminates in the phone plug. The capacitance of *C1* is approximately 1 mmfd. while that of the shielded cable and plug (combined with the input capacitance of the r.f.-i.f. channel) is approximately 100 mmfd.

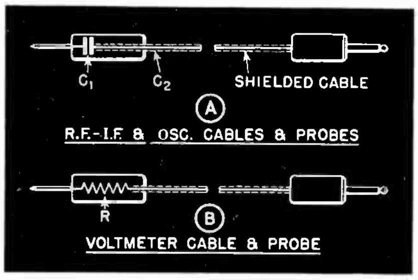


Fig. 3. Special isolating probes are required in signal-tracing work. They place a minimum load on the circuit in which signal- or dc-voltage readings are being taken.

If this type of probe were not used, then when the cable was connected to a circuit and the common ground connection of the signal-tracing instrument clipped to the receiver chassis, the total capacity of the cable would be shunted across the circuit under test. In testing r-f, i-f and oscillator circuits, this would mean that 100 mmfd. would be shunted across the tuned circuit, detuning it to

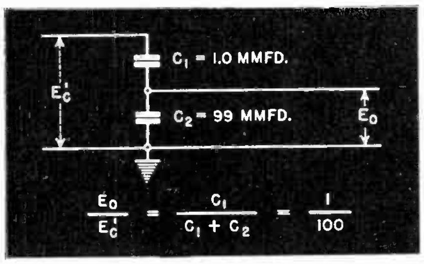


Fig. 4. Demonstrating how a small series capacity in the r.f., i.f. and oscillator probe reduces detuning to a negligible degree.

such a degree that no reliable test could be made. By using the series capacity of 1 mmfd, detuning becomes negligible, particularly since tests are usually made at the low-frequency end of a band where the capacity of the receiver tuning condenser is near maximum. Thus, adding an extra 1 mmfd to a total circuit capacity of 300 to 400 mmfd is negligible.

When the series capacity *C1* is 1 mmfd and the cable and input capacities *C2* total, for example, 99 mmfd, as shown in Fig. 4, the signal voltage reaching the r.f.-i.f. channel input is 1/100th of that at the probe tip since the voltage is divided in proportion to the ratio of $\frac{C_1}{C_1 + C_2}$. Therefore, if a 50-microvolt signal is required at the channel input to give a maximum reading on the indicator, a 5,000-microvolt signal will be required at the probe tip to do the job. This is the usual reference level used for the signal fed to the antenna and ground terminals of the receiver.

As the signal is amplified, in progressing through the receiver, some means of accurately determining the amplification is required. This is done by shunting additional capacity across *C2*. Thus, if *C2* is 100 mmfd. and we increase its capacity to 1000 mmfd. by shunting a 900-mmfd. condenser across it, the signal reaching the r.f.-i.f. channel input grid is reduced to 1/1000th that at the probe tip. By using additional shunting condensers in like manner, additional multiplier ranges are secured.

The level control used in conjunction with the multiplier, varies the sensitivity of the r.f.-i.f. channel over a 10 to 1 ratio.

Since the electronic voltmeter reads only d.c., a series capacity cannot be used in its probe. Accordingly, a 1-meg resistor is used to isolate the cable capacity from the circuit under test in the same manner as that of the built-in capacity in the r-f probe. This is shown in Fig. 3B. Thus, when the probe tip is placed on a tuned circuit and the ground return for the voltmeter is connected, effectively the r-f load on the tuned circuit is 1 meg, which is negligible in most receiver circuits. The d-c load, as pointed out before, remains 11 megohms.

THE SIGNAL SOURCE

The type of test signal to be traced depends upon the nature of the receiver fault. That is, if a receiver is weak or inoperative, then the test signal should be applied by a test oscillator. If the complaint is noise or hum, then the noise or hum is the test signal which is to be traced. If distortion is present, a test oscillator may be used in conjunction with a cathode-ray oscillograph to localize the distortion. If phones are to be used, it is better to use a broadcast signal for checking distortion, since this trouble is more apparent on such a signal than on the usual 400-cycle modulated test-oscillator signal.

If the receiver oscillates with no applied signal, then the oscillation is traced to its source without an external signal. If a signal is required to make the oscillation appear, then a test oscillator should be used for the purpose. The essential point is to duplicate the dynamic operating conditions under which the trouble is present.

A dummy antenna is desirable but not essential. It may consist of the small fixed condenser recommended by the receiver manufacturer for alignment purposes. Some manufacturers supply gain data based on the use of a special dummy antenna. When such is the case, the specified dummy antenna should be employed.

TEST PROCEDURE

A certain amount of horse sense is necessary in applying signal tracing, as with any other test method. Obvious faults should be corrected first. Thus, if noise or oscillation is the complaint, and this fault is evident when the gang condenser is rotated, the first step is to clean and tighten the gang condenser wipers and check the receiver grounds. If noise or hum is present, and it does not vary in strength when the volume-control setting is at minimum, the trouble is immediately localized to some portion of the power supply or of the a-f section. Again, in the case of a multi-band receiver, if the fault is present on one band and not another, the trouble is most certainly not in the i-f or a-f systems, since these are common to all bands. So our attention may be concentrated on the r-f and converter sections which concern the particular band at fault. The oscillator channel of the signal-tracing instrument will enable checks at frequencies up to 15 mc or so. The electronic voltmeter will serve to test the receiver oscillator for operation up to 100 mc. Consequently, if the trouble is present only on a short-wave band of a multi-range receiver, these tests will localize the trouble to either the converter or r-f section and no further signal tracing is necessary. For short-wave receivers which do not embrace the broadcast band, a special procedure should be followed, which will be described later.

It is relatively easy to shoot trouble in a "dead" set by any man's method

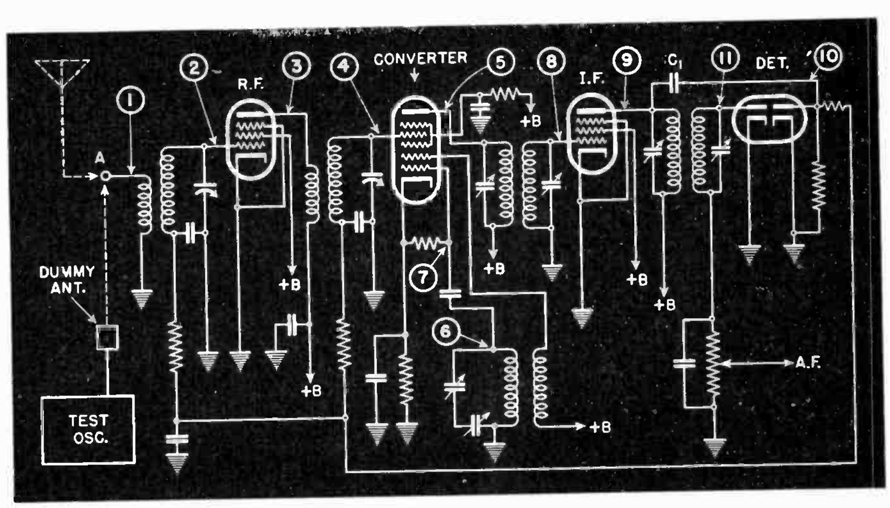


Fig. 5. In servicing by signal tracing, there are only eleven points in the average receiver where readings need be taken—all of them accessible. Ordinarly, the fault is located before all points have been covered.

. . . it is easier by signal tracing. If desired, the tubes may be checked first in a tube checker, to catch obviously bad tubes. Then the set is plugged into the wattage test receptacle and the set and signal tracing instrument are placed in operation. If there is a major short or open in the receiver power supply, the power consumption will be far above or below normal. The rated power consumption can be obtained from the receiver service notes in most cases, but if not given, can be roughly estimated at 10 watts per tube.

If the set passes this test, we may proceed with signal tracing. Since the receiver is inoperative, we know that a modulated r-f signal fed to the receiver will not be reproduced by the speaker. The problem then is simply to find how far the signal progresses in the receiver before it disappears. If there is a short or an open circuit in the first stage, then the signal will not pass that point. So let us proceed with the test.

Referring to Fig. 5, which is a schematic of a representative superheterodyne receiver up to the second detector, you will note that each test point is numbered, representing the order of test. Once one becomes familiar with the system, it is not necessary to test at each point. Complete stages may be checked, or even complete sections of the receiver, by a single test with the proper probe.

The test oscillator is placed in operation and adjusted to produce a 600-kc, 400-cycle modulated signal. The r.f.-i.f. channel probe is connected to point *1*; likewise the test oscillator dummy antenna, as shown. The test oscillator attenuator is then set until a convenient reference indication is obtained when the r.f.-i.f. channel is tuned to 600 kc and adjusted for maximum sensitivity. If no indication is obtained, or if the indication is very weak when the test oscillator is set for maximum output, disconnect the test oscillator from the receiver and measure its output with the r.f.-i.f. channel. If a strong indication is then obtained, this indicates that the receiver input circuit is shorted and the trouble is immediately localized. Cases have been noted where a short in an antenna coil is not revealed by d-c measurement but is immediately evident when this type of test is employed.

With the set tuned to 600 kc, tests may proceed (if the antenna circuit checks OK) by moving the probe to point *2*. If a signal is indicated, the probe may be placed on point *3* or point *4*; the latter is more accessible, since it can be made right at the tuning condenser stator. Failure to pick up the signal at either point localizes the trouble to that circuit and it is simply necessary to check the voltages or the components individually which affect the operation of that stage, to locate the defective component.

By tuning the r.f.-i.f. channel to the i.f. used in the receiver, the signal should be picked up when the probe is placed on the converter plate terminal, at *5*. If not, the set oscillator should be checked. This is done by placing the electronic voltmeter probe on point *7*. If the oscillator is functioning, a negative voltage will normally be indicated with respect to the point to which the signal tracing instrument ground clip is connected—normally the chassis, or B- in an a-c/d-c set. If the voltage is zero or positive, the oscillator is not functioning and the trouble is localized to some defective component in the oscillator circuit which can be found by ohmmeter check. In some receivers, the positive voltage at the converter cathode may exceed the negative voltage at the oscillator grid, causing a slight positive voltage even when the oscillator is functioning. As a final move, the oscillator frequency may be checked with the oscillator channel of the signal tracer. It should function at a frequency equal to that to which the receiver is tuned plus the i.f. If the i.f. is 465 kc and the set is tuned to 600 kc, then the oscillator should function at 1065 kc.

Signal tracing proceeds by checking at each numbered point until point *11*, the second detector diode, is reached. If at any point along this normal signal path no signal is indicated, then the trouble is immediately localized to that particular stage.

This may sound a little complicated, but actually all these tests can be made in a moment. If the chassis does not use single-ended tubes, it need not be turned upside down for the preliminary tests up to the second i-f stage. The probe is simply placed on the gang condenser stators in checking the r-f, converter and oscillator stages, and on the i-f grid caps for the i-f stages.

TABLE I

AVERAGE GAIN-PER-STAGE VALUES

The gain-per-stage figures listed below are average and are based on the assumption that the receiver avc system is not operating. The avc action will reduce the r-f, mixer and i-f stage gains. For comparisan purposes, a weak signal should be used or the avc action temporarily shorted out.

In the a-f section, for resistance-coupled amplifiers, the lower gain figures represent average gains for a-c/d-c receivers while the higher gains apply to a-c operated receivers.

R-F SECTION	
Antenna to grid of first tube	2 to 10
Antenna to grid of first tube (auto-radios	10 to 50
R-f amplifier, superheterodynes	10 to 40
R-f amplifier, t-r-f receivers	50 to 100
MIXER SECTION:	
Converter grid to i-f grid (1-stage i-f amp.)	30 to 60
Converter grid to i-f grid (2-stage i-f amp.)	5 to 20
I-F SECTION:	
I-F Stage (1-stage amp.)	40 to 150
I-F Stage (2-stage amp.)	5 to 20
BIASED DETECTOR:	
PENTODES (Types 57, 6C6, 6J7)	
A-F SECTION:	
MEDIUM-MU TRIODES, RESISTANCE-COUPLED:	
Type 6N7, 6C8 (each section)	20 to 25
HIGH-MU TRIODES, RESISTANCE-COUPLED:	
Type 75, 2A6, 6F5, 6SQ7	40 to 55
PENTODES:	
Type 2B7, 6B7, 6B8	50 to 80
Type 6F6, 2A5, 47, 6V6 6K6, (grid-to-plate gain)	8 to 20
TRIODE OUTPUT TUBES:	
Type 2A3, 45, 71A, 6A5G	2 to 5

A 1.0 volt rms signal (modulated 20%) at the grid will produce approximately 10 volts rms of a-f at the plate. Higher modulation percentages will produce correspondingly higher a-f voltages. Thus, 40% modulation will produce 20 volts rms of a-f at the plate. (Biased detector)

This table appears in Servicing By Signal Tracing, *by John F. Rider, and is reproduced by permission of the author.*

CHECKING WEAK RECEIVERS

Before considering the a-f system tests, let us assume that the receiver under test is insensitive . . . it will reproduce a strong signal only. This indicates that some stage, or perhaps more than one stage, is functioning far below normal. The normal gain which we should expect is given in Table I, the Table of Average Gain-Per-Stage Values. The stage gain is determined by checking the relative signal levels at the input and output of the stage, normally from grid to grid. If the signal level at point *1*, for instance, is just sufficient to produce a reference level indication on the r.f.-i.f. channel indicator, while when the probe is transferred to point *2* the signal level increases so that the attenuator of the r.f.-i.f. channel must be re-set (say to 5) to restore the reference level indication, then the gain of the antenna transformer is 5, about average, incidentally.

The actual gain, in stages under avc control, will depend upon the signal level and will be less when a strong signal is being received. To measure the true gain, the avc bus should be grounded or the avc tube removed, provided this does not cause oscillation. Normally, a loss rather than a gain results when a stage has a defective component, so precise measurements are seldom necessary. Just check from stage to stage, and, when a loss is noted or the gain is far below normal, check the components of that stage.

The conversion gain is the ratio of the signal level at the intermediate frequency measured at the converter plate to the signal level, at the r-f signal frequency, applied to the signal grid of the converter tube. The conversion gain may be low, or a loss may result, if the oscillator section is not functioning properly. The average d-c voltage developed across the oscillator grid leak is given in Table II. This voltage should be measured with the electronic voltmeter and, it should be remembered, is always *negative* with respect to the cathode.

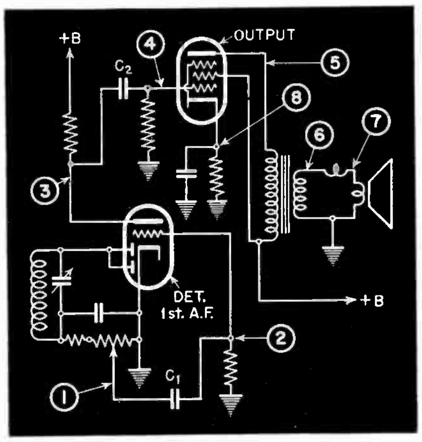


Fig. 6. The points in the circuit of an audio amplifier where the signal should be checked. Explanation of procedure is given in text.

CHECKING NOISY RECEIVERS

No signal source is necessary in checking for noise. Noise will normally be registered as a flickering of the indicator eye or movement of the indicator needle, but it is better to use phones in this test so that the noise may be readily identified as being of the same type as that emitted by the speaker.

Tests are made in the r-f and i-f sections of the receiver by tuning the r.f.-i.f. channel to the same frequency as that to which the circuit under test is tuned. Phones are inserted in the output jack or the speaker switched in and the probe is moved to each of the numbered points until the point is reached where the noise *first* appears. Since the stages which follow simply amplify the noise, they need not be checked.

Noise due to a faulty component in the power-supply system will be present in all circuits. This may be traced by following through the power-supply system, using the a-f channel probe, until the point is reached where the noise is loudest. Components in that particular section can then be checked individually.

CHECKING FOR DISTORTION

Tracing distortion may be done either with phones or with a cathode-ray oscillograph plugged into the channel output jack. If phones are used, the test oscillator may be modulated with a phonograph record by means of a pickup and amplifier, or simpler, by picking up a local broadcast signal and listening to it as the probe is moved from one test point to another. The trouble is localized as described for checking noise.

If the oscillograph is used, the test oscillator should be used with 400-cycle modulation. The signal is then traced in the same manner as for phones or loudspeaker.

CHECKING A-F SYSTEMS

Audio systems are checked in the same manner as r-f and i-f circuits, but the a-f channel is used for this signal tracing.

Referring to Fig. 6, the audio signal is first developed across the diode load which, in the diagram, is represented as a volume control. Assuming that the modulated r-f signal has been traced to the diode, the first step is to check the a-f signal at point *1* by placing the a-f probe on this point and adjusting the volume control setting until a reference indication is obtained on the channel output indicator. If none is obtained, then the fault is localized to some component in this circuit. A short in the grid circuit of the first a-f tube would cause this condition.

If the signal is obtained, it may be traced to point *2*. Failure to obtain a signal at this point indicates an open coupling condenser, *C1*. In some cases, even though *C1* is open, a weak signal may be transferred to point *2*. In normal operation the signal level should be the same at point *2* as at point *1*.

At point *3* the signal level should increase, due to the normal gain in this circuit (see Table I). The coupling condenser *C2* may be checked in the same manner as *C1*. A shorted coupling condenser will place the plate voltage of the first a-f tube on the output tube grid. This will be indicated by a positive voltage when the electronic voltmeter probe is placed on point *4*. This same indication will be obtained if the output tube is gassy, but in the latter case, the positive voltage will gradually increase as the tube heats while a shorted coupling condenser will apply the maximum voltage immediately to this point.

At point *5*, the gain of the output tube is checked. At point *6*, the signal level will normally be about 1/25th that at the plate, if a single-ended output pentode stage is used. At point *7*, the signal passing the hum-bucking coil is checked.

Tests for noise and distortion are made in the same manner as described before for the r.f.-i.f. channel application.

CHECKING AVC SYSTEMS

The signal voltage applied to the avc diode may be traced by means of the r.f.-i.f. channel. The rectified voltage which then results is traced with the electronic voltmeter. Since the 1-meg resistor in the probe isolates the cable capacity from the circuit under test, the probe may be placed directly on the grid cap of a controlled tube and the avc voltage checked at this point.

Leakage in avc bypass condensers will be evidenced by a drop in avc voltage across the condenser, when the leakage is of sufficient magnitude to cause this trouble.

CHECKING SHORT-WAVE SUPERHETERODYNES

When it is desired to make a gain check at frequencies beyond the range of the r.f.-i.f. channel, the channel probe may be connected at the second detector and the channel tuned to the intermediate frequency. The r-f signal may then be first fed to the converter grid and a reference indication is obtained on the r.f.-i.f. channel indicator. The signal is then fed to the antenna and ground posts of the receiver, without changing the attenuator setting of the test oscillator. If r-f gain is present, the r.f.-i.f. channel attenuator is readjusted until original reference level is restored. The r-f gain is then determined.

The foregoing tests represent only a few of those which can be made with signal-tracing instruments. Components, such as bypass condensers, can be given a functional test in the receiver to determine if they are actually doing the job they are supposed to do.

—*J. F. P.*

TABLE II

AVERAGE OSCILLATOR D-C VOLTAGE

The following tabulation gives the average d-c voltage developed across the oscillator grid leak in representative modern all-wave and broadcast-band receivers at various operating frequencies. These voltages are measured with an electronic voltmeter and isolating probe, similar to that described in the accompanying text. Ordinary 1000-ohms-per-volt meters are not suitable for such measurements, due to their loading effect on the circuit under test.

The values given are average; variations of up to 50 percent may be encountered due to differing design characteristics. Normal variations in tube characteristics will likewise affect the resulting voltage. All voltages are specified with respect to the return point of the grid leak, either ground or cathode of the tube.

A-C/D-C SUPERHETERODYNES:					
Frequency (in kc)	600	1000	1400	6000	18,000
Eosc (d-c volts)	—11	—11.5	—13	—10.5	—5.8
A-C SUPERHETERODYNES					
Eosc (d-c volts)	—19	—19	—19	—12	—14
AUTOMOBILE SUPERHETERODYNES					
Eosc (d-c volts)	—19	—19	—19	—	—

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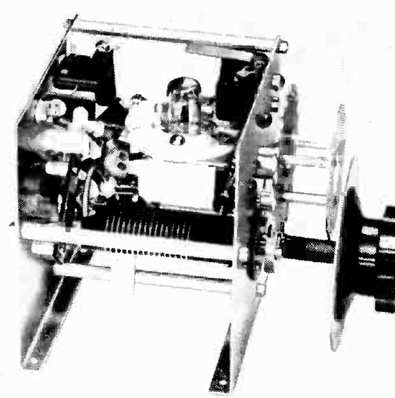
Frequency Modulation Field Problems

By E. T. HIGGONS*

THE rapid and wide-spread construction of frequency-modulation stations is bound to result in drastic changes in the present radio picture. There are some thirty odd stations now broadcasting and over one-hundred in the course of construction. These new, improved transmissions will, therefore, be available to many millions of people throughout the country, and should result in the sale of thousands of f-m receivers during a reasonably short period of time. It will therefore be necessary for every dealer and serviceman to immediately familiarize himself with the new f-m equipment, in order to be in a position to deal with the problems which will be encountered.

Before any study of frequency-modulation receivers can be attempted, it will be necessary to know something about the new method of transmission. The technical aspects of frequency-modulation transmission need not be covered completely, but we must be familiar with the differences between the old amplitude-modulated system, and the new f-m system.

Frequency modulation has already been given considerable publicity and we believe everyone by this time realizes that the transmissions are occurring at frequencies between 40 and 44 megacycles, with each station occupying a bandwidth of 100 to 150 kilocycles. However, a



Interior of Weston u-h-f oscillator, showing the acorn tube and inductive tuning mechanism. Has direct-drive dial.

good many people have been given the impression that the extremely wide band is required in order to obtain the high-fidelity reception which is claimed for f-m broadcasts. Such is not the case, and

Weston Model 787 u-h-f oscillator provides stable signals from 22 to 150 mc. Inductive tuning permits easy readibility to 40 kc at 50 mc. No connection to receiver needed.

it is most important at this point to thoroughly understand the reasons for the wide-band transmission. The following are the essential facts relating to f.m.

TRANSMISSION CHARACTERISTICS

The bandwidth does *not* determine the audio-frequency range. Bandwidth is a direct result of the percentage of modulation, or the volume level of the program at the transmitter. The deviation of the carrier from its center or "resting" frequency is directly proportional to the percentage of modulation. For example, if 100 percent modulation results in a swing of the carrier through a band 150 kc. wide, or in other words, 75 kc. either side of center, then 50 percent modulation will result in a 75 kc. bandwidth, or a deviation 37.5 kc. either side of center, as shown in Fig. 1.

The bandwidth of 150 kc. has been designated as being desirable in order to provide an increase in the signal-to-noise ratio. Noise impulses due to electrical disturbances always occur within definite limits in the radio-frequency spectrum. It therefore follows that noise impulses occupying a bandwidth of 1 kc. will be more noticeable on transmissions 10-kc. wide, than those same impulses when occurring in a transmission band 150-kc. wide.

Audio-frequency changes cause only a change in the *rate* of carrier swing. As shown in Fig. 2, 100 percent modulation by means of a 1000-cycle note results in a carrier deviation of 150 kc. in .001 second, while the same modulation from a 2000-cycle note will cause one complete cycle of carrier deviation in .0005 second. The audio-frequency range of f-m transmissions is therefore unlimited, as it depends only upon time. Of course, the present telephone lines, microphones, etc., introduce physical limitations.

The *amplitude* of an f-m carrier is constant at all times. As shown in Fig.

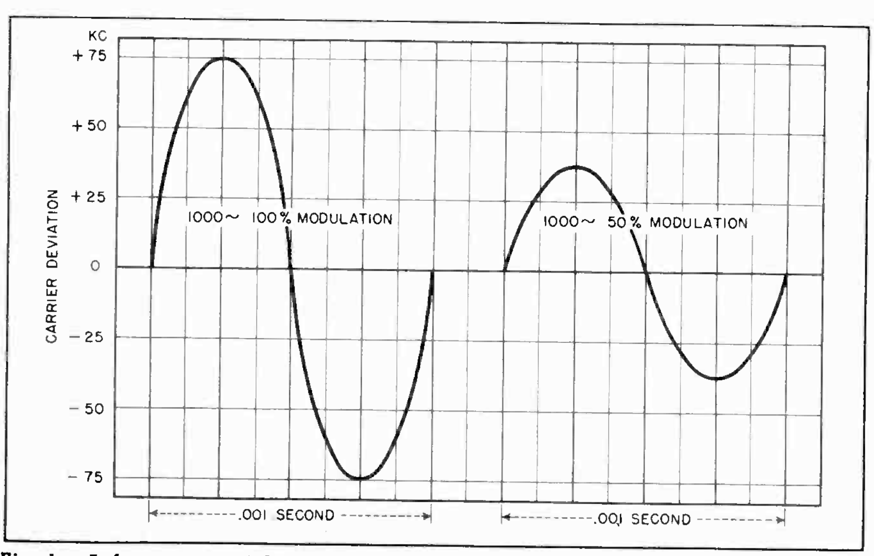


Fig. 1. A frequency-modulated wave deviates from its normal or "resting" frequency, the extent of the deviation depending upon the volume of the audio signal.

* *Weston Electrical Instrument Corp.*

3, the antenna current remains at a fixed value regardless of the nature of the program.

RECEIVER REQUIREMENTS

With the above transmission characteristics we find the following conditions must be created in a suitable f-m receiver:

The receiver must cover a tuning range from 40 to 44 megacycles and must be capable of reasonably flat response over a band of 100 to 200 kc. wide.

Since the amplitude of the original transmission is constant, any changes in amplitude which are present at the receiver input must be the result of fading or noise impulses. Such amplitude changes can, therefore, be removed in the receiver without affecting the over-all fidelity of reception.

Some system must be available for the conversion of r-f carrier deviations into a-f voltage changes on the basis of time only. The developed a-f voltage must be proportional to the r-f deviation.

Now let us look at a typical f-m receiver circuit and see just how it meets these requirements.

Referring to Fig. 4, it will be seen that the first detector, oscillator and i-f stages are conventional except for the loading resistors across the transformers.

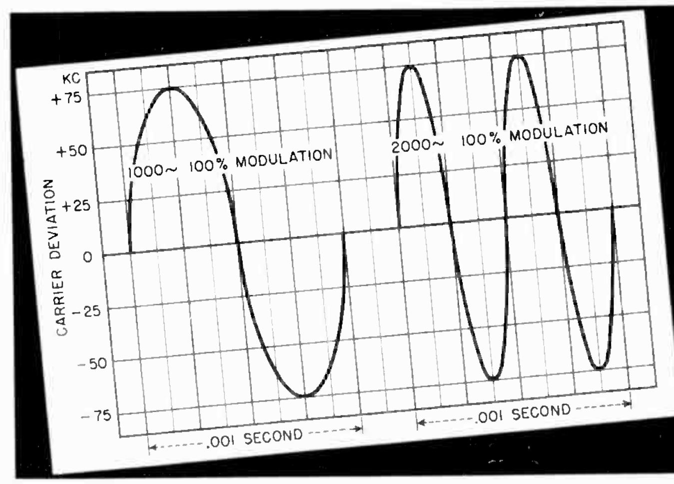


Fig. 2. With f.m. audio-frequency changes cause only a change in the rate of carrier swing. Thus, one cycle of a 1000-cycle tone takes place in .001 second; of a 2000-cycle tone, .0005 second (two are shown).

These resistors, plus the inherent design of the transformers, result in the desired 200-kc. band-pass characteristics.

The resistors also serve to dampen the transient currents which occur in the transformers as a result of the rapid frequency changes of the f-m signal.

THE LIMITER

Passing through the i-f stages we arrive at what is known as the limiter stage. In some future receiver designs two tubes may be used at this point, but the function will be exactly the same.

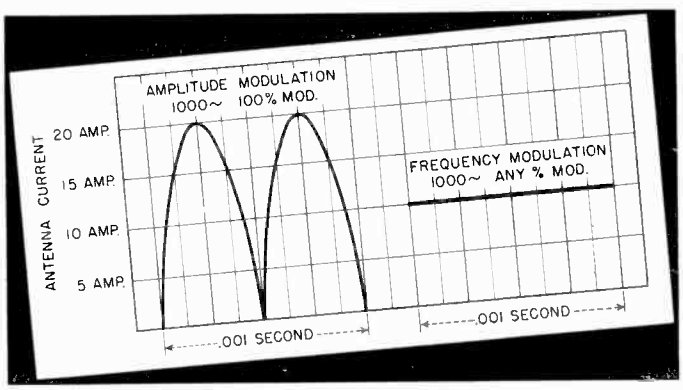


Fig. 3. With amplitude modulation, the carrier power is varied; carrier power remains constant when the wave is frequency modulated. Both conditions are shown.

The limiter circuit is so designed as to block off when any large changes in amplitude occur, and at the same time being capable of passing radio frequencies. The limiter tube serves only as a means of maintaining flat amplitude characteristics; in other words, a constant-current condition. Since noises usually cause amplitude peaks, this tube is responsible for most of the noise-reducing properties of an f-m receiver. It also prevents most signal fading from affecting the final audio signal. If amplitude variations were permitted to occur in the following discriminator circuits, distortion would appear in the a.f.

Please note that the limiter tube is operated at a relatively low plate and screen voltage. There is no cathode resistor and all bias is developed directly across the grid resistor *R10*. If a signal were applied to the grid of the limiter tube, and a milliammeter inserted in the plate circuit, it would be found that any variation from 0 to 3 volts in the signal would result in a proportionate increase in the plate current. But any further increase in the signal above 3 or 4 volts would result in no additional change in the plate current, which would indicate

(Turn to page 29)

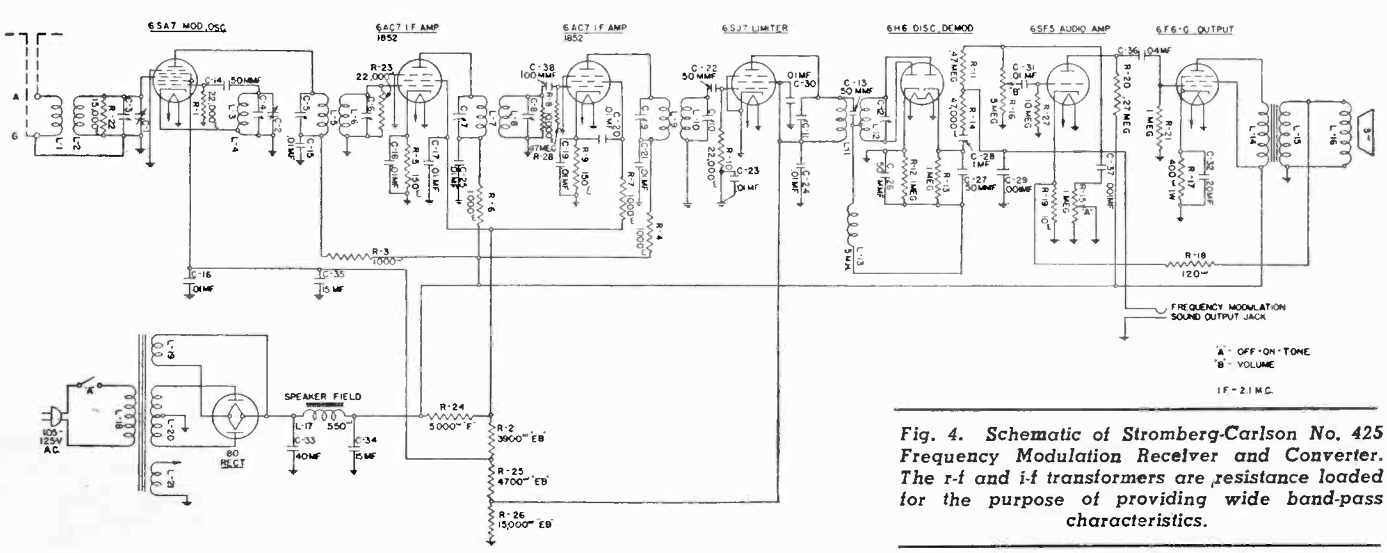


Fig. 4. Schematic of Stromberg-Carlson No. 425 Frequency Modulation Receiver and Converter. The r-f and i-f transformers are resistance loaded for the purpose of providing wide band-pass characteristics.

Practical Use Of

THE purpose of this second part of the discussion on degenerative amplifiers is to show how the various methods of producing feedback may be applied in practice.

Last month several representative types of feedback circuits were examined and their action explained in a qualitative sense. In this part we shall try to show how these general types may be incorporated into actual commercial circuits, and the benefits to be derived by so doing.

Figs. 1A and 1B are two of the most common feedback circuits published. They are very widely used diagrams because they represent simple forms of single-stage feedback, the action of which can be very easily explained. They are included here only because they are perfect examples of the theoretical case which is of extremely doubtful practical value.

It has often been stated that by removing the cathode bypass condenser in an output stage, inverse feedback is introduced and the usual manifold benefits obtained. There has even appeared data showing the extent to which distortion in a single-ended pentode output stage may be reduced by leaving out the cathode bypass condenser. This data is correct as far as it goes, but it does not tell the whole story.

CURRENT AND VOLTAGE FEEDBACK

An examination of Fig. 1A will show why. In order for inverse feedback to be completely effective, the feedback voltage must be a fraction of the output *voltage*. The voltage generated across an unbypassed cathode resistor is not proportional to the voltage which appears across the primary of the output transformer, but is proportional to the plate *current*. Consequently, variations in frequency response due to the output transformer, as well as variations in load impedance due to the non-linear impedence characteristic of the speaker, do *not* affect the feedback voltage and are not corrected by this type of feedback. Moreover, current feedback has the reverse effect on apparent plate resistance that occurs with voltage feedback; i.e., current feedback *raises* the apparent plate resistance of the output tube. Since one of the most advantageous aspects of inverse feedback is its lowering of tube plate resistance, it is obviously somewhat senseless to use the one type of feedback which does just the opposite. Therefore, as a general rule, it may be stated that current feedback, though it may reduce distortion slightly, introduces other disagreeable effects which may be more serious than those corrected.

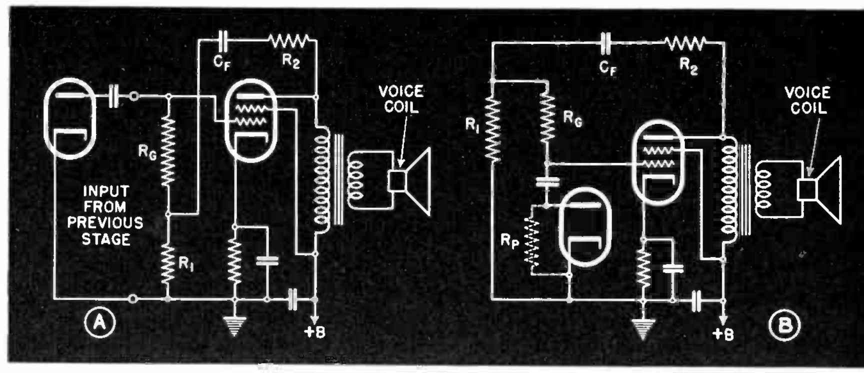


Fig. 2. A. Looks good, but feedback is small. B. This explains why (see text).

PART II

★ The previous article covered the fundamentals of inverse feedback. In this, the concluding article, the practical aspects are dealt with. Data is given on the application of degeneration to single-ended and push-pull amplifiers, the calculation of feedback percentage and gain loss, current and voltage feedback, one- and two-stage feedback loops, frequency compensation, and methods of feedback to guard against

Fig. 1B has also been widely publicized as a typical feedback circuit. Here, the feedback voltage is introduced in series with the input by use of an input transformer, and true inverse feedback action occurs. The drawback is a purely practical one; namely, that very few if any receivers or amplifiers of recent vintage use a single output tube fed by an input transformer. Virtually all such units are resistance coupled, and this feedback connection cannot be used with resistance input because neither side of the input can be grounded for it to work properly. In this connection it might be mentioned that some experimenters have tried to substitute for the transformer secondary the usual grid resistor and have attempted to introduce the feedback voltage in series with this resistor, as in Fig. 2A.

This system does not work according to usual calculations, and the reason may be best explained by referring to Fig. 2B. This is the same circuit, but the placement of parts has been re-arranged so that the effect of the various components with respect to the feedback voltage is more clearly shown. It can be seen that if *R1* is considered as the source of feedback voltage, the amount of feedback voltage which appears between grid and ground is only a small fraction of the voltage across *R1*. This is so because *Rg*, the grid resistor, and *Rp*, the plate resistance of the preceding tube, form a voltage divider across *R1*. In practice *Rg* is many times larger than *Rp*; usual values would be something like 0.5 meg. for *Rg* and 10,000 ohms for *Rp*. Returning to Fig. 2A for the moment, if the ratio $\frac{R2 + R1}{R1} = 10$

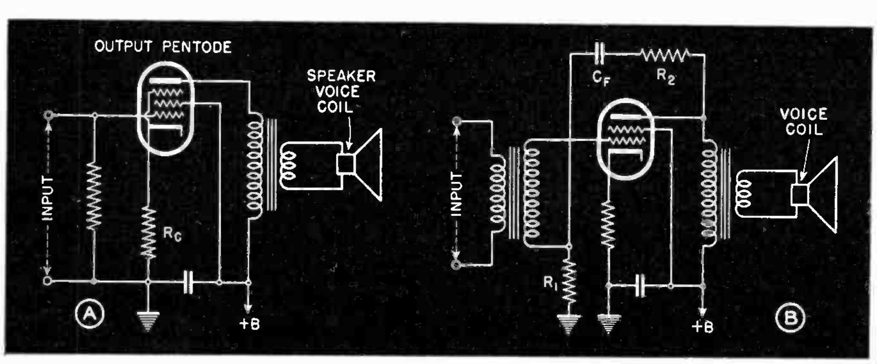


Fig. 1. A. Example of current feedback, which is not so good. B. Example of voltage feedback; good but not practical, since single-ended stages are seldom transformer-coupled.

Inverse Feedback

By MAURICE APSTEIN

it would appear that 10 percent feedback would result. By looking at Fig. 2B, however, it becomes apparent that there is a further stepdown through the divider *Rg-Rp,* and that the actual value of feedback is one fiftieth of 10 percent or 0.2 percent, a completely negligible factor.

FEEDBACK TO CATHODE

One of the simplest methods of introducing feedback in a resistance-coupled amplifier is by injecting the feedback voltage into the cathode circuit. It has been shown, however, that this should not be done in such a way that the feedback voltage is a function of the plate current, but is truly proportional to the output voltage. This is very easily accomplished by the arrangement of Fig. 3. Here, *Rc,* the cathode resistor, is left bypassed and causes no degeneration. In series with *Rc* is a resistor of small value, *R1,* which comprises the lower section of the feedback divider *R2-R1,* the whole of which is connected across the secondary of the output transformer. If *R1* is small compared to *Rc,* the cathode current degeneration will be slight and have no harmful effects. However, a fraction of the output voltage appears across *R1* and is in series with the input voltage to the tube, resulting in true voltage feedback with its attendant benefits. Since the source of feedback voltage is the secondary of the output transformer, the feedback will tend to correct both distortion and frequency discrimination due to tube and transformer as pointed out in the previous article.

A major advantage of this system is that the proper phase relationship between input and feedback voltages can be accomplished by simply reversing either the voice-coil terminals or the primary of the output transformer. With the feedback voltage in improper phase, the amplifier will oscillate; reversing the connections will stop the oscillation. This obviates the need of being able to predict in design the phase relationship between feedback and input voltages, which will depend upon the number of stages in the feedback loop. With single-stage feedback this is not such a problem, but the arrangement becomes more advantageous as the number of stages and components included in the feedback loop is increased.

Fig. 4 shows how the same system is expanded so that the feedback loop includes two stages instead of just the output stage. Here, *R1* is inserted in the cathode lead of the voltage amplifier preceding the output tube and the top resistor of the divider, *R2,* is again taken off the secondary of the output transformer. Save for the fact that possibility of oscillation due to excessive phase shift is increased, this is a considerably more satisfactory method. First of all, a smaller feedback voltage is required to effect a given number of db of feedback, which means that *R1* can be very small compared to *Rc.* Secondly, by this simple method, where but two stages are involved, distortion and frequency discrimination in the entire audio system can be minimized.

Due to the wide variety of tube and gain combinations encountered in various p-a units, it is a bit difficult to recommend specific values for *R1* and *R2.* However, a few simple rules can be applied which will enable the proper values to be chosen from the resistors that are already in use. As mentioned in Part I, if the percentage of feedback is equal to the reciprocal of the gain between the feedback points, then the loss in gain due to feedback will be 6 db. This is a very convenient degree of feedback for application to existing equipment because it does not necessitate that the overall gain be increased too much to make up for the loss in sensitivity due to feedback. At the same time it reduces harmonic content to one-fourth of the original value, and results in a corresponding improvement in frequency response.

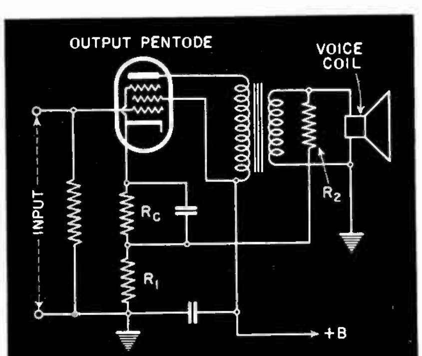


***Fig. 3.** Example of inverse feedback from voice coil to cathode circuit. Voltage is developed across R1-R2.*

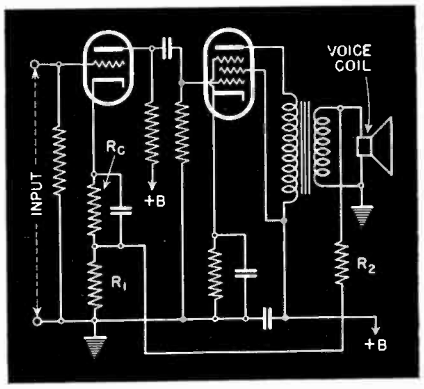


***Fig. 4.** Same as Fig. 3 except that the feedback is over two stages. Much more effective.*

DETERMINING COMPONENT VALUES

To choose suitable values for *R1* and *R2* the following rules should be kept in mind:

1) *R1* plus *R2* should be at least 10 times the output impedance so as not to absorb too much power.
2) *Rc* should be at least 10 times *R1* so that the cathode current degeneration will be small.

Keeping these factors in mind, suppose, in Fig. 3, the output tube is a 6L6 and the voice-coil impedance is 8 ohms; a common value. The 6L6 requires a cathode bias resistor of 400 ohms, which means that *R1* should not be more than 40 ohms. The original value of bias must be maintained, so *Rc* should be replaced with a 360-ohm resistor and *R1,* 40 ohms, added in series with it. To determine *R2* is now a simple matter. Since *R1* plus *R2* must be larger than 80 ohms (to fulfill rule 2) any value above 40 ohms for *R2* is suitable. The larger the value of *R2,* the smaller the amount of feedback, and vice versa. It will be found that with two-stage feedback, it becomes very much simpler to abide by these rules than with a single stage, because the additional gain allows a much smaller feedback voltage to accomplish a given amount of degeneration.

A major problem in the application of feedback to existing equipment is the required increase in overall gain for normal operation. The writer has found that this can usually be accomplished by replacing existing tube types with more modern ones of higher gain. A typical receiver setup, for instance, would be a diode detector followed by a high-mu triode followed by a single pentode or beam-power output tube. The output tube would have a gain of approximately 10 and the triode a gain between 25 and

(Turn to page 23)

Serviceman's Diary

By J. P. HOLLISTER

TUESDAY—Pouring rain. A gray Cadillac coupe scooted up to the station, brakes screeching, and a tall fellow burst out of the car. Coat-tails flying, he just made the 8:41, clambering on with the conductor's aid. I stepped out from the station shelter to slam the door he had left open, hoping to get an offer of a lift for the eight-block stretch to the shop.

"Ha!" sounded a female voice from the interior. "You're just the man I'm looking for. Jump in."

The invitation sounded just a little too cordial, but I swished the water off my last year's Stetson and slid in alongside a streamlined chassis dressed in slacks, with hair finished in light brown. I was sure I didn't know her.

"I know we've met somewhere," I began, "but at the moment I can't just recall . . . " She was gorgeous!

"I'll make it easier for you," she snapped. "You fixed my radio last week and now it's worse than ever!"

Dizzy dame with rouge-plated lips! Why is it they look so different in the morning? And the set's worse than ever. It's funny about those things—the set's never "almost as bad," or "just as bad," it's always "worse than ever."

I looked at her again and remembered. She had stopped at the shop to have the tubes checked. Found a noisy 6A7 and replaced it. That was all. And now the set's worse than ever. My luck!

I reached over and switched on the set. Lots of hop but signals weak and noisy. Massaged the set with my fist. Nothing loose, apparently. Disconnected the antenna plug and touched the set input conductor. Signal volume increased. Evidently an open in the antenna circuit.

Meanwhile she watched curiously. When I told her I would have to check the antenna wiring, she remembered that her brother had noticed a wire dangling loose under the car and had clipped it off. He would! She agreed to bring the car down in the afternoon, so I could run it over to a garage and jack it up for the repair.

She drove me to the shop and I noticed Jerry was already busy dressing the window. He tries to pick out a rainy day for window-dressing, partly because there aren't so many customers coming in to interrupt, but mainly because he doesn't like to be stared at while working in the window.

"Gee!" he said as I entered, "you come to work in style this morning. Who's the girl friend?"

"She's no friend," I answered. "She's a customer. You didn't hang the under-car antenna on that Cadillac, did you?"

"Not guilty," he answered. "The built-in antennas in those models work swell."

I breathed easier. It wasn't going to be a no-charge job after all. Jerry went ahead with his window-dressing. He had a tilting-handle electric iron in the center, flanked by two electric toasters; then a long line of tube cartons, with two vacuum cleaners bringing up the rear. Not enough radio equipment.

"Hey!" I yelled. "How about some sets in the window? After all, this is supposed to be a radio shop. And what have the vacuum cleaners got to do with those radio tubes?"

"After all," he mimicked, "there is some relationship between vacuum tubes and vacuum cleaners. At least, they both help pay the rent. And I'm going to put in the two f-m sets you've been raving about. As for squawking, you'll find two sets on the bench which are even better at it than you. The big Motorola squawks all the time, while the little bastardyne only squawks on strong signals. Both have been batted around from shop to shop. Have a good time!"

Somehow, it seems, we get all the headaches. Both of these were tough and it took me until after lunch to find the troubles and fix them. On the Motorola, someone had grounded the suppressor of the r-f stage 6K7 with a piece of wire about two inches long. When the suppressor was grounded directly to the chassis with a screwdriver, the trouble stopped. This wasn't so hard to find, since the symptoms indicated a bad r-f ground, but the no-name midget was not so easy. The electrolytics had been replaced and, in reconnecting the leads, the plate of the output 43 had been hooked to the plate of the 77 detector. When the signal level got high enough, audio oscillation occurred. At low signal levels, everything checked normally, though there was a little audio distortion.

Jerry pushed back the sliding door between the shop and the salesroom.

"Listen!" he whispered. "I've got a bird up front who wants a demonstration of the Stromberg 480. Says he wants to see if this frequency modulation stuff really works and figures this storm ought to be a good test. You'll have to give me a hand to get it out of the window."

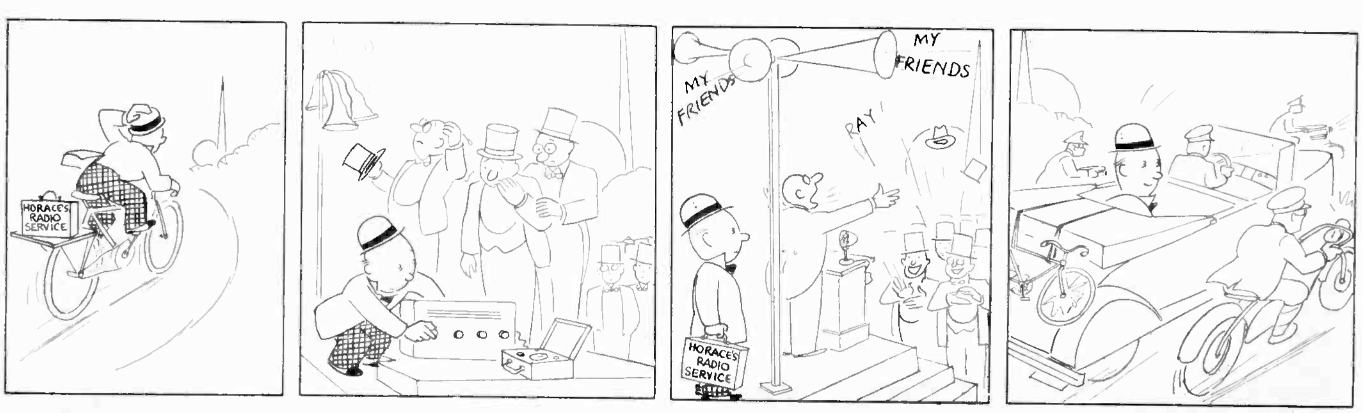
"Why spoil the window?" I told him. "You're a good salesman—can't you switch him to a ten-dollar midget?"

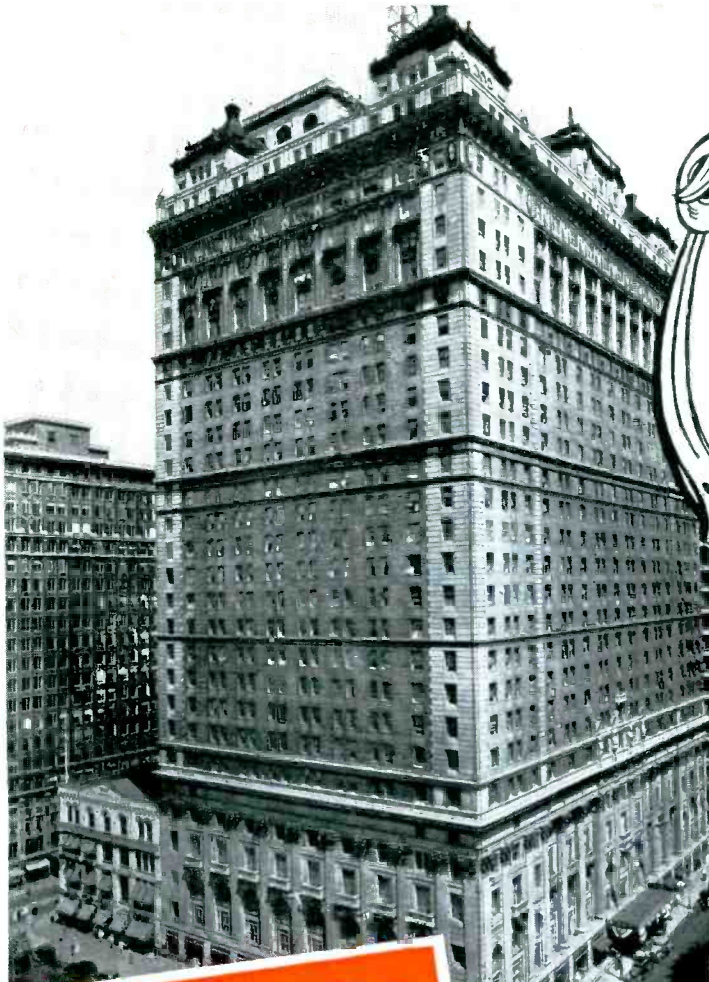
"Lay off the kidding," he growled. "I sell 'em, you fix 'em. That's all."

We got the set out and hooked it up. It worked swell, but now the fellow

(Turn to page 21)

HORACE—





the BOOK-CADILLAC

Center of the Auto World

...insists upon RAYTHEON TUBES

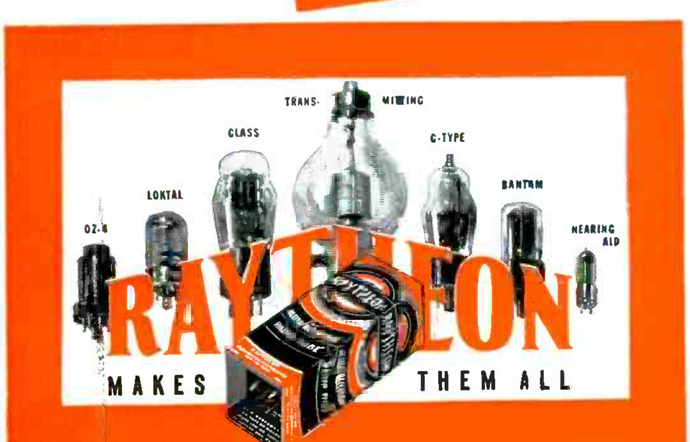
Popular meeting places are the Book-Casino (top) and the Motor Bar (right).

Probably not in all the world is there a place to compare with the Book-Cadillac, Detroit, as the accepted rendezvous for the giants of the auto industry and other leaders in the business, civic, and social life of our nation. Here they gather for conventions, balls, and banquets. They know, and demand, the utmost in service, convenience and comfort. And here they get it . . . for it is the progressive policy of the management to provide it.

Among other modern facilities for their enjoyment is a superb 84-tube radio installation, operated from a central control and transmitting music and voice from any source to numerous function rooms and lobbies. Of course, the tubes are the heart of such a system. So in the Book-Cadillac they must be the best obtainable . . . RAYTHEONS! "They give us a feeling of confidence," says L. E. Ames, executive of the hotel, "for at all times their performance is the peak of perfection."

Remember, these RAYTHEONS are "stock" tubes, the kind that are giving such outstanding service everywhere. For back of them are years of experience of expert engineers who devote their time exclusively to developing and improving tubes for every purpose. They are constantly pioneering in tube design and construction . . . constantly anticipating future requirements in the fast-moving radio circuit field.

When you use RAYTHEONS for replacements, you know you are supplying tubes that meet the most exacting demands of important users. It builds good-will! It builds business! It gets you the important service contracts! It increases profits! Yet RAYTHEONS *cost no more!* No wonder the *businessmen* in service work use RAYTHEONS.



WORLD'S LARGEST EXCLUSIVE RADIO TUBE MANUFACTURERS

NEWTON, MASS. • NEW YORK • CHICAGO • SAN FRANCISCO • ATLANTA

Mr. Dealer -

Test Your Lines for Profit

By J. P. KENNEDY

QUIT kidding yourself, Mr. Dealer, and quit kidding your customers while you still have their good will and patronage.

Frankly, have you the low-down on the sets you handle—do you make any tests to determine how good they are? Are you certain that when you tell a customer he is getting the best value for his money when he purchases a certain make of radio, that you aren't hanging yourself higher than a kite?

There are good radio sets available to every legitimate radio dealer—radios that can be sold with a straight face and clear conscience, and radios that won't bounce back. All modern radios are good, yes, but some makes are better, and it's the difference between good and better that can make a whale of a difference in your business.

You can't rely entirely on the descriptive literature covering a line of sets. It is true as far as it goes—the Better Business Bureau sees to that—but often it doesn't go far enough.

How can you choose the right lines of receivers? By analyzing the lines you intend taking on. You can do it yourself if you have the technical ability *and* the proper test equipment. If not, consult the boys in the back room—the men in your service department—or call in a good serviceman from the outside who can put the sets through their paces. Investigate the new receiver lines now being introduced and pick yourself the honeys—the stout fellas that stand up under test.

HOW'S THE CIRCUIT?

First of all, go over the circuit diagram and tube lineup of each receiver you plan to stock. If it's an all-wave job, is there an r-f stage? You'll need it to get Europe consistently on short waves. Do the i-f stages use iron-core or air-core transformers? Transformers with adjustable iron cores and high-grade fixed capacitors have the edge on air-core transformers with adjustable mica trimmers when it comes to holding alignment. Are the r-f and i-f circuits well filtered? Are dual-purpose tubes used judiciously?

If push-button tuning is provided, what type is employed? If it is mechanical or electro-mechanical, make a note to check its precision in tuning and its ability to stand up and hold adjustment under constant usage. If electrical, are separate coils with adjustable iron cores employed, or do the switches shunt adjustable mica trimmers across the A-band coils? If the latter, make a note to test them for drift.

If the receiver is a console job with a large speaker, does the circuit and the number of tubes used live up to the housing? Is the power stage single-ended or push-pull? In any case, has it sufficient *undistorted* power output to match the power rating of the loudspeaker and the impressiveness of the cabinet? Does the set have a bass-compensated volume control, or other means for adjusting the response of the receiver over fairly wide limits?

If the receiver is directly fed from the power line, are provisions made to reduce shock hazard? If filaments are series-fed, are they protected against surges? Is there adequate filtering in the power supplies of receivers having good frequency response in the low range?

HOW'S THE CABINET?

Assuming that your examination of the circuit indicates a well-designed receiver, next take a look at the merchandise. The external appearance is what your customer sees first, especially Mrs. Customer.

Is the finish on the wood smooth? Does it have that deep multi-coat appearance of a grand piano, or do the pores of the grain show through thin layers of lacquer? Are the sides of the cabinet finished with the same care as the top and front? A smooth mirror surface is easy to dust and polish—Mrs. Customer knows that. She knows that horizontal fluting and projecting trim collects dust and is a constant cleaning problem.

Does the cabinet have genuine wood inlays or paper imitations pasted over the surface? You can spot the paper imitations with a reading glass—look for the half-tone dots which come from the engraving that printed the wood pattern. You'll lose a customer if the paper overlay peels or blisters; furthermore, it is almost impossible to refinish a deep scratch on a paper overlay.

Is the cabinet well made? Are there butt joints, not mortised or securely reinforced, which may open in dry, hot weather? Is the dial well lighted and easy to read?

HOW'S THE SET?

Now we get down to business. How good is the set? Check the alignment carefully with a good signal generator, as very few production receivers reach a dealer's shop in as perfect condition as when they left the factory. Check the sensitivity of the receiver at a number of points on all bands, using an accurately calibrated signal generator and output indicator, or a signal tracer. At the same time, determine if the avc action is adequate on weak signals. Also check oscillator voltage on all bands.

Check the i-f amplifier with a frequency-modulated oscillator and cathode-ray oscillograph to determine if the i-f transformers have clean, sharp peaks that will indicate adequate selectivity. If provisions for high-fidelity reception are included, determine with the same equipment if the resonance curves have true band-pass characteristics.

Check the audio amplifier for distortion and frequency range, using an audio oscillator or frequency test record and a good output indicator; or check the over-all frequency response of the set with a modulated r-f signal and oscillograph.

Needless to say, the accuracy of tuning-dial calibration, smoothness of controls, mechanical rigidity, disposition of parts on the chassis, durability of tuning indicator drive cord, gang-condenser mounting, etc., are all points to be taken into consideration.

The final test can best be made by ear. Open up on a strong signal from a nearby station and see if the automatic volume control and the speaker can take it without distortion. A slight rattling or rasping may merely mean a speaker that is not functioning properly and should not be taken as a basis for condemning the set. The speaker may have been damaged in shipping and this can usually be corrected very easily or a new speaker can be installed.

(Turn to page 21)

INSTRUCTIONS

THIS stroboscope disc may be used to check the speed of any recording or reproducing turntable at either 78.26 r.p.m. or 33 1/3 r.p.m.

Cut out and mount on stiff cardboard, or on a 10-inch phonograph record, using rubber cement or any other adhesive that will not shrink the paper. Do not use ordinary paste.

If the disc is mounted on a phonograph record, make sure that the record spindle hole is truly centered; if it is off-centered, thus causing a "wow" or variation in musical pitch, it will affect the accuracy of the stroboscope disc, resulting in a backward and forward movement of the segments, even though the turntable speed may be constant.

By the same token, care must be exercised in cutting out or punching out the center hole for the stroboscope disc. The white dot is the exact center, the black area the portion to be removed. A scriber compass will do the job nicely.

In using the stroboscope, it is preferable that a normal load be placed on the turntable, so that operating conditions are simulated. In checking the speed of a record-player turntable, for instance, check the speed with the pickup needle traversing the outer grooves of a 10-inch record placed on the turntable underneath the stroboscope disc — or the outer grooves of the record on which the stroboscope disc is mounted, as the case may be.

With the turntable in motion and the stroboscope disc in place, cast the light from a neon tube directly on to the rotating disc segments. The neon tube must be energized from a 60-cycle source. If the turntable speed is exactly 78.26 r.p.m., the inside segments will appear to be stationary; if the speed is 33 1/3 r.p.m., the outside segments will appear stationary. A backward and forward motion of the segments will indicate a variation in turntable speed; a backward or forward motion will indicate that the turntable is running below or above the required speed, and should be adjusted until the proper series of segments appear stationary.

Mr. JOBBER!
N.R.P.D.A.
Has an Important Message for You!

On Thursday, June 13th, 1940 at 7 P.M. at the Stevens Hotel in Chicago, there will be held the First Annual Meeting of the NATIONAL RADIO PARTS DISTRIBUTORS ASSOCIATION.

This will be a Dinner Meeting, for N.R.P.D.A. Members exclusively, immediately after which a Business Meeting will be held. Complete reports will be rendered by your Officers. A feature of this meeting will be an Open Forum which will afford Members the opportunity to express their opinions on the major issues facing our Industry.

You cannot afford to be absent from this important meeting. Use the coupon below and mail it at once to N.R.P.D.A., 5 West 86th Street, New York, N. Y.

It is up to ALL of us to make this meeting a success. Let us set an example to the entire Radio Industry by showing that we can and will solve our business problems through mutual cooperation.

Since it is essential to make the necessary preparations well ahead of the date of the dinner, only Members making reservations in advance can be admitted to this meeting. It is to your advantage to send your check AT ONCE covering reservations for the number of individuals in your organization who will attend.

NOTICE TO NON-MEMBERS

If you have not yet become a Member of N.R.P.D.A. but plan joining this growing group of influential and far-sighted jobbers at Show Time, we suggest that you send your check covering your dinner reservations and request that we send Application for Membership in N.R.P.D.A. (Only enrolled members may attend this dinner.)

MAIL THIS RESERVATION COUPON NOW

N.R.P.D.A.
Arthur Moss, Executive Secretary
5 West 86th Street, New York, N. Y.

Please reserve .... places at your Dinner Meeting, Thursday June 13th, 1940, at 7 P.M. Enclosed is my check for $.............. ($2.50 per person).

NAME OF COMPANY ....

ADDRESS ....

CITY .... STATE ....

NAME OF INDIVIDUAL ....

SOUND RECORDING

(From page 6)

room have a very definite bearing on tone quality and deserve considerable attention in order to determine the best position in the room for the subject. The proper setting of the volume control can only be determined by actual test. The practice of making test cuts before recording is to be highly recommended. Feeling the cutting stylus to be sure that the recording head is in operation is a good idea if done with care, but the practice of "wiggling" the stylus in a recording head is a bad one. If the head is a crystal type, there are chances of cracking the crystal element. With a magnetic type, no permanent damage is done, but the delicate balance of the armature may be upset to the extent that it will be necessary to return it for repair.

The serviceman with the necessary equipment will find it to his and the customer's advantage to make a frequency response record of the complete system *before* and *after* servicing. This constitutes a positive and permanent check. It also furnishes positive proof of improved operation.

SERVICEMAN'S DIARY

(From page 16)

wants a home demonstration. Sometimes selling isn't so easy.

At three in the afternoon, the Cadillac came back. The rain had stopped and the streets glistened in the sun. The girl had changed to a blue dress; the same color as her eyes, I noticed. She looked lovely.

"Where would you like me to take you?" she asked.

"To South America," I murmured.

"Where?" she gasped.

"To South Street," I sighed. "Two blocks down. The garage is on the left."

TEST YOUR LINES

(From page 18)

HOW'S CONSTRUCTION?

Next remove the chassis and look over the wiring and construction. Note if the power transformer runs excessively hot. See that electrolytic condensers can be easily replaced.

Look carefully at soldered joints to see that the solder has been flowed into each connection rather than just smeared on. Give preference to a set in which the wiring is neat and cleanly laid out, to one that looks haywire; it will make a difference if you have to service the set within the guarantee period.

(Turn to page 23)

Circuit Court

NO GRID CONDENSER?

As WE CAST A roving eye over the circuits before the bar this month, our attention rests first on the case of the oscillator circuit of the *RCA 45 X 5*, shown in schematic form in Fig. 1. No, there's

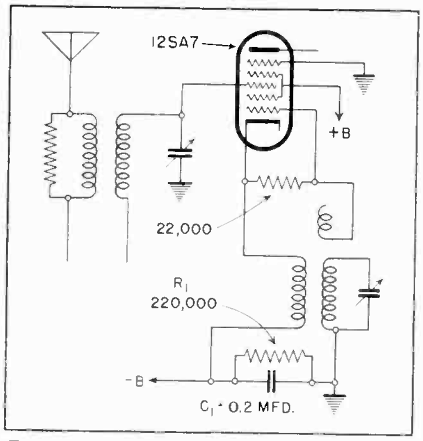


Fig. 1. The oscillator grid condenser is an open-ended coil coupled to the tank circuit.

no error in it—the little coil adjacent to the oscillator circuit has a free and untrammeled end, completely divorced from all other points to which it might, but doesn't, connect. It nestles close to the tuned circuit—so closely that the capacity coupling between it and the oscillator tank coil is sufficient to enable it to serve as a grid condenser. Result—one part less, one soldered joint saved; and, for you and ***you,*** fewer headaches. This stunt is used in other sets, too. *Emerson*, for instance.

CHARGE DISMISSED

Before we pass on to the next circuit, let us consider the 0.2-mfd condenser shown connected from B minus to ground in Fig. 1. This condenser has nothing to do with the operation of the oscillator circuit; neither has the 220,000-ohm resistor which shunts it. It so happens that this is an a-c/d-c set, and if no bypass to ground is provided, r-f currents will float around the chassis and barge into circuits where they aren't wanted. The 0.2-mfd condenser stops all that, but, (there's always a but) since there is potential difference between chassis and B minus, this condenser accumulates a charge, which often gets back into the circuit and causes blocking. Hence the 220,000-ohm resistor. When it shunts the condenser, the accumulated charge can leak off and . . . the charge is dismissed.

WAVEMAGNET

THE CIRCUIT shown in Fig. 2 is the switching arrangement used on the "Wavemagnet" in the *Zenith* 1940 Advance Line Receivers with chassis employing more than one waveband.

With the Wavemagnet antenna switch in the "Wavemagnet" position the two shields surrounding the loop winding are connected together and grounded to the chassis through the short-wave primary winding and an isolation condenser of .05-mfd. The reactance of the short-wave primary is negligible at broadcast frequencies and the shield is effectively grounded, although the primary winding is in the circuit.

When the receiver is switched to short wave, the entire Wavemagnet assembly acts as a small antenna coupled to the short-wave input winding by means of the aforementioned primary winding.

The trimmer condenser connected be-

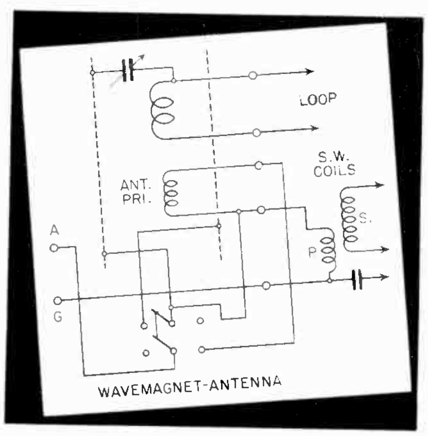


Fig. 2. Wavemagnet switching arrangement used in Zenith 1940 Advance Line Receivers.

tween the shield and the grid end of the loop winding is used to compensate for unavoidable variation of distributed capacity between the shield and the loop winding and preserves tracking over the high-frequency portion of the broadcast band.

With the Wavemagnet antenna switch in the "Antenna" position, the connection between the two shields is broken and the outer shield acts as an antenna connected to the loop by means of the trimmer condenser which, in this case, also acts as a coupling condenser. In many cases an increase of signal strength will be apparent with this connection but at the expense of increased pickup of interference inasmuch as the shielding action of the shield is no longer effective. The antenna primary winding which is associated with the loop winding is not effective unless an outside antenna is connected to the antenna terminal of the Wavemagnet.

◆

RESISTANCE COUPLING

RESISTANCE COUPLING is nothing new . . . when it's used in a-f stages. But in Fig. 3A, we find it in the r-f stage of the *Galvin 26-C*. The resistors are lower in value than we generally expect in a-f stages because more gain is obtained with low values of resistors than with high ones, which is just exactly opposite to the results under the same conditions at audio frequencies. Why?—well, because the tube and circuit capacities at radio frequencies serve as bypass condensers across the resistors and thereby limit the gain. Putting in high resistance values causes less gain because the effective plate voltage on the tube is reduced; also the mutual conductance, which is the other important item in the situation.

Let's say the total shunt capacity is 40 mmfd. The reactance figures out to about 25,000 ohms at 1500 kc, which is in shunt with the plate and grid load resistors and no matter how many megohms were put in each circuit, the impedance could never equal 25,000 ohms, yet the plate voltage and, as stated before, the mutual conductance and gain, would decrease. By making the plate load 10,000 ohms (which is effectively in parallel with the 22,000-ohm grid resistor) we

(Turn to page 34)

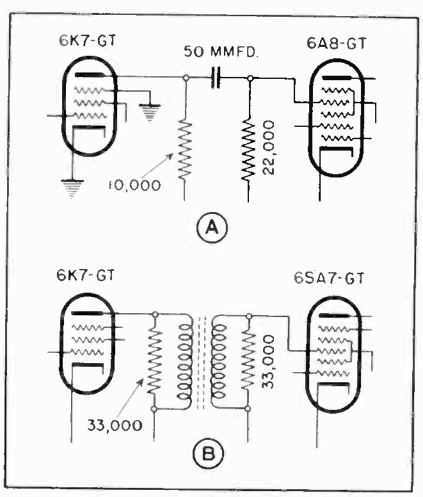


Fig. 3. A—Galvin resistance-coupled r-f stage. B—Untuned r-f transformer stage with loading resistors.

(From page 21)

See that the dial arrangement and push-buttons are mechanically strong. If dial cable is used, can it be easily replaced? Note if the contact fingers on the tuning condenser rotor are bonded by soldered connections to a common ground circuit—otherwise these will likely become a source of noise while tuning. Observe if the volume control is a standard type for which a replacement can be obtained easily.

These reminders are but the basis of your examination. You know from experience what has sold and stayed sold to satisfied customers in the past. Look for the features of those sets in your new line.

HOW'S THE PROFIT?

There is one more point to be considered. Is it profitable to sell the set you chose? If your gross operating cost is 30% of the gross sales, you must have at least a 40% margin of gross profit. Short discount lines which are intended for leaders at the expense of the dealer's profit, too often become loss leaders. You are in business to make a profit, and if you lose sight of this objective, you'll soon be out of business.

If after this rigamarole, you are convinced that you have found a good group of radio sets and their performance on the air supports your analyses, you can sell them regardless of competition, cut prices or bargain deals, because *you'll* be sold on them. Your sales talk will be sincere and convincing. You can tell about your search for the best receivers on the market and how you arrived at your decision to handle them.

Customers have confidence in dealers who know what they are talking about. These are the dealers who will sell the bulk of the new receivers.

INVERSE FEEDBACK

(From page 15)

50, depending upon the constants of the particular circuit. By substituting a pentode for the triode, the gain of this stage could be increased to 100. This means an increase in gain of from 6 to 12 db, depending on the original gain in the triode stage. A corresponding amount of feedback over either one or two stages could then be introduced and the gain would be brought back to the previous level. The same reasoning applies to a p-a amplifier.

The feedback method described; i. e., tapping the feedback voltage from the output transformer secondary, is so flexible that it can be applied to a wide variety of circuit combinations. Wherever it is permissible to ground one side

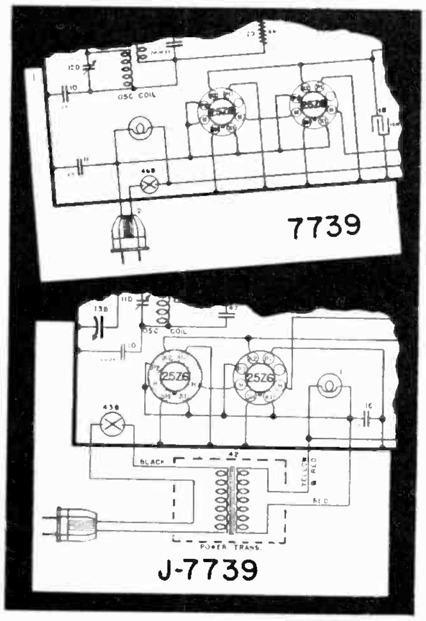
(Turn to page 25)

Shop Notes

CROSLEY J-7739 and 7739

Point of Difference

Model J-7739 is the same as Model 7739 except that the former has a 1-to-1 isolating power transformer. See accompanying circuits.



Alignment procedure and socket voltages for both are the same as for the other models in the series; namely, 739, 7739, J-739 and J-7739.

◆

GALVIN MOTOROLA

Antenna Check

Don't pull an auto set when the complaint is weak or noisy reception, without first checking the antenna. More often than not the trouble is due to a poor or inadequate antenna installation. Hence, always make the antenna your first point of attack.

◆

GALVIN WIRELESS RECORD PLAYER

Tuning Error

If the tuning trimmer in the Model 11A or 21A Wireless Record Player is set too tight, it is possible to tune the receiver mistakenly to the harmonic, rather than to the fundamental carrier frequency. Set the receiver dial at about 1600 kc and back the trimmer out until the strongest signal is heard. The fundamental is many times stronger than the harmonic.

◆

PHONOGRAPH PICKUPS, CRYSTAL

Unaccountable Distortion

Distortion on loud passages which cannot be traced to any other source may be due to a loose crystal cartridge. Examine the mounting and make sure that the cartridge is secure. If there is any play, the cartridge rather than the needle will vibrate where the record groove amplitudes are great enough to move a large mass.

◆

STEWART-WARNER 01-5D

When the 01-5D chassis is removed for service, the phonograph pickup cable must be plugged in and the "Radio-Phono" switch placed in the "Radio" position before the set will operate.

The 01-5D9 phonograph motor must be operated on a.c. only.

◆

STEWART-WARNER A-6 (07-31 CHASSIS)

I-F Oscillation

When aligning this set, i-f oscillation may be encountered if the following precautions are not observed:

Keep the bottom cover plate on during alignment.

Keep the signal generator leads as far from the chassis as possible in order to prevent unnecessary feedback.

Connect the ground lead of the signal generator through a .25 mfd. condenser to some part of the chassis in the *vicinity of the gang condenser.*

Keep the orange lead of the volume control away from the 2nd i-f transformer. Separating this lead from the others surrounding it at the base of the 25B8GT tube will also help.

◆

STEWART-WARNER 01-6B9

Phonograph Notes

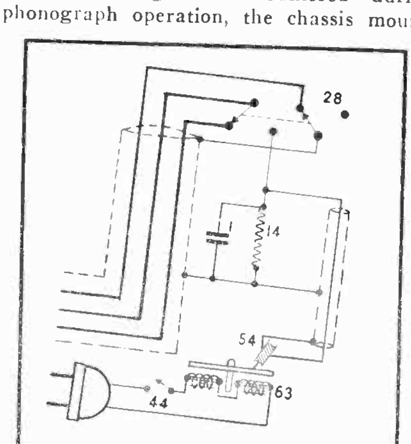
On early releases of model 01-6B9, a 220,000 ohm resistor was connected across the phonograph pickup at the "phono-radio" switch.

In order to eliminate needle scratch on these sets, a 68,000 ohm resistor, 14, and a .003 mfd condenser, 1, were substituted for the 220,000 ohm resistor. These were connected as shown in the circuit diagram.

On all late releases a pickup with different cushioning was used, and the values of the resistor and condenser were changed to 470,000 ohms and .001 mfd.

If "growling" is encountered during phonograph operation, the chassis mounting bolts should be checked to see that they are loose enough to allow the chassis to float on its rubber cushions.

If the set is of the early type using the 220,000 ohm resistor, the substitution of the 68,000 ohm resistor and .003 mfd. condenser described above may help to reduce "growling"



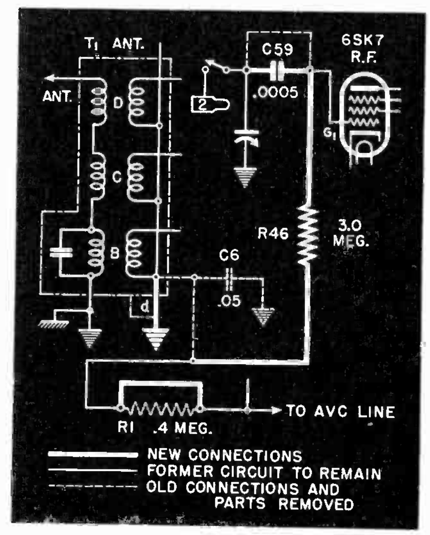
◆

WELLS-GARDNER SERIES 1A29 "B" ISSUE

Changes to Reduce Hum Modulation

In order to reduce hum modulation, the changes shown in the accompanying schematic were made in the receivers carrying chassis number 1A29-2B or 1A29-3B.

Resistor *R1* in series with the avc connection to the antenna coil, has been removed from the circuit.



The avc line is no longer connected to the antenna coil at terminal *D*. Instead, this terminal is connected to ground. The bypass condenser *C6*, formerly connected between the same terminal and ground, has been removed from the circuit.

The avc line which formerly connected to the *D* terminal of the antenna coil and *C6*, is now connected through a 3-meg, resistor, *R46* to *G1* of the 6SK7 r-f tube.

Grid 1 of the 6SK7 r-f tube, which formerly connected directly to the stator of the gang condenser, is now connected to this point through a .0005-mfd condenser, *C59*.

◆

WELLS-GARDNER, GENERAL

Tuning Eye Distortion

Distortion and overloading on strong signals in sets using the 6U5 and 6AB5 tuning-eye tubes may be caused by grid current in these tubes. Try one or more new tubes and check results.

The control grid of the triode section of the 6U5 and 6AB5 tubes is connected to the avc circuit and grid current will affect the avc voltage.

These tubes were used in Wells-Gardner sets made in 1938 and in some sets made in 1939.

(From page 23)

of the voice coil, and wherever a single-ended voltage amplifier is present in the audio system, this method may be used to advantage. A particularly simple variation obtains when a very low im-

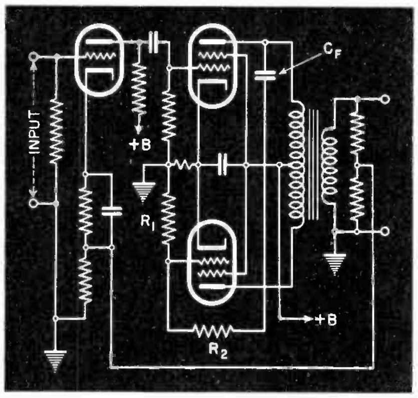


Fig. 5. Phase-inverted push-pull stage with inverse feedback from secondary of output transformer to cathode circuit of a-f voltage amplifier.

pedance voice coil (1 or 2 ohms) is being used. In this case, the voltage across the voice coil is so low that a divider across it becomes unnecessary and the whole winding may be used to feed the voltage back to the cathode of the voltage amplifier. Instead of the low side of the cathode resistor and bypass condenser going directly to ground, they are simply brought to the high side of the voice coil and the other side of the voice coil grounded. The milliampere or so that flows through the plate circuit of the voltage amplifier will do no harm to the voice coil, but of course this method cannot be used where appreciable plate current flows, as in the case of an output tube cathode circuit.

PUSH-PULL FEEDBACK

All circuits considered so far have been single-ended outputs. Fig. 5 illustrates how the same method of feedback cou-

(Turn to page 27)

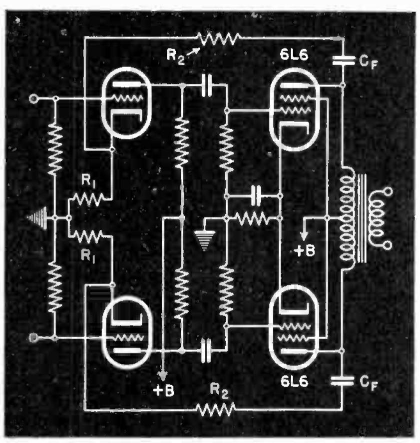
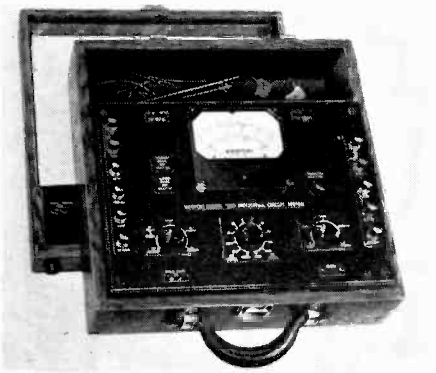


Fig. 6. Push-pull feedback over two stages, the feedback being from plate circuits of output tubes to cathode circuits of driver tubes. A good system.

WESTON

Industrial Circuit Tester—Model 785 for signal and telegraph systems, telephone and communications, laboratories, schools, and service work. Has 27 practical ranges, as follows:



D-C Voltage—From 10 millivolts to 1000 volts (20,000 ohms per volt) in full-scale range of: 1/10/50/200/500/1000 volts. Accurate within 2% up to 500 volts.

A-C Voltage—From 0.1 to 500 (1000 ohms per volt) in full-scale ranges of: 5/15/30/150/300/500 volts. Accurate within 3%.

D-C Current—From 0.5 microampere to 10 amperes in full-scale ranges of: 1/10/-100 milliamperes, 1/10 amperes. Accurate within 2%.

A-C Current—From 10 milliamperes to 10 amperes in full-scale ranges of: 0.5/1/5/10 amperes. Higher ranges with external current transformers. Accurate within 3% on 60 cycles. Slightly less accurate on 25 and 133 cycles.

Resistance—From 0.5 ohm to 30 megohms in full-scale ranges of: 3000/30,000/-300,000/3 meg./30 meg. Center scale values are: 25/250/2500/25,000/250,000 ohms. Self-contained batteries. Accurate within 2% of the linear arc length on any ohmmeter range. By Weston Electrical Instrument Corp., 605 Frelinghuysen Ave., Newark, N. J. RADIO SERVICE-DEALER.

◆

CLAROSTAT

Serrated-Shaft Controls—Volume Controls with serrated shafts, for quick and exact replacement of controls having the knurl and slot shafts, are announced by Clarostat

Mfg. Co., Inc., 285-7 North Sixth St., Brooklyn, N. Y. These Series KS controls are of the popular Clarostat midget type, and permit replacements without having to replace the slip-on knobs as well. Series KS units are available in all required resistance values, although only six values are required in servicing the bulk of existing radio sets. RADIO SERVICE-DEALER.

◆

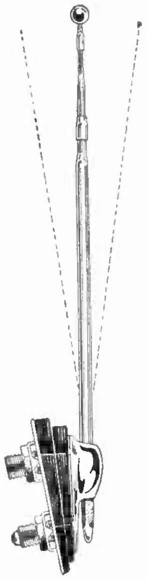
LIFETIME

Dynamic Trumpet Unit—New No. 40 - PM permanent-magnet dynamic unit for trumpets, with replaceable top and diaphragm which can be interchanged in a few minutes in case of damage. Diaphragm alignment with the pole pieces is predetermined and self-centered upon replacing head. Capacity of unit, 15 watts continuous; voice-coil impedance, 15 ohms at 1000 cycles. High conversion efficiency and response. By The Lifetime Corp., 1825 Adams St., Toledo, Ohio. RADIO SERVICE-DEALER.

◆

WARD PRODUCTS

Flex-Angle Aerial—This auto - antenna by Ward Products Corp., Ward Building,



Cleveland, Ohio, is single mounting and can be set to a vertical position on any body contour without use of special parts to compensate for angle. The Flex-Angle antenna can be adjusted to a vertical position through an arc of 16 degrees. RADIO SERVICE-DEALER.

◆

TRIPLETT

New Television Tester—Designed especially to service television instruments where high voltages are invariablly present. Special

test leads, 3 ft. long, have been tested to 25,000-v. breakdown. Posts are provided on the panel for grounding the metal case which is protection against bodily injury at high voltage. Tests a-c and d-c voltage in steps of 2,500 and 10,000 v.; d-c microamperes in steps of 50, 500 and 5,000. Meter sensitivity is 25,000 ohms/volt for d-c and 5,000 ohms/volt for a-c. The meter is a 4" instrument in a bakelite case. Dimensions, 7⅞" x 6½" x 5⅝" overall. Model 1280. Triplett Electrical Instrument Co., Bluffton, Ohio. RADIO SERVICE-DEALER.

◆

READRITE

Combination Tester—Model 432A742 combination tube tester and volt-ohm-milliammeter. Separate panels provided for tube

and set tests. 5 ranges in a-c and d-c volts to 2,500 volts; 3 d-c ranges to 100 ma and 2 resistance ranges to 1½ meg plus 0.5 to 500-ohm range. Readrite Meter Works, Bluffton, Ohio. RADIO SERVICE-DEALER.

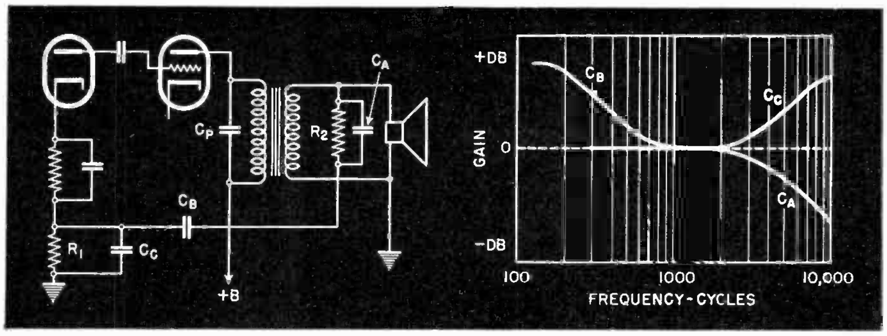


Fig. 7. Frequency compensation incorporated in an inverse feedback circuit. The degree of compensation and its point in the frequency range is governed by condensers Ca, Cb and Cc. Thus, bass boost, treble boost or treble attenuation may be had.

pling may be applied when the output stage is push-pull, accomplished by means of phase inversion in the output stage. It is evident that this changes the picture not at all, since the voltage amplifier is still single-ended.

A different situation is presented when the next to the last stage is push-pull also, as is often the case in public-address or hi-fidelity phonograph amplifiers. The system must be revised somewhat to meet these conditions, as shown in Fig. 6. Here, push-pull feedback is required and it cannot be obtained from the asymmetrical voice-coil circuit, unless the output transformer secondary is center-tapped and the tap grounded. It becomes necessary to go back to the primary of the output transformer for the source of feedback voltage. In this case two dividers are set up; one for each side of the push-pull circuit. Due to the high voltage ratio between the input and output points of the feedback loop, it is usually necessary to use the whole cathode resistor for *R1* because *R2* must be quite large in order not to absorb appreciable power. Fig. 6 as shown is a widely used circuit in high-grade amplifying equipment, and is recommended where the original equipment is sufficiently comprehensive to allow its adaptation. Usual values are about 75,000 ohms for *R2* and 0.5 mfd for *Cf*.

COMPENSATED FEEDBACK

In all previous discussion, it has been assumed that the feedback network had a flat frequency response; i. e., that it fed back all frequencies without discrimination. If the feedback network is so arranged that it discriminates against certain bands of frequencies, marked changes in the response of the amplifier will result. This can be readily appreciated from the following line of thought: The gain of the amplifier is dependent upon the degree of feedback. If the feedback network has a poor high-frequency response, only slight feedback action will occur at these frequencies, and the gain will be higher than normal at the high end of the response range. If the feedback network has a rising frequency response, more high-frequency energy will be present in the feedback voltage, a high degree of feedback will be present at these frequencies and there will be consequent loss in gain. It follows that the response of the amplifier can be changed and controlled by varying the response of the feedback network, since one compensates the other.

Thus, to create a rising response in the amplifier, it becomes only necessary to shunt a small bypass condenser across *R1*. This has the effect of bypassing the high frequencies out of the feedback voltage and decreasing the amount of feedback at the high frequencies, and consequently increasing the gain in this region. To increase bass response, a small condenser in series with *R2* will cause a drop in low-frequency feedback voltage and increase the bass gain. The exact values depend of course upon the size of *R1* and *R2*, but an approximation may be made as follows: The reactance of the condenser (at the frequency in question) is equal to:

$$Reactance = \frac{1{,}000{,}000}{6.3 \times F \times C}$$

Where *F* is the frequency in cycles, *C* is the capacity in mfd.

When the reactance of the condenser is equal to the resistance of the resistor that it shunts, the effect of the condenser will just be noticeable to the ear. Thus, if it is desired to cause a rising characteristic starting at 5000 cycles, calculate the capacity from the above formula to equal *R1* at 5000 cycles and curve *Cc*, Fig. 7, will result. Similarly, to obtain bass boost, as in curve *Cb* of Fig. 7, the condenser *Cb* is calculated to have the same reactance as the resistor *R2* with which it is in series. If it is desired to have the curve start to become effective at 500 cycles, then the reactance of the condenser should equal the value of the resistor at this frequency.

Variable tone control may be accomplished by using tap switches and several capacities, and low- and high-frequency combinations can be easily worked out to suit the particular requirements.

OSCILLATION

The main difficulty which most servicemen seem to encounter when applying inverse feedback to existing equipment is a tendency toward instability and/or oscillation, even though the phase relationship seems to be proper according to calculation. This tendency is usually due to additional phase shift occurring in the output transformer and coupling networks between stages. This can almost always be cured by shunting the primary of the output transformer with a small tubular condenser, varying in capacity from .001 mfd to .005 mfd. It should be a high-voltage type, and the smallest capacity which squelches the oscillation should be used. It will be found that this capacity has negligible effect on the response of the amplifier, since the feedback tends to correct the slight bypassing action. Still smaller condensers from grid to ground of the output stage are also effective; .0001 mfd to .0005 mfd being usual values. To counteract excessive shift in the grid-coupling condensers, these should be made as large as possible, sometimes as large as .25 mfd in cases of low values of grid resistors and multi-stage feedback.

It will be found that the application of inverse feedback can be made to pay dividends in terms of both improved performance and greater response flexibility, and if the general procedure outlined above is followed, the improvement should far outweigh the effort involved.

FREQUENCY MODULATION

(From page 13)

that the limiter tube had leveled off and had become a current-limiting device. A good limiter circuit is designed to level off with between 3 and 5 volts of signal applied to the grid.

THE DISCRIMINATOR

Next we find what is equivalent to a detector, but more correctly referred to as the discriminator. This circuit is exactly the same as similar arrangements used to provide automatic frequency control in amplitude-modulation receivers. If the incoming signal is the same as the resonant frequency of the discriminator transformer, the rectified voltage of the two diodes will be exactly the same and of opposite polarity, so that the sum of the two rectified potentials at *C28* will be zero. As the carrier deviates either side of center, one diode develops more voltage than the other so that when added algebraically a definite potential appears at *C28*. This potential will be greater if the deviation increases so that the audio output voltage will be directly proportional to the carrier frequency deviation. If the frequency changes occur very rapidly, the audio voltage will swing to zero and back again to full potential just as rapidly. The timing or rapidity of the carrier swing will therefore determine the frequency of the audio voltage changes, and will appear at the output of the discriminator as definite audio-frequency changes.

Now let us see just what special requirements are involved in the servicing of frequency-modulation receivers.

ALIGNMENT AT I.F.

First and most important of all is the need for most accurate alignment of the various tuned circuits. This point cannot be stressed too strongly. We feel safe in stating that about 75 percent of the cases of unsatisfactory reception with f-m receivers will be directly traceable to improper alignment. *All of the tuned circuits in an f-m receiver must have exactly the same center resonant frequency,* and the overall response within a 200-kc. band must be symmetrical. The i-f transformers need not be absolutely flat top. As a matter of fact, none will be. The curves should, however, be all the same. Due to frequency limitations, it will not be practical to use an oscillograph and frequency-modulated oscillator for checking the wave-shape of the tuned circuits. However, other equally good methods are available.

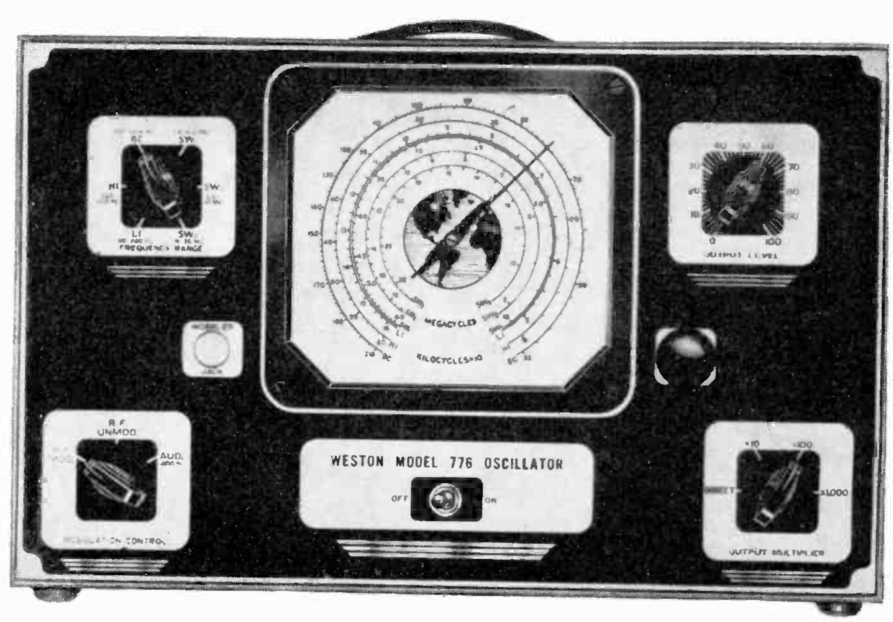
Before attempting to align the r-f and i-f stages, the discriminator circuit should be adjusted. The intermediate frequencies now being used by most of the manufacturers lie between 1 and 5 megacycles. A standard service oscillator can therefore be used. However, as previously pointed out, these circuits must all be aligned at precisely the same frequency. The service oscillator must, therefore, be absolutely stable. If drift occurs in the service oscillator during the time required for adjustment of the various circuits, the final alignment will not be correct and distortion will result. There is one oscillator on the market today having an automatic amplitude control circuit which results in extreme stability. Field tests have shown a drift of less than ½ of 1% at 5 megacycles for an extended period of operation. These characteristics are extremely desirable in an instrument for this particular work.

With the oscillator set to the i-f peak and connected to the grid of the limiter tube, a 20,000 ohms-per-volt voltmeter, or preferably a vacuum-tube voltmeter, should be connected across the two cathodes of the 6H6 discriminator tube. The secondary of the discriminator transformer is then adjusted until maximum voltage is obtained. The primary is then adjusted until zero voltage is indicated. Please note that it is possible to obtain both a positive and negative potential at this point while making the adjustments. Absolute zero voltage is the point which is desired. After these adjustments have been made, both the secondary and primary trimmers should be checked a second time. Now we can pass on to the i-f transformers.

In adjusting the i-f transformers, it is essential that the oscillator be set to exactly the same frequency as was used for the discriminator adjustment. Each i-f stage should be adjusted using a 100- or 200-microampere instrument in series with the ground side of the limiter grid resister *R10*. Adjustment is made so as to obtain a maximum meter reading. In other words, the transformers are peaked. No attempt should be made to stagger tune in an effort to flat-top the i-f transformers. Stagger tuning will only result in amplitude distortion. Remember that symmetry between stages is much more important than absolute flat response.

ALIGNMENT AT R.F.

The last adjustments are those of the r-f and oscillator circuits. Here again the adjustment is made so as to obtain maximum current in the limiter grid circuit. A stable signal source is once again essential, and since the signal frequencies are between 40 and 44 megacycles, stability in a signal generator is quite a problem. A close examination of the tuning condensers on the present frequency-modulation receivers will reveal very special designs. The condenser plates which are being used are very heavy in order to prevent any possibility of vibration, which would cause a change in the tuning of the various r-f circuits. There is at present an inductively-tuned ultra-high-frequency oscillator on the market which is remarkable in its stability at high frequencies. It is worth mentioning that this particular instrument is also the only one available which



Weston Model 776 oscillator with automatic amplitude control, providing very stable signals from 50 kc to 33 mc.

can be tuned to the degree of accuracy required in order to check the final over-all alignment job. This checking involves the determination of the final band-pass characteristics, and more important, the symmetry of the complete alignment.

After final alignment, the u-h-f oscillator is slowly tuned 100 kc. either side of the center frequency to which the receiver is tuned. The microammeter in the limiter grid circuit should not vary too greatly through that range. The exact degree of variation permissible will not be the same for all receivers. Actual experience will be necessary to determine those limits, but regardless of that fact, the change in the meter readings should be the same for an equivalent frequency deviation either side of center. In other words, if a change of 5 microamperes occurs when the u-h-f oscillator is de-tuned to 50 kc. above the center frequency, a similar shift to 50 kc. below the center frequency should likewise result in a change of 5 microamperes. If the final check does not indicate symmetrical alignment, all of the adjustments should be made a second time.

TUNING CHARACTERISTICS

If a receiver is properly aligned, the reception of actual station programs will be rather peculiar in nature as the listener tunes through the station channel. As the station channel is approached, the signals will gradually become louder, and if some external noises exist, those noises will also be audible. Gradually a point will be reached where the signals apparently are at maximum volume. Continuing beyond that point the signal will appear to become weaker, but at the same time the noise level will drop way down and in most cases disappear completely. This is the correct tuning point. Continuing on through the band, another peak will appear, gradually followed by a falling off of the signal.

Because of the above characteristics, it is essential that all purchasers of f-m receivers be properly instructed in the correct method of tuning. If such instructions are not given, all kinds of complaints are likely to result.

CATALOGS—LITERATURE

Raytheon Tube Manual—New, revised 13th edition of the Raytheon Characteristic Data Chart, free on application to any Raytheon sales office. Has 28 pages giving characteristics of 331 receiving-type tubes, also plug-in resistors and pilot lamps. Included are 121 basing diagrams, 52 outline sketches and table of 194 interchangeable tube types. The section given over to circuit diagrams has been enlarged and revised and is completely up-to-date.

♦

Mallory Supplement—Supplement No. 6 to the 3rd edition of the Mallory-Yaxley

Radio Service Encyclopedia, contains 22 pages of data on Half-Wave and Doubler Power-Supply Systems. The text covers the operating characteristics of half-wave rectifiers, functioning of the symmetrical or full-wave type of voltage doubler, and the series line feed or half-wave doubler with common cathode type condenser. Also component failures in transformerless power-supply systems.

✦

S.R.C. 1940 Catalog—New Spokane Radio and Sound Equipment Catalog with spiral binding and 235 pages. Contains handy 3-page index with over 1200 listings. Released by Spokane Radio Company, Inc., 611 First Ave., Spokane, Washington.

✦

Lafayette Spring Catalog—Issued by Radio Wire Television Inc. (formerly Wholesale Radio Service Co., Inc.). Contains first listing of new public-address line, recorders, etc. Copies available from above company at 100 Sixth Ave., New York, N. Y.

✦

Atlas Sound Catalog—Covers new line of speakers, marine horns, parabolic baffles, chandelier baffles, enclosures, projectors, p-m driver units etc. Ask for Catalog F-40 from Atlas Sound Corporation, 1448 39th St., Brooklyn, N. Y.

✦

Terminal P-A Catalog—Released by Terminal Radio Corp., 68 West 45th St., New York, N. Y. Includes, complete systems, tuners, microphones, speakers, record players and accessories.

✦

Clarion Spring P-A Catalog—Contains amplifiers and complete sound systems from 7 to 100 watts, including mobile jobs, recorders, school systems, musicians' sound equipment, record changers, transcription players etc. Address Clarion Institute of Sound Engineers, c/o Transformer Corp. of America, 69 Wooster St., New York, N. Y.

✦

Clarostat Manual—A 32-page Plug-In Resistor Tube Service Manual arranged by respective sets and resistor type numbers, and again as a numerical listing of all types with corresponding Clarostat standard and universal types. Copy for 15 cents, coin or stamps, from Clarostat Mfg. Co., Inc., 285 North Sixth St., Brooklyn, N. Y.

✦

Shure Sales Manual—As aid in selling sound in conjunction with Replacement Sales Plan instituted by Shure Brothers, 225 West Huron St., Chicago, Ill.

✦

Sylvania Window Display—Issued by Hygrade Sylvania Corp., 500 Fifth Ave., New York, N. Y., featuring tieup with Pinocchio and Jiminy Cricket. Lithographed in eight colors; stands 40" high.

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Sylvania Puzzle Tag—Available to dealers and servicemen, with imprint. Tag reads, "We will be glad to solve it for you if requested, and we can help solve your radio problems, too."

BOOK REVIEWS

FREQUENCY MODULATION, by John F. Rider. Flexible cloth cover, 5½" by 8¼", 136 pages, illustrated. Published by John F. Rider Publisher, Inc., 404 Fourth Ave., New York, N. Y. Price $1.00.

If frequency modulation isn't of importance to the serviceman at the time of this writing, it soon will be. Hence, this new book by Rider is not only timely, but a "must" for those who safeguard their reputations as crack servicemen by keeping up-to-date.

From the viewpoint of the theoretical, frequency modulation is a formidable subject, but in his inimitable way and style, Rider has smoothed out the peaks and the valleys, and presented the case of f.m. in a thoroughly practical and understandable manner. More than this, the text is authoritative, reveals facts regarding f.m. which have not hitherto been published, and, most important of all, provides factual rather than "armchair" data on the installation, trouble-shooting and servicing of frequency-modulation receivers, obtained directly from tests and measurements made in the laboratory.

The book is divided into six chapters, the first of which explains what frequency modulation is, as compared to amplitude modulation. The chapters following deal with what happens at the transmitter, what happens in the receiver, the transmission of f-m signals, f-m receiving antennas, and servicing f-m receivers. There is also a bibliography.

Of particular interest are the explanations of the manner in which the limiter and discriminator stages function, just how important the i-f response curves are in relation to limiter action, the relation of signal strength to noise and audio response, the effect on response of off-resonance conditions, and types of defects in f-m receivers.

Frequency Modulation will prove of interest and value not only to servicemen, for whom the book is primarily intended, but to engineers and students as well.

◆

THE OSCILLATOR AT WORK, by John F. Rider. Stiff cloth cover, 5½" by 8¼", 243 pages, illustrated. Published by John F. Rider Publisher, Inc., 404 Fourth Ave., New York, N. Y. Price $1.50.

With the practical and theoretical aspects of the oscillator well balanced in the text, and the book backed up by preliminary tests and research in the laboratory, Rider's latest is prepared much along the same lines as his now famous *The Cathode-Ray Tube at Work*.

The Oscillator at Work will serve both as a working text and a reference book. The introductory chapters deal with the numerous types of oscillators, how they work, their applications, their behavior, and how their performance may be improved. Also the very important subject of oscillation itself—what it is and the various forms it assumes.

The subjects covered are: Oscillation, Complex Waves, How an Oscillator Works, Triode Oscillators, Electron-coupled Oscillators, Ultra-high-frequency Oscillators, Negative Resistance Oscillators, Electro-mechanical Oscillators, Relaxation Oscillators, Modulation of Oscillators, Audio-frequency Oscillators, Radio-frequency Oscillators, Testing and Servicing Test Oscillators, Receiver Checking with Test Oscillator, Oscillators in Superheterodynes.

There is an Appendix crammed with useful data on laboratory methods of testing broadcast receivers; measuring receiver sensitivity, selectivity and fidelity; measuring noise, modulation percentage, tube loads, amplifier gain, etc.

A seven-page Bibliography is included for those wishing to delve further into the more complex and technical phases of specific types of oscillation generators.

An excellent book for the serviceman, the engineer and the student.

◆

RCA RECEIVING TUBE MANUAL, Technical Series RC-14. Paper cover, 5½" by 8½", 217 pages, illustrated. Published by RCA Manufacturing Co., Inc., Camden, N. J. Price 25 cents.

This Manual, like its preceding editions, has been prepared to assist those who work or experiment with radio tubes and circuits.

In addition to the characteristics, applications and installation data for each tube type, the Manual contains an introductory section dealing with the elementary principles of vacuum-tube operation, definitions of tube characteristics, types of amplifiers, etc.

There are also sections on radio tube testing, resistance-coupled amplifiers, and modern receiver and amplifier circuits. The resistance-coupled amplifier chart has been revised and includes circuit data on the latest tube types.

The Manual is an indispenable source of reference data for all who work with tubes.

CIRCUIT COURT

(From page 22)

get a net load of about 5,000 ohms, which, with a tube of 1500 G*m*, will give a gain of 7.5. More than that, of course, at lower frequencies.

What's nice about it, in addition to the gain, is the fact that no tuning condenser gang is required, and it acts as a buffer between the converter oscillator and the antenna, minimizing radiation. But the selectivity which would be secured by a tuned stage is absent. For auto sets, however, sensitivity is more important.

UNTUNED TRANSFORMERS, TOO

Are used in r-f stages, as shown in Fig. 3B. Radio goes in cycles in more ways than one. Old-timers will remember the early loop sets, all of which used untuned r-f transformers. Now they're back again, but better.

In the diagram shown, the 33,000-ohm resistors serve to broaden any peaks in the operating range. This is used by *Galvin*, in the model *26C-7*. This arrangement helps to give the additional pep which auto-radios always can use.

DIRECT-COUPLED PUSH-PULL

THE CIRCUIT OF a 30-watt push-pull, direct-coupled audio amplifier developed by *Amplifier Company of America*, is shown in Fig. 4. Dual inverse feedback is included.

As direct-coupled amplifiers have the plate of the input tube connected directly to the grid of the succeeding tube, both elements have the same applied

(Turn to page 36)

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(From page 34)

potential. Hence it is necessary to apply all the suitable voltages to the output tube so that the effective bias, plate and screen voltages are in conformance with standard ratings.

It will be noted from the diagram that, though 150 volts are applied to the plates of the 6SJ7 input tubes and to the grids of the 6L6G output tubes, 175 volts is applied to the cathodes of the latter at point *Y*. This provides an *effective* bias of 25 volts.

By the same token, though the output tubes have 575 volts on their plates and 475 volts on their screens, only 400 and 300 volts respectively are actually applied to these elements. These are the *effective* voltages, and are derived by subtracting the cathode voltage from both the plate and screen voltages.

An interesting form of balanced inverse feedback is applied to the input stage. The bias voltage for the 6SJ7 tubes is developed across the potentiometer *R* and the resistor *R1* which is common to both cathodes. Adjustment of the potentiometer *R* will naturally provide a means of compensating for plate-current variations. Moreover, since *R* and *R1* are not bypassed, there is a degenerative action in the cathode circuit. Since the inverse audio voltage developed across *R* and *R1* is in series with the input signal voltage, cancellation takes place. The degree of cancellation in the grid circuit of each of the 6SJ7 tubes will depend upon the audio voltages and the total resistance in each cathode circuit, and this is governed by the position of the potentiometer arm. By virtue of this arrangement, a balanced audio output is obtained.

Inverse feedback in the output stage is taken from the secondary of the output transformer so as to compensate for frequency discrimination of this unit. The audio voltage is fed back through *R2-C* and *R3-C1* to points *A-A* in the grid circuits of the 6L6G tubes.

Two power supplies are employed; one with a 5Y3G for supplying the fixed bias for the output stage, and a separate supply for all plate and screen voltages.

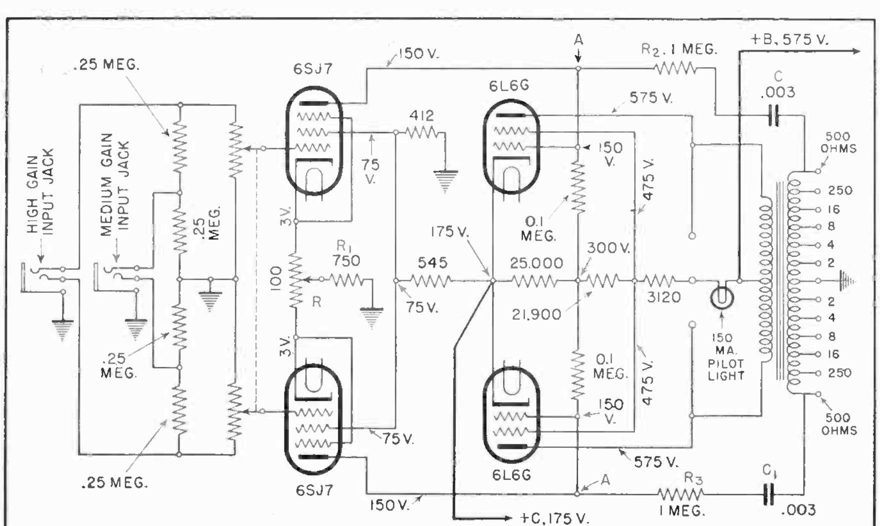
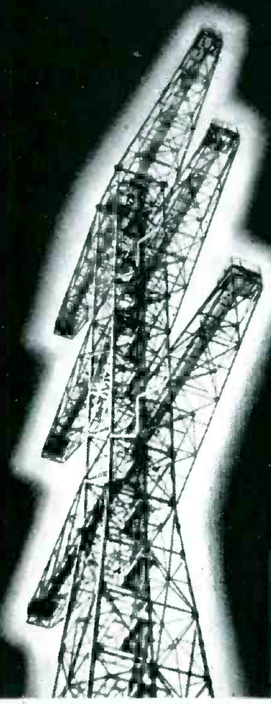


Fig. 4. A direct-coupled push-pull amplifier with dual inverse feedback.

FOR NEW TEST REQUIREMENTS OF

Frequency Modulation



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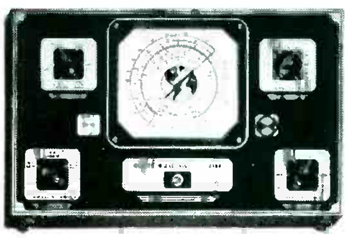

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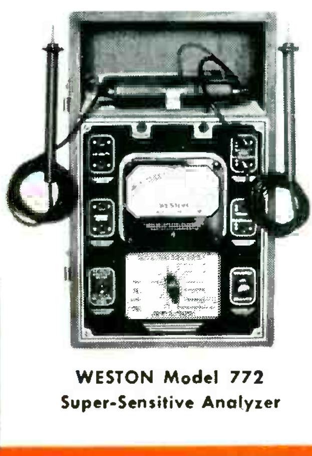

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1. The WESTON Model 787 is the only service Oscillator which reads 40 kc. per division at 40 mc. This precise tuning is absolutely essential to test the band width of F.M. receivers. Each instrument is individually hand calibrated at 2 mc. intervals. (The broad frequency coverage of Model 787 . . . from 22 to 150 mc. fundamental frequencies . . . safeguards against obsolescence in the event of changes in assigned channels.)

2. The WESTON Model 776 Oscillator supplies an absolutely stable signal source. Laboratory tests have shown that the frequency drift is less than .05% at 5 mc. for an operation period of several hours. This stability is the result of newly improved control circuits. With Model 776, too, an individually hand calibrated scale insures dependable accuracy over its entire frequency range of from 50 kc. to 33 mc., fundamental frequencies.

3. Because of frequency limitations of present visual aligning equipment, current measurements down to 1 microampere offer the only means of checking I.F. alignments, cut-off point on limiter tube, and adjustment of discriminators. WESTON Model 772 Super-Sensitive Analyzer offers all ranges necessary to make these sensitive measurements; *plus* additional ranges for all customary voltage, current and resistance measurement needs.

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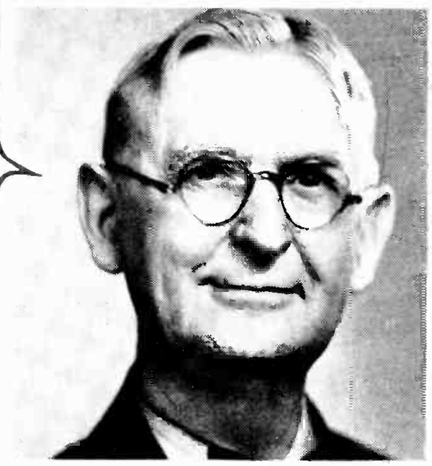

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