How To Choose A Radio
All Factory and Laboratory Views were
Photographed at the Rochester, N.Y. Plant.
HOW TO CHOOSE A RADIO.

Most people do not care to know the technicalities of radio; and radio is a very complex science. They are content to know that their radio brings in programs and reproduces them satisfactorily, without questioning how. Yet a little knowledge of radio principles, and of radio manufacturing processes, is required of those who purchase receivers, if they are to make an intelligent selection.

Let us glance briefly at the operating characteristics and construction details which the engineers think are important. They are:

A. The Cabinet.

1. Large Size. While a small cabinet is portable and inconspicuous, it seriously handicaps the loud speaker in its work of reproducing all musical tones. A large cabinet is needed as a wall or barrier surrounding the loud speaker, to prevent the air pushed by the speaker from simply "slipping around the edge" and coming to rest again. This is especially important for reproducing low bass notes and, within reason, the larger the cabinet the lower the fundamental tones that its speaker can reproduce. When low notes are sounded on midget radios, they usually comprise only "overtones" one or two octaves higher than the true fundamental pitch. This is unnatural reproduction and, in time, is tiring to the listener. If the same speaker unit and chassis were transferred to a large cabinet, a marked improvement would be noticed.

2. Wide, Shallow Shape. The shape, as well as the size, is important to tone. Unfortunately, only two or three manufacturers have the facilities (acoustic laboratory equipment, trained engineers and technique) to make over-all "sound pressure" measurements of the tone quality of their chassis and speaker when installed in the cabinet. Thus you are taking a chance on tone, except on a few trade names where

   a. The manufacturer is noted for excellent engineering and research.
   
   b. He makes his own cabinet and speaker and chassis.

3. Durability. Some radio cabinets are transformed from raw wood to finished and polished cabinets, ready for shipment, in two days. Yet it takes a month to make a good cabinet. The difference is the time spent in kiln drying, to season the wood, and in letting glue dry while the cabinet is clamped in presses. These details of furniture construction are important to purchasers who would beware of warped lids and doors, or checks and cracks that develop in poorly seasoned wood.

Finish. Fine radio cabinets, like fine furniture, are finished with a water stain that soaks deep into the pores of the wood, thoroughly dried before protecting with several coats of lacquer or varnish, and hand-rubbed with pumice stone to a dull gloss finish.
A QUICK TRIP THROUGH THE CABINET SHOP

(It takes each cabinet a month to make this trip)

Black American Walnut Wood In A Drying Kiln

Rubbing Down By Hand To A Dull Gloss Finish.
Inexpensive cabinets are stained with an oil stain, which does not dry quickly and does not penetrate the wood deeply. This wet oil stain slowly works its way through the outer lacquer finish to dry in the air. This is known as "blooming". Such a finish easily flakes off, as a rule.

5. **Non-Resonant Construction.** For sound reproduction purposes, the cabinet is not supposed to act as a "sounding board" but simply as a barrier around the loud speaker. Thin wood or metal cabinets usually introduce their own resonance tones, which distort the music. In certain cabinets (as best determined by Sound Pressure measurements) the bottom as well as the back should be open or vented, to prevent drum-like "cavity resonances". This requires that a sturdy, rigid frame be used, as it eliminates the usual stiffening effect of the cabinet bottom.

6. **Open Cabinet Back.** Loud speaker efficiency requires that air be allowed to circulate freely at both the front and back of the speaker unit. Thus the back should be open or vented, or covered with cloth. Sound absorbent material, if used, should be compensated by other tone characteristics of the cabinet, speaker or chassis, because of the non-uniform effect of all sound absorbent materials to different musical tones.

7. **Avoidance of "Beam Effect".** In the concert hall, all musical tones are diffused almost uniformly throughout the room. When these tones are reproduced by a dynamic speaker, however, the low notes are diffused but the high notes tend to project in a concentrated beam. To listeners directly in the path of this beam, the music will sound high pitched or unnaturally brilliant. Thus, the speaker should be so directed that this beam will always be below the ear-level of listeners, whether they are seated or standing.

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**B. The Chassis.**

1. **Sensitivity.** The radio chassis should be sensitive so as to pick up weak signals from distant or low-powered stations, and so as to extend the effectiveness of the Automatic Volume Control on fading stations.

To some extent, the sensitivity can be complemented by the size, shape and degree of exposure of the aerial used. Thus, a very sensitive receiver needs only a short aerial but will work better with a large aerial, providing the lead-in wire is protected from man-made static noises; and a large aerial connected to a receiver having rather poor sensitivity will enable it to bring in a few distant stations.

In the best modern receivers, sensitivity has been pursued to a practical limit, as set by the noise level of natural and man-made static. Thus, a modern receiver, equipped with a large, efficient aerial, should be so sensitive that the static noises become objectionable when the volume is turned on full. Of course, the noise suppression circuit (if there is one) should
(A) The IDEAL Selectivity Curve (Which cannot be reached in practice).

(B) To approach this ideal selectivity curve, we have seven or more tuned circuits to work with, each of which has a rounded "resonance curve" like this.

(C) Result of aligning all tuned circuits to highest "peak", using a simple oscillator.

Result: Too sharp selectivity near the "peak", impairing tone;
and: Too broad selectivity at the "tails", allowing powerful stations on adjacent channels to interfere.

(D) Tuned circuits in stagger alignment to conform to a pre-determined curve. This can only be done with visual oscillograph instruments.

Result: Broad top, retaining fine tone, and steep sides, for better over-all selectivity.
be disconnected during this test, in order to insure maximum sensitivity. If reception is ordinarily quiet, with the volume knob turned full on, then you should consider installing a larger, more exposed outside aerial or a more sensitive receiver, because you are not getting all of the distant reception possible in your locality. If, on the other hand, the static noises become objectionably loud when the volume knob is turned only part way on, then your aerial or lead-in is picking up an excessive amount of static noises and you should consider using a shielded lead-in wire or low impedance transmission line lead-in, as your receiver provides more sensitivity than you can now use to advantage.

2. **Selectivity.** Selectivity is the ability to separate broadcasting stations into their respective channels. This is an important and difficult function, inasmuch as there are more than 600 broadcasting stations in the United States and Canada, broadcasting on only 96 channels. Where two stations using the same channel can be heard, no receiver on earth can separate them, but good selectivity is required to receive clearly a station on the desired channel with its full tone range, and yet to eliminate all interference from stations on adjacent channels.

Each broadcasting channel is 10 kilocycles wide and the claim is sometimes made by radio manufacturers that their receivers have "absolute 10 kilocycle selectivity". This is obviously absurd, because the only means of approaching this ideal or absolute 10 kilocycle selectivity, shown to the left at "A", is by judicious use of individual tuned circuits, each circuit having a rounded selectivity curve, as shown at "B". When a number of these are added together algebraically, with their peaks tuned or aligned to the same frequency, a "peaked" selectivity curve is obtained, as shown at "C". This is the type of curve provided in ordinary radio sets, aligned with simple oscillators. This is the method used in aligning 90% of the radios being manufactured today because the apparatus required is simple to use and inexpensive to make. Many service men have made or purchased oscillators good enough for alignment by the "peaked" method.

The method of alignment used by Stromberg-Carlson and one or two other radio manufacturers results in a curve, as shown at "D", more nearly approximating the ideal. This requires expensive oscillograph instruments and trained operators, but the results are noticeably superior in both tone and selectivity. Where the peaked method is used, a compromise must be established, because a too sharply peaked selectivity curve will impair the tone quality of the receiver. The oscillograph method permits even sharper selectivity and even better tone, because the individual tuned circuits are so aligned as to form a curve with steep sides and broad, flat top, without a pointed peak.

3. **Image Selectivity.** Image selectivity is required in superheterodyne receivers to prevent each broadcasting station from being
Two Of The Shielded
Laboratories In Which
Receivers Are Designed.

A RADIO CHASSIS ASSEMBLY LINE IN THE STROMBERG-CARLSON FACTORY.
received at two or more places on the dial, and to prevent stations outside the broadcast band from interfering with stations transmitting in regular broadcast channels.

Unfortunately, one of the easiest ways to cut costs in an economically designed receiver, and one that the average customer doesn't understand when trouble arises, is to reduce the image selectivity to an unsafe ratio. The first evidences of poor image selectivity are whistles, squeals, or "tweets", usually received between 650 to 800 kilocycles, due to image signals beating with the desired signals, causing a beat note. In some cases, the image selectivity is so poor that stations are clearly received at the wrong part of the dial, or police car, airplane, amateur radio and ship signals are heard when the dial is tuned to certain channels in the broadcast band.

Receivers employing a "4-gang" tuning condenser usually have adequate image selectivity. Receivers using a "3-gang" condenser may have ample image selectivity if they incorporate a special image rejection circuit, but interference from image signals should be listened for when testing such a receiver. Superheterodyne receivers employing only two-gang variable condensers are obviously poor as regards image selectivity and had best be poor in sensitivity also, so as to avoid image interference, even on local stations.

4. Automatic Volume Control. The Automatic Volume Control has tremendously added to the enjoyment of radio reception by counteracting the tendency for some stations to fade in and fade out. Formerly, listening to such stations required constant adjustment of the volume knob. Now, it is simply a matter of turning the volume knob to the particular level that you desire in your home and thereafter the receiver will automatically raise or lower each station to that volume, whether it is a weak distant station or a nearby powerful one, and will tend to bring in fading stations at that steady volume, except at such times as the signal fades out beyond the limits of sensitivity of the receiver.

There are good automatic volume controls and poor ones, but even the best cannot be perfect. The best test is probably to tune rapidly to weak distant stations and then to nearby powerful stations at night time, and see how nearly they are reproduced at the same volume level. A receiver having good automatic volume control should also have good maximum sensitivity, of course, so as to hang on to stations that tend to fade out.

5. Visual Tuning Meter, or Automatic Tuning. In a receiver equipped with Automatic Volume Control, the set holds the volume fairly constant whether you are tuned accurately and getting the best tone quality from the station, or whether you are detuned a little on either side. For this reason, some means of accurate automatic tuning, such as is provided in the Stromberg-Carlson Telek-tor and Telek-tor-et Receivers, or of visual meter tuning, as incorporated in Stromberg-Carlson Telek-tor and standard receivers, is necessary. The meter type of visual indicator is superior to shadowgraphs and Neon column type indicators which serve as
RADIO ALIGNMENT AND INSPECTION EQUIPMENT.

Constantly striving for uniform high quality, Stromberg-Carlson recently invested $30,000 to modernize this equipment. The copper screen shielding is to eliminate factory machinery static noises.

1. The five crystal-controlled constant output transmitters which provide programs to all inspection positions. 2. Aligning the R.F. stages to "track the dial" and provide the required sensitivity. 3. Five of the visual oscillograph instruments for aligning I.F. stages for the required selectivity and fidelity. 4. One of four final inspection booths, through which all receivers must pass to get into the Shipping Room.
tuning indicators alone, inasmuch as the calibrated meter also
gives an indication of the relative signal strength of two sta-
tions to permit selection of stations carrying the same program;
gives an indication of the condition of certain tubes in the
radio set, and warns, by failing to swing strongly, when they need
replacement; and permits the installer to adjust the Antenna Align-
er knob for best operation with the owner's aerial.

6. Quietness. Relatively quiet reception is needed if you are to
enjoy the programs and yet it takes careful design and first grade
materials to provide and assure continued quiet reception. Such
parts as filter condensers, gang tuning condensers, volume con-
trols, small fixed resistors, tube sockets, and power transformers
are often the real offenders for noises laid to man-made static;
and for those who would enjoy their programs uninterrupted by
crackles and buzzes due to chemical reactions or poor electric
contacts, only the best receivers made of the finest materials
are good enough.

In superheterodyne receivers, those which have a tuned radio fre-
quency amplifying tube or two ahead of the superheterodyne portion
of the set are usually quieter in operation than those not having
this preliminary amplification. The difference will be heard as a
hiss. It is expensive to provide this preliminary amplification
but it is worthwhile to those who require truly fine performance.

The "noise suppression circuits" now widely being incorporated in
radio receiver design are effective only while tuning between
stations. The instant a strong station is tuned in, then static
noises will be heard if they are anywhere near as strong as the
signals from the station tuned in.

7. Tone Quality. The tone quality of the radio chassis is important
as regards the frequency range of the music reproduced, and many
receivers have been improved within the last year by better ampli-
fication of the low and high tones to extend the musical range of
the instrument. This improvement is especially noticeable in the
reproduction of phonograph records, in a combination instrument,
or in an electric phonograph connected to the phonograph jack of
one of these receivers. This extension of the musical range is
effective on radio programs as well. As for the flatness or
smoothness of the amplification of different tones, this is mean-
ingless and confusing as represented in the usual "chassis fidel-
ity curve" unless the tone quality characteristics of the speaker
unit and cabinet are known. Most manufacturers, for an investment
of $600.00, can purchase equipment to measure the fidelity curve
of their chassis, but what the speaker unit and cabinet do to the
tone quality is beyond their power to determine except by listening
methods. It is only where the manufacturer maintains an Acoustic
Laboratory for sound pressure measurements, as discussed under
cabinets, that any accurate test of the over-all tone quality from
the antenna binding post right out of the loud speaker can be made.

8. Moisture-proofing. A little-known requirement of much importance,
if the radio receiver is to give reliable service, is the moisture-
proofing of its parts to preserve its sensitivity and selectivity
Testing a loud speaker unit in the Stromberg-Carlson Acoustic Laboratories. The first measurement is made with a flat baffle. Later it is repeated using the same speaker in its console cabinet.

Some of the instruments used in sound pressure measurements.

Checking indoor measurements by repeating them forty feet off the ground.
characteristics during weather conditions of fog or high relative humidity, as well as for protection against corrosion and rust.

Many very sensitive receivers that are made without adequate moisture protection become practically useless after two or three days of wet weather. Their sensitive coils and condensers and wires absorb so much moisture from the air as to cause detuning of the critical circuits or even partial short circuits. Moreover, the sensitivity is likely to stay poor for several days, even after conditions have changed to warm, dry weather, until this moisture has thoroughly dried out.

In the case of Stromberg-Carlson home type radio receivers, they are made with the same provisions against moisture absorption that we have found necessary in aircraft radio and in police prowler car receivers, where keen sensitivity is absolutely necessary under all weather conditions. During a fog, for example, an airplane pilot is almost wholly dependent upon his radio to direct him in "blind flying" and, if necessary, to enable him to make a "blind landing" at a radio equipped airport. Because this is so important, Stromberg-Carlson has adopted extreme measures to insure uniformity and reliability of the critical parts. The steel chassis base, for example, is copper plated before it is enameled. This copper finish not only protects against rusting but insures good "ground" contacts and good surface conductivity for shielding purposes. We buy bare copper wire or rubber-covered wire and apply the insulation braid ourselves, waxing the braid to prevent the absorption of moisture. We make our own paper filter condensers and, after they are wound, we draw all the air and moisture out of them in a vacuum chamber and then impregnate them with hot wax. We assemble the wires that connect chassis parts underneath the base of the chassis into a braided cable. This is the standard practice in the telephone industry for wiring switchboards, but most radio manufacturers cannot afford this extra care and expense. Yet, who wants to buy a radio receiver whose operating characteristics change from day to day?

9. Durability of Chassis Parts. In choosing a radio, your selection will be based largely upon the appearance and tone and price. Yet there are other factors to consider, hidden in the workmanship and choice of materials, that may not appear in a single listening test. Some of these may be hidden defects in design or construction that will become apparent only after a few months of operation.

There is so little of mechanical wear in a radio set that at first glance one would say "There is nothing to wear out except the vacuum tubes". This is true of the finer receivers, employing thoroughly inert materials. But, in recent efforts to build performance down to a price, most radio manufacturers have adopted materials which work best the first day they are placed in service, and then slowly deteriorate, due to the effect of heat or of chemical change. This applies not only to the filter condensers, but to voltage dividers, fixed resistors, by-pass condensers, transformers and many small parts. Mechanical wear is also a factor in the design of switches, volume controls, means for turn-
At Top: The "A" Board For Incoming Local Calls.
Below, at left: Battery Charger Generators.
Below, at right: The Main Distributing Frame For Telephone Cables.
At Top: The "B" Board for Calls From Other Exchanges.
Below: Rear View of "B" Board and Cable Rack.
A FEW STEPS IN THE MANUFACTURE OF
STROMBERG-CARLSON DYNAMIC SPEAKER UNITS

1. Forming the Parchment Cone. 2. Mounting the Voice Coil And the Bellows Leather Suspension Ring. 3. Testing the Flux Density Of Magnetic Field In the Air Gap. 4. Testing Completed Units On All Musical Tones As Created By a Beat Frequency Oscillator.
Sample tests are continually conducted in the Stromberg-Carlson laboratories to select or develop reliable parts. This testing is conducted by the same engineers who select parts for telephone instruments and switchboards, which must give service to operating companies for 20 or more years. In fact, the influence of our 40 years' experience in manufacturing telephone equipment, bought on the basis of merit by telephone operating company engineers, is evidenced all through our policy of radio receiver design and manufacture.

10. **Underwriter Approval.** Many of the radio sets being manufactured today, small sets and consoles alike, cannot pass the tests required for approval by the Underwriters Laboratories, Inc., an organization sponsored by the Fire Insurance underwriters. This indicates that such receivers are not fool-proof in design from the standpoint of fire or shock hazard.

At present, one state and a few communities in the United States prohibit by law the sale of radio receivers and electric appliances that cannot meet Underwriters' requirements. In Canada, however, the approval of the Hydro-Electric Commission is required throughout the Dominion.

Even in those localities where dealers are permitted to sell unapproved merchandise, it is well to insist upon a product listed as safe by the Underwriters. No one can tell how far a fire might spread and, in the event that a large fire were to originate on your property and there was even a suspicion it started in your radio, your Insurance Company might try to avoid their responsibility on the ground that you were negligible in operating a hazardous device. If your receiver is of a type that has been approved by their own Underwriters' Laboratories, you can hold them to their responsibility.

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C. **The Loud Speaker.**

1. **A Single Dynamic Unit.** Recently a few manufacturers equipped their console cabinet radios with two or more dynamic speaker units in an attempt to reinforce low tones. In most radio sets using multiple speaker units, the individual speakers are inefficient due to cost restrictions or to the necessity of dividing the direct current field supply (obtained from the rectifier system in the radio chassis) among so many field coils. Thus they defeat any theoretical advantage. We favor the use of a single dynamic speaker of efficient design, representing a "point source" of sound. We find that the added volume on low tones, when using two or more dynamic units, even of efficient design, is so small that it is perceptible only to a highly trained ear, but that these multiple speaker units usually introduce "peaks" and "valleys" in the tone quality characteristic on high tones, causing non-uniform reproduction of the musical scale. When two dynamic units are placed near each other in a cabinet, the distance between their centers is a critical factor. Those musical tones for which this distance represents one-quarter the wave length of the tone (also one-half, one wave length, and other simple multiples of one-quarter) are reproduced differently.
This unique "relay gate", developed in the Stromberg-Carlson Telephone Laboratories, gives access to the relay covers and springs when closed, and to all wiring when open.
than other notes just a little higher or lower in the musical scale. If both speaker units are pushing forward at the same instant, these particular notes will be reinforced louder than others; or, if one speaker is connected to pull back when the other pushes forward, and vice versa, then these particular notes will tend to cancel out. This applies whether the multiple speakers are of mixed sizes or similar types.

It is only fair to state that three possible roads for future improvements in tone resulting from multiple speaker units are still open. These are:

(a) A small dynamic unit may be built inside a larger dynamic unit, with their centers concentric in a "point source" of sound. Several schemes of this type are now on file in the Patent Office, and none of them seem practical.

(b) Filter systems with or without separate audio amplifiers may be used, so that the different speaker units reproduce different parts of the musical scale, with no overlap between them. This is expensive, and unnecessary except where great volume is required to fill an auditorium.

(c) New type speaker units having "capacitive impedance" and hence out-of-phase with a dynamic unit which has "inductive impedance" may some day be practical for combining with a dynamic speaker, without a filter. At present, all speaker units of this type are too fragile or short-lived, or inefficient for use outside the laboratory.

2. Efficient Speaker Design. It is difficult to prescribe accurate earmarks or tests for distinguishing efficient from inefficient types of speaker units because it has been shown of late that the size of the cone and the size of the magnet structure are likely to deceive. A large magnet does not necessarily mean a strong magnetic field in the air gap in which the moving coil travels, which is the only place where the magnetic field does any useful work. Measurements recently taken on two speaker units, one of which had twice as much iron and copper in the magnetic structure as the other, showed that the smaller one had 20% more magnetic field strength in the air gap than the larger one, simply due to efficient design and prevention of magnetic leakage. As for the moving cone, the best speakers have cone shaped diaphragms which are 7" or more in diameter across the opening, and which are suspended either on embossed creases at the rim of the cone itself (which must be made of a "grainless" paper in this case) or which are suspended on a good grade of flexible bellows leather. Other types of suspension, using cheap leather or cloth impregnated with "dope", may harden and crack under the tremendous stress of vibration that speaker units are subjected to, or may become flabby with age.

So much for the desirable features in a broadcast receiver. Now, let us explore some of the "Rabbit Tracks" down which many radio manufacturers have wandered; some of them by sheer force of their advertising, dragging a share of the public (and of dealers not completely "in the know") along with them.
IT TAKES SKILLED WORKMEN TO MAKE PRECISION SWITCHBOARD PARTS
The AC-DC set was originally developed for the traveling man, who might find himself in a hotel with alternating current one night and in another with direct current the next, and for people whose homes are located in DC areas. Lately, these receivers have been widely adopted for home use even on continuous AC operation. This is needlessly expensive and inefficient. When operating on AC current, the AC-DC Receiver usually draws from two to four times as much power from the electric light line as a straight AC Receiver of equivalent size and price would, and does not perform as well. The excess power consumption does no useful work but is simply wasted as heat. Usually the AC-DC Receiver has less maximum volume than the straight AC Receiver. Thus, many radio owners are paying extra dollars to the Light and Power Company, and yet are getting poorer performance than a straight AC Radio Receiver can give them.

As for the "Universal" application of AC-DC radios, to operate from a 6 volt storage battery in an automobile or motorboat, the "Universal" receiver is generally less efficient than a receiver designed especially for automobile use, and its volume and power output are so low that most "Universal" sets cannot be heard in an automobile or boat when travelling at normal touring speeds.

RAABIT TRACK NO. 2: POLICE CALL RECEPTION.

In certain localities, radio calls from police headquarters to cruising prowl cars can be heard every quarter-hour or so by broadcast radio receivers in which the manufacturer has provided a switch or a long-range tuning dial to permit tuning to wave lengths a little shorter than those of broadcast stations. Occasionally, airplane calls for weather and bearings, or amateur radio transmitters, can be heard.

As a rule, provisions for tuning-in these calls are made only in inexpensive receivers, rather than in those designed for the best tone quality and selectivity, because the inclusion of the police band switch or long-range tuning dial also involves some sacrifice in good operating characteristics.

These police calls have no real entertainment value. They are intermittent in time, with long waits between them. Important police calls are usually given in unintelligible coded numbers or word phrases. Moreover, many authorities believe that present police wave lengths will be changed in the future to very short wave lengths around eight meters (where even the short wave radios being sold today cannot tune) because at the short wave lengths, the prowl cars can have transmitters, as well as receivers, and can reply to headquarters by radio.

Unauthorized listening to police calls is objectionable to Police Authorities. Laws pertaining to this subject are now under consideration in many localities, and a few states have already made it unlawful to have a radio set in an automobile that can tune-in police calls.

All in all, it hardly seems worthwhile to spoil any operating characteristics of a fine radio broadcast receiver just in order to receive police calls. In our opinion, where reception of such calls is insisted upon, the receiver might as well be a short wave receiver.
"Sky" Waves and "Ground" Waves Radiating from a Transmitting Station, with Reflection of the Sky Waves from the "Mirror" of Ionized Gasses.

Modern Short Wave Receivers Tune as low as 13 or 15 Meters. To receive Ultra-Short Radio Waves of .001 Meter to 13 Meters, Now Largely Undeveloped but Including 5 Meter Experimental Television and 8 Meter Two-Way Police Calls, Special Receivers and Special Tubes are Used.
There are two kinds of radio waves: the "ground wave", which follows the curvature of the earth but is rapidly absorbed or dissipated in space, and the "sky wave", which travels in straight lines like light, is very little absorbed or attenuated even after travelling great distances, and which is apparently reflected back to earth from a "mirror" of ionized gases surrounding the earth. This mirror of gases is known to scientists as the Kennelly-Heaviside Layer, and is usually 40 to 140 miles above the earth's surface. It rises and falls from time to time, particularly at sunrise and sunset.

At the longer wave-lengths, including the 200 to 2000 meter (1500 to 150 Kilocycle) band used by European broadcast stations, and the 200 to 525 meter (1500 to 540 Kilocycle) band used by American and Canadian broadcast stations, most of the electric energy at the transmitter is converted into "ground" waves. In fact, when you hear any of these stations in the daytime, you are getting almost pure ground wave. At night, some of the sky waves from these stations are likewise audible (having been absorbed in daylight hours, by the sun) and permit the station to be heard at greater distances.

The ground wave is steady and reliable, and those listeners who live close enough (70 to 150 miles, depending on the channel carrier frequency) to a broadcast station to receive its ground wave at a loud enough volume to overcome ordinary static are assured of good radio service.

Short wave radio, on the other hand, consists almost entirely of sky waves. And the sky waves are unreliable and freakish. They "fade in" and "fade out". They change in "polarity" direction and phase, causing a queer distortion that sounds like waves beating upon the shore. They are often reflected back and forth several times from the earth to the "mirror", causing a stutter or echo. They act differently at different hours of the day, and on different days of the year.

Obviously, the best quality and most reliable reception for North American and European listeners will always come from the regular broadcast stations.

In North Africa and Central America, tropical static is so severe that regular broadcast stations cannot be heard, whereas short wave channels are fairly quiet. Moreover, short wave signals, when natural conditions are right, can be sent tremendous distances with very little power. Therefore, short wave broadcasting will continue to be used for international and intercontinental work, but it will never be as reliable, nor as satisfactory for entertainment purposes as our regular broadcast programs.

Moreover, sophisticated engineers do not get much thrill out of tuning in short wave stations at these tremendous distances because they realize how dependent such reception is on freak conditions of weather and natural phenomena, rather than on any exceptional sensitivity of the receiving instrument. It has been said that, if you set the dial of a short wave receiver for a certain short wave station, no matter how distant it may be or how weak in power, and then sit and listen, keeping a constant vigil while tuned to that station, sooner or later the chances are that you will hear signals from it.

Reception of short wave programs in foreign languages is interesting.
Comparison of Audio Ranges of Speech and Musical Instruments with Audio Ranges of Radio Receivers

This is the Stromberg-Carlson Tone Chart, published in 1931. Intended to show the advantage of a full-size console cabinet, it started quality radio manufacturers claiming a wider and wider tone range.
and educational but, due to the fading interruptions and distortions, cannot be classed as real entertainment. The hours of best reception are also inconvenient; the listener must stay at home from 2:00 P.M. to 5:00 P.M. to listen for European short wave stations, and must arise early to listen for Japan and Asia between 4:00 A.M. and 7:00 A.M. Owners of receivers that can tune in short wave and also broadcast stations seldom use them for short wave reception more than 2% of the time after the initial novelty has worn off. It is obvious, therefore, that in purchasing such a receiver, the customer should base his judgment at least 90% on its broadcast reception performance and less than 10% on its short wave tuning provision.

Most of the short wave receivers of today can tune as low as 13 to 15 meters and hence do not cover the entire radio spectrum by any means. To receive television signals, or eight-meter police car signals, a special type of receiver employing special tubes is required.

The matter of quietness is especially important in short wave reception, inasmuch as a number of the short wave and broadcast radio sets being sold today are poorly designed from the quietness standpoint and have poor insulation in the first few stages of short wave amplification, thus losing part of the weak short wave signal. They make up for this later by using an excessive amount of intermediate frequency amplification. By this means, they are able to restore the receiver to good sensitivity and at economical cost, but, unfortunately, they are amplifying tube hiss noises of the first few amplifier tubes in the same ratio as the desired program and, as a result, many of these receivers are two or three times as noisy as is necessary for a good receiver of equivalent sensitivity.

RABBIT TRACK NO. 4: CLAIMS FOR EXTENDED TONE RANGE.

In 1931, Stromberg-Carlson published a tone chart showing the frequency range of a piano, various choral voices and musical instruments, and the comparative ability of a Stromberg-Carlson console versus a midget radio to reproduce these musical frequencies. Several months of study went into the preparation of this chart. Our purpose was to show the value of a full-sized cabinet, when equipped with a fine chassis and loud speaker.

Naturally, this chart showed the maximum and minimum tone frequencies which the best Stromberg-Carlsons of that day could reproduce. We believe this was the first time that a manufacturer disclosed such facts in definite figures. Dealers seized upon this knowledge, and used it in selling. Soon we found that we had set up a target for others to shoot at as, one by one, other radio manufacturers in the quality field claimed a wider and wider frequency range for their new models. Today, nearly all such claims and "doctored" tone charts are too exaggerated to be trusted.

Manufacturers who claim that their radios reproduce tones much below "fifty cycles per second" or much above "five thousand cycles per second" are usually relying upon the credulity of their dealers and on public ignorance of radio as an over-all transmitting and receiving system. Receivers that live up to these claims can be built, but are more valuable as laboratory curiosities than for general use. When operated in the home, their reception would be so noisy as to be impractical and to spoil all enjoyment of the programs. Broadcasting facilities are not designed for this type of service. The microphones would
have to be compensated by electrical circuits to filter out low frequency rumbles and to smooth out peaks and valleys in their output. The station would have to originate all its own programs (could not obtain them from chain networks) in a studio right next to the transmitter equipment, because these high frequencies cannot be carried over telephone lines. To broadcast these frequencies, the station would have to overlap and interfere with any stations broadcasting in the two adjacent radio "channels". Tube "hiss" noises and power supply hum would be excessive, due to reception of these noises from the transmitting station as well as those generated within the receiver. Static crackles become very objectionable as the frequency range of the receiver is extended. And a receiver built to respond to the high frequencies would not be selective enough for modern broadcast conditions; interferences would be heard on almost every channel.

The same difficulties are met in phonograph instruments when attempts are made to extend the musical range, these attempts being futile because the frequencies above five thousand cycles and below fifty cycles are not usually recorded in phonograph records. Thus the "improvement" to be expected is simply an excessive amount of needle scratch noise. This also signifies that modern broadcast programs include all the useful musical tones required for satisfactory reproduction. The range of tones delivered by a good broadcast receiver includes the fundamental or pitch tone of practically all notes on the piano key-board. Thus the object of extending the frequency range is merely to preserve some of the higher harmonics or overtones, which add to the "brilliance" of the music. Yet many listeners do not make full use of the brilliance available in receivers today, and use their tone control to reduce the response to these overtones.

STABILITY OF THE RADIO BUSINESS.

In relatively few years, the radio industry has grown up both in the development of good broadcasting stations and technique, and in the mature design of instruments for receiving those programs. Radio receivers today have reached the same stage of perfection as the automobile. Everyone knows that real major improvements in automobiles are developed only at about four-year intervals and therefore the purchaser of a fine automobile can expect from two to five years' use out of it before the new models will be so much better as to tempt him to trade in his car. So it is in radio. Since the total elimination of batteries in 1926, and the introduction of Automatic Volume Control in 1928, there have been few radical improvements, but rather a slow and steady progress toward perfection in the operating characteristics known to be worthwhile. We foresee no immediate changes that will result in radically different performance, but rather believe that the purchaser of a fine radio receiver today can expect full satisfaction from it for at least as many years as from a fine automobile.

Go to your dealer. Arrange for a demonstration of several radios. By all means, listen carefully to the tone quality on low and high notes. There is a real difference, although the difference is noticeable only after you have listened to one set for twenty minutes or more (long enough to become conscious of distortions, if it has them) on several types of programs, or after you switch quickly back and forth (ten seconds is too long to remember tone) from one set to another. Remember, the tone quality of the radio you choose will affect you mentally and
Notice that the small, economical sets are light in weight, often fragile. Pound for pound of material, you are getting even better value in large, full-sized instruments.

Choose the product of a manufacturer who is in the radio business to stay; remember that twenty-nine out of thirty among the hundreds of radio trade-names are orphans; some of them famous names, the products of well-organized, strong companies who jumped into radio and then, finding it unprofitable, jumped out again.

Many notable contributions and improvements to radio have been developed in telephone laboratories. The DeForest tube, total shielding, electric recording and electric reproducing phonographs, high-quality broadcasting transmitters, and high quality telephone lines for chain station networks are but a few examples. Yet only one representative of the telephone industry, only one manufacturer who has the heritage of precision telephone manufacturing, likewise makes home-type radios.

Plan your investment wisely. Then don't hesitate to spend to the limit of your means. The fine radio instruments of today will serve you well and faithfully with many a beautiful program.

A FEW TYPES OF THE TELEPHONE INSTRUMENTS MANUFACTURED BY STROMBERG-Carlson SINCE 1894.