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RADIO DESIGN

IN THIS ISSUE:

the new

PILOT "ALL-WAVE"

Eleven-tube double super-heterodyne for short wave and broadcast reception — — the last word in radio thrills and enjoyment

also

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Volume 4
Number 1

Fall 1931
Issue

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RADIO DESIGN

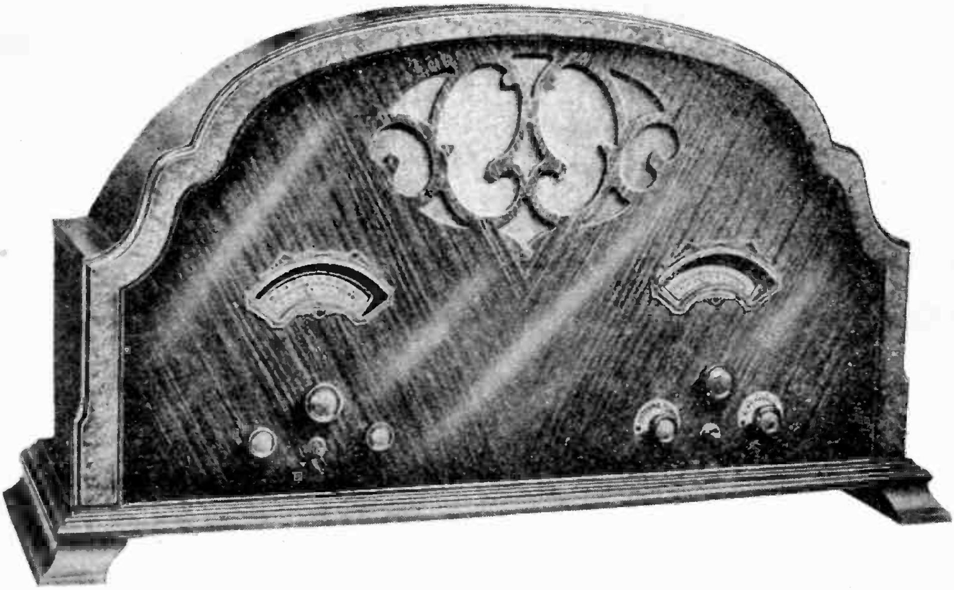
OFFICIAL ORGAN OF THE RADIO INTERNATIONAL GUILD

Vol. 4
No. 1

Fall
Issue
1931

CONTENTS OF THIS ISSUE

RADIO DESIGN MAGAZINE
Is Published By
RADIO DESIGN PUBLISHING CO., INC., Lawrence, Mass.



The new "All-Wave" set in its handsome table model cabinet. At the left is the broadcast section, at the right, the short-wave converter. The dynamic speaker is in the center.

Introducing the New

Pilot "ALL-WAVE" Receiver

Covering a Wavelength Range from 10 to 550 meters, this eleven-tube set is a double super-heterodyne of unrivalled sensitivity, selectivity and tone quality. Features include built-in wavechanging switch, dynamic speaker, all-metal chassis and beautiful cabinet.

R. F. SHEA

Chief engineer, Pilot Radio & Tube Corp., and* EDGAR MESSING, *circuit engineer.

FROM the same laboratory that produced the Wasp, the Super-Wasp and the Universal Super-Wasp, there now emerges another short-wave receiver that promises to eclipse the world-wide fame achieved by its three predecessors. This is the new Pilot "All-Wave," an eleven-tube double super-heterodyne that has features of design and construction that were undreamed of only a year ago.

Covering a wavelength range from 10 to 550 meters at the turn of a knob, the "All-Wave" is a *real* combination receiver. Previous combination-wave sets were primarily short-wave receptors, and only incidentally broadcast receivers. They brought in the stations on the 200-550 meter band fairly well, but in this regard they admittedly were inferior to standard broadcast instruments. The new "All-Wave" does not suffer from this shortcoming. On the broadcast range it is an honest-to-goodness super-heterodyne of the latest design; in fact, it uses the regular seven-tube chassis and dynamic loud speaker of the new Pilot Midget, model No. S-148, described elsewhere in this issue.

For the short-waves, a separate four-tube super-heterodyne converter unit is brought into action. This feeds into the seven-tube unit, which is adjusted to 550 kc. and left there. The tremendous amplification of this chassis is brought into full use for short-wave reception, the set being employed as an intermediate-frequency amplifier at this frequency. This arrangement was devised for technical reasons, and not merely for mechanical convenience. The reason is that the optimum intermediate frequency for 200-550 meter operation is quite different from the ideal intermediate frequency for waves below 200 meters. The "All-Wave" was designed to use two I.F.'s so as to give maximum efficiency on both spectra.

This has worked out remarkably well. There is absolutely no comparison between this set and the tuned radio frequency receivers heretofore employed for short wave reception. American broadcasting stations on the 49 meter band are heard with the same fineness of tone and clarity of reception that characterizes the regular Pilot midget on the 200-550 meter range. Chelmsford, Paris, Rome, Sydney, and other foreign stations have been and are being received in New York with power and clarity that a year ago we would have deemed impossible. The only limit to the set's sensitivity below 200 meters is the noise level in the vicinity of the receiver. The selectivity of the "super" shows to excellent advantage on short waves and allows split-hair tuning between stations 10 kc. apart.

Volume control is exercised for both the short wave and the 200-550 meter ranges by the regular volume control on the midget super. The tone control knob on the broadcast section allows progressive attenuation of the higher audio frequencies and is of considerable help in reducing noice when fishing for distant stations.

EASY TO TUNE

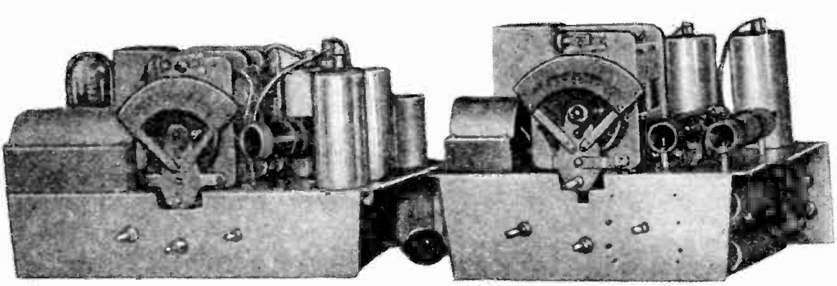
The set itself is very simple to tune and entirely eliminates the breathless manipulation so necessary with the old t.r.f. sets. As seen from the accompanying photographs, there are two sections, each with a clear vision tuning dial, two auxiliary knobs, and a switch. For broadcast operation the switch on the left side of the cabinet is turned on, the wave-changer on the short wave section set to the "BC" position, the switch on the face of the cabinet put in either the "local" or "distance" position, depending on the station to be received, and the tone control, volume control, and tuning control operated as usual. For reception on wavelengths under 200 meters, the switch on the short wave section is turned on, the tuning control on the broadcast section set to approximately 550 kc., the wavelength indicator set to the desired range and the tuning knob operated as usual. The small knob at the left marked "Antenna Tuner" acts as a vernier on the tunning control and is the final adjustment after a station has been tuned in with the main tuning control.

CIRCUIT DETAILS

Referring to the schematic diagram, we see that when the short wave section is used the antenna is coupled to the detector tuned circuit through a fixed condenser. The oscillator and detector circuits are magnetically coupled. Both circuits are tuned by a two-gang variable condenser with a small additional vernier across the detector tuning condenser to provide accurate tuning. This is especially necessary on short wave sets where antenna constants and large frequency coverage make it almost impossible to absolutely align both detector and oscillator circuits with a ganged condenser.

The induced voltage from the oscillator mixes with the incoming signal in the grid circuit of the detector and the resulting beat, which is about 550 kc., is impressed across a circuit tuned to that frequency and transferred from there to the grid of the second 224 tube. This tube, which is a very efficient amplifier, is coupled to the broadcast section of the set through a fixed condenser.

A tuned plate oscillator is used in this section to secure maximum frequency stability. For each band the plate and grid coils of the oscillator and the detector grid coil are all wound on the same form. The spacing between the coils decides the value of induced voltage that the detector grid receives from the oscillator. Generally speaking, the higher



The chassis of the "All-Wave" out of the cabinet. Left, the 7-tube broadcast unit; right, the four-tube short-wave converter. Four of the coils of the latter unit are visible at the extreme right.

The short-wave converter of the "All-Wave" is available as a separate unit, which may be used with any broadcast receiver, regardless of type. It makes short-wave reception comfortable and easy.

the induced voltage from the oscillator the greater the sensitivity of the receiver. There are, however, certain limitations to be considered. Of these the reaction of one circuit on the circuit coupled to it is the most important, so that the spacing becomes a compromise between the highest induced voltage and minimum reaction. The coil forms themselves are so located around the wave-changing switch that the effect of any one coil upon any one other coil is negligible. The forms are so situated that three are mounted directly on the switch and two, covering the fourth and fifth bands, are mounted on top of the chassis, which thereby acts as a shield between the two sets of coils.

SWITCH IS RELIABLE

The switch itself is absolutely fool-proof and represents a very ingenious extension of the most common form of switch—the knife blade type. Contact is absolutely positive and is more satisfactory and reliable than that afforded by plug-in coil arrangements. There are five contacts on each of the three switch sections. As seen from the schematic diagram, the detector grid, the oscillator plate and the oscillator grid are the points that are switched.

The first intermediate frequency is 550 kc. This value, however, is not critical and if there is a strong local station broadcasting on that frequency the broadcast section tuning control can be set either slightly above or slightly below 550 without impairing the sensitivity of the set. This should be done because the broadcast section is so sensitive that there may be some direct pick-up that will cause interference with short wave reception.

The second intermediate frequency is that of the standard broadcast section, 175 kc. This means that the oscillator in the broadcast section will be operating at approximately 550 plus 175 kc., or 725 kc. It is impossible to shield this oscillator absolutely and its harmonics will therefore be picked up by the short wave section. The third harmonic, for example, is 2175 kc., which is slightly under 150 meters. At about the middle of the fifth band, therefore, the short wave section will appear to have tuned in on a very strong carrier that will have no modulation. These harmonics are not annoying and the operator will quickly become accustomed to them.

SEPARATE POWER SUPPLIES

Each section has its own power system and is adequately filtered so that there is no possibility of hum troubles. This separation of power systems allows for easiest serving and makes for greater simplification. Each section can be removed and inspected separately.

The spectrum between 10-200 meters is divided into five bands which allow for an unusually wide coverage. These bands are 10 to 19 meters, 19 to 35 meters, 35 to 65 meters, 65 to 110 meters, and 110 to 200 meters. There is, of course, generous overlap between bands.

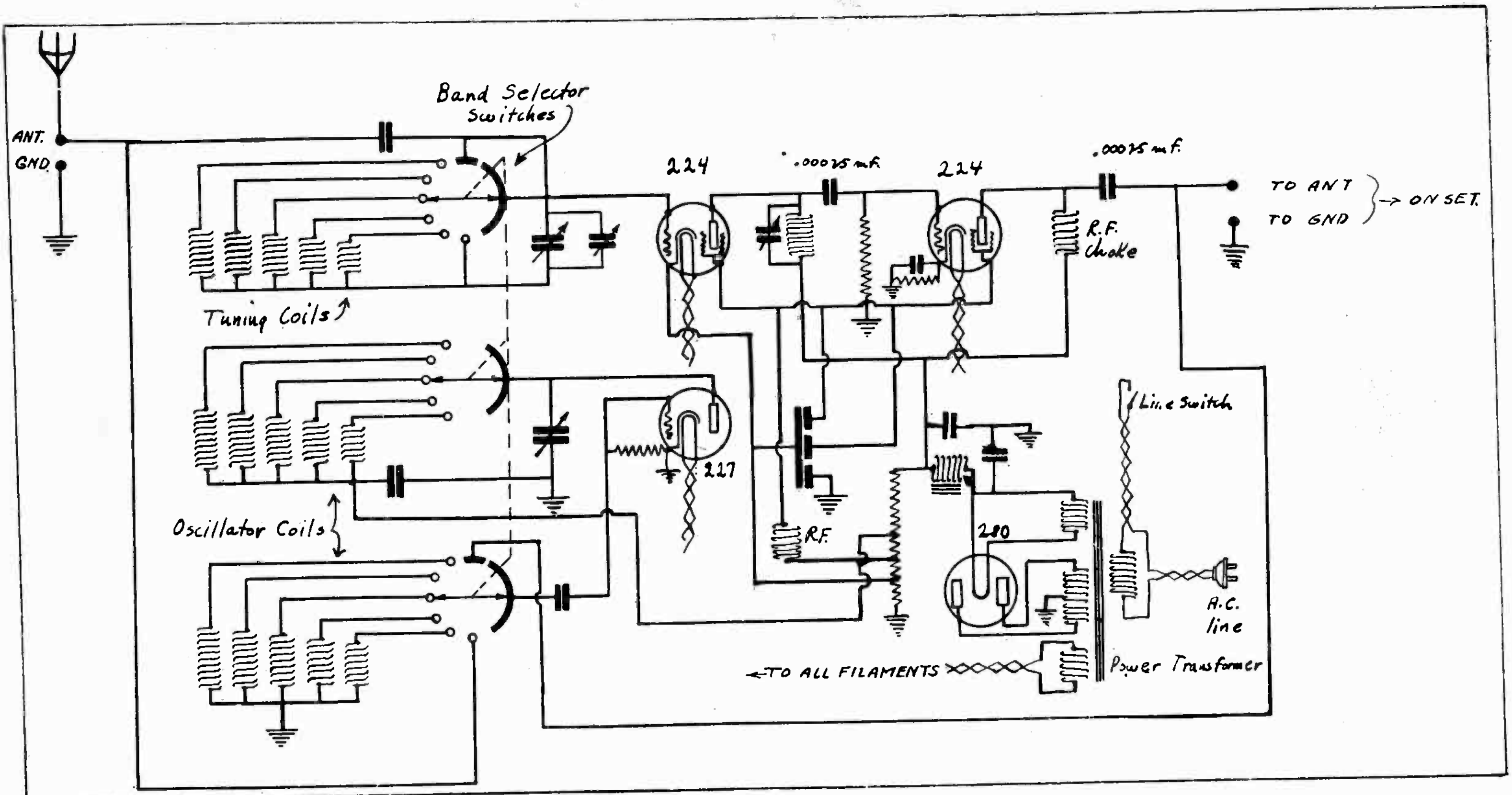
There is not much going on in the way of phone broadcasts on the lower part of the first band. The transatlantic telephone services use various waves in this section but speech is purposely scrambled and cannot be understood. Scrambled speech can be recognized by the peculiar shrill sound that squeaks forth every few seconds. Occasionally the phone stations will test without scrambling. The London end has been heard frequently and comes in as loud as the American transmitter. Between 70 and 80 on the dial there are a few continental phones that can be heard in the morning and early afternoon.

The second band is very much alive with code and phone stations. Between 60 and 95 there are many stations, such as FYA in Paris and G5SW in England. These stations come in quite loudly and gain power as evening draws on. Both stations have been picked up with sufficient volume to overload the broadcast section of the set.

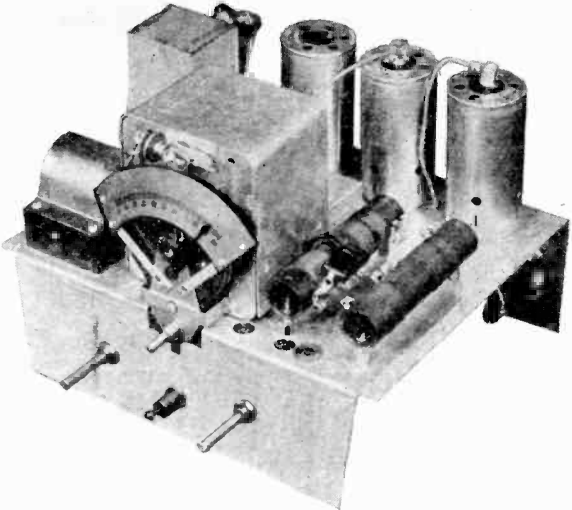
PLENTY TO HEAR

On the third band the main source of interest is the American broadcast channel around 49 meters. Here reception is usually excellent with stations several hundred miles away coming in with as much strength as local broadcast stations. We have also picked up Canadian stations across the continent with good volume. The Vatican City station is located about 50 meters and can be picked up third band.

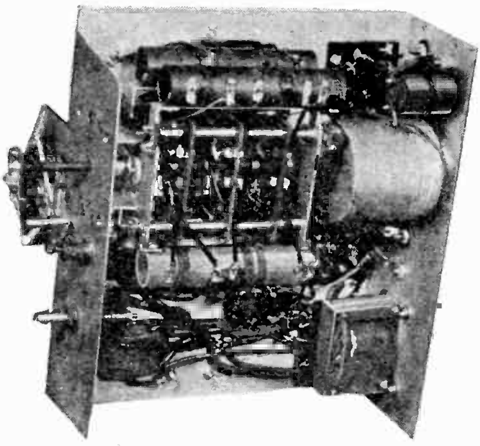
The range from 65 to 110 meters includes a host of interesting things—airplanes, police reports, which are highly exciting, and amateur phones, which are usually a lot of fun. The fifth



This is the full schematic wiring diagram of the new Pilot "All-Wave" receiver, and shows the switch connections very plainly. The circuit comprises a first detector, an oscillator and a 550 kc. fixed R.F. amplifier, with a power section using a 280 tube.



Left: A close-up of the short-wave converter chassis. The four tubes are along the back edge, the coils above and below the chassis in the right foreground. Below: the under side of the chassis, showing the other three coils grouped around the wave-changing switch.



Left: Messrs. Shea and Messing (left and right) inspecting an experimental model of the "All-Wave" chassis in the Pilot laboratory.

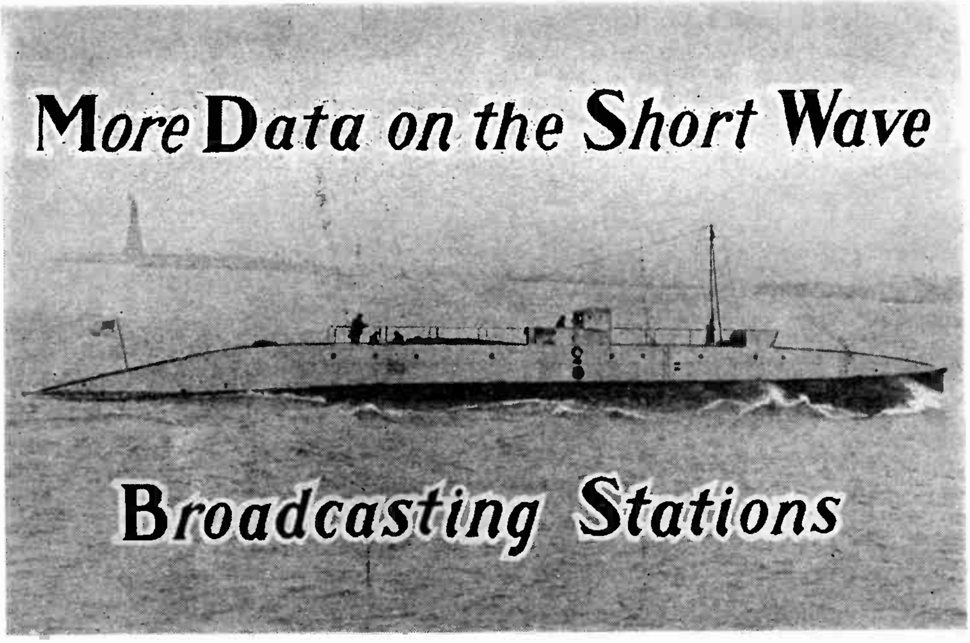
band has more amateur phones, several police broadcasting stations and a number of television stations.

The "All-Wave" in its handsome table model cabinet is an ideal radio receiver for any home, and will provide thrills and enjoyment for every member of the family. It is supplied only in complete factory-built form, all ready for use. It is not sold in kit form, nor are the parts available separately.

The short-wave converter unit alone will be sold in a small cabinet for people who have good broadcast receivers and who want to enjoy foreign reception without going to the expense and trouble of obtaining a complete short-wave set. This converter, containing its own power supply, may be used in conjunction with any neutrodyne, T.R.F., or super-heterodyne receiver.

The broadcast set is simply adjusted to 550 kc., which is at the high end of the scale. All short-wave tuning is then done with the single selector dial on the converter, and the volume is regulated by means of the regular volume control on the broadcast outfit. Nothing could be easier.

More Data on the Short Wave Broadcasting Stations



The title cut above shows Sir Hubert Wilkins' specially equipped Arctic submarine, the Nautilus, in New York harbor before the start of her trip into the North Atlantic. The V-shaped radio aerial is plainly visible. In the background is the Statue of Liberty.

THE NORTH POLE?

The submarine in which Sir Hubert Wilkins will attempt to reach the North Pole will be equipped with a short-wave *telephone* transmitter. Mind you, a *telephone* transmitter. Practically every expedition in the last five years that amounted to anything had a C.W. outfit along, and managed to maintain contact with civilization through amateur or newspaper stations. However, Sir Hubert may be the first explorer to talk to the world, via shortwave relay to the chains, directly from the scene of his activities! What a stunt that would be!

SHIP STATIONS

Most of the trans-Atlantic liners equipped with radio telephone apparatus have dropped the experimental calls they used during the preliminary testing work last year. The *S.S. Majestic* is now GFWV, the *Olympic* GLSQ, the *Homeric* GDLJ, and the *Bremen* DDDX. Marconi's yacht, the *Eletra,* is IBDX.

The *S.S. Malola,* a well-known Pacific liner, is the latest passenger vessel to be equipped with ship-to-shore radiophone. Using the call letters W10XAI, it is testing on 31.48 meters with Point Reyis, California, and has been heard around 2:00 in the morning, Pacific time. This testing is done in the clear, but the ship will undoubtedly use a "scrambler" when regular toll service begins.

Speaking of this radiophone stuff prompts us to warn new listeners against using their imagination too freely when they pick up the trans-oceanic telephones. The unholy gibberish that comes out of the loud speaker from the scrambled transmissions can readily be interpreted as any foreign language you like. Don't tell your friends you have tuned in Japan or Turkey until you've waited patiently for the end of the conversation and then heard the technical operators say "Hello London" or "Hello New York" in perfectly clear English.

SCHENECTADY

W2XO, one of the numerous calls assigned to the General Electric Company at Schenectady, N. Y., is evidently in use for one of the G.E. short-wave stations. A reader in South Africa reports hearing W2XO on 23.65 meters, in addition to W2XAF on 31.48.

CANADA

The Calgary *Herald,* station CKS, broadcasts every afternoon from 3:30 to 4:30 p.m., on Tuesday evenings from 9:00 to 10:30 p.m., and on Thursday evenings from 7:30 to 10:30 p.m., Mountain Standard Time, on 7,550 kilocycles.

MEXICO

Station XDA, which makes such a big hole in the ether with its modulated telegraph signals, has become articulate and is now using voice as well as I.C.W. The following dispatch speaks for itself:

"Will you please tune in every night at eight o'clock Central Standard Time on station XDA, Mexico City, Mexico, and hear the regular spot news report of the Trens Mexican News Agency, which goes out in English on a 51.1 meter short wave, for half an hour.

"The report is a good will report pure and simple and its primary purpose is to carry into the homes of foreign people and specially of the people of the United States of America a picture of the Mexico of today, from the political, economic, financial, commercial and business points of view, to the end that the listeners-in may be brought to a better and more sympathetic understanding of Mexico, the people who inhabit it, and what they are doing in the world of affairs.

"The report, so we learn from innumerable messages we have already received, is being heard with the greatest possible clarity in many parts of the United States. We should appreciate a card from you, at our address, Colon Street, 43, Mexico City, telling of how you, yourself, are receiving the broadcast which, by reason of its entire impartiality and reliability, has aroused sympathetic understanding in all parts of your country.

"Also copy code press report, English, at 10:00 a.m. C.S.T. on 20.5 meters, for five minutes."

GUATEMALA

Evidently spurred by the success of TI4NRH and other well-known Central American stations, the government of Guatemala is sponsoring an experimental short-wave broadcasting in the capital city. This has the call letters TGW and is known as "Radiodifusora Nacional." It is the property of the government and was constructed by Senor Julio Caballeros.

At present a frequency of 6675 kilocycles is being used with a power of 100 watts. This doesn't sound like much, but remember that TI4NRH achieved international renown with only 7½ watts. The schedule on this frequency is from 8:00 to 10:30 p.m. Central Standard Time. A frequency of 10,715 kilocycles will be used for daylight work, but no definite schedule for this wave has been adopted.

TGW has already been received in Mexico and parts of the United States, and reports from listeners are invited. These should be addressed as follows: Telegrafos y Telefonos Nacionales, Seccion de Radio, Guatemala City, Guatemala, Central America.

A second station in Guatemala City is TGCA, on the Hotel Rex. This works on 13,040 kilocycles between 9:00 and 11:00 p.m., C.S.T., with a power of about 80 watts. This is a rather short wavelength for night time transmission, but the short waves are full of surprises, and, as frequently remarked in RADIO DESIGN, most anything is likely to happen. Address your QSL cards to Senor Guillermo Andreu y Enrique Castillo, Hotel Rex, Guatemala City.

Still a third outfit will soon be on the air to acquaint short-wave listeners with Guatemala City. This will be located on the Hotel Palace, and will use 25 watts of power on 9,373 kilocycles. The call letters are TGX, the owner and operator Senor Miguel Angel Mejicano Novales. The station is altogether experimental, but has been heard between 9:00 and 11:00 Central Standard Time.

COSTA RICA

The amateur station in Heredia, Costa Rica, that achieved international renown under the call letters NHR, which rightfully belong to the United States Navy, is now using the call TI4NRH. It has also changed its wavelength from 30.5 meters to 29.3 meters, and is on the air Monday, Tuesday and Wednesday from 6:30 to 7:30 p.m., Central Standard Time, and on other week days from 8:00 to 9:00 p.m.

The owner of TI4NRH, Senor Amondo Cespedes Marin, is anxious for reports from listeners, and will gladly acknowledge them. He reads, writes and talks English as well as Spanish.

COLOMBIA

We are glad to be able to clear the confusion that has surrounded HKF for the past several months. A letter has been received from the owners of the station, Messrs. Manuel Jose Uribe & Cia., Apartado 317, Bogota, Colombia, in which they state that the wavelength is 39.7 meters and the hours of operation 6:00 to 10:00 p.m., Eastern Standard Time, nightly. They, too, welcome reports of reception, which may be sent to the aforementioned address in South America.

The South Americans have gone into short-wave radio for all it is worth. Another station in Colombia that is attracting considerable attention is HKD, located in Barranquilla (post office box 715). The owner is Elias J. Pellet, and announcements are made in both English and Spanish.

The wavelength is 42.92 meters (6,993 kilocycles), and the hours of operation as follows: Monday, Wednesday and Friday, 7:45

to 10:30 p.m., E.S.T.; and Sunday, 2:00 to 4:00 p.m. and 7:45 to 8:30 p.m., when they broadcast open-air concerts played by the local police band in one of the city parks.

Reports from listeners are acknowledged promptly.

Has any one heard a station purported to be located in the city of Medellin, in Columbia? The wavelength is said to be 50.6 meters. Reports on this outfit will be appreciated.

ECUADOR

Station HC1DR, located at Quito, Ecuador, is a small but active outfit. Opened in May, 1930, as an experimental station by a number of local amateurs, it has gained considerable popularity because of its lively programs. It is on the air nightly except Sunday from eight to ten o'clock E.S.T., on a wavelength of 48 meters. Reports of reception are desired, and will be quickly acknowledged. As announcements are made in English as well as Spanish, the station can be identified without much trouble. Many listeners in the United States have already logged it.

Address your reports to Arturo Meneses, Box 262, Quito, Ecuador, South America.

CZECHO SLOVAKIA

There has been a short-wave broadcasting station in Prague for some time, but it has used only a few watts of power. It is to be replaced soon by a new transmitter of five kilowatts rating at Hloubetin, a short distance from the city. The wavelength is 58 meters (well above the American 49-meter channel). We have no definite schedule for this station, but if it follows the usual European habits, it will operate during the afternoon and evening, which means morning and afternoon in the Eastern United States.

HOLLAND

PCJ, the most famous of all short-wave stations, has been establishing new records with the aid of three aerials for its well-known 31.28 meter wave. The first is a regular broadcast aerial having no particular directional characteristics. The second is an intentionally directional affair, radiating east-west and aimed at the Dutch East Indies on one side. The third aerial, intended to hit South America, is pointed southwest.

The latest schedule of PCJ is as follows: Wednesday, 1720 G.M.T.; Thursday, 1418 and 2220 G.M.T.; and Friday, 1920 and 2600 G.M.T.

FRANCE

The French colonial station at Pointoise, the scene of the French Colonial Exposition, is

Inside the Nautilus. Sir Hubert Wilkins, center, is reading a message received by Ray Meyers, radio operator, who is seated in front of one of the transmitters. Directly behind Sir Hubert is the ice-boring shaft intended for piercing the overhead ice in the Polar regions.

Sir Hubert has been dogged by considerable misfortune on this daring venture, and it is unlikely that he will reach his goal this Fall. However, he is cruising around in northern waters and acquainting himself with the problems of sub-sea travel.

quite active now. In addition to the 40.73 meter wave last reported, it is also playing with 25.63 meters between 3:00 and 4:00 in the afternoon (E.S.T.), and with 23.20 and 19.69 meters earlier in the morning. A correspondent in Port Said, Egypt, writes that reports of reception are desired and should be addressed as follows: "Service de Radiofusion de l'administration Francaise des Postes et Telegraphes," 103 Rue de Grenelles, Paris, France.

The call letters of this station are FYA. Like most of the Europeans, it can be heard usually during the early morning and afternoon only. (Eastern Time.)

BELGIUM

English listeners report a newcomer in the 49-meter group: a station ONVA, at Brussels, Belgium. American interference on this crowded channel may make reception in the United States difficult.

VATICAN STATION NEWS

A British reader has sent in a clipping to the effect that the Pontifical Academy of Science broadcasts the "Giornale Radiofonico" twice daily: 5:00 a.m., E.S.T. on 1984 meters and 2:00 p.m., E.S.T. on 50.26 meters, through station HVJ. The Academy receives correspondence from all parts of the world on scientific questions.

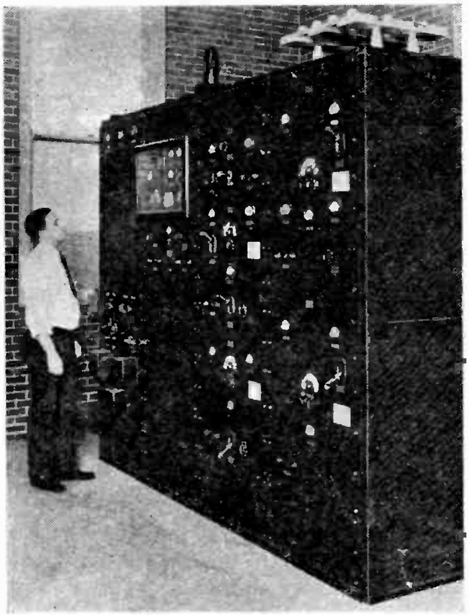
HVJ continues to put signals of terrific strength into most parts of the United States. The transmissions may be recognized by the opening announcement *"Laudatur Jesus Christus"* ("Praise be to Jesus"), and by interval announcements in Italian and English. Before phonograph music, the announcement "Radio Citta Vaticana" is made.

SPAIN

A station whose identity and existence have been very much in doubt is the supposed EAR110, listed for Madrid. A listener in Pretoria, South Africa, says he heard it and gives the dial settings of his receiver, from which we judge the wavelength to be around 50 meters. However, we have seen several letters stating that no such station is on the air. We have been writing to Madrid now for almost two years in an effort to obtain some authentic information, but as yet have had no replies to any of our letters.

Station EAQ, using radio telegraph transmission, is known to every amateur who can read the code, but that it also uses voice on occasions is news to us. The following letter from Mr. Arthus C. Pfister, of Fairfield, Ohio, may throw some light on the subject:

"—you asked about telephone transmission from EAQ. The reception I was referring to was on the date of the inauguration of the President of Spain. The services were being transmitted by several GB= stations also, but I had them on EAQ before any of the English phones were on the air. The time was about 5:00 p.m., E.S.T. I also had EAQ for about a week before, when they were testing with New York in preparation for the services. The wavelength used was 30.40 meters. Time was always about 5:00 p.m. Lately I haven't heard them."



This illustration shows a section of the equipment recently installed in the new Westinghouse transmitting station of KDKA located near Saxonburg, Pennsylvania. This apparatus is for use with the short-wave transmitters. Shown in the photograph is the crystal control equipment, as well as the frequency multiplying and amplifying apparatus. This panel is of the very latest design and will insure accurate maintenance of frequency.

A HINT

Rome and Chelmsford are only a fraction of a meter apart. You can always distinguish between them because Rome has a woman announcer who clearly says "Radio Roma Napoli," pronouncing the word "radio" like "rahdio."

SWITZERLAND

The League of Nations, which has been in the process of erecting a short-wave broadcasting station for many months, is finally expected to have the outfit in operation in a "short time." A wavelength of 15 meters will be used during daylight hours, and 35 meters at night. The station is at Geneva.

PORTUGAL

A couple of short-wave stations are supposed to exist in Portugal, but until recently we never saw any actual reports of reception of them. A British friend reports hearing CT1AA, Lisbon, on 42.9 meters, but fails to give the schedule. As with the other European stations, it is safe to assume that it is on the air not later than about 7:00 p.m., E.S.T.

MADEIRA

The home of a famous wine is now also the home of a new short-wave station, CT3AQ. It is working on 24 meters, on an irregular schedule.

POLAND

A one-kilowatt station in Poznan is operating on 31.35 meters, crystal controlled, on Tuesdays from 2:45 p.m. to 5:45 p.m., and on Thursdays from 2:30 p.m. to 9:00 p.m., Eastern Standard Time.

DENMARK

There is an experimental short-wave station, OXY, at Lyngby, Denmark, transmitting on 31.6 meters. Lyngby, whether you know it or not, is a rather historical radio place, for it was here that the famous Danish radio inventor, Waldemar Poulsen, in the year 1906, demonstrated his talking arc. Until the development of the Alexanderson alternator, during the war, the Poulsen art was almost the exclusive means of long distance communication, but is now quite passé.

SOS ON THE SHORT WAVES?

The greatest thrill in radio is not hearing Mars, but in intercepting an SOS. Now comes the news that possibly short-wave listeners may have a chance to hear one. Captain S. C. Hooper, director of U. S. Naval Communications, is urging the reservation of a band of short waves for distress calls, his contention being that the range of the usual 600 meter distress signals is inadequate over some of the vast stretches of the Pacific, Indian and South Atlantic oceans.

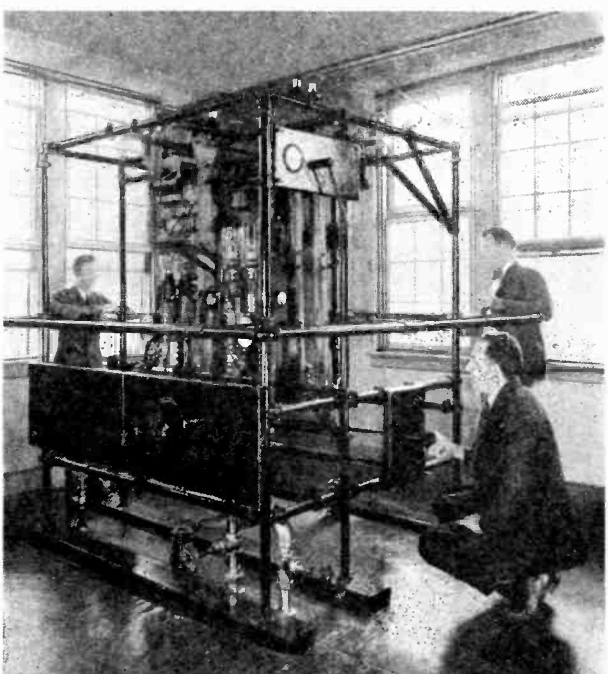
MADAGASCAR

The French authorities have erected a short-wave station on the island of Madagascar, off the east coast of Africa. The announcer identifies the station as "Radio Tananarive." It transmits daily on 50 meters from 1:00 to 3:00 p.m., E.S.T., and on Saturdays from 2:00 to 6:00 p.m. Not much chance of hearing this outfit in the United States at these hours, but of course there's no telling.

SOUTH AFRICA

One of our faithful correspondents in Johannesburg reports that a five-kilowatt short-wave

Tuning up the National Broadcasting Company's short-wave transmitter, W3XAL, at Bound Brook, N. J. It is this transmitter that sends NBC's short-wave programs hurtling around the entire globe on low-wave lengths. Note the size of the tubes in the center of the transmitter.



station is now in operation in his city. The wavelength is 49.4 meters, and the schedule daily, is 12 noon to 2:00 p.m.; 4:00 to 6:30 p.m.; and 7:00 to 10:30 p.m. Saturday nights until 11:45 p.m. This is South African Time.

U.S.S.R.

With one fine short-waver at Khabarovsk, Siberia, the Russians are now adding to their chain, and have opened a new station in Moscow on 50 meters. We don't think anyone in the U. S. has heard it yet, but it is making a lot of noise in Europe and Great Britain. The operating schedule is not known, but it probably follows the usual evening activities. This corresponds to noon and afternoon in the Eastern states and late morning and early afternoon in the Western ones.

SIAM

HS2PJ, one of the group of royal Siamese short-wave stations, is on the air only on Mondays, from 8:00 to 11:00 a.m., Eastern Standard Time. The wavelength is 29.5 meters, the power 500 watts. The opening and closing announcements are made in Siamese, English and French, with chimes of six different notes on a musical gong between the items.

This information, taken directly from a letter from the manager of the Siamese broadcasting service, should settle the status of HS2PJ, which has been listed differently in every short-wave station list in print.

JAPAN

Verifications on the new Japanese station J1AA have been quite numerous. Mr. Russel Leach, of Glen Rose, Texas, has received a letter stating that 19.04 and 38.07 meters are used with powers varying between three and five kilowatts. The transmitter is located in Kemikawa, Japan, just outside of Tokio. It works with various commercial stations on the West Coast: KEE, KEL, etc.

The amount of misinformation on short-wave transmissions that appears in the press is appalling. A leading German radio magazine lists K1XR-KZRM for Havana, Cuba, which will probably be news to the Radio Corporation of the Philippines!

What Users Think of the Pilot "All-Wave" Receiver

Note: The Pilot "Universal Super-Wasp," described in the last issue of RADIO DESIGN, *is now called the "All-Wave" receiver to distinguish it from numerous imitations that have appeared on the market since it was brought out several months ago.*

While on a visit to New York City I bought a Universal Super-Wasp. Will say that of all the short wave sets I have used this is the best.

WARREN MACK,
1508 E. Powhattan Ave.,
Tampa, Florida.

Here is some new "dope" on S-W stations:

W10XAI. S.S. Malola, Radio Department, S.S. Malola, San Francisco, California—31.48 meters testing around 2 a.m. P.S.T. with Pt. Reyes, Calif.

Sourabaya, Java. On about 38 meters or a little under, testing with Sydney, Australia from 3 a.m. to 4 a.m. P.S.T. Believe call letters PK3BK.

VK2ME. Now on 31.28 meters every Saturday night and Sunday morning. They operate four schedules. Here they are:

No. 1—I am sorry but I missed this one,
2—0930 to 1130 G.M.T.
3—1130 to 1330 G.M.T.
4—1900 to 2100 G.M.T.

VK3ME. Melbourne has been testing lately on 31.48 meters.

I am using one of the new "Universal Super-Wasps" and have played VK2ME, VK3ME, J1AA, RV15, F31CD, VE9CS, HKA, HRB, PK3AN, PK3BK, G5SW, CTIAA, and others.

You should organize a club for members that have heard all continents. I have for some time had verifications from all continents and have heard four in one day. It is my ambition to hear all of them in one day. It would be a record of some kind.

Yours truly,
STANNARD SMITH,
"Los Angeles Times,"
Los Angeles, Calif.

The "Universal" is doing good so far. We haven't tried very much for a lot of stations but we can still get England, Holland, Central America, Rome, and now last Thursday we got France.

We hope it keeps on being as good and we won't be able to kick.

Yours very truly,
MRS. W. MILOT,
P.O. Box 384,
Haverhill, Mass.

Theory of Super-Heterodyne Operation

By KENNETH HARKNESS

Research Engineer, Pilot Radio & Tube Corporation

THE outstanding advantages of the super-heterodyne circuit have been recognized for many years. It is one of the few basic circuits in radio. Developed during the war by Major E. H. Armstrong, it was designed to circumvent the almost impossible task, at that time, of obtaining effective radio frequency amplification at broadcast frequencies. The tubes and circuits then in use made it practically impossible to obtain good amplification of radio frequency signals below 1,000 meters, although such amplification was readily obtainable on the longer wavelengths.

Major Armstrong conceived the idea of converting short-wave signals to a single long wavelength and then amplifying this long-wave signal. This idea, and the method he invented to accomplish it, forms the underlying principles of the super-heterodyne circuit.

With the later advent of neutralized T.R.F. receivers and screen-grid tubes, amplification at the high frequencies of the broadcast band became much more efficient and it then became possible to build highly sensitive and fairly selective receivers without using the super-heterodyne principle. Furthermore, single dial tuning was developed and perfected. The super-heterodyne, which required two tuning controls, was relegated to the background.

SUPER-HET IS MODERNIZED

Engineers, however, have always realized that the super-heterodyne is the most efficient type of circuit. By using this principle it is possible to obtain a degree of sensitivity and selectivity which cannot be secured with a straight T.R.F. receiver. While the T.R.F. set was at the height of its popularity, engineers were working in their laboratories perfecting the super-heterodyne circuit, utilizing all the latest developments in tubes, circuits and mechanical design.

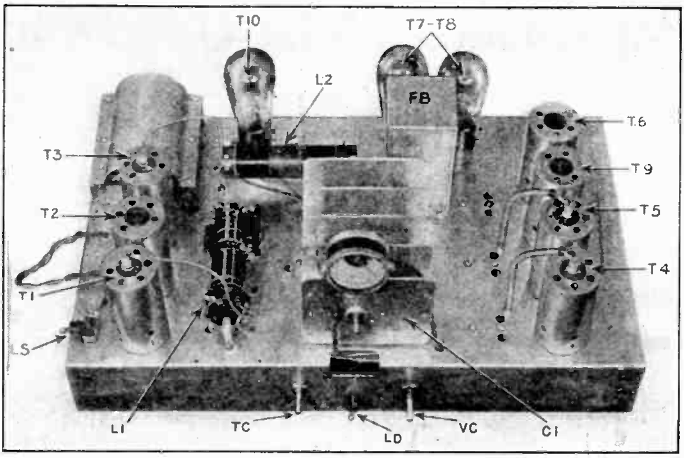
Less than two years ago the new, modernized super-heterodyne was released to the public. The tremendous advantages of this new type of super-heterodyne appealed to the trade and the public alike. Within a few months it won international prominence and it is now by far the most popular circuit. Only a small percentage of the sets manufactured today are of the T.R.F. variety. The vast majority are the new, up-to-date version of the super-heterodyne circuit. The "super" staged the most remarkable come-back in the history of radio.

NEW PILOT SUPER-HETERODYNES

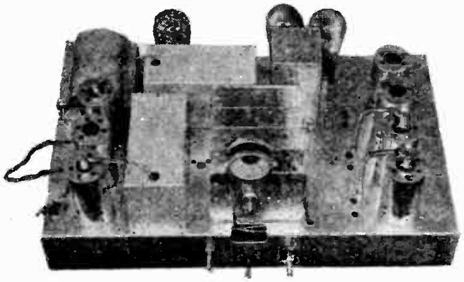
The new Pilot seven-tube and ten-tube sets, illustrated on these pages, are outstanding examples of modern super-heterodynes. These sets possess the renowned sensitivity and the 10 kc. selectivity which can only be obtained with a super-heterodyne circuit. All the disadvantages of the old supers have been eliminated. It is no longer necessary to have two tuning controls; a single control selects any channel in the broadcast band without a trace of interference from stations on adjacent channels. "Double-spot" tuning is also eliminated. Whereas, with the old-time supers, a station could be tuned in at two different spots on the dial, the new Pilot super-heterodynes make this impossible.

A station can be tuned in at only one position on the dial. Excessive hiss and tube noise, which were such objectionable features in old-fashioned supers, are not present in the new Pilot sets. There is no more tube noise or hiss in these sets than in a T.R.F. set of equivalent sensitivity. Side-band cutting, which spoils the quality of so many supers, has also been eliminated in the Pilot sets by the careful design of the I.F. transformers.

Kenneth Harkness



Left: The 10-tube Pilot super-heterodyne chassis with the coil shields removed. The various parts are lettered to correspond with the schematic diagram on page 17. Below: the same chassis with the coil shields in place.



FUNDAMENTALS OF THE SUPER-HETERODYNE CIRCUIT

As outlined in a previous paragraph, the operation of any super-heterodyne is based on the idea of changing the incoming broadcast signal to a low frequency and then amplifying this low frequency signal. The manner in which this is accomplished has been explained many times in radio magazines and text books. For those who are interested, we will briefly review the principles involved.

By referring to the circuit diagram of the Pilot ten-tube set, it will be realized that the circuit consists of six main sections as follows:

1. Pre-selector and R.F. Amplifier.
2. Local oscillator.
3. First detector.
4. I.F. (Intermediate Frequency) amplifier.
5. Second detector.
6. Audio amplifier and loud speaker.

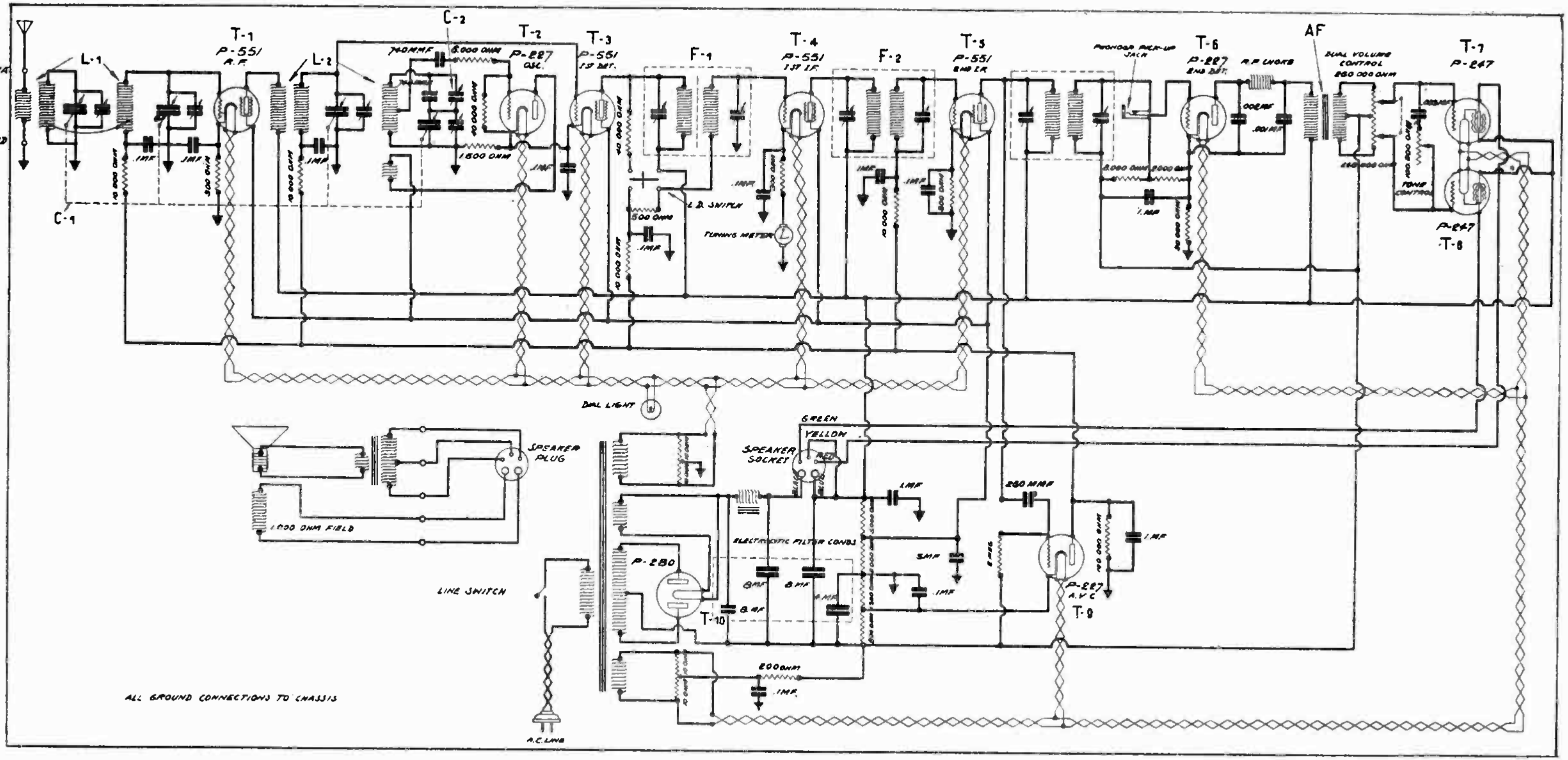
An incoming signal is selected by the pre-selector and amplified by the R.F. amplifier in the usual manner. The amplified signal is impressed on the grid of the first detector. This tube is the "frequency changer" of the super-heterodyne. By the action of this tube, in conjunction with the local oscillator, any incoming signal is changed to a lower frequency so that it can be amplified by the I.F. amplifier.

To illustrate how this change in frequency is accomplished, let us suppose that we wish to receive a broadcast signal of 1,000 kc. This signal is amplified and impressed on the grid of the first detector. At the same time, a signal of 1175 kc., generated by the local oscillator, is also impressed on the grid of the first detector. These two signals, being of different frequencies, beat with each other and produce, in the output of the detector, the resulting beat frequency of 175 kc. This beat frequency is detected by the tube in much the same way as the audio frequency component of an incoming signal is selected by the detector of an ordinary T.R.F. set.

The plate circuit of the first detector and the succeeding circuits of the I.F. amplifier are permanently tuned to 175 kc. The 175 kc. beat frequency signal is thus amplified and impressed on the second detector, which selects the audio frequency component in the usual manner. This audio frequency component is then amplified by the pentode output tubes and reproduced by the loud speaker.

FREQUENCY CHANGING IN THE SUPER-HET

In the foregoing, we have chosen as an example an incoming signal of 1000 kc. The same procedure takes place at all other incoming signal frequencies. The tuned circuits of the pre-selector R.F. amplifier, first detector and oscillator are so arranged that, at any position of the four-gang condenser, the oscillator is invariably tuned to a frequency 175 kc. higher than the other three circuits. In other words, the pre-selector, R.F. stage, and first detector can be tuned from 1500 to 550 kc. to cover the broadcast band while the oscillator is simultaneously tuned from 1675 to 725 kc. At any intermediate position of the dial the oscillator is generating a signal 175 kc. higher in frequency than the frequency to which the other circuits are tuned.



This is the full schematic wiring diagram of the Pilot 10-tube super-heterodynes, using automatic volume control and visual tuning meter. It appears to be complicated, but can readily be understood after it is studied a little.

It will be evident that, by arranging the oscillator and R.F. circuits in this manner, the beat frequency between the incoming signal and the signal generated by the oscillator is invariably 175 kc., no matter what the frequency of the incoming signal may be. Thus, any incoming signal, at any frequency within the broadcast band, is changed to 175 kc. and amplified by the I.F. amplifier.

SINGLE CONTROL TUNING

The simultaneous tuning of the R.F., detector and oscillator circuits, to produce the effect described above, was one of the major problems of super-heterodyne design. In the old-time supers two dials were invariably used, one to tune the detector and the other to tune the oscillator. In the modern super-heterodyne, however, an ingenious arrangement of the circuit constants enables us to use a single tuning control. A full explanation of the arrangement used is beyond the scope of this article.

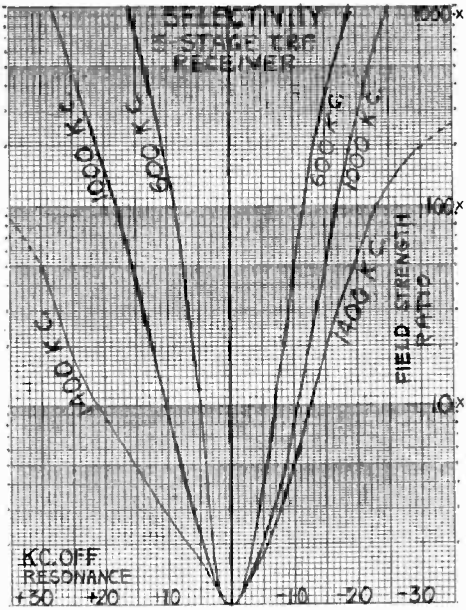
Briefly, the tuned grid circuit of the oscillator is made to track with the other three tuned circuits by adjustments at the lower and upper ends of the tuning range. At the lower end (1400 kc.) the four circuits are lined up by means of the trimmers across the four sections of the main tuning condenser. At the upper end (600 kc.) the oscillator is adjusted to tune at the desired frequency by means of a trimmer (known as the 600 kc. oscillator trimmer) which is connected across a 740 mmfd. padding condenser, as shown in the wiring diagram.

This padding condenser limits the maximum capacity of the oscillator tuned grid circuits. By selecting the correct value of padding condenser and varying the trimmer across it, the maximum capacity of the oscillator circuit can be adjusted to tune at any desired frequency. In practice, then, the oscillator is tuned to exactly 1575 kc. when the other three circuits are resonant at 1400 kc. and the oscillator is again tuned to 775 kc. when the other three circuits are resonant at 600 kc. At all other positions of the tuning dial the frequency of the oscillator is approximately 175 kc. higher than the other circuits, the inductance of the oscillator coil being selected to produce this tuning curve.

At this point it might be logical to ask why we go to the trouble of changing all incoming signals to 175 kc. and then amplify this frequency. How is this method superior to the T.R.F. system?

In reply to this question we will consider a few of the advantages of the super-het circuit as compared with the T.R.F. system.

Perhaps the most important attribute of the super-het circuit is its selectivity. Under normal conditions this type of receiver will

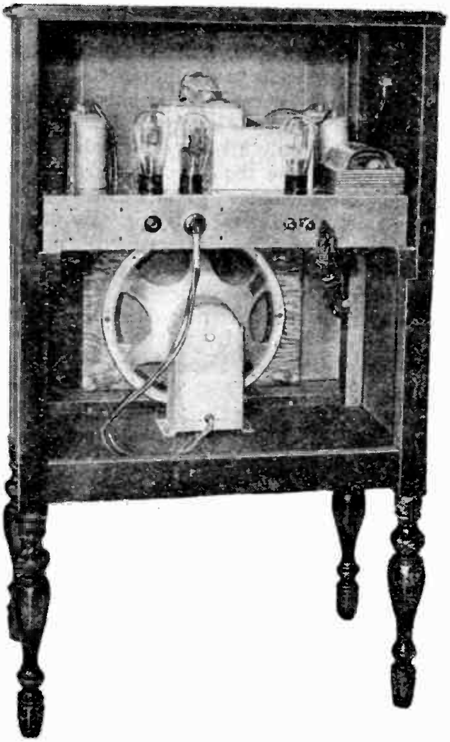


tune in any broadcast station without a trace of interference from stations on adjacent channels. Furthermore, the selectivity is uniform at all broadcast frequencies.

The accompanying curves provide a comparison between the selectivity of the Pilot 10-tube super-heterodyne and a standard make of T.R.F. receiver with three stages of R.F. amplification. Both these sets use a four-gang variable condenser for tuning. The tremendous difference in selectivity is quite apparent. The Pilot set is very much more selective and the selectivity is uniform at 1400, 1000 and 600 kc. The T.R.F. set is fairly selective at 600 kc. but is very broad at 1000 and 1400 kc.

The remarkable selectivity of the super-heterodyne and the uniformity of this selectivity are due to the fact that all incoming signals, after being changed to 175 kc., must pass through the highly selective intermediate frequency amplifier before they are rectified by the second detector. The selectivity of this I.F. amplifier is constant and is responsible for over 90 per cent of the overall selectivity. Consequently, the selectivity is uniform at all broadcast frequencies.

The selectivity of any receiver depends largely upon the number of tuned circuits which are used. Furthermore, the selectivity improves rapidly as the number of tuned circuits is increased. For instance, if one tuned circuit reduces an unwanted signal to one-half of its original intensity, three similar circuits, in cascade, will reduce the signal about eight times; six tuned circuits will reduce it about 60 times and nine tuned circuits will attentuate the undesired signal about 500 times.



Back view of the Pilot 10-tube Console, showing the arrangement of the chassis and the nine-inch dynamic speaker.

Of course, in a T.R.F. set it is impractical to use nine tuned circuits, as this would require a nine-gang variable condenser. In the Pilot 10-tube super-heterodyne, however, there is a total of nine tuned circuits, not counting the oscillator, through which the signal must pass before it reaches the second detector. Only three of these circuits are tuned by the variable gang condenser; the remaining six tuned circuits are in the I.F. amplifier and are permanently tuned to 175 kc. In the Pilot 7-tube super-heterodyne there is a total of six tuned circuits, not counting the oscillator. Only two of these are tuned by the gang condenser, the remaining four being permanently tuned to 175 kc.

ARITHMETIC SELECTIVITY OF THE SUPER

The large number of tuned circuits in these sets will give some idea of the degree of selectivity which is obtained. From a practical point of view it is evident that selectivity of this order could not be obtained with a T.R.F. receiver. There is, however, another factor which must be considered. The selectivity of a super with a given number of tuned circuits is infinitely superior to the selectivity of a T.R.F. set with the *same* number of tuned circuits. The use of low intermediate frequency amplification in the super is responsible for this difference and the additional selectivity thereby secured is known as the "arithmetic selectivity" of the super-heterodyne.

To understand this attribute of a super-heterodyne it is necessary to realize that the selectivity of any tuned circuit depends upon the *percentage* difference between the frequency of the unwanted signal and the frequency to which the circuit is tuned. For instance, if a circuit is tuned to 1000 kc., its selectivity may be such that a signal of 1010 kc. is reduced to one-third of its original intensity. The absolute difference in frequency is 10 kc. and the percentage difference is 1 per cent, 10 kc. being 1 per cent of 1000 kc. In the case of a circuit which is tuned to 100 kc., an unwanted signal of 101 kc. will similarly be reduced to about one-third of its original intensity. Here the absolute difference in frequency is only 1 kc., but the percentage difference is still 1 per cent. The selectivity of the two circuits, under these conditions, is the same. However, if a signal of 110 kc. is impressed on the circuit which is resonant at 100 kc., the percentage difference then becomes 10% and the circuit is ten times more effective in eliminating this undesired frequency. The absolute difference in frequency, in the latter case, is 10 kc.

Now let us apply the above facts to the operation of a super-heterodyne. Suppose we wish to receive a station on 1000 kc. and there is an interfering station on 1010 kc. The difference in frequency between the two stations is 10 kc. In the case of a T.R.F. receiver this means that we must eliminate a station only 1 per cent off resonance, which is extremely difficult. In the case of a super-heterodyne, with an intermediate frequency amplifier tuned to 175 kc., the desired signal of 1000 kc. will be converted to 175 kc., while the interfering signal of 1010 kc., if it is strong enough to reach the grid of the first detector, will be converted to 185 kc. The absolute difference in frequency between the two signals is still 10 kc. but the interfering signal is now nearly 6 per cent off resonance, 10 kc. being nearly 6% of 175 kc. This means that it is six times easier to eliminate the interfering signal. In other words, with a super-heterodyne it is just as easy to separate stations 10 kc. apart as it is to separate stations 60 kc. apart with a T.R.F. set.

Another important advantage of the super-heterodyne is the ease with which a high degree of sensitivity can be obtained and the uniformity of the sensitivity over the broadcast band. The accompanying curve shows the sensitivity of an average 10-tube Pilot super-heterodyne. Note how flat the curve is. The sensitivity is practically uniform from 1500 to 550 kc. This curve shows the signal strength required at the antenna to produce a standard 50 milliwatts output in the loud-speaker. The required signal strength averages only two microvolts with a 4-meter antenna, or one-half microvolt per meter. This represents a very high order of sensitivity. When combined with the perfect selectivity of this set it means that the user, in an average location, can tune in stations all over the continent with good loud speaker volume and without interference.

This high degree of sensitivity is very easily obtained in a super-heterodyne and the shielding problem is greatly simplified. A gain of 60 to 100 per stage is readily obtainable at 175 kc. without any danger of oscillation. Moreover, all the amplification of a super does note take place at a single frequency, as in the T.R.F. receiver. Some of the amplification is at the fundamental broadcast frequency and the remainder at the intermediate frequency. Consequently, there is much less tendency for the output to react on the input.

UNSPOILED TONE FIDELITY

The tone fidelity of the modern super-heterodyne is not adversely affected by the high selectivity. A band-pass filter arrangement is used in the I.F. amplifier which permits this amplifier to receive a band of frequencies extending about 5 kc. on either side of the resonant frequency. As a result there is no audible loss in the high frequency response. The output is practically uniform over the entire range of audio frequencies.

PRE-DETECTOR SELECTIVITY NECESSARY

It will be noticed that, in the Pilot ten-tube super-heterodyne, a pre-selector and a stage of tuned radio frequency amplification are used before the first detector. With the oscillator tuning condenser, this necessitates the use of a four-gang variable condenser and the associated coils and other parts.

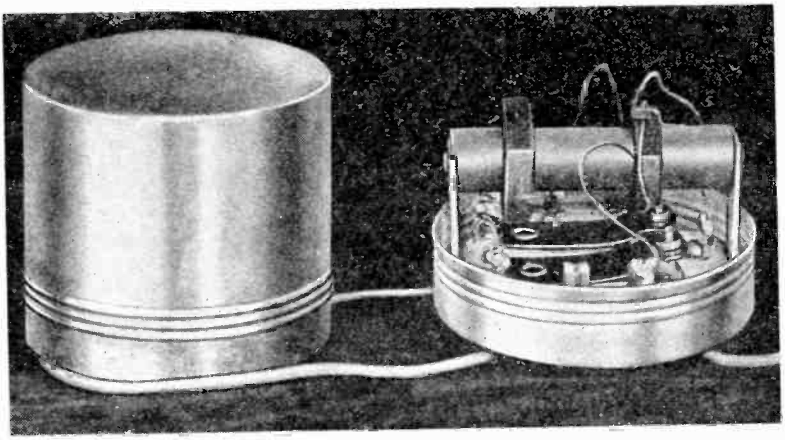
It would, of course, be very much easier to couple the antenna directly to the first detector and use only a two-gang condenser, one condenser to tune the detector and the other to tune the oscillator. The earlier types of super-heterodynes were built in this manner, using two separate condensers for the purpose.

There are, however, two very important reasons why it is necessary to provide both amplification and selectivity before the first detector.

In the first place, there is much less tube noise and oscillator hiss when some amplification is used before the first detector. There is a ratio of radio frequency to intermediate frequency amplification which gives the least noise for a given total amplification. The ratio maintained in the Pilot super-heterodynes has been carefully worked out so that noise and hiss are reduced to a minimum and are actually negligible. There is no more noise or hiss in these sets than in T.R.F. sets of equivalent sensitivity.

In the second place, a certain amount of selectivity before the first detector is necessary to eliminate what is known as the "image interference" of a super-heterodyne. This type of interference is peculiar to super-heterodynes and is due to the fact that, for any given setting of the oscillator, there are two signal frequencies which will produce a beat frequency of 175 kc.

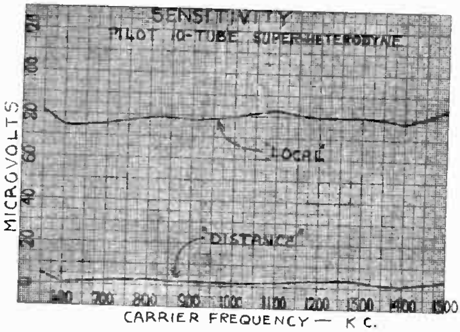
It will be remembered that a 175 kc. signal is produced when two frequencies, 175 kc. apart, are impressed on the grid of the first detector. For instance, to receive a desired signal of 1000 kc. we tune the detector and preceding r.f. circuits to 1000 kc. and simul-



A close-up of one of the intermediate frequency transformers used in all the Pilot super-heterodyne receivers. The two coils are wound on an impregnated wooden form. The small balancing condensers are just underneath.

Right: the new Pilot ten-tube super-heterodyne in its handsome open-face Console cabinet. This beautiful instrument is an attractive addition to any home. With its automatic volume control, visual tuning meter, easy operating dial and nine-inch dynamic speaker, it provides superlative radio reception.

Left: This is the new Pilot ten-tube super-heterodyne in a de-luxe walnut cabinet with hinged doors and six legs. It uses the same chassis and loud speaker as the model above. Opened or closed, this set harmonizes well with its surroundings in the home, and is a superb musical instrument as well as a fine piece of furniture.



taneously tune the oscillator to generate a signal of 1175 kc. These two signals are 175 kc. apart and are both impressed on the grid of the first detector; consequently, a 175 kc. beat frequency signal is produced in the output of the detector. Now, at this same setting of the oscillator, a 175 kc. beat frequency signal will also be produced if an incoming signal of 1350 kc. reaches the grid of the first detector. The reason for this is apparent: the incoming signal of 1350 kc. and the oscillator signal of 1175 kc. are 175 kc. apart.

Thus, when the oscillator is tuned to 1175 kc., there are two incoming signal frequencies, 1000 kc. and 1350 kc., which will produce a beat frequency of 175 kc. and which will be amplified by the i.f. amplifier. The 1000 kc. signal is 175 kc. lower than the oscillator frequency, while the 1350 kc. signal is 175 kc. higher than the oscillator.

In the Pilot super-heterodyne, for this setting of the oscillator, the 1000 kc. signal would be the desired signal to which the preselector, r.f. stage and detector circuits are tuned, while the 1350 kc. signal would be the undesired image.

It will be evident that some selectivity is required before the first detector to reduce image interference to a minimum. Otherwise, if two stations are separated by 350 kc., the higher frequency station will interfere with the reception of the lower frequency station. The degree of selectivity at this point, however, does not have to be very great, as the interfering signal, at the image frequency, is invariably 350 kc. away from the frequency we wish to receive. However, the interfering signal may be from a local high power station and it is necessary, therefore, to provide sufficient selectivity before the detector to eliminate any such interference.

In the Pilot 10-tube super-heterodyne the incoming signal must pass through three tuned circuits before it reaches the grid of the first detector. These three circuits provide ample selectivity to prevent any possibility of a strong local station causing image interference. Tests have been made under extremely adverse conditions and have proved that this set is free from such interference.

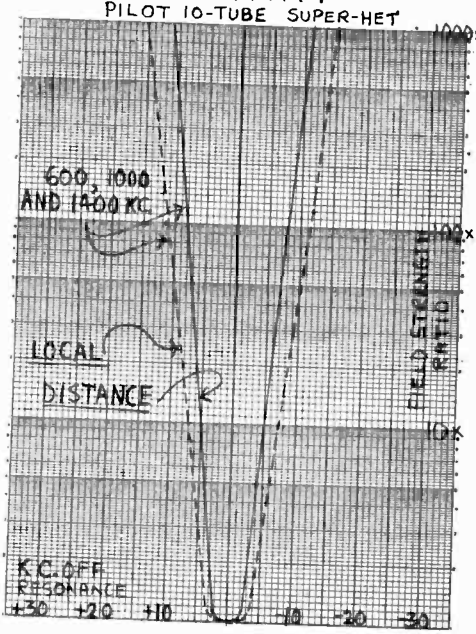
NEW TUBES IN PILOT SUPERS

It will be noticed that the new Pilot super-heterodynes make use of the new variable-mu and pentode tubes. Type 551 variable-mu tubes are used in the r.f., first detector and i.f. stages of the 10-tube model. These tubes make it possible to control the amplification of the receiver without introducing distortion and without any danger of "modulation" interference. With the 224 tube, which the 551 has replaced as an amplifier, some distortion was introduced when the grid bias was increased to reduce the amplification. Furthermore, a strong local station would frequently cause interference due to the rectifying action of the 224 tube. Both these effects made it extremely difficult to control the r.f. gain of a receiver with 224 tubes. The 551 tube has completely cured these troubles.

The Pilot set also uses two of the new type 247 pentode tubes in the push-pull output stage. These tubes have a much higher undistorted power output and much higher gain than the 245 tubes which they have largely replaced. The maximum undistorted output of the 10-tube set is about 5 watts. This output can, of course, be reduced to any degree of volume by means of the volume control.

The Pilot 10-tube model is equipped with automatic volume control which greatly facilitates the tuning of the receiver and tends to reduce fading.

SELECTIVITY
PILOT 10-TUBE SUPER-HET



Complete Descriptions of the New

Pilot 7-Tube Super-Heterodynes

The Pilot Midget super-heterodyne, in its modified Gothic cabinet, presents a highly pleasing appearance.

THE new Pilot 7-tube Midget Super-Heterodyne is illustrated on these pages and the schematic diagram is also given.

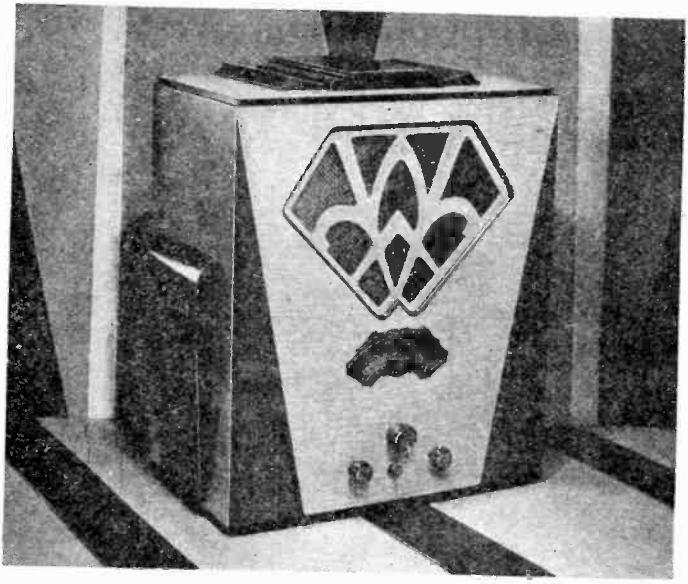
This set is a complete super-heterodyne, with all the sensitivity, 10-kc. selectivity, power output and tone quality of much larger sets, and is assembled in a compact, mantel-type cabinet.

SENSITIVITY ABOVE AVERAGE

Perhaps the most remarkable characteristic of this set is its unusual sensitivity. In actual side-by-side tests it has out-performed 10- and 11-tube sets of other makes. Laboratory measurements show that the sensitivity is actually less than 3 microvolts per meter over the entire tuning range. This order of sensitivity is rarely found in a midget set. In fact, not wishing to sacrifice this high sensitivity, the Pilot company has equipped the set with a local-distance switch. On the "local" side of the switch the sensitivity of the set conforms to the average midget set, with a sensitivity of about 25 to 35 microvolts per meter. At this sensitivity level there is, of course, less noise and less tendency to overload when receiving local stations. The extreme sensitivity of the set, however, is at all times available by turning the switch to the distant position.

ABSOLUTE 10 KC. SELECTIVITY

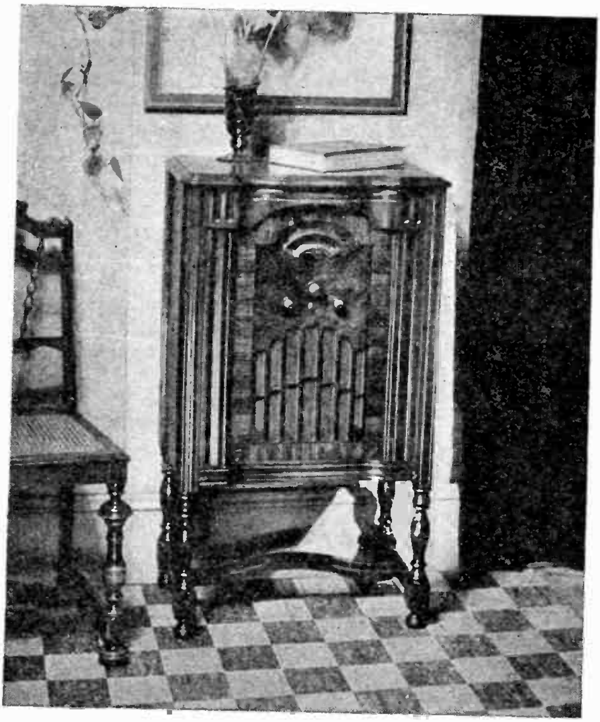
The selectivity, too, is well above the average. Stations all over the country can be tuned in without a trace of interference. There is a total of six tuned circuits, not counting the oscillator, through which the signal must pass before it reaches the second detector. Furthermore, the "arithmetic selectivity" of a

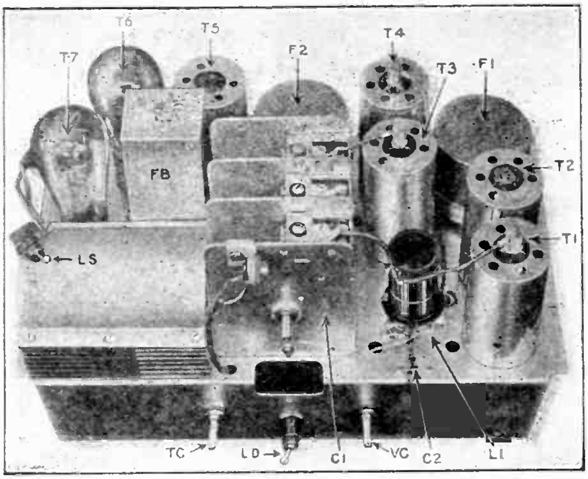


Left: The seven-tube super-heterodyne chassis in this Modernistic cabinet makes a stunning radio receiver. Finished contrastingly in ebony black and light and dark colors of walnut, this unusual set is altogether distinctive, and must be seen to be appreciated.

Beauty of Appearance Makes These New Radio Sets Very Attractive

Right: The seven-tube chassis in this handsome Console, with ample baffle area provided by the cabinet area, provided high quality reception and attractive appearance at a low price. The tuning controls are at just the right height for comfortable adjustment.





A close-up of the seven-tube super-heterodyne chassis, with all the parts marked to correspond with the designation on the schematic diagram on the next page.

super-heterodyne circuit, explained in another article in this magazine, makes the adjacent channel selectivity so perfect that interference is seldom encountered.

UNUSUAL TONE QUALITY

For a set of this size, the quality of the reproduction is strikingly realistic. It is so far ahead of the kind of quality delivered by last year's midget sets that there is no room for comparison. The tone is pleasing and distinct. Tremendous volume can be obtained, if desired, without distortion. The undistorted power output of the set is 2.5 watts, which is more than will ever be required in the home.

FULL VISION DIAL

Tuning, of course, in accomplished with a single control. By a special arrangement of the circuit constants, explained elsewhere, the local oscillator circuit tracks perfectly with the r.f. and detector circuits. The full vision dial on the tuning control helps to simplify the tuning. The dial pointer is visible at all times and the dial is graduated both in kilocycles and in numbered divisions from zero to 100.

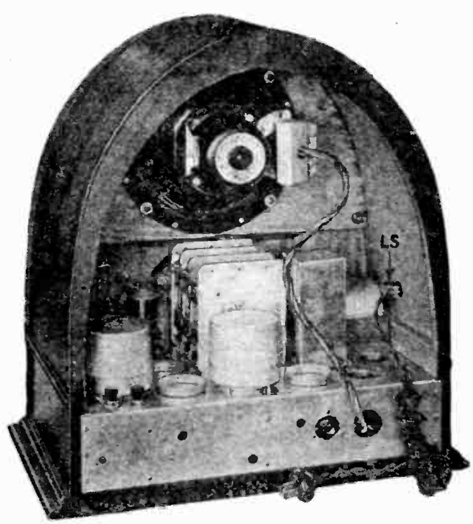
NEW TUBES USED

This set uses all the very latest developments, including the new variable-mu and pentode tubes. Type 551 variable-mu tubes are employed in the r.f. and i.f. stages. The output tube is a type 247 pentode. The 551 tubes make the volume control completely free from distortion and eliminate the "modulation" interference formerly encountered with 224 tubes. The 247 pentode tube gives tremendous undistorted power output and increases the sensitivity of the receiver.

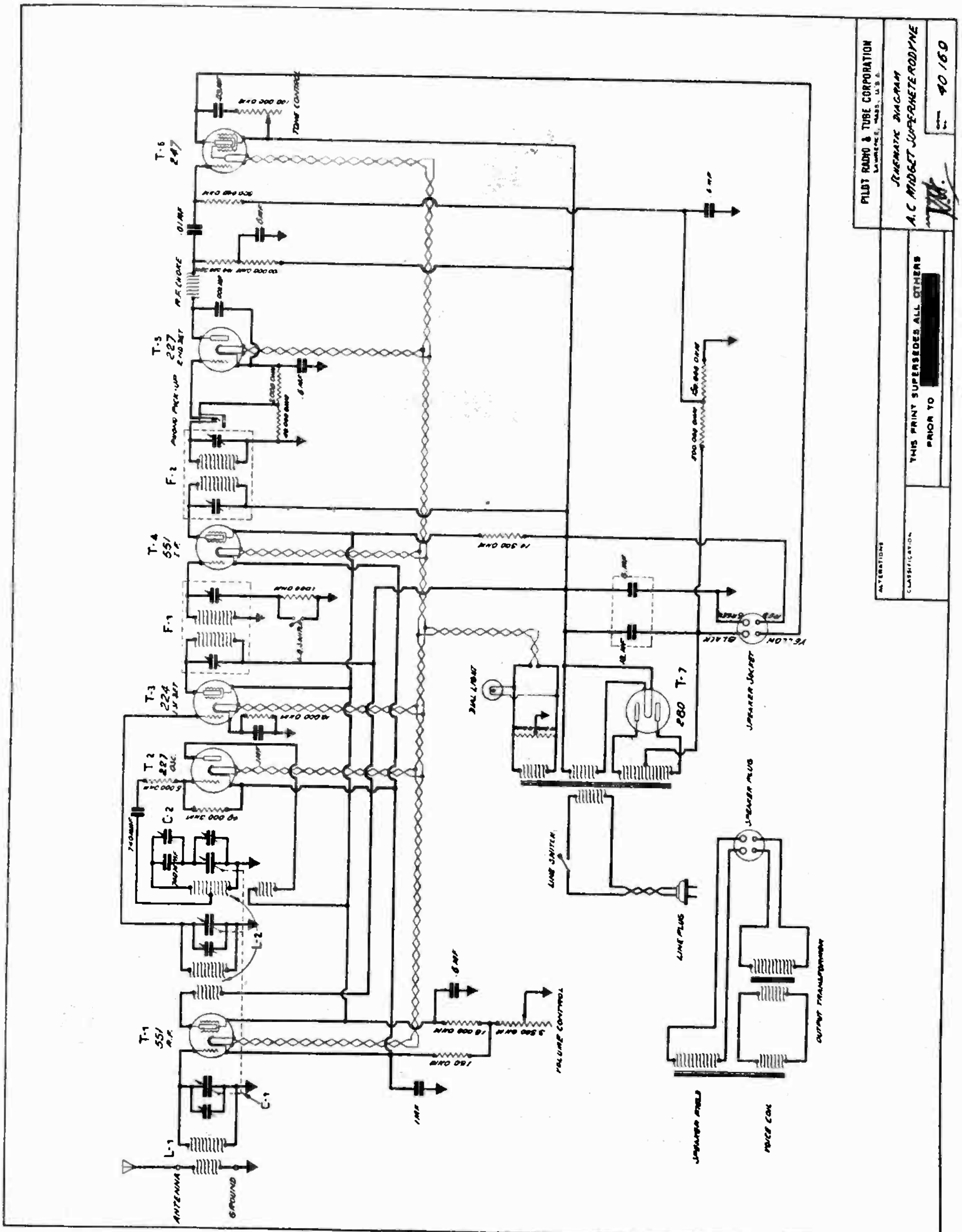
A tone control is also furnished so that the quality can be adjusted to suit the taste of the user. This control reduces the high note response of the set and, at the same time, helps to reduce heterodyne interference and soften the effect of static.

WIRING DIAGRAM EXPLAINED

For those who are interested in the technical details, the wiring diagram of the Pilot 7-tube super is shown on these pages. Tracing the path of an incoming signal, it will be noticed that a stage of r.f. is used ahead of the first detector. This amplifies the signal so that the "frequency changing" can be accomplished with the least amount of oscillator hiss. As a result, there is no audible hiss and reception



Back view of the Pilot Midget super-heterodyne, showing the arrangement of the chassis and the loud speaker. LS is the line switch.

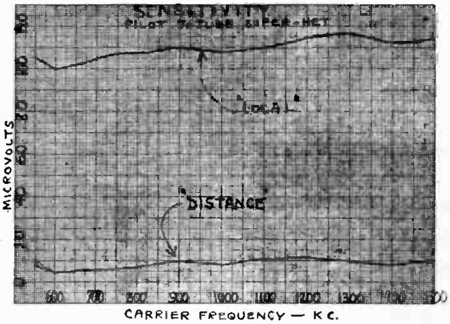


Schematic diagram of the Pilot 7-tube super-heterodyne

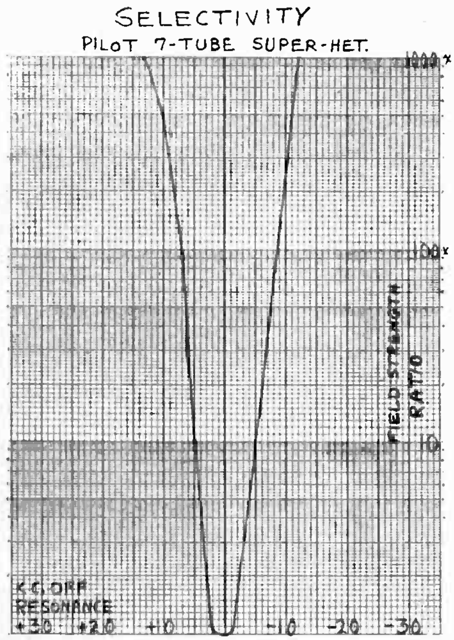
is just as quiet and as free from tube noise as a t.r.f. set. The stage of r.f. also provides sufficient selectivity to eliminate "image interference."

After being amplified by the first r.f. stage the signal is impressed on the grid of the first detector, which is a self-biased 224 tube. At the same time, a signal generated by the local oscillator is also impressed on the grid of the first detector. The beat frequency between these two signals is selected by the first detector. This beat frequency, of 175 kc., is then amplified by the 551 intermediate frequency amplifying tube and impressed on the second detector. The latter selects the audio frequency component, which is then amplified by the pentode output tube. The second detector is resistance-coupled to the pentode.

It will be noticed that there is only stage of intermediate frequency amplification. Special



Above: sensitivity curves of the seven-tube super-heterodyne. Right: selectivity curve of the same set.



i.f. transformers, however, are used in this set which make the gain obtained in this stage extremely high.

The power supply conforms to the latest developments and most improved design. The rectifier is a 280 and two large electrolytic condensers, of the dry type, together with the field of the dynamic speaker, are used for filtering out hum. The hum of the set is practically inaudible, a special neutralizing coil being used in the dynamic speaker to aid in this respect.

Sensitivity and selectivity curves of this receiver are shown. The extreme sensitivity and high order of selectivity are quite apparent from these curves.

USED IN ALL-WAVE SUPER

This 7-tube super-heterodyne chassis and loud speaker are used in the new Pilot All-Wave receiver described in another article. It will be apparent, therefore, that the broadcast reception of the All-Wave set is exactly the same as the reception obtained with the 7-tube model, the same chassis being used.

New Edition of "Radio Physics Course" Ready

READERS of RADIO DESIGN will be interested to know that a completely revised and greatly enlarged second edition of the "Radio Physics Course," by Alfred A. Ghirardi, has just been released by the Radio Technical Publishing Company, of New York. It will be remembered that this course was originally published as a series of articles in RADIO DESIGN, and became one of the most instructive features in the magazine. It was then published in book form by RADIO DESIGN, and was adopted as a standard radio text by dozens of radio schools and technical high schools throughout the country, in addition to achieving considerable popularity among individual radio fans.

Mr. Ghirardi has completely revised the text from cover to cover. Many new chapters have been added, covering such subjects as super-heterodyne receivers, public address and sound amplifiers, automobile and aircraft radio equipment, radio servicing and testing, modern A. C. electric receivers, new types of two-volt battery operated receivers, pentode tubes, photo-electric cells, etc. A complete course in elementary electricity, written especially for radio students, has been included. This is of special value to the many people who are interested in radio but who lack the necessary background of fundamental electrical knowlege. The chapter on television has received special attention, and includes detailed descriptions of all the systems in use today, including the Farnsworth.

Some idea of how completely the "Radio Physics Course" has been revised and rewritten may be gained from the fact that the new edition contains more than 900 pages, while the first edition contained only 362 pages. Throughout the new text Mr. Ghirardi uses the same clear style of writing that has won him international fame as a radio writer and instructor.

Copies of the new edition, which cost $3.50 each, postpaid anywhere, may be obtained from the Radio Technical Publishing Company, 22 West 21st Street, New York, N. Y. Please send your orders directly to this company, *not* to RADIO DESIGN.

Is Television Coming Around That Corner At Last?

By Robert Hertzberg

With a telephone carrying his voice and a bank of photo-electric cells picking up his image, Edwin K. Cohan, technical director of the Columbia Broadcasting System, demonstrates the essence of sight-and-sound transmission in the studio of the newly inaugurated television station, W2XAB, New York.

IS television coming around that corner at last? A lot of anxious station owners and stock promoters seem to think so, even if some responsible radio engineers are inclined to believe that the present hurrah is forced and premature. Anyway, the fact is that dozens of firms and individuals, of varying degrees of financial and technical integrity, have applied to the Federal Radio Commission for experimental visual broadcasting licenses. Stations in Chicago, Boston, Washington and New York are on the air with disc systems that are already doomed. They hopefully "televise" city officials, prize fighters, chorus girls and acrobats, and get a lot of newspaper space even if they don't contribute much to the advancement of the science.

MUCH ACTIVITY

The Columbia Broadcasting System, bitter commercial rival of the RCA-owned National Broadcasting Company, is transmitting with obsolescent RCA apparatus, while RCA engineers work feverishly behind locked doors on new electronic devices of great promise. The NBC rents the 85th floor of the Empire State Building, and prepares to sprinkle New York City with television images on the quasi-optical waves. NBC-RCA officials smile mysteriously when the word "television" is mentioned and issue vague but hopeful statements to the press.

The button-hole makers and milliners who gambled in the radio boom a decade ago are forming high-sounding corporations whose personnel seems to consist mostly of stock salesmen. Radio experimenters are still using the old thumb method of synchronization and wondering if their scanning motors wouldn't be more useful as electric fans. The public reads but fails to discount exaggerated claims of impractical inventors. It's all very confusing.

BUT TOO MUCH PUBLICITY

Television at the present time is the victim of too much publicity of the wrong kind. The sponsors of some half-baked systems are too anxious to get the public to buy, and the reaction that is setting in is altogether negative. The available television receivers are clumsy, noisy and expensive and the meagre results they produce are very disappointing to people who have been led to think they will enjoy continuous thrills. The images wander out of frame, assume weird and grotesque shapes and are generally wobbly.

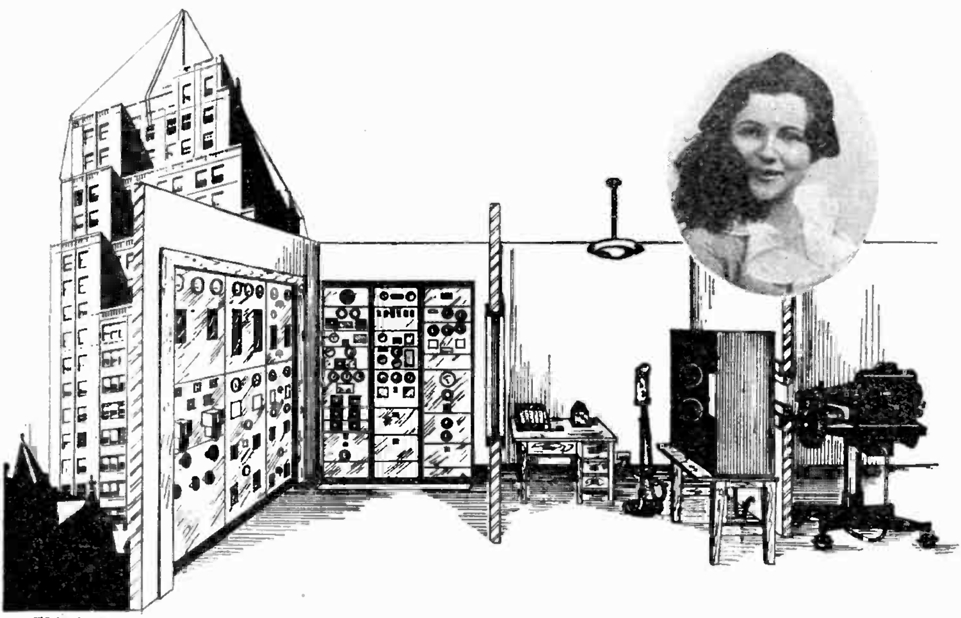
WILL HISTORY REPEAT ITSELF?

The over-enthusiastic televisionists are making their big mistake in thinking that television will repeat the glamorous history of radio broadcasting, when every sign indicates it will not and indeed cannot. Conditions now are altogether different from what they were ten years ago. Today we have a Federal Radio Commission, an aggravating patent situation, an overcrowded ether, an overabundance of radio factories, a lot of politicians with radio axes to grind, and, worst of all, a sophisticated buying element that has been spoiled by high quality broadcasting and high quality talking motion pictures.

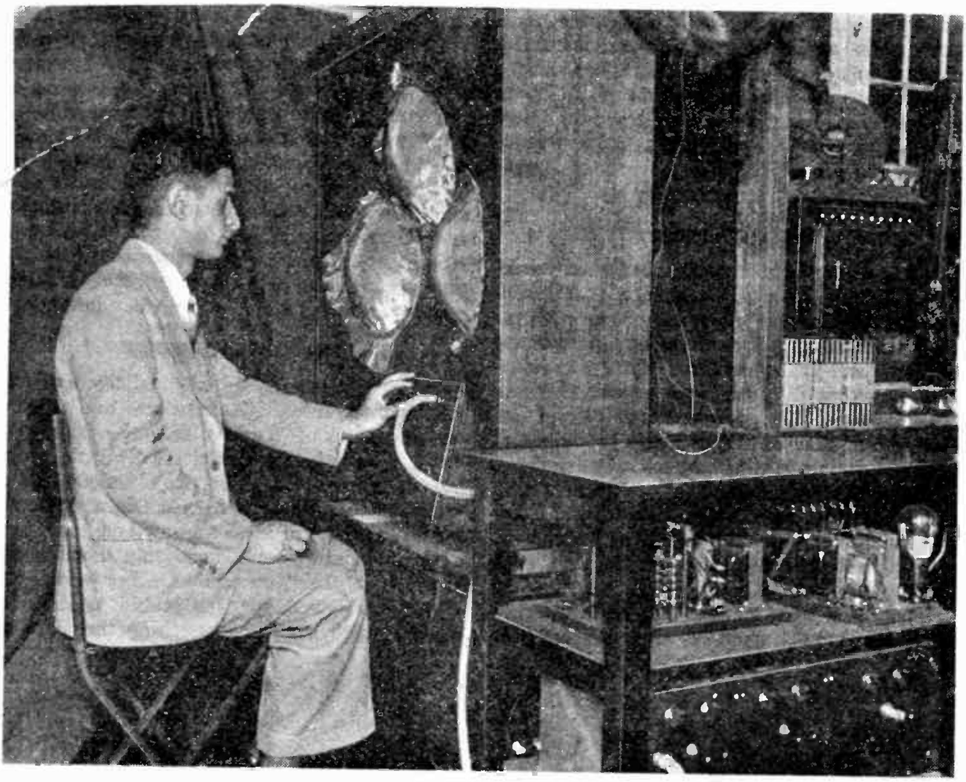
If not for the "talkies," the present crude televisors might stand a slight chance, as the mere novelty of a sight-and-sound combination would be enough to sell a lot of radio apparatus. However, the "talkies" have entirely erased this possibility. People went to see and hear the first sound films, terrible a they were, merely because they were novel. They went to marvel, not to be entertained. Then the novelty wore off, as all novelties do, and now people take perfect synchronization and clear reproduction for granted. Unconsciously they are putting television up to the same standard, regardless of the infinitely greater difficulties that impede this newer art.

NOT MUCH PROGRESS

If some of the hysterical publicity that has blighted television is overlooked, and a calm review made of the available television systems, it will be found that really little progress is evident, except in the technique of the exploiters. There has been outright and unabashed swiping of ideas and methods, with the swiper claiming—and invariably obtaining—credit for their conception. For example: about four years ago Papa Jenkins used a disc scanner with small lenses taking the place of



Here's artist's drawing of the new television studios of the Columbia Broadcasting System, located at 485 Madison Avenue, New York, which started regular schedules on the air on the night of Tuesday, July 28, 1931. At the left the peculiar type doublet antenna is shown on the roof of the C. B. S. Building. At the right is Natalie Towers, first girl ever engaged by a nation-wide broadcasting system exclusively for television. Under the call letters W2XAB, the television station operates on 2,750 to 2,850 kilocycles, with 500 watts power.



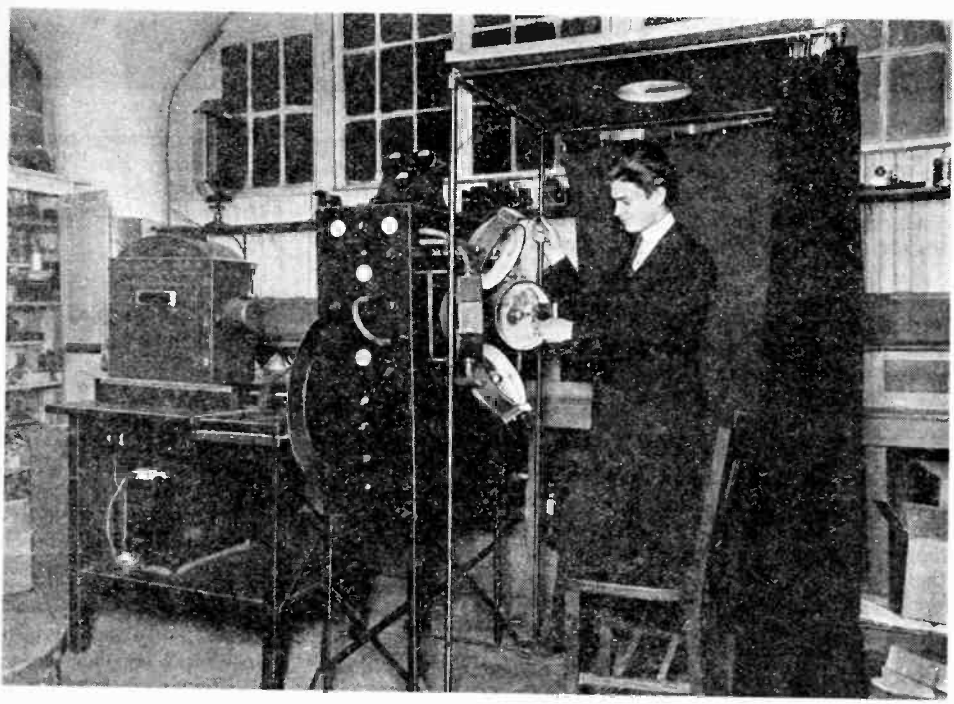
Above: the television transmitter constructed in 1928 for station WRNY, New York, by the Pilot Electric Mfg. Co., now the Pilot Radio & Tube Corporation. Left: the television transmitter used experimentally during 1931 by station W2XBS, of the National Broadcasting Company, New York. Note that the 1928 transmitter is almost identical in construction with the 1931 outfit. Both use arc lights, scanning discs and large photo-electric cells in an upright frame.

the usual naked holes. About four months ago a Western "inventor" fitted up just such a disc, projected large images on a screen, and was immediately hailed as a genius. What the newspapers overlooked was the fact that *wire lines* and not radio was the medium of transmission, and that the apparatus cost as much as a transport plane and was about as easy to operate. Newspaper readers were not apprised of these facts, but instead were treated to the stock line about "television being brought a step nearer to the home by this invention."

TRANSMISSION DIFFICULTIES

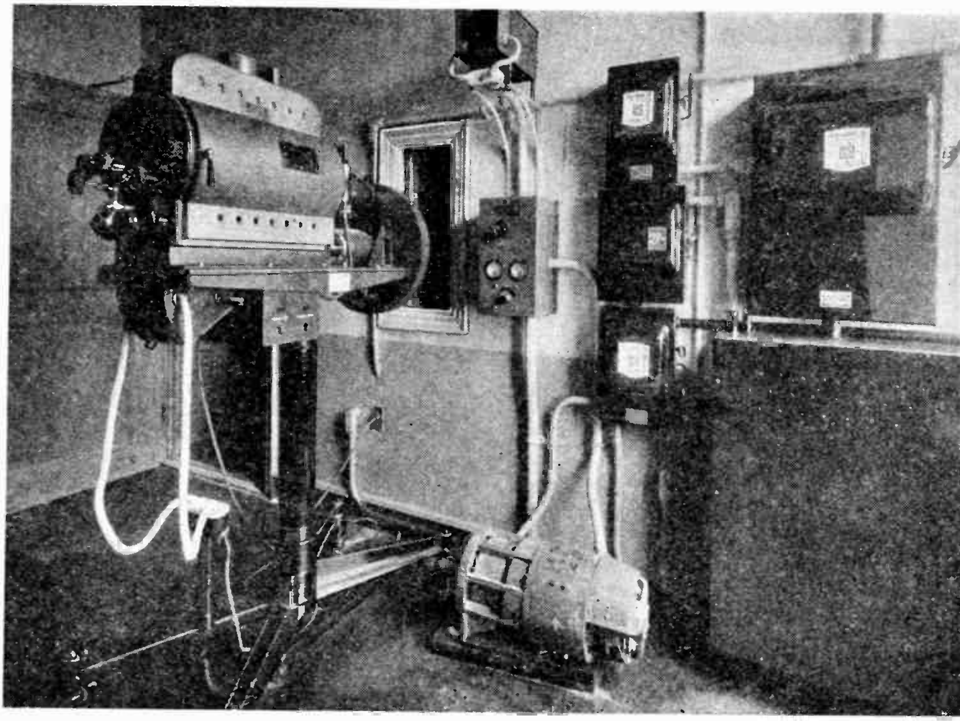
That little joker about the use of wire-line transmission pops up disconcertingly, as jokers do. There have been any number of excellent demonstrations of television from one room or city to another; right now, in fact, the telephone company amuses distinguished visitors in New York by demonstrating its wonderful voice-and-image connection between its laboratory and one of its offices, which are separated a couple of miles in lower Manhattan. This, however, bears no more relation to *radio* television as the public expects it than a kite does to an airplane.

A wire line is a tangible, private medium of communication that will do just what its builders want it to do, and rarely more. How simple would be the problems of the television engineer if he worked with wire lines alone! As technical conditions exist now, it is comparatively easy to produce very fine television images, but exceedingly difficult to transmit them by radio. *It is the medium of transmission that limits the entire art.* The air is simply crowded to suffocation, and even the most restricted television systems require a healthy slice of space. Those that have managed to squeeze into the narrow visual broadcasting channel have been beset with atmospheric difficulties, and are not having a happy existence. The television channels around 2100 kilocycles are more or less orphans, being too high to be considered short waves and too low to be high waves. At the time they



This is another Pilot television transmitter, more compact than the one pictured at the top of the preceding page, constructed in 1929 and demonstrated at the New York Electrical Show of that year. John Geloso, then chief engineer of the Pilot company, is pointing to the one of the small but highly sensitive photo-electric cells that made 48-line images possible. The vertical rack supporting the cells holds the cell amplifiers. Behind it is the scanning disc, and to the extreme left the arc light.

In fundamental construction, and also in perfection of results, this 1929 outfit is fully the equal of most of the highly-exploited present day televisors.



No, this is not a motion picture theatre projection room. It is the scanning room of the Columbia Broadcasting System's television station W2XAB. The heavy stand holds a 30-ampere arc light shining through a synchronously driven scanning disc, the combination producing a "flying spot" which travels over the face of the subject in the adjoining room. On the floor is the generator that feeds the arc.

were assigned, a few years ago, television was a vague uncertainty, and the broadcasting and short-wave telegraphic services were crowding each other for elbow room.

THE QUASI-OPTICAL WAVES

The Federal Radio Commission is now reserving some very high-frequency channels, between 43,000 and 80,000 kilocycles, and in these quasi-optical waves—so-called because they have many of the properties of light—great hope is being put. The National Broadcasting Company has selected the Empire State Building for the site of its quasi-optical wave transmitter because this is the highest structure in New York—or the world, for that matter, and the waves will thus cover a great area to the building's horizon.

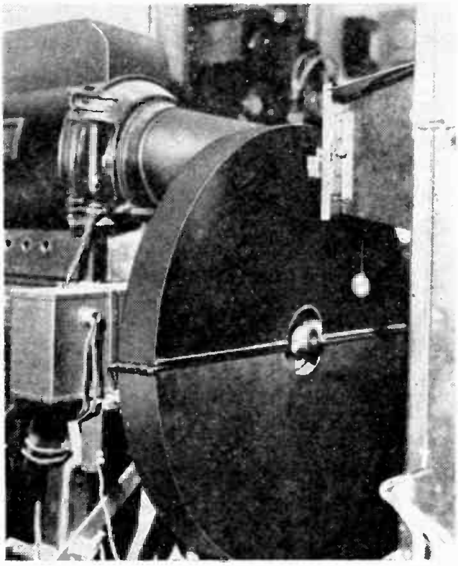
If these quasi-optical waves work out satisfactorily, the receiving aerial will have to be in actual sight of the transmitting aerial and the range of the transmitting station, for the first time in the history of radio, will be definitely controllable. This means that television will not suffer from the same cancerous interference that has troubled broadcasting from its very inception.

SOME PROGRESS AT THAT

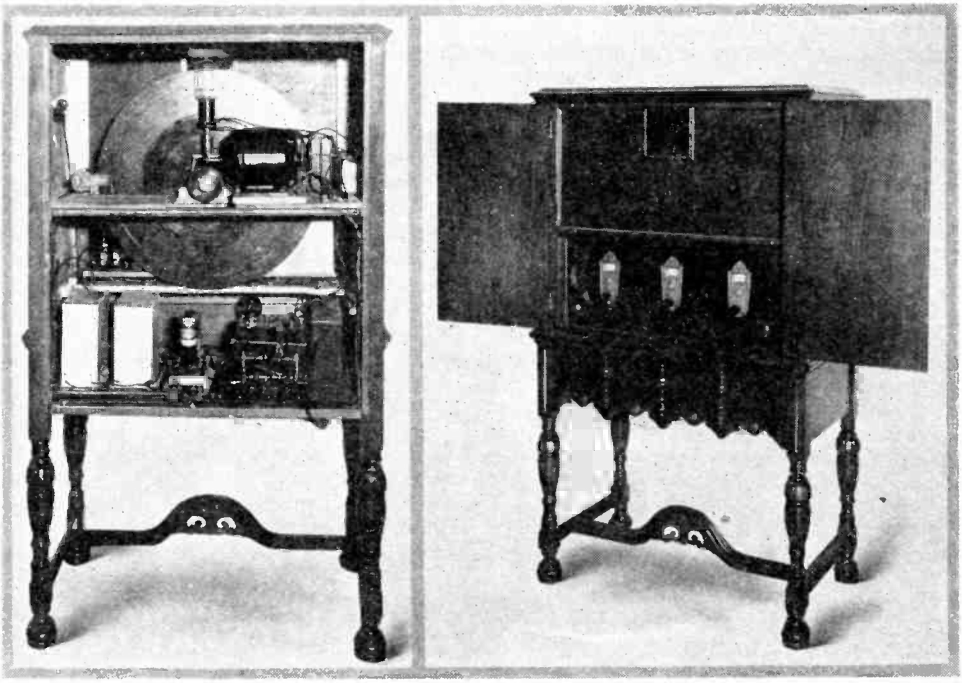
Perhaps an earlier statement in this article about the lack of real progress in television should be qualified a bit. There has been noteworthy improvement in some phases of the art, particularly in neon tubes and projection methods. Except in small, cheap kit outfits intended for the experimenter, the pale neon lamp of cylindrical shape has been replaced by "crater" neon arcs that produce a fairly brilliant light. However, they do not make up for the distortion visited upon the images by atmospheric fluctuations, side-band cut-off in the R. F. circuits, regeneration, uneven audio response, disc wobbling, or motor hunting.

NO SYNCHRONIZATION

Even at this stage of the game, with extravagant claims being made for the entertainment value of television, none of the systems on the air has any provisions at all for synchronization. In metropolitan New York,



Above: A close-up of the enclosed scanning disc used in the W2XBS television transmitter. Behind it is the arc light, and in front the opening in the frame that holds the photo-electric cells.



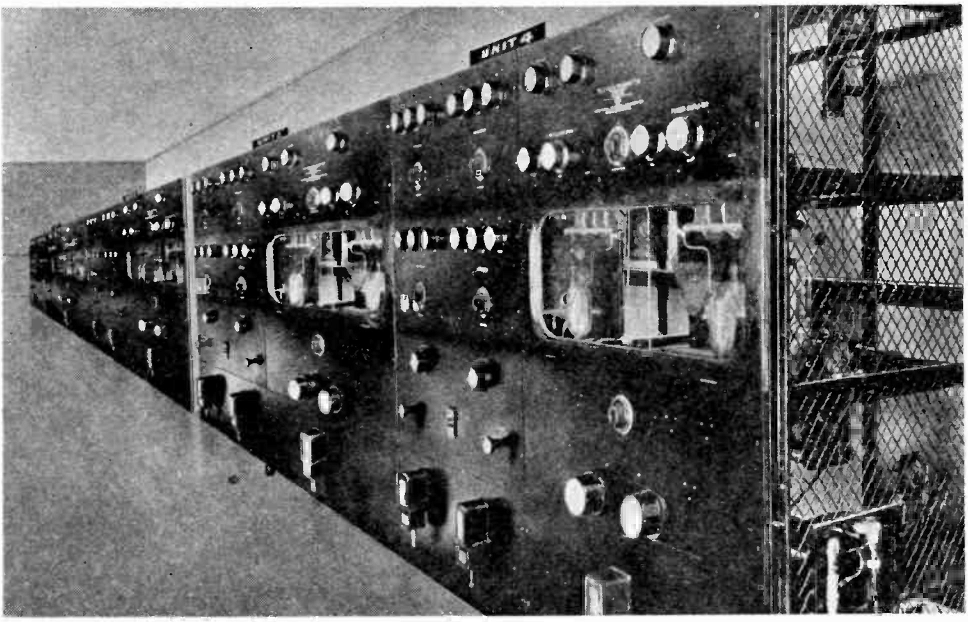
This television receiver made history in 1928 when it was used at New York University in the Fall of 1928 for the first public demonstration of radio television staged in the East. It successfully reproduced 1½-inch images broadcast from station WRNY by the transmitter pictured on page 30. The instrument was constructed in the Pilot laboratories.

Chicago and Boston set owners must depend on synchronous motors operating on the same power line that feeds the transmitter. Every television experimenter knows how unsatisfactory this arrangement is in practice, regardless of how well it works in theory. The images in the televisor wander in and out of frame in spite of every adjustment.

THE CATHODE RAY TUBE

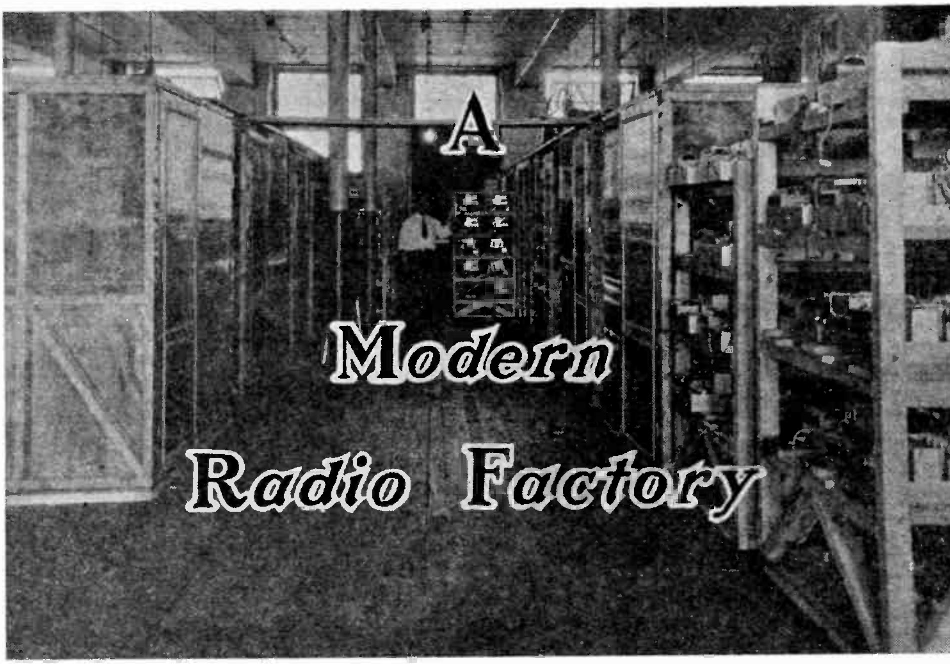
The bright ray of hope that penetrates the television fog is the promise of electrical rather than mechanical scanning, with some form of cathode ray tube replacing the unwieldy disc. The advantages of working with a flexible, inertialess stream of electrons, subject to instantaneous control, have been obvious for years, but only recently has any concerted effort been made to develop suitable apparatus. At Camden, N. J., a great deal of intensive work is being done, but it is being kept so secret that only the highest RCA and NBC officials have been privileged to see its results. As usual when the truth is not known, there are many rumors. Some would have us believe that the images run to 60, 120 and even 240 lines, with 18, 22, 28 and 30 exposures per second. If half of this is true, then television is approaching on the run, and we'll have something to talk about pretty soon.

Just as this issue of Radio Design went to press the New York Radio Show opened at Madison Square Garden, where the Sanabria television equipment attracted a great deal of interest. U. A. Sanabria, a young television experimenter of considerable talent, has probably done more with the disc system than anyone else, and at the Show demonstrated 10-foot square images of remarkable clarity. Wire lines, of course, were used for transmission. The Sanabria apparatus is being taken on a tour of vaudeville theatres, and should be seen by every radio fan interested in the progress of the television art.



This is what the voice-and-television transmitters of stations W1XAV-W1XAU, of the Short-Wave and Television Corp., Boston, Mass., will look like when they are finished. W1XAV, on 2,870 kc. and 1,000 watts, is transmitting 60-line, 20-image television. W1XAU, on 1604 kc. and 500 watts, broadcasts voice simultaneously with the images. Two other units will be devoted to relay broadcasting on 6,040, 11,800, 15,250 and 21,460 kc.

A Modern Radio Factory



This view shows the double line of shielded test cages in the Pilot factory. There are twelve cages altogether, equipped with the latest testing apparatus.

By R. F. SHEA
Chief Engineer, Pilot Radio & Tube Corporation

IN the past decade we have observed the rapid growth of radio from infancy to one of our great industries. This tremendous expansion has been due to the rapid strides in radio technique and to new fields being opened by science, new applications of old fields and continual improvement in the art.

Fully abreast of scientific achievement in the laboratory has gone scientific adaptation in the manufacturing processes; and today the excellence of our radio products is due equally to improved design and improved manufacture. Certainly without truly scientific manufacturing radio would never have reached its present status as a public commodity, for the secret of its success has been the ability to reproduce consistently excellent merchandise, just as good as can be made in the laboratory.

Let us take a trip through the Pilot plant and see in just what manner science has been applied to make possible the high standard constantly maintained by Pilot Radio Receivers.

PARTS COME FIRST

Just as a chain is no stronger than its weakest link, so is a radio set no better than its poorest component part. Of what avail is excellence in all other parts, if one small item is defective? The most minute detail can make a receiver inoperative; consequently, long before we ever assemble a complete receiver, we must carefully manufacture, check and double-check every part going into that receiver. The most up-to-date equipment must be used, accurate checks kept on this use, and a detailed inspection made of every resultant item manufactured.

As an example, let us consider condenser manufacturing, possibly the heart of the set, if any one detail can be so designated. Figure one illustrates a corner of the condenser winding department of the Pilot plant, showing some of the large impregnating and storage tanks used in the process.

In order that Pilot condensers can be made as nearly perfect as possible, an extremely close contact is kept between the engineering department and this section. Every piece of paper used in manufacture is carefully tested for all the necessary properties for good condenser paper. The impregnating compounds are periodically checked and the cycle itself is recorded on the latest apparatus. Every precaution is observed to make this product good, and after manufacture it is subjected to severe leakage and breakdown checks. Last, but far from least, a daily sample is submitted to the laboratory, where it is placed on an accelerated life test under extremely vigorous operating conditions, to make finally certain that all Pilot condensers will stand up in use, well beyond the normal life of any radio receiver.

THE BAKELITE DEPARTMENT

Another example of up-to-date manufacture in the bakelite department. In line with latest practices Pilot manufactures every component part entering its receivers, this including bakelite in sheet, tube and molded forms. Here the manufacturing checks are mostly chemical, as the ingredients entering the sheet bakelite must be maintained in the proper relationship very closely, and checks must be made on volatile materials and water content. The manufacturing method is most important and Pilot has spared no expense in obtaining what we consider the best bakelite manufacturing department of any radio manufacturer. Figure two shows one of the giant presses, in which the paper is placed and baked under tremendous pressure, coming out as laminated sheet bakelite. Here, as in the case of condenser manufacture, the laboratory keeps a close check on production, taking regular sample lots and subjecting these to a variety of severe tests to insure a uniformly good product.

TRANSFORMER TESTING

An example of the extremes to which the engineering department goes in its desire to uphold Pilot quality is illustrated in figure three, which shows a test board for power transformers. Here any transformer may be connected to a dummy load simulating actual operating conditions and all its operating characteristics determined. After it is checked for correct voltages it is placed on a heat run, and before any transformer is released for production it is known to be satisfactory in all respects. Once in production every transformer manufactured is subjected to a series of exacting tests, and must pass these or else be torn apart.

All these are but illustrations. Similar close checks are maintained on every other item entering a Pilot receiver: coils, variable condensers, fixed condensers, resistances, and myriad other similar items. It should be obvious, therefore, that Pilot maintains the best quality of component parts possible, and spares no expense in so doing, to insure satisfaction to the purchaser of a Pilot Radio.

SET MANUFACTURING

Let us now turn to our set manufacturing department, where all these component parts are assembled into complete receivers, making up the Pilot line. The same care in manufacturing and engineering contact is evident here, possibly even more than in parts manu-

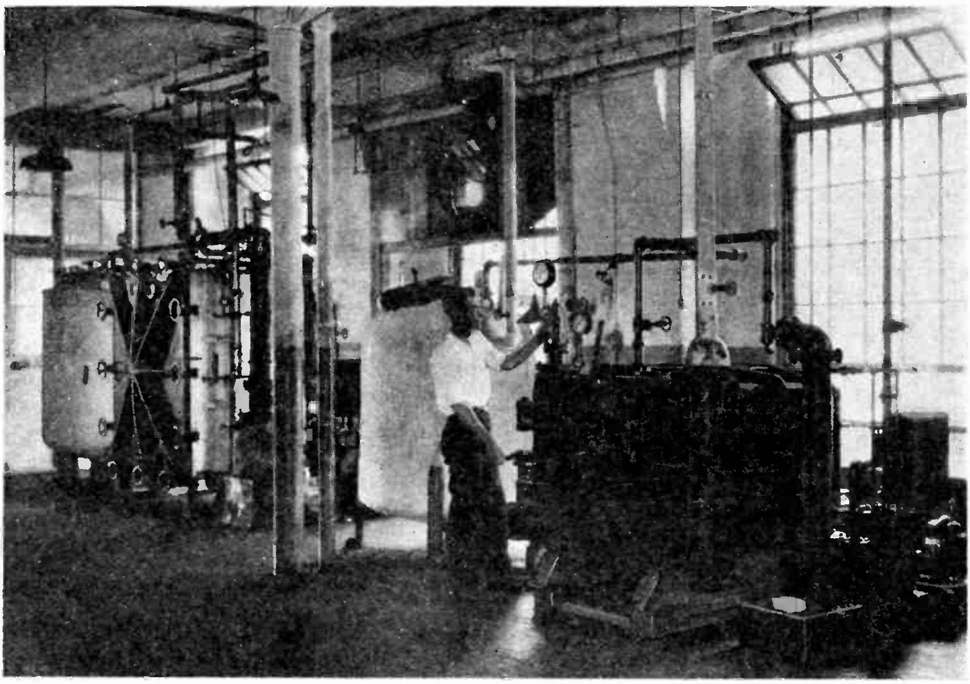
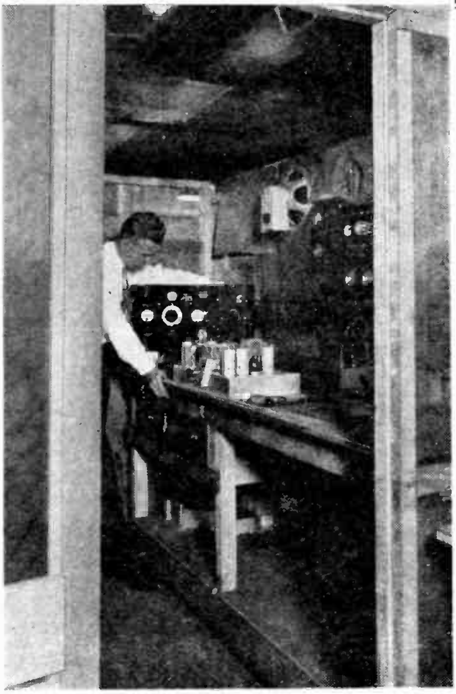
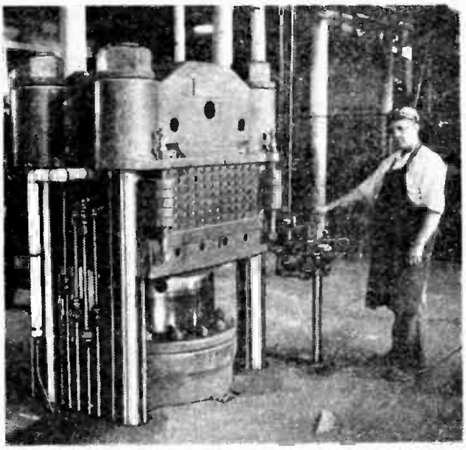


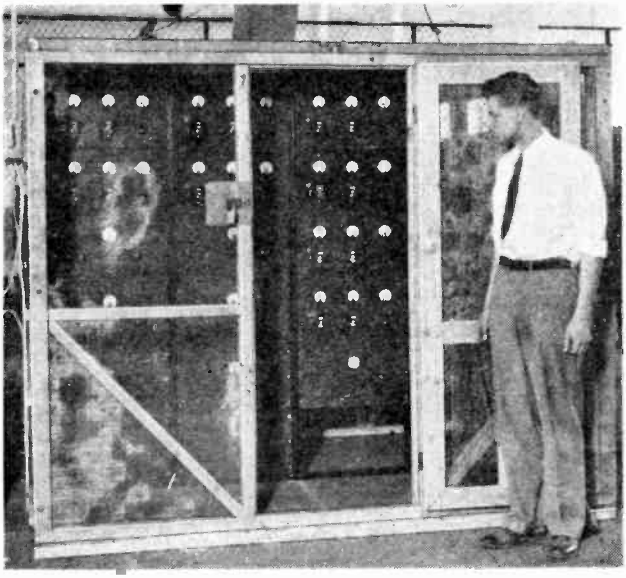
Fig. 1: A section of the condenser department, showing the large storage and impregnating tanks used in the manufacture of fixed condensers of various kinds.



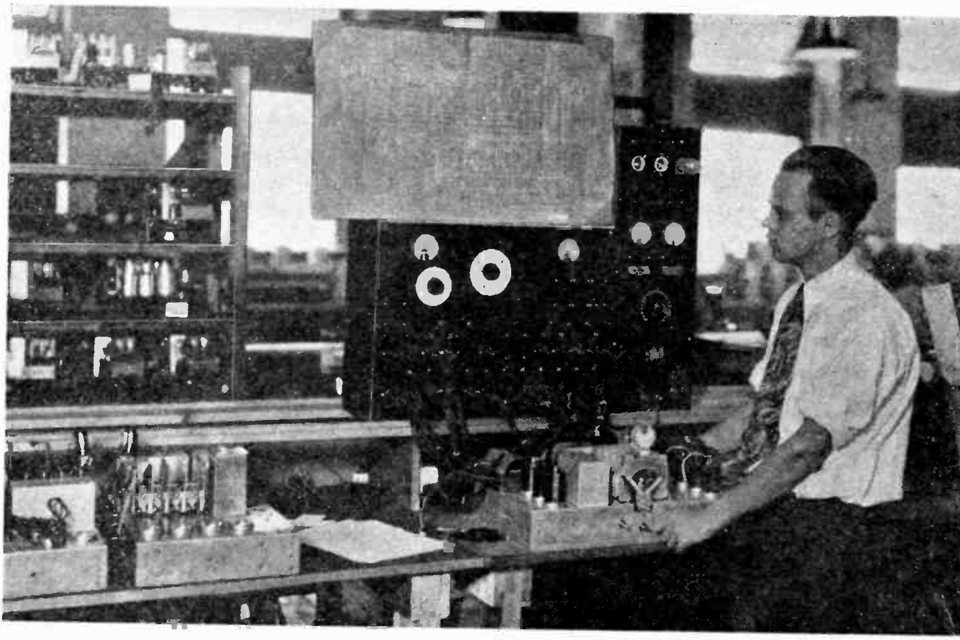
Left, Fig. 6: One of the shielded cages on the set floor of the Pilot plant, where assembled chassis are tested thoroughly with equipment of the very latest design and construction. The apparatus in each of these booths costs more than a thousand dollars.



Right, Fig. 2: One of the giant bakelite presses used for the manufacture of sheet bakelite. Compare this in size with the husky operator, who stands more than six feet tall.

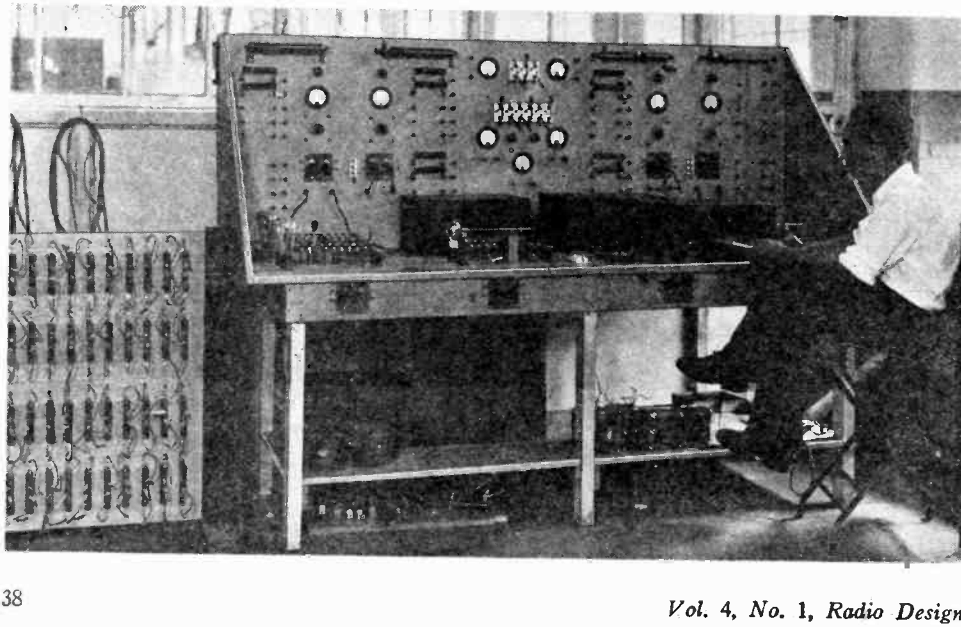


Left, Fig. 5: The signal generating booth, containing half a dozen miniature transmitters, all crystal-controlled. These are connected by shielded cables to the test cages pictured in Fig. 6. This complicated apparatus was designed and constructed by J. L. Montgomery, who is shown in the photograph.



Above, Fig. 4: The ingenious continuity testing board, which indicates the condition of every circuit in a receiver. After a set comes off the assembly line it is passed on to this board before it goes to the shielded test booths. Minor errors in wiring or adjustment are quickly detected, and the necessary repairs made without delay.

Below, Fig. 3: The elaborate transformer testing board, where all kinds of tests are made on the various power units used in kits and sets. The bank of resistors at the left is used to duplicate "loads" such as would be encountered in actual practice.



facture, as all the quality of parts will not avail the least if they are improperly assembled.

To insure this the engineering department has developed and installed the most up-to-date inspection equipment in the industry. From the time a chassis starts down the line until it finds its final resting place in its shipping carton, every Pilot radio is under a continuous system of checks designed to make it impossible for a set to go out which does not conform to our standards of quality.

Figure four illustrates a continuity testing board which indicates to the operator almost instantaneously what details are incorrect in the wiring of the set. This is the first major check on the receiver as, up to this point, the progress has been purely mechanical, the chassis starting at one end of the line and accumulating parts as it travels until it finally reaches the continuity board, a completely wired set, ready for test and adjustment. This completed set is connected to the continuity board by a number of plugs which fit in the tube sockets. By reading the proper meters the operator can check various component parts and the wiring, and in the case of a faulty connection locate it with a minimum of effort.

THE SHIELDED TEST BOOTHS

After passing the continuity test the receiver enters one of a line of shielded booths, some of which are shown in the photograph heading this article. In the first row of booths it is adjusted and tested for "gain" of the intermediate frequency amplifier and the audio amplifier. Next it goes into another booth where the variable condensers are adjusted and the set tested for overall performance. Lastly it is placed in a cabinet and given a final check in a third booth before packing. After passing all these checks there is little chance of anything but a mighty good set getting out.

The equipment used in these tests merits special attention, and represents what we believe to be the most modern system of production set measurement used in any radio plant today. To justify this claim let me go a bit into detail regarding this equipment, and the reader will soon share our enthusiasm in it.

Figure five shows the generating apparatus, all contained in a shielded booth to eliminate undesirable radiation. To further reduce this, large filters are in every line leading from this booth and every booth in the set department to the power supply system, making it impossible to pick up signals in this manner.

This generating apparatus consists of a series of crystal controlled oscillators, set at various frequencies throughout the broadcast band. Some of these are modulated with a constant note of four hundred cycles, while others have phonograph music impressed on them. One has an interrupter arranged to alternately send out music and the steady note. Thus we have a series of small broadcast stations, smaller in power output than regular broadcasters, but as good as any from a quality standpoint. These oscillators are fed to amplifiers, which in turn are fed to a series of shielded lines which carry these psuedo-broadcast signals upstairs to the set department.

SIGNALS UNDER FULL CONTROL

Here, the signals are piped to the various booths, the interior of one being illustrated in figure six. Set into the wall is an attenuator which takes the output from the signal generators downstairs and reduces it to a level comparable with actual broadcast reception. This is now fed to the receivers under test and the output from the receiver is measured on a meter. The input from the attenuator can be changed at will to any of the test frequencies and to any desired intensity and there are very vigorous limits set as to how much signal shall be required to produce a satisfactory output. Any receiver failing to pass this requirement is returned to the repair bench, where it is inspected and the trouble quickly located and repaired.

Pilot maintains one of the biggest and best engineering staffs in the industry, and over two-thirds of this staff is directly or indirectly employed in upholding the standard of Pilot products. No effort has been spared to supply all the latest and best equipment available for radio manufacture and great pains are taken in the proper training of the testing personnel. The result of all this care is directly returnable in the good will of a satisfied Pilot customer.

The Window Lead-in Strip

ONE of the most annoying and least suspected sources of trouble in service work is the flexible lead-in strip usually used under the window to bring the aerial connection inside the house After the window has been opened and slammed shut several times the conductor sometimes breaks inside the fabric covering, and the set then produces only weak signals even though it sounds "live." The trouble is made doubly mysterious if the swaying of the lead-in wire causes the broken ends to make contact intermittently.

Loud Speakers *and* Baffles

An Easily Understood Explanation of How Baffle Boards Help Loud Speakers Reproduce Voice and Music

Part 2

by ALFRED A. GHIRARDI

EDITOR'S NOTE

The first part of this interesting and instructive article on loud speakers and baffles appeared in the Volume 3, Number 3, issue of RADIO DESIGN. *If your files are not complete, you can obtain a copy of this issue by sending fifteen cents in stamps to the Radio Design Publishing Co., Lawrence, Mass.*

FREE-EDGE cone speakers need not have a large cone in order to reproduce the low-frequencies, but they should be attached to large baffles. These are necessary because the front and the back of a cone speaker set up air-waves which would alternately reinforce and neutralize each other, and they seriously affect the volume of the lower frequency notes if it were not for the baffle. The true function of the baffle seems to be a mystery to most people. In some cases their real purpose seems to have been forgotten. Otherwise, baffles the size of pie plates would never be used, as they do not baffle anything except the users.

When the loud speaker is producing sound, the cone is in vibration; that is, first it moves forward in the direction shown by arrow "A," Fig. 1, and the next instant it moves in the direction of arrow "B." The cone is shown attached to a dynamic speaker driving-unit for simplicity. If the audio current flowing through the voice coil has a frequency of, say, 100 cycles, then the cone moves in the direction "A" 100 times every second, and in the direction "B" 100 times every second. Each time it moves in direction "A" it compresses the air in front of it. At the same time the air in back of it is rarefied or decompressed, since the cone, on moving forward, has left more space behind for the air to fill. These differences in air pressure (more pressure in front and less pressure in the rear) immediately tend to equalize each other and the extra air in front immediately tends to move around the edge of the cone to the rear, where there is not sufficient air.

HOW SOUNDS ARE MADE

Now, we know that sounds are caused by movements of air, due to tiny air pressures, and rarefactions. If these pressures are allowed to neutralize each other, there will be no movement of air directly from the front or the back of the speaker toward "C" or "D," and hence no sound will be produced. Consequently, something must be done to prevent the tiny compressions of air from getting from the front to the back of the cone in time to equalize the pressure at the back (or vice versa).

This is accomplished by placing a baffle around the cone, taking either of the forms shown in Fig. 2. The air must now take the long path L around the baffle in order to get from one side of the cone to the other. By making this path long enough, the air cannot get from the front to the back of the cone (or vice versa) in time to equalize the air pressure, as will now be explained.

It must be remembered that the current flowing through the voice coil is alternating current (in the case of a speaker coil connected directly in the plate circuit of an output tube without a coupling transformer, the current is a pulsating direct current, but the same reasoning also applies to this case). This alternating current may be represented by the familiar form shown in part B of Fig. 1, although the wave form of actual voice currents is much more complicated than this. Since the cone follows the variations in the current, the air pressure variations will follow the same curve. In terms of air pressure in front of the cone, we can decide that from 1 to 2 the pressure is increasing above the normal value. From 2 to 3 it is gradually decreasing to normal. From 3 to 4 it is decreasing below normal. And from 4 to 5 it is gradually increasing to normal.

CHANGES IN AIR PRESSURE

The air pressure in front of the cone, therefore, goes through four distinct changes during one complete cycle (one forward and backward movement of the cone). If the current has a frequency of, 100 cycles, there would be four times 100, or 400, changes in pressure per second. Sound waves travel about 1,100 feet per second. Therefore, in the case of a 100-cycle note, during any one change in pressure (each of which takes place in one 400th of a second), the sound pressure wave will travel 1,100 divided by 400 or 2.75 feet. Keep that in mind for a moment. Now, if we allow the pressure wave from the front to go around directly to the back of the cone it will neutralize the rarefaction wave there. But if we make this pressure wave travel around a distance at least equal to 2.75 feet it will take it at least one 400th of a second to get to the back of the cone. But we calculated that this is the time required for one change in pressure. Therefore, by the time the pressure wave from the front gets to the back, the cone has changed its direction of motion and the back is now producing a pressure wave, so that the two waves do not neutralize each other but actually reinforce each other.

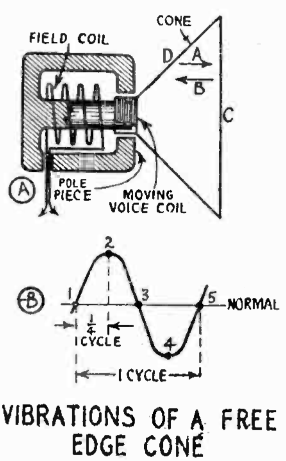


Figure 1

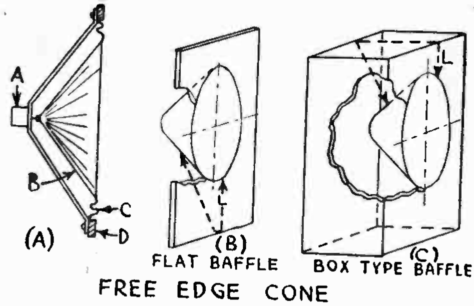


Figure 2

It is evident then that the purpose of the baffle is simply to *delay* the meeting of the front and back sound waves by artificially increasing the distance from the front to the back of the cone. It is evident that to fully reproduce any note the shortest length of the path from the front to the back of the cone (distance L in Fig. 2, B and C) must be made at least equal to the distance the sound travels during the time it takes to complete one-quarter of a cycle of that note or during the time it takes the cone to move from the center position to the extreme position in either direction. The distance the sound travels during one complete cycle is defined as the wavelength of the sound and is equal to the velocity of sound, 1,084 feet per second, divided by the frequency in cycles per second. Therefore, the length a baffle should be, to permit full reproduction of any frequency, can be easily calculated by the simple rule that the baffle length in feet is equal to one-quarter the wavelength of the note to be reproduced. That is:

FIGURING BAFFLE LENGTH

Baffle length =

$$\frac{1}{4}\text{ W. L.} = \frac{1}{4} \times \frac{1{,}084}{\text{Frequency}} = \frac{271}{\text{Frequency}}$$

A baffle to permit full reproduction of tones as low as 30 cycles must be at least

$$\frac{271}{30} = 9.03 \text{ feet}$$

in effective length (L).

Referring to Fig. 4, on page 47 of the Vol. 1, No. 3, issue of RADIO DESIGN, the frequency range of the various instruments may be seen, and the lowest note which any instrument can produce may be ascertained. To reproduce the lower notes with a free-edge type of cone speaker, a baffle must be used. The graph of Fig. 11 shows the minimum size of baffle required for complete reproduction of the various frequencies. These values were calculated by the above formula. The baffle size is given in inches, for convenience. This is obtained by multiplying the values obtained by the above formula by 12. At the top of Fig. 11, the lowest frequencies of the various musical instruments are noted. This chart can be used to determine the size of baffle required for full reproduction of the lowest note of any musical instrument.

A study of the chart on page 63 of the last issue of RADIO DESIGN shows that the required length of the baffle air path decreases as the frequency goes up. At 2,000 cycles, for example, the air path need be only 1.63 inches. Since the distance from the front to a point near the center of the back of an ordinary ten-inch diameter cone is about five inches, it follows that the cone itself is an effective baffle at the high frequencies. Therefore, the baffle is only important at the low frequencies and its size is determined by the *lowest* frequency to be reproduced.

It is difficult to define exactly what the baffle length is, since, strictly speaking, all parts of the cone are helping to produce sound.

Note: The Fig. 11 referred to above appears on page 63, Vol. 3, No. 4, of RADIO DESIGN.

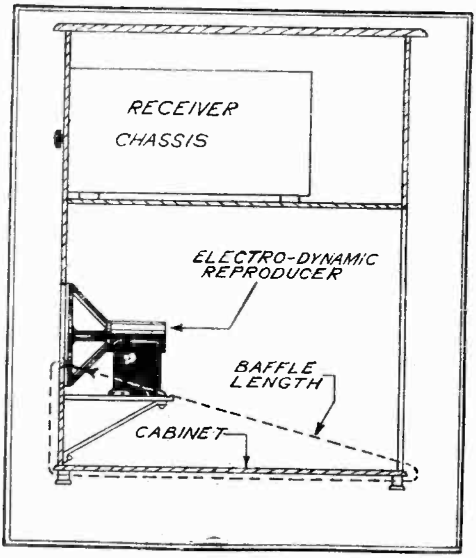


Fig. 3: How the front and sides of a cabinet act as baffle for the loud speaker.

Some authorities define the baffle length as the distance from a point in the center of the front of the cone to a point in the center of the rear. This length would be slightly longer than that taken throughout this discussion. However, as the baffle lengths are usually worked out for low frequencies, and these lengths work out in some cases to 36 inches or more, a difference of an inch or two in considering the baffle length does not make much difference in the practical results.

FORMS OF BAFFLES

As it makes no difference how the length of air path for the baffle is obtained, baffles take many forms in actual practice. Flat baffles are probably the best types theoretically, as they are not troubled by resonance effects, but their large size and ungainly appearance hardly make them suitable for use in homes. Fig. 2B shows a straight square baffle in position on a cone.

Fig. 2C shows a box-shaped baffle which is more compact. This type is used extensively in homes because of its compactness and better appearance. The box-type baffle is made up into artistic-looking cabinets which blend with the rest of the furniture in a room. The back of the box or cabinet type baffle should be left open to allow free circulation of the air. If it is closed up or restricted, resonance effects will be set up in the cabinet, resulting in better reproduction of some frequencies than others, and also resulting in "barrel tone." Often the response of a cabinet type speaker can be improved by lining it with some non-resonant material such as thick felt, Celotex, etc.

Where receiver and speaker are both mounted in a cabinet together, the front and sides of the cabinet may be made to act as a baffle, as shown in Fig. 3. No additional baffleboard is then required.

When a dynamic unit is operated in the same cabinet with the radio receiver, the entire system may break into continual oscillation due to the mechanical vibrations being set up in the elements of the detector tube by the sound vibrations. The remedy for this is to wrap the detector tube in thick felt, or to weigh it down with a heavy metal cap to dampen the vibrations. Felt washers between the socket and the tube base are also helpful.

Sometimes, horn type baffles are used on dynamic speakers. They are specially useful in public-address work, since the horn baffle makes the speaker directional. It is claimed that a horn baffle is equivalent to a straight baffle of approximately double the size. As a horn, it loads the cone with an air column and therefore tends to reduce "blasting" effects.

NOT SOUNDING BOARDS!

It must be evident from the foregoing discussion that baffles do not act as "sounding boards," as many people think. They are not supposed to vibrate or emit sound waves themselves at all, although sometimes baffle resonance effects are designed to accentuate the response of some frequencies in which the speaker itself is deficient. Baffleboards should be very rigid and are usually made of wood. Baffleboards made of Celotex, one inch thick, are also very good, as this is a non-resonant material. For very low frequency reproduction the wall or ceiling of a room may be used as a baffle by cutting a circular hole in it large enough for the cone to fit through, but usually the volume of sound is reduced by this as the sound waves from the rear of the speaker are not heard at the front.

If a baffle is made smaller than the size required to reproduce that frequency, it does not mean that this frequency will be completely suppressed—it simply means that notes of this frequency will be partially suppressed, the extent of this suppression being determined by how much smaller the baffle is than the correct size. If notes below the actual "cutoff" frequency of the baffle are impressed on the loud speaker, the resulting tone is made up mostly of the higher harmonics of these notes. Thus, while a baffle may not be large enough to permit of reproduction of a 60 cycle note, it may be large enough to permit of reproduction of the second harmonic frequency of 120 cycles. Thus, this note would be partially reproduced, but, of course, not in its true tone. This accounts for the partial low note reproduction effect produced by speakers having small baffles. Of course, it is assumed that the receiving set passes on the low frequency notes to the speaker motor, and that the motor is capable of operating the cone at these frequencies. It would be foolish to design a 55-inch baffle to permit reproduction of 60 cycle notes, for instance, if the set and speaker combination were unable to reproduce frequencies below 200 cycles. In this case a 16.5 inch baffle would suffice, and the reproduction with it would be just as good on this particular set and speaker as with the 55 inch baffle.

With ordinary receiving equipment, it is not necessary to use baffles larger than about 48 inches, since these give a cut-off frequency of about 70 cycles.

LOUD SPEAKER PERFORMANCE

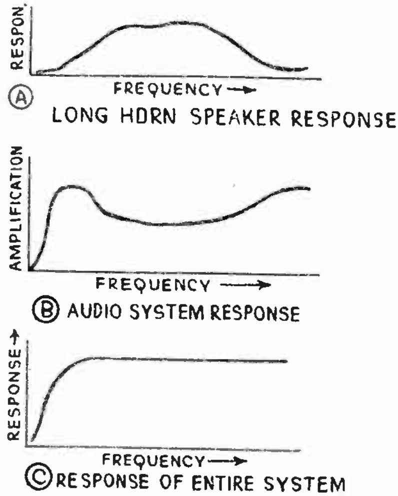
Theoretically, some types of loud speakers are inherently better than others, but they may not be so in practice due to incorrect design. Due to poor design a dynamic speaker may be much inferior to an average magnetic cone or horn speaker, or vice versa. It is safe to say that the exponential horn, the fixed or free-edge cones and the dynamic cone speakers will all give excellent results if designed and constructed correctly and used intelligently with a consideration of the characteristics of the audio amplifier employed and the results desired.

The desirable characteristics of the loud speaker depend on the audio amplifier with which it is used (assuming no sidebands are cut in the R.F. amplifier). If the A.F. amplifier approaches the ideal type, i.e., amplifies all frequencies from about 32 to 8,000 cycles equally, then the ideal speaker for use with this amplifier should reproduce all frequencies from 32 to 8,000 cycles equally well, in order to preserve perfect quality. The problem in A.F. amplification and sound reproduction is the equal reproduction of all frequencies for a definite voltage input; in other words, uniform sound output from the loud speaker. While it is possible to construct an A.F. amplifier which has a practically flat characteristic curve from 32 to 8,000 cycles per second, the loud speakers available at the present time have definite frequency limitations. There is no commercial speaker made, which, to the writer's knowledge, has a flat frequency characteristic over this range. Most speakers fall off in response at the very low and at the very high frequencies, but this can be partly compensated by proper design of the audio amplifier.

COMBINING CHARACTERISTICS

If definite knowledge regarding the frequency-response of a certain loud speaker is at hand, the audio-frequency amplifier for use with it can be designed to supplement the loud speaker at its weak points; that is, on certain frequencies where the loud speaker is deficient, the amplifier can be designed to increase the response, and conversely where the loud speaker response is more than normal, the amplifier should be arranged to reduce the response. As an example of this, Fig. 4A shows the middle frequencies normal and the high frequencies weak. Obviously, the amplifier should be designed to have the response shown in Fig. 4B, with low and high frequency-response exaggerated and relatively lower output in the middle register. The approximate resultant response-curve of the speaker and horn combined is shown in Fig. 4C. Notice that the deficiencies of the speaker have been nearly corrected by proper design of the A.F. amplifier. Obviously, this amplifier would only give these good results when used with this particular speaker. If another speaker were used the resulting response would be totally different.

Transformer coupling lends itself nicely to this sort of work, since the amplification characteristics of the transformer can be modified easily. Also certain frequencies can be suppressed by band filters, or strengthened by resonant circuits. This practice of making up for the deficiencies of one electrical circuit by over-exaggerating the corresponding characteristics in another circuit in a system is used extensively in telephone work.



MATCHING THE SPEAKER WITH R.F. AND A.F. AMPLIFIERS

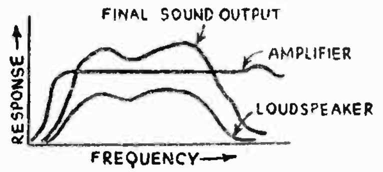
Above: Figure 4

Right: Figure 5

It is evident from a study of the curves of Fig. 4 that any type of loud speaker will not operate equally well with any audio amplifier. This is the reason why a certain loud speaker appears to work very well with a certain set and gives only average results when connected to a different receiver. As a matter of fact, an audio amplifier having ideal straight line frequency response intensifies the poor frequency response of a loud speaker of average worth, as shown in Fig. 5, and really makes it sound worse than it might when used with a less perfect amplifier whose frequency characteristics just happen to fit in with it.

These points should be kept clearly in mind when deciding whether or not to use a dynamic speaker with a particular set. The use of a dynamic speaker of itself will not cure any ills which the set or tubes may have. Admitting that the set is designed for use with a dynamic speaker, it will work with one, in the sense that the tone will be more nearly what the designer expected; but otherwise, a particular set may sound indefinitely better with a magnetic type of speaker than with a dynamic type. Some sets are not capable of working a dynamic speaker at all satisfactory due to insufficient output, while other sets will overload an ordinary magnetic cone type speaker completely. Therefore, the choice of the type of speaker depends largely on the set employed.

One of the main advantages of the dynamic speaker is that it is capable of handling (without rattling) more output from the set. It will not give more output to the set, but it will handle it with less distortion if the set produces sufficient power or output. For instance, we often receive letters about the use of a dynamic speaker with the Super-Wasp receiver. If the Super-Wasp is operated in a location where the volume obtained from most stations is just about of average intensity, then a good magnetic cone speaker will give just as good results as a dynamic speaker. However, if the Super-Wasp is operated in a very good location, or with a booster unit, and the volume obtained is so great that the ordinary cone speaker rattles on



HOW STRAIGHT LINE AMPLIFIER INTENSIFIES LOUDSPEAKER CHARACTERISTICS

the loud or low frequency notes, then, obviously, a dynamic speaker would give better results insofar as output handling ability is concerned.

It must be kept in mind, however, that the difference in hearing facilities of different persons makes it impossible to produce one sound-reproducing system which is absolutely satisfactory to every person. Compromises must be effected. Some persons are pleased with reproduction where all of the low notes are reproduced. Others are pleased with reproduction which includes only part of the low note range, etc.

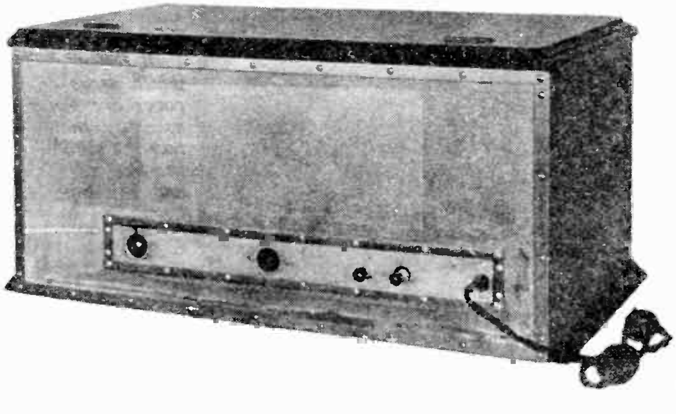
King of Siam Buys a Pilot "All-Wave" Receiver

His Majesty King Prajadhipok of Siam

AN unusual honor was conferred recently on the makers of the well-known Pilot "All-Wave" receiver when King Prajadhipok of Siam ordered one of these sets for his personal use after witnessing a two-hour demonstration staged at his special request. This event took place on Sunday, July 26, 1931, only two days before the King and his party left the United States after a four months' visit. The demonstration was held at Ophir Hall, Purchase, N. Y., where the King made his temporary residence. It was staged by the editor of RADIO DESIGN, who made the trip from Lawrence, Mass., to White Plains, N. Y., for the purpose.

AN ARDENT FAN

It seems that His Majesty is an ardent radio fan and has experimented with many radio receivers of both European and American manufacture. Just before he appeared for the demonstration, his secretary revealed the fact that the King has done considerable listening on both the short and long waves in his famous palace in Bangkok and is familiar with most of the short-wave stations on the air. He found radio a most interesting diversion when his eyesight was impaired, and he developed into a real fan. The operation on his eyes was highly successful, but His Majesty has not lost his interest in radio.



Back view of the "All-Wave" receiver purchased by the King of Siam. This is a stock instrument except for the special nickel-plate mesh back.

KNOWS RADIO

Judging from the King's numerous questions and remarks, he has considerable knowledge of the technical side of the science. Like all true radio fans, he dropped all formalities during the demonstration and personally examined and operated the "All-Wave" set for half an hour. When he heard a slight whistle from the loud speaker he said, "Ah, that sounds familiar." He showed great interest in the cam switches and asked for an explanation of the mechanism.

His Majesty was greatly impressed by the set's ease of operation and the absence of plug-in coils, with which he has had some experience. After satisfying himself that the "All-Wave" was just the set he wanted, he ordered one and specified certain special changes to meet reception conditions in Siam. His Majesty is particularly interested in picking up the American short-wave stations and bought the Pilot receiver because of the company's reputation in the short-wave field.

Gets London and Rome

I like the Universal Super-Wasp very much and have had quite a number of distant stations. Have listened to London and Rome every afternoon (when on the air) for two weeks.

CARL WAGNER,
2709 Market St.,
Youngstown, Ohio.

The Short-Wave Set That Brings 'Em In!

I am the proud owner of one of your new Universal Super-Wasps, serial No. 30516. I have had this set only one week, but in this short time I have picked up the following stations with tremendous volume:

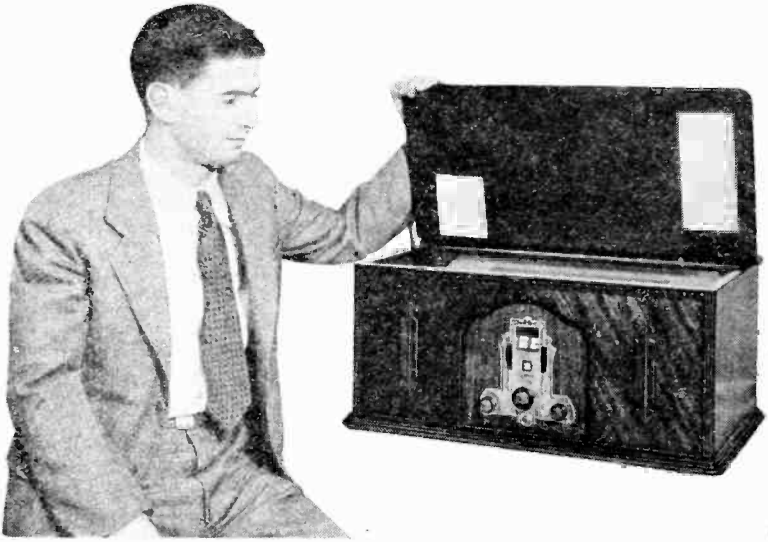
I2RO—Rome	25.40 M
W8XK—Pittsburgh	25.25 M
G5SW—England	25.53 M
W2XAF—U. S. A.	31.48 M
XDA—Mexico	25.61 M
PCJ—Holland	31.26 M
W1XAZ—U. S. A.	31.35 M
Germany	31.46 M
Paris	25.65 M

And plenty more on the other wavelengths. These stations come in so loud that I put the speaker on the window and the music can be heard for blocks up and down the street. I always have a good crowd of listeners, who delight in hearing Big Ben strike at midnight in London.

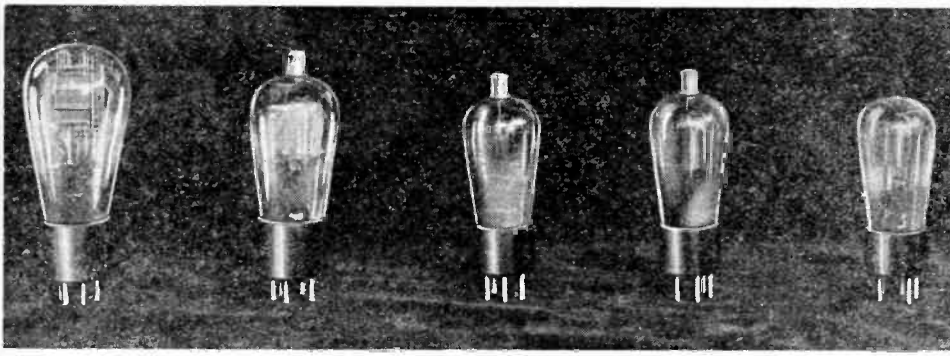
I had a very good opinion of the Super-Wasp I had before I got my new machine, but it was only a crystal set compared to the Universal.

I am more than satisfied with the machine in all respects and cannot praise it too highly and I believe I have created interest in at least three more sales for your machines.

Yours very truly,
W. E. LOCKHART,
11 Church St.,
Moncton, N. B.
Canada.



His Majesty's personal short-wave receiver, a Pilot "All-Wave". The white areas on the cover are pieces of asbestos that protect the wood from the heat of the 280 and 245 tubes.



Left to right: the 247 power pentode, the 551 variable-mu, the 237 screen-grid, the 238 power pentode, and the 236 general purpose tube.

New A.C. and Battery Tubes Make Better Receivers Possible

Power Pentode, Variable-Mu and Rugged "Automobile" Types Are Latest Laboratory Developments

By A. S. FRIEDMAN

THE 1931 season has witnessed several innovations in the radio tube industry. New designs and types of tubes have made their appearance to meet the exigencies of the times.

With the growing popularity of the midget type of receiver radio engineers were faced with the necessity of maintaining sensitivity, selectivity and fidelity in a total space of about one-third of the usual allotment and at a cost of less than one-third of what a full-sized set would bring. The development of the pentode tube did much toward solving the engineers' problem. The characteristics of the tube are such that it may alone perform the work formerly done by three tubes. This naturally helped greatly in the conservation of space, as well as eliminating the additional cost of sockets, transformers and associated apparatus formerly used by the other tubes.

FEATURES OF THE PENTODE

The amplifying qualities of the tube are such that it is unnecessary to use an audio stage preceding it and the undistorted power output of the tube is very nearly equal to that obtained by two 245 tubes used in push-pull. Its sensitivity also is about four times that of the 245 tubes.

The constructional details of the tube can be seen in Figure 1, which shows an exploded view of the elements. In place of the ordinary three elements present in the accepted types of tubes, the pentode, as its name implies, contains five elements. Two additional grids are used, one as a screen grid and the other as a neutralizing or suppressor grid. In the circuit arrangement of the pentode, the screen grid is maintained at a potential equal to that of the plate of the tube and serves largely to neutralize the effects of the space charge field. The suppressor grid is electrically connected to the center of the cathode or filament and is therefore maintained at the filament or cathode potential. Its function is to eliminate the secondary emission which limits the output of the tetrode type tube. As in its predecessor, the output tube type 245, the pentode tube contains a rigid carbonized or sand-blasted plate for the greater dissipation of heat.

The pentode also differs from the triode (three-element tube) in its output characteristics. In general, the maximum undistorted power of the triode is produced when the load impedance is twice the internal impedance of the tube. However, an entirely different condition exists in the pentode. For maximum undistorted power it is necessary that the load impedance be approximately one-fourth that of the tube impedance.

HIGH VACUUM NECESSARY

An item of interest that appeared in the manufacture of this tube was that in view of its greater undistorted power output it was necessary to attain a higher degree of vacuum than formerly. The high potentials at which this tube operates made it easier to ionize any residual gas which might be present in the tube and more elaborate methods of evacuating the bulb, as well as the insertion of new types of "getter" materials, all helped to solve this problem. Commercially, the pentode tube is known as the type 247, and can be used only in circuits designed to give large audio outputs with relatively small input voltages.

THE VARIABLE-MU TUBE

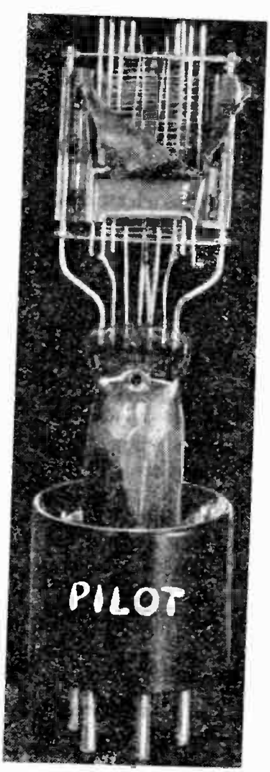
Another tube made its appearance this season to help solve some of the problems facing the radio engineer in the design of a radio receiver whose characteristics would equal that of a full-sized set. It was the multi- or variable-mu tube, known commercially both as the 235 and 551. This tube was an outgrowth or development of the screen grid type 224 and possesses certain advantages not incorporated in the latter type. Briefly, its chief advantage lies in its ability to reduce cross modulation and modulation distortion.

As its name indicates, this tube is capable of having its mutual conductance vary directly as the input voltage, and its construction is such as to allow for a greater grid voltage swing than has hitherto been possible with screen grid tubes. The engineer was faced with a problem of reshaping the plate current —grid voltage curve over the portion of low mutual conductance while retaining the original characteristics at normal operating voltages. It was necessary, therefore, to secure a tube of such a structure as to allow the amplification to vary directly with the cathode area. There are various means of attaining this result. One scheme was to taper the grid with respect to the cathode and inversely to use a tapered cathode with a uniform grid. From a manufacturing standpoint this construction introduced complications which were costly to eliminate. Other schemes of using cathodes specially placed with respect to the grid, or using stepped diameter grids, were rejected because of manufacturing difficulties, although all performed with some degree of satisfaction. The scheme generally used now which provided certain characteristics and entails the minimum manufacturing difficulty is that of varying the pitch of the grid in such a manner as to secure the Hyperbolic relationship desired as indicated in Figure 2.

The variable-mu tube, in addition to its advantages in reducing modulation distortion, has the added advantage of making unnecessary local distance switches and makes possible the use of automatic volume control.

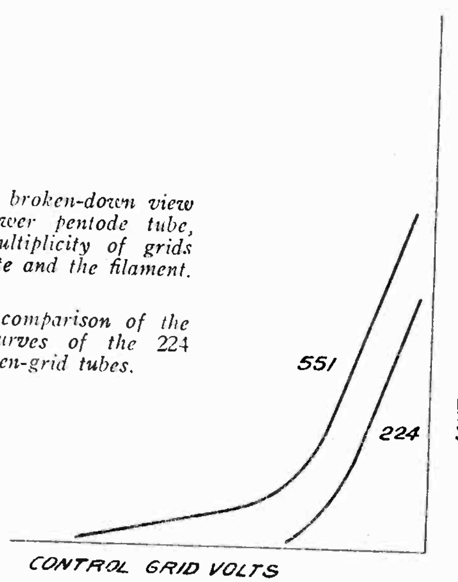
BATTERY TYPE TUBES

This season has also witnessed the advent of a new series of tubes whose compactness and ruggedness is specially desirable in portable, as well as automobile, sets, which are



Left, Fig. 1: a broken-down view of the 247 power pentode tube, showing the multiplicity of grids between the plate and the filament.

Right, Fig. 2: comparison of the characteristic curves of the 224 and the 551 screen-grid tubes.



Characteristics of New Tubes

Pilot Type Number	P-247	P-236		P-237		P-238	P-551
Filament Voltage	2.5 A.C.	6.3 D.C.		6.3 D.C.		6.3 D.C.	2.5 A.C.
Filament Current in Amperes	1.5 A.C.	.3 D.C.		.3 D.C.		.3 D.c.	1.75 A.C.
Electron Emitter	oxide coated filament, burns cherry red	Heated cathode		Heated cathode		Heated cathode	Heated cathode
Plate Voltage	250; screen voltage, 250	90-135; screen voltage, 55-75		90	135	135; screen voltage, 135	180; screen voltage 75
Corresponding Negative Grid Bias	16.5	—1.5	—1.5	—6	—9	—13.5	—1.5
Corresponding Plate Current in milliamperes	32; screen, 7.5 mla.	1.8	3.5	2.7	4.5	8	5.5
Corresponding Plate Resistance, in ohms	38,000	200,000	300,000	11,500	10,000	110,000	250,000
Corresponding Mutual Conductance, in micromhos	2,500	850	1100	780	900	900	1100
Amplification Factor	95	170	275	9	9	100	275
Overall Height	5 5/32"	4 11/16"		4 1/4"		4 3/4"	4 11/16"
Overall Diameter	2 1/8"	1 9/16"		1 9/16"		1 9/16"	1 13/16"
Base	Five-prong	Five-prong		Five-prong		Five-prong	Five-prong
Applications	Power output pentode capable of delivering 2.5 watts maximum undistorted power	First list of voltage values best for auto sets; second list for 110 volt D.C. operation		First list of voltage values best for auto sets; second list for 110 volt D.C. operation		Power output pentode capable of delivering 375 milliwatts maximum undistorted power	Variable-mu screen-grid amplifier. For R. F. and I. F. stages

subject to severe shocks and jars. These tubes were designed for either battery or D. C. operation, and their characteristics and design are such as to insure trouble-free service with good life. This series includes a screen grid amplifier and detector, known as the 236, a general purpose tube 237, and a power output pentode known as the 238.

The screen grid amplifier 236 is a midget model of the type 224 into which is incorporated a cathode of new design. The heating element used in all three types of tubes in this series is a helical coil whose operating temperature covers a range corresponding to the fully-charged and discharged conditions of the average automobile storage battery.

The type 237 general purpose tube is a small edition of its brother, the 227. It is a three-element cathode type tube and is used either as a detector or amplifier. The 238, which is an output pentode amplifier, is a five-element tube which corresponds on a lesser scale to the output pentode 247. It is capable of delivering 375 milliwatts of undistorted power and is usually found in conjunction with a 236 and 237 in the latest portable and D. C. receivers.

Adding R.F. Amplification to the Straight Regenerator

Untuned Stage Can Be Installed with Little Trouble and Improves Operation of Circuit Noticeably

A FREQUENTLY recurring question in the Radio Design mail concerns the addition of radio-frequency amplification to old style short-wave receivers of the straight regenerative type. As a stage of untuned or tuned screen-grid R.F. increases sensitivity, smooths out the regeneration, and eliminates "dead spots" due to antenna absorption, such addition is usually well worth while. It can be made at little expense or trouble, and often without disturbing the existing layout.

FOR BATTERY CIRCUITS

Figure 1 shows how an untuned screen-grid stage is added to a battery operated set. Tube T1, which may be either a 222 or a 232, is coupled to the antenna circuit by the R.F. choke across its grid and filament. Its plate runs directly into the grid or input circuit of the detector, and receives plate voltage through the grid or secondary winding of the present plug-in coil. As this high voltage must be prevented from short-circuiting itself back through the filament, a blocking condenser C3 is inserted in the tuning circuit. This must be a good mica condenser of about .01 mf. capacity. Its impedance to the radio-frequency currents in the tuning circuit is so slight that for all practical purposes it doesn't exist as far as the R.F. juice is concerned.

To keep the plate voltage of T1 off the grid of T2, the present grid condenser is left where it is, but the grid leak is removed from its usual connection across the condenser and swung across the grid and filament of the tube itself.

By-pass condensers of .01 mf. capacity are desirable across the R.F. "C" battery and between the screen of T1 and the filament. These condensers, as well as C3, are not critical in size. Anything between .01 and 1.0 mf. may be used *as long as they are of the non-inductive type.*

The various "B" and "C" voltages will depend on the particular tubes used. If T1 is of the 222 type, the "C" should be 1½ volts, "B" plus screen 45 volts, and "B" plus plate 135 volts. For a 232 type tube, use three volts "C," 67 volts screen, and 135 volts plate. The "C" battery may consist merely of one or two small flashlight cells, which cost only ten cents each.

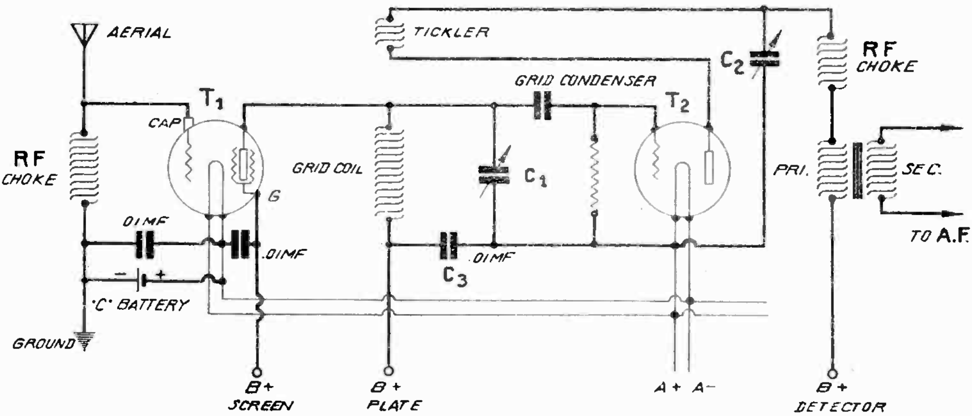


Fig. 1: How a stage of untuned radio-frequency amplification is added to the familiar straight regenerative tuner. The connections are shown only up to the detector, as the audio system remains unchanged.

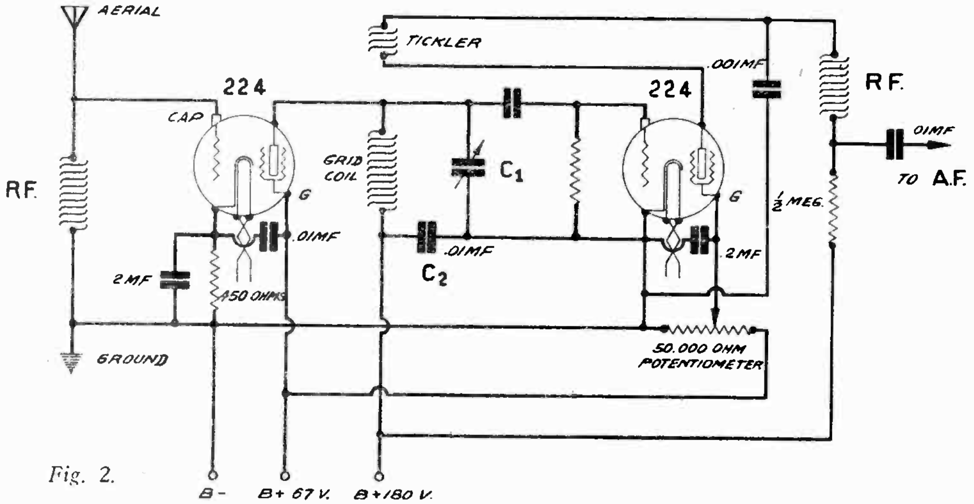


Fig. 2.

A. C. OPERATION

Circuits of the A.C. type are easily revamped in a similar fashion, as shown in Figure 2. The same protective measures must be taken in the detector tuning circuit. The R.F. portion is a little different in that the grid bias for the 224 tube is obtained from a 450-ohm resistance connected in the cathode lead. As before, the fixed condenser capacities are not critical, but the condensers *must* be non-inductive. If rolled condensers of the old-fashioned variety are used the set will probably hum very badly, if it works at all.

The heater connections are not shown in Figure 2. The filaments are simply connected in parallel and run to the 2½-volt taps on the power pack, with center-tapped resistances and by-pass condensers added as on the K-115 model A. C. Super-Wasp. This "dope" is contained in the No. 115 data sheet, copies of which are free for the asking.

The detector shown in Figure 2 is of the screen-grid type. Regeneration is controlled by a 50,000 ohm potentiometer connected in the screen circuit. A fixed screen voltage of about 50 or 55 volts may be employed with a variable condenser from the tickler to "B" minus. Both methods are good.

PLACING THE PARTS

The R. F. tube and its associated parts can usually be placed somewhere in the old set without requiring a rearrangement of the layout. It is not necessary to shield the screen-grid tube. The R. F. choke can simply be hung in mid-air by its own connecting wires.

The antenna choke. by the way, should be a good one. Most broadcast chokes have too much distributed capacity, but can be made to work nicely if about one-third of the wire on them is pulled off.

TUNED R. F.

Some people have inquired about adding a *tuned* R. F. stage to their sets. This is not practical unless you are prepared to rebuild the whole outfit, as most straight regenerators are altogether too small for the additional parts and shielding. The hook-up, as shown in Figure 3, is simple enough. Antenna coil L is a plug-in coil having approximately the same number of turns as the grid winding of the detector coil for any particular wave range, while condenser C is a duplicate of the detector tuning condenser.

To prevent coupling and inter-stage feedback, the entire R. F. stage, including coil, condensers and tube, should be enclosed in a shield can. Similar shielding of the detector stage is desirable but not necessary.

A tuned R. F. stage gives more amplification than an untuned stage, but at the price of more apparatus and labor.

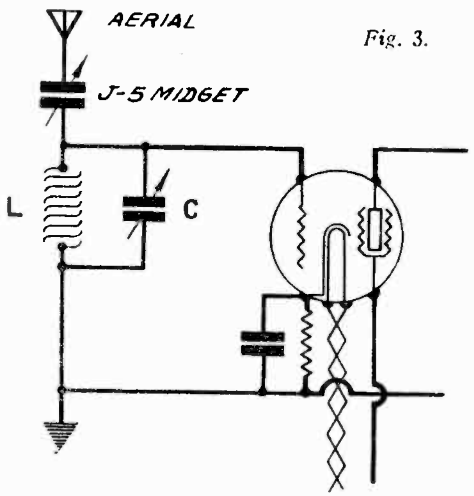


Fig. 3.

SCREEN-GRID DETECTION IN THE SUPER-WASPS

Question: "In the last issue of RADIO DESIGN you published a diagram of a screen-grid detector in the A. C. Super-Wasp. Will you please show a similar diagram for the battery model?"

Answer: A diagram showing the use of a 222 screen-grid detector in the battery model Super-Wasp is printed on the next page. Note carefully that the grid condenser and leak connections are made to the cap on the top of the tube. The present "G" post of the detector socket becomes the screen connection. Also note that the first audio stage is now impedance coupled, the secondary of the first No. 391 A. F. transformer being used as a choke. The .01 mf. grid condenser and the half-megohm grid leak may be supported in mid-air by their connection wires.

Both the A. C. and the battery models of the Super-Wasp are improved considerably by the installation of screen-grid detectors. The change is a very simple one and is highly recommended. The A. C. diagram appeared on page 57 of Volume 3 Number 4 of RADIO DESIGN.

201A's ON A. C.

Question: "Please show how a K-111 power pack can be wired to a six-tube battery set using five 201A's and one 171A."

Answer: We'd like to oblige, but we're afraid it can't be done. Battery tubes of the 201A type will not work with raw alternating current on their filaments. A receiver using them cannot be "electrified" by the mere use of a separate power pack, but must be rewired to take A. C. tubes, preferably of the 227 type. The 171A, however, will work on A. C. as supplied by the five-volt filament winding on the K-111; it needs only a 50-ohm center-tapped resistance.

PLATE VOLTAGE ON THE 245

Question: "The plate voltage for the 245 tube is supposed to be 250, according to published charts of tube characteristics. Why is it that practically all diagrams show a 300-volt tap or binding post for the last audio stage?"

Answer: The correct plate voltage for the 245 is 250 volts, and the grid bias about 50 volts. As this bias is invariably obtained by the voltage drop across a fixed resistance in the plate circuit, the applied plate voltage must be the sum of 250 and 50, or 300. The effective voltage on the plate of the tube is still only 250 volts.

COMMON AERIAL FOR TWO SETS

Question: "I want to use a short-wave receiver, but cannot put up a separate aerial for it. Is it possible to use the aerial of the regular broadcast receiver without interfering with the latter?"

Answer: Yes. A great many short-wave fans simply run another lead from the aerial post of the broadcast receiver to the aerial post of the short-wave outfit, and find that there is no interference between the two sets. Sometimes, when a direct connection of this kind decreases the volume of the broadcast receiver somewhat, a satisfactory arrangement is to wrap about fifteen or eighteen inches of the short-wave aerial wire around the lead-in without making a direct metallic contact. The capacity between the two wires is usually enough for high-frequency energy transfer, but not nearly enough to cause the broadcast signals to leak off.

280 VS. 281 RECTIFIERS

Question: "My set does not seem to have enough power. Can I increase its strength by using a 281 rectifier tube instead of a 280? I understand that this tube has more power."

Answer: The rectifier tube supplies the "power" to a set only in the sense that it provides plate current. It is not responsible for the volume or amplification, which is what you mean in this case. If your set is deficient in these respects you will have to make the improvements in the R. F. or A. F. circuits, not in the rectifier.

At any event, the 280 and the 281 are not interchangeable. The 280 is a full-wave rectifier, consisting really of two two-element tubes in one glass bulb. It is capable of supplying plate current for the most powerful ten-tube super-heterodynes now on the market. The 281 is a half-wave rectifier intended for heavier service with public address amplifiers and short-wave transmitters. Two 281's are usually used to give full-wave rectification.

REGENERATIVE HOOK-UP

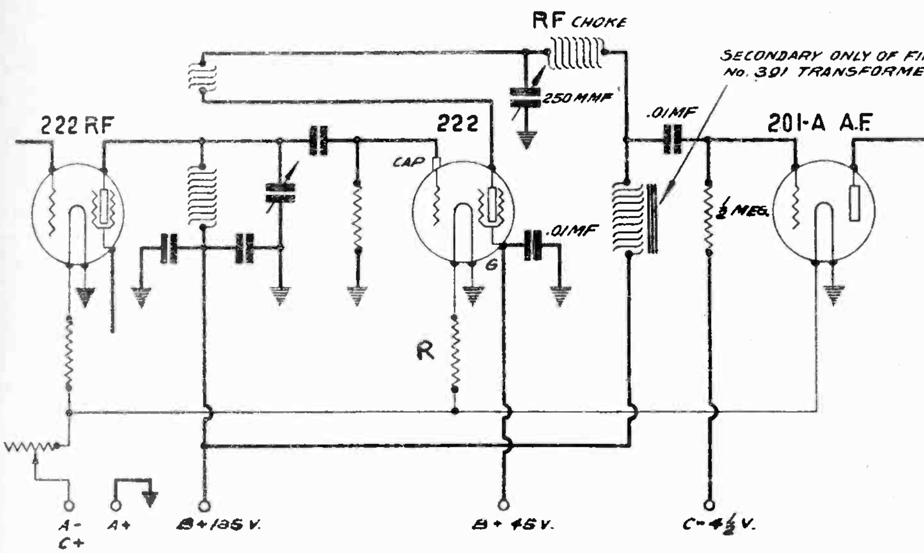
Question: "Please publish a diagram of the Pilot No. 180-4 coils. These have a primary, a secondary and a tickler. I wish to use batteries and earphones."

Answer: A diagram of a very fine little two-tube receiver using the No. 180-4 coils is shown on page 54. A screen-grid tube is used as the detector, with a regular three-element tube for the amplifier. If a six-volt "A" battery is used, these tubes should be a 222 and a 201A, respectively; if dry cells are used, they should be a 232 and a 230.

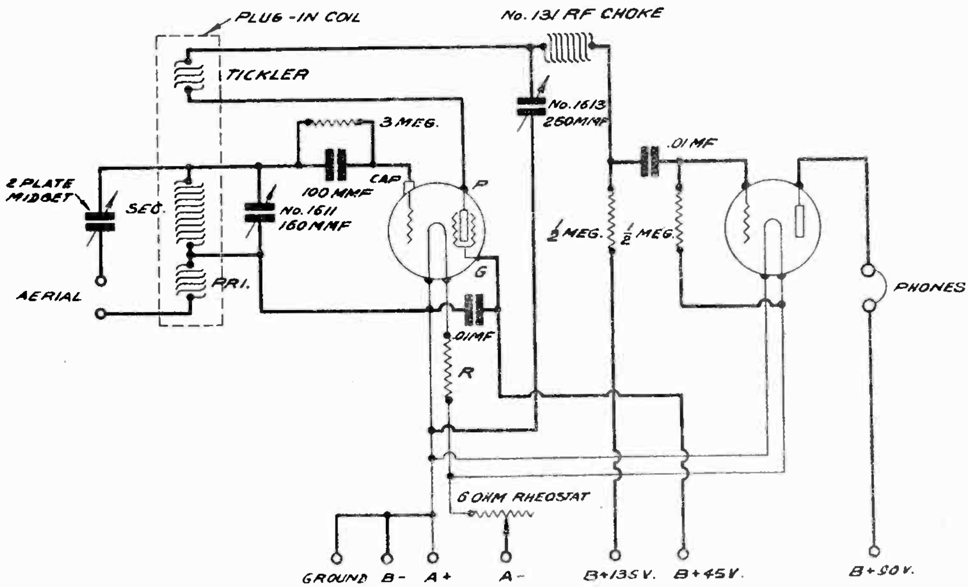
This same hook-up can be used with any short-wave plug-in coils, with or without primary coils. A two-plate midget condenser serves as the aerial coupling condenser. This can be made from a regular J-5 Pilot Midget. (The unnecessary plates are easily removed.) With some aerials, the primary coils give best results; with others, the coupling condenser is desirable. Try both connections and suit yourself in this regard.

USING PENTODES

There have been numerous questions about the use of pentodes in Super-Wasps and regular broadcast receivers. Please be careful about this, as the 247 requires considerably more plate current than the 245, its plate impedance is much higher, and the grid bias is different. The bias is easily fixed, but the power pack is likely to be overloaded, and at any event a special audio output transformer is needed. Also, a new tube socket must be installed and the wiring revised. All in all, the trouble is hardly worth while. The pen-



This diagram shows how a screen-grid detector is used in the K-110 *model Super-Wasp. The rest of the R.F. and A.F. connections remain the same as before.*



Hook-up of a two-tube short-wave regenerative receiver using the No. 180-4 coils. Another audio stage may be added if loud speaker results are desired.

tode is a special tube designed for a special purpose, and it cannot and should not be installed in old sets just because it sounds interesting.

IGNITION NOISE

Question: "I live on a heavily traveled road, and find that the interference from the ignition systems of some cars is very bad on the short waves. At times I cannot hear anything else for minutes at a time. Is there any way of shielding my set or putting in filters to stop this?"

Answer: There is nothing you can do to your receiver to eliminate this interference. Like static, it is of the same character as radio signals, and anything you do to cut out the noise will, unfortunately, also cut out the signals. The cure lies at the other end. Many automobile manufacturers, with an eye to the auto-radio business, are fitting their cars with ignition filters, so at least the interference will become less troublesome as new cars replace old ones on the road.

Short-wave fans may find some consolation in the fact that they are not alone in their suffering, if it may seriously be called that. At one of the trans-oceanic radio-telephone receiving stations in New Jersey no automobiles except those of employees, which are equipped with filters, are allowed within a mile or so of the grounds. The place is guarded and only horse-drawn vehicles are admitted! Otherwise, the super-sensitive receivers (see page 43, Vol 3, No. 3 of Radio Design) pick up the groaning of every farmer's flivver and someone's expensive telephone call to London or Paris is ruined.

FAILURE TO REGENERATE

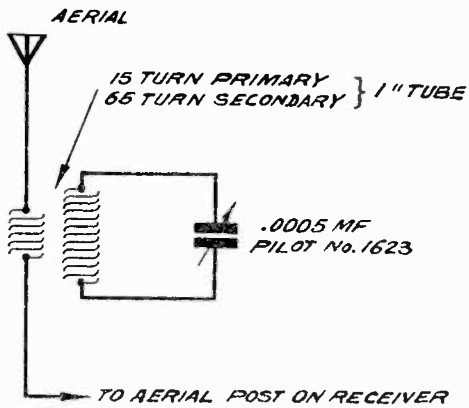
Question: "I have wired and rewired my short-wave set half a dozen times and am absolutely stumped. It simply refuses to regenerate. I have tried different tubes and grid leaks, and have even put in several different sockets in the suspicion that my original one was leaky. What can I do now?"

Answer: The hook-up referred to is of the straight regenerative type, in use by thousands of listeners. Its failure to regenerate is due probably to the most common cause of such trouble: a reversed tickler. Even experienced experimenters frequently overlook this point, and tear their sets to pieces before they remember to switch the tickler leads around. The promptness with which the set comes to life is surprising—and also pleasing.

THE WAVE TRAP TO THE RESCUE

Question: "How can I eliminate or at least reduce the interference from my local 500-watt broadcasting station when using a short-wave receiver? It can be heard in the background even down on 40 meters."

Answer: The good old wave trap comes to the rescue. This handy and very simple device is still useful and effective after many years of existence. It consists merely of a small R. F. coupler and a variable condenser, connected as shown. You adjust the condenser to the wavelength of the undesired station, and the signals from that station then run themselves to death in the trap formed by the tuned circuit. Signals on all other wavelengths continue uninterrupted to the receiver proper.



This simple wave trap will help eliminate interference from strong local stations.

The coupler may consist of a piece of cardboard, formalite or bakelite tubing an inch in diameter and about three inches long, wound with a 15-turn primary and a 65-turn secondary. No. 26 or No. 28 wire is used. The condenser is any .0005 mf. variable. It is advisable to enclose the coil and the condenser in a small aluminum box, so as to shield it entirely.

FLEA-POWER TRANSMITTER

Question: "Can the 'Flea-Power' transmitter described on page 60 of the last issue of RADIO DESIGN be used with larger tubes than the 201A?"

Answer: Yes. This transmitter can be used with a 171A, a 245 or, best of all, a 210. Of course, the K-111 power pack will be suitable only for a 201A or 171A. For a 245, a K-112 or K-139 power pack should be used; and with a 210, a pack made up of a 445 power transformer, a 444 filter block, and 443 choke coil.

A single 201A, properly operated, will give remarkable results. We would advise you to stick to this tube for a couple of months to obtain experience in amateur radio work. Then you can build a larger and somewhat more powerful outfit. For "dope" on this fascinating subject, see "The Radio Amateur's Handbook" (One dollar per copy, postpaid, from RADIO DESIGN.)

AMATEUR PHONE STATIONS

Question: "Around 75 or 80 meters I hear a lot of short-wave stations that are always testing or talking to each other, but never broadcasting any music. They seem to be scattered all over the country, judging from the locations they announce. Who are they?"

Answer: You have merely run into the 80-meter amateur phone band. There are hundreds of such stations, engaged in experimental work. They are not allowed to broadcast music, but confine their transmissions to conversation.

SHORT-WAVE OPERATING DOPE

Question: "Have you ever published any general operating 'dope' on short-wave receivers? If you have, how can I obtain back copies?"

Answer: A long article containing a lot of very useful information on short-wave operation appeared in the Summer, 1930, issue of RADIO DESIGN. Copies of this issue can be obtained for fifteen cents in stamps. Order from the Radio Design Publishing Co., Inc., Lawrence, Mass.

IMPORTANT NOTICE

Because of the great amount of work involved in the handling of our technical mail, which amounts to as much as 1500 questions a week, we have been forced to limit our free service to questions concerning only such apparatus mentioned or described in RADIO DESIGN *or produced by the Pilot Radio & Tube Corporation. We can no longer answer letters dealing with the following subjects: service problems on obsolete or current factory-built receivers, or home-made sets of individual design; the drawing of special hook-ups to fit odd collections of parts; the design of new circuits, sets or parts; criticism or analysis of proposed ideas; and the identification of unknown stations.*

Correspondents are requested to write plainly and clearly (we are not mind readers), to sign their full names and addresses, and to send either U. S. stamps or stamped and addressed envelopes along with their letters.

A Heavy Duty Power Pack for "Ham" Transmitters

Easily Made Unit Can Be Used With One or Two 210's in Any Standard Circuits

THE article in the last issue of RADIO DESIGN on a "Flea Power" short-wave transmitter made out of standard Pilot parts aroused considerable interest. Many ex-amateurs, as well as new converts from the short-wave broadcast field, have built this simple little outfit, which used a single 201A with a K-111 power pack.

210 CAN BE USED

Many readers have written in to inquire if the same set can be used with a 210-type tube, which is practically the standard medium power oscillator of the amateur fraternity. The answer is yes, but of course a suitable power supply must be available. The 210 is rated at 425 volts, though many amateurs put as much as 600 or 700 on it. Such overloading is not recommended, as it shortens the life of the tube. Also, it causes the plate to become red hot, and the frequency then tends to shift because of the changing capacity of the elements.

A SUITABLE POWER PACK

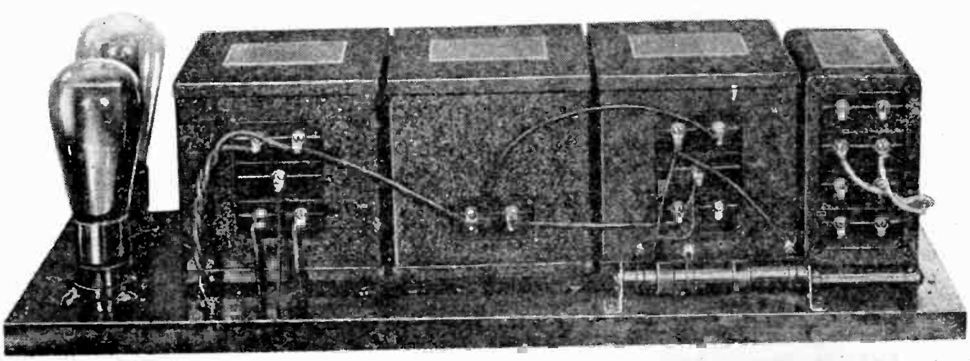
An excellent power pack of reasonable cost can be made of the Pilot Jumbo power units, the No. 445 transformer, the No. 444 filter condenser block, and the No. 443 choke coil. The transformer has three secondaries: 1,200 volts, center tapped, for high voltage, and the other two 7½-volts each, for the filaments of the 281 rectifiers and the 210 oscillators. The filter block has 2.0 mf. and 3.0 mf. sections for 900 volts working, and one 3.0 mf. section rated at 650 volts. The choke has an inductance of 32 henries. Since this combination has ample capacity for two 210's, it can be used first with a single 210 in the "Flea Power" job (which then is no longer in the "flea" class), and later with a master-oscillator-power-amplifier using two 210's. The latter is a highly efficient and popular combination, but should be attempted only after the builder has had some experience with the smaller transmitter.

CIRCUIT IS SIMPLE

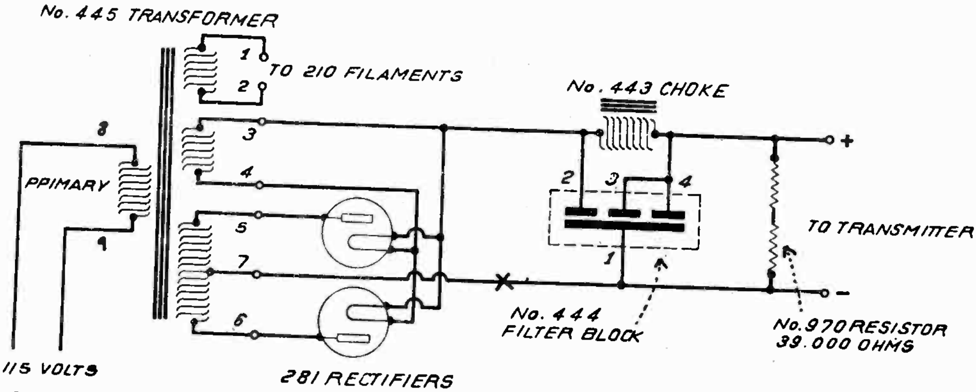
The accompanying diagram shows the connections of the power pack, which are very simple. The illustration shows a pack made of the old No. 441 power transformer (next to the rectifier tubes), with a No. 446 filament transformer (at the extreme right) for filament supply for the 210. This particular combination was designed for experimental work, the No. 446 transformer having a 2½-volt winding that allowed the use of 245 tubes. However, the No. 441 has been replaced entirely by the No. 445, which looks exactly like the transformer in the picture except that it has a few more binding posts.

WOOD BASEBOARD

A piece of one-inch shelving eight inches wide and twenty inches long will hold the



The simple "breadboard" layout of the power pack makes wiring easy. Left to right: 281 rectifiers, No. 441 power transformer (replaced by the No. 445 since this picture was taken). No. 443 choke, No. 444 filter block; No. 446 transformer (now unnecessary). The No. 970 resistor is in front of the filter block.



Schematic diagram of the heavy duty power pack. A single pole switch should be connected at the point marked X in the negative lead.

tube sockets, 445, 444 and 443, and No. 970 resistor very nicely. The board in the picture was twenty-three inches long, to accommodate the now unnecessary 446 transformer. The four under corners should be fitted with soft rubber feet, so that wires brought underneath the board will not bear the weight of the instruments. The No. 216 four-prong sockets for the rectifier tubes, and also the No. 970 resistor, are mounted with wood screws. The power units are fastened with 6-32 machine screws and nuts.

Considerable heat is generated by the 281 rectifier tubes. This is perfectly natural and is no cause for alarm. However, free circulation of air should be provided. The pack should not be enclosed in a box or cabinet unless there are numerous, large holes in the bottom and sides or top to provide a draft.

BE CAREFUL!

It is hardly necessary to emphasize the importance of using a high-voltage power pack with extreme care. Under no conditions touch any "hot" part of the transmitter with your bare hands while the current is on. It is a good idea to provide a separate single-pole-single-throw insulated switch in the "B" minus side of the circuit, as marked, so that the tubes can be left on continuously and the high voltage turned off temporarily while an adjustment is being made. Don't wear ear phones while playing with the transmitter, as leakage through a common ground system may give you a jolt.

Give the tubes a chance to warm up before closing the high-voltage switch or pressing the key. Don't be too impatient in this regard, as 210 and 281 tubes cost a little more than 201A's and 280's, and sudden loads raise havoc with them.

Again we wish to call our readers' attention to the Bible of transmitting amateurs, "The Radio Amateur's Handbook." The latest edition is available through Radio Design at the usual bargain price of $1.00, postpaid.

Using the Ground as an Aerial

A number of service men have written in about their experiences in some locations with using the ground as an aerial. That is, they connect the wire from the steam or water pipe to the *aerial* binding post, leaving the ground post on the set idle. They report that reception is altogether satisfactory, and in some cases even better than when an outside aerial is used.

This trick is well known to set installers. In fact, some men try it before even bothering with an outside aerial, as it sometimes saves work on their part and eliminates an unsightly aerial.

Various explanations of this phenomenon have been offered. It seems that water and steam piping is not always thoroughly "grounded" to the actual earth, and where there is a good deal of it wandering through a house it acts to a considerable extent like an aerial, picking up energy from passing radio waves. (Remember that wood and brick do not obstruct the passage of radio waves.)

The real "ground" connection of the set is usually made through the electric line, which is invariably very well grounded. While there is no direct metallic connection between the "grounded" frame of the set and the line, the capacity between the two is so high that an excellent connection exists as far as the radio-frequency currents are concerned.

Mr. A. Van Santen New Pilot Vice-President

MR. A. VAN SANTEN, of Amsterdam, Holland, who visited the United States early in August of this year, has been appointed commercial vice-president in charge of European sales of the Pilot Radio & Tube Corporation. He will make his headquarters in Amsterdam, but his duties will take him through all the important countries of Europe and also to French Algiers and Egypt.

Arriving in New York on Monday, July 27th, Mr. Van Santen went immediately to Lawrence, Mass., to confer with Mr. I. Goldberg, president of the Pilot company. He sailed back to Holland from New York on August 16th, on the steamer *Statendam* of the Holland-American line.

Mr. I. Goldberg, left, with Mr. Van Santen

Mr. Van Santen spent considerable time in the great Pilot factory, whose size and facilities amazed him. He has been handling Pilot products since 1926, when he took over sales in the country of Belgium, but until he came over and saw the plant at Lawrence with his own eyes, he did not appreciate the power and background of the organization.

"Pilot parts and sets have been received with great enthusiasm in Belgium, Holland and France," said Mr. Van Santen. "In fact one of our distributors in Holland, Nijkerk's Radio Company, is probably the largest radio parts jobber in the world, not excluding even the United States. This firm took on the Pilot agency four years ago and found that Dutch radio fans like Pilot parts very much. It issues nice catalogs, prints numerous hookups, and runs a special service department.

"The Pilot sets, introduced last year, were successful immediately. They became popular because of their neat appearance, their selectivity and their tone quality. In tone quality particularly they are ahead of most European receivers.

"I expect that our business this year will break all records. We have a fine line of products and radio users throughout Europe are looking forward to it."

Explorer Uses Short-Wave Radio

WHEN Doctor Herbert Spencer Dickey, well known explorer, left New York this spring on his ninth expedition into the wilds of South America, he took with him for the second time a complete Super-Wasp receiver, and also a short-wave transmitting outfit, in charge of an experienced radio operator. Doctor Dickey has been endeavoring for many years to discover the source of the mysterious Orinoco River in Venezuela, and in July of this year he was finally successful.

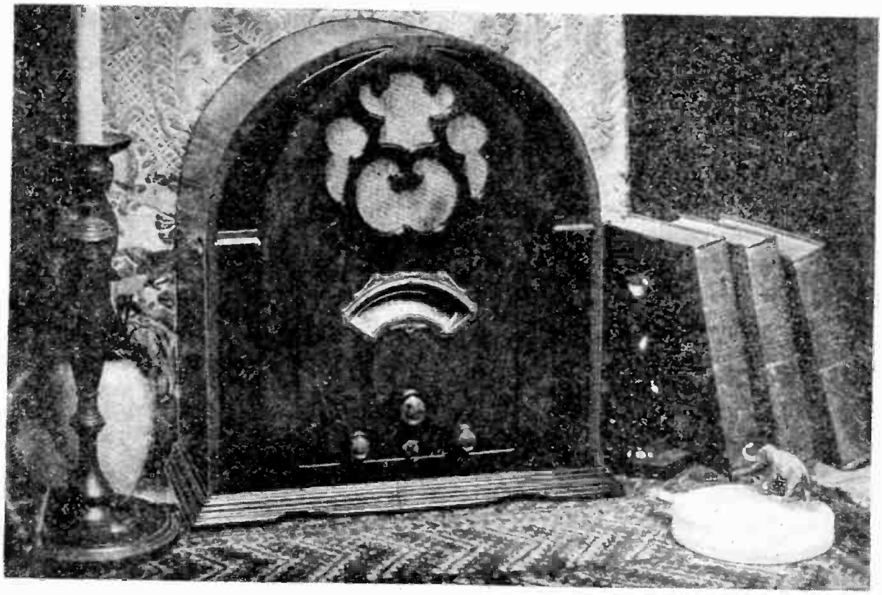
On his 1929 trip, Doctor Dickey did not carry a transmitter, but made extensive use of the Super-Wasp for the reception of time signals, by means of which he checked his chronometers. He also heard many of the short-wave broadcasting stations of Europe and the United States, and found the instrument a source of great pleasure. This year, with the aid of the short-wave transmitter, he was able to maintain contact with civilization and to send stories of his progress back to American newspapers. In fact he used the short waves to send a message to the Pilot Radio & Tube Corporation. This reads as follows:

The New York Times
RADIOGRAM
Times Square, New York
May 29, 1931
18 DDOE San Fernando de Atabapo
Venezuela, Orinoco River
Pilot Radio & Tube Corporation
Lawrence, Mass.

Receiving set in excellent order and giving magnificent results.

DICKEY—1040p

At the time this article was written, Doctor Dickey was still in South America, so we are not able to publish the full details of his radio experiences.



The TRF Midget is compact but very efficient. It makes an ideal personal receiver in the bedroom, den, office, etc.

New Pilot Midget Receiver Has Novel Features

Selectivity, Sensitivity and Tone Quality Obtained From Small Chassis; Special Model for European Use Tunes to 2000 Meters.

TO meet the demand for a small but efficient radio receiver of low price, for use in offices, dens, private living rooms, summer camps, etc., where the expense and size of a large set is not justified, the Pilot company has brought out a compact little five tube set of pleasing appearance and great effectiveness. Complete with dynamic loud speaker and built-in power supply, it measures only 12 by 16 by 8 inches in its handsome walnut finish cabinet.

HAS BIG-SET FEATURES

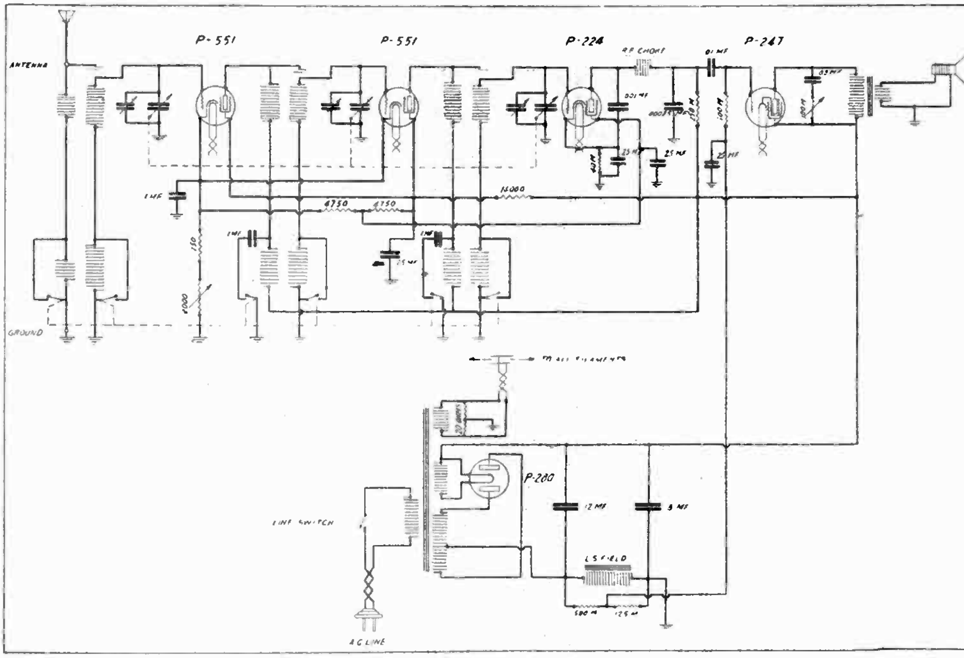
It has a full-vision illuminated dial, calibrated directly in kilocycles, a smooth volume control, and a tone control. The chassis is of the same rigid, all-metal construction characteristic of all Pilot receivers, and the workmanship is of the same high order. Not much higher than a book, it affords the same radio enjoyment obtainable from many higher-priced and more complicated instruments.

CIRCUIT USES NEW TUBES

There are three 551 variable-mu, one 224 screen-grid, one 247 pentode and one 280 rectifier in the set. Two stages of tuned radio frequency amplification feed into a screen-grid power detector, which in turn works directly into the pentode output stage through a resistance-capacity network. The use of variable-mu tubes in the R. F. circuits provides a degree of selectivity and sensitivity not heretofore achieved in TRF hook-ups.

Detector distortion is avoided by the power detector arrangement, wherein the usual grid condenser and leak is eliminated and the tube made to operate on the bottom bend of its grid voltage-plate current curve. The 247 pentode, which is the only audio amplifier, gives more than enough volume for all ordinary purposes.

Volume control is obtained by a 4000 ohm variable resister in the cathode circuit of the R. F. tubes. The tone control consists of a



This schematic diagram of the Pilot TRF Midget shows the long-wave loading transformers, which give the set a wavelength range from 800 to 2000 meters in addition to the regular 200-550 meter coverage.

Mr. A. M. Morgan, of the Pilot engineering staff, showing the chassis construction of the TRF Midget. The RF transformers for the 200-550 meter range are in the shield cans next to the three-gang tuning condenser.

100,000 ohm variable resister and a .03 mf. fixed condenser across the primary of the output transformer in the audio stage.

SPECIAL LONG-WAVE MODEL

The wavelength range of the standard TRF Midget is 200 to 550 meters, which takes in all the American broadcasting stations. To make the set usable in Europe, where many of the important stations operate on much higher wavelengths, a special model is being made that tunes from 800 to 2000 meters in addition to covering the 200-550 meter range. In external appearance this model is like the standard one. The tone control is absent, its space being occupied by a wave changing switch which controls a set of three R. F. loading transformers. These are mounted on the under side of the chassis, and, of course, are enclosed within suitable shield cans.

COILS CONNECTED IN SERIES

Examination of the schematic diagram on page 60 will reveal that these loading transformers are connected in series with the respective primaries and secondaries of the transformers used for the 200-550 meter range. With the switch in the 200-550 meter position, the loading transformers are simply short circuited through to ground. When the switch is turned to the 800-2000 meter setting, the short circuit is opened, and the tuning circuits then each consist of two coils in series, with a section of the three-gang variable condenser across the combination. The arrangement is simple but effective and foolproof.

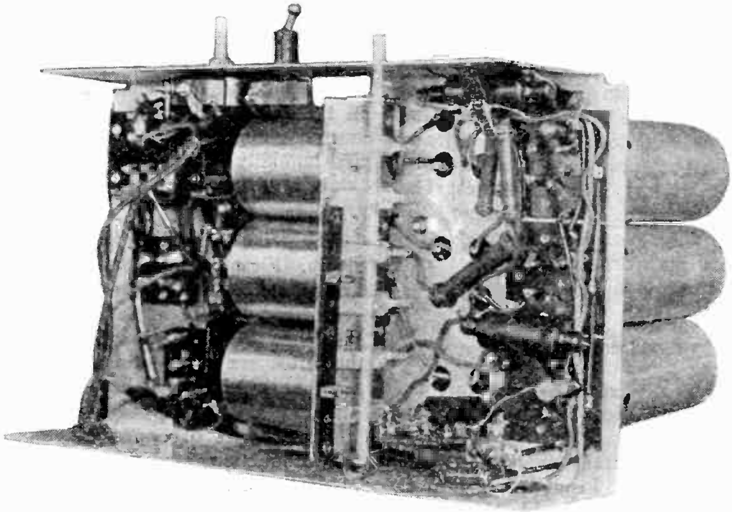
GET A GLOBE

As pointed out in previous issues of Radio Design, an ordinary flat map gives a very distorted idea of the appearance of the earth. As the owner of a short-wave receiver you will jump around a great deal from one country to another, and you must have a globe to figure distances and to get a true conception of the position of one country in relation to another.

To give an idea of how far apart certain places are, the writer measured distances carefully on a twelve-inch globe and obtained the following figures:

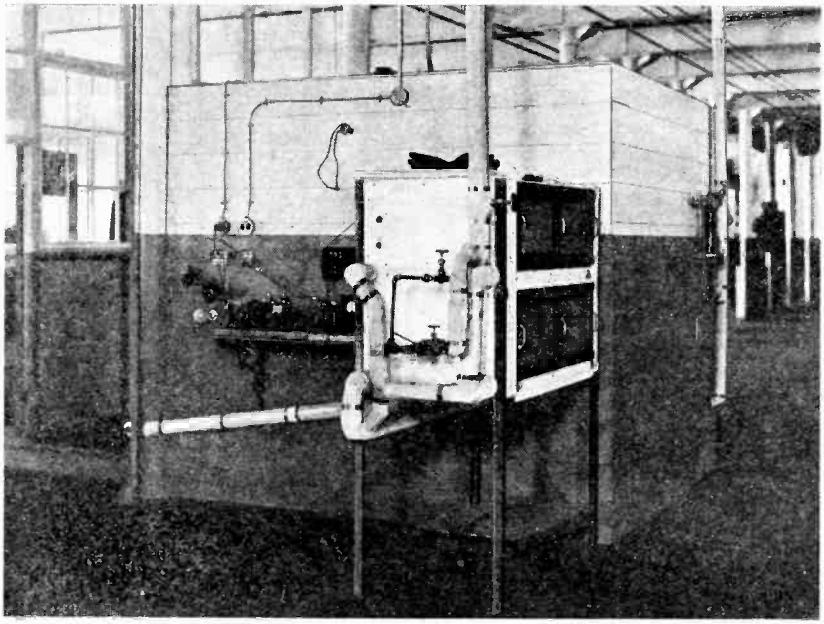
New York to London	3630 miles
New York to Eindhoven	3800 miles
Boston to San Francisco	2800 miles
New York to Sydney	10,230 miles
Manila to San Francisco	7000 miles
Buenos Aires to New York	5200 miles
Khabarovsk to Ohio	6105 miles
Costa Rica to New York	2310 miles
Georgetown to Ohio	2970 miles
South Pole to New York	9200 miles
Bangkok to New York	8910 miles
Berlin to San Francisco	5940 miles
Berlin to New York	4125 miles
Kansas City to London	4620 miles

Short-wave stations are springing up in remote places, because those are the very places that need short-wave radio for communication purposes. Your enjoyment of your short-wave receiver will increase if you spend a few minutes during the evening with your son's or younger brother's geography book.



Under view of the TRF Midget chassis, with the long-wave coils and wave-changing switch in position along the center

The Radio TORTURE CHAMBER



Back view of the "Torture Chamber," with the separate condenser over in the foreground.

THE "Torture Chamber" in the Pilot plant at Lawrence, Mass., was named by a newly-employed engineer, who unsuspectingly opened the door and walked in when he was told it contained some apparatus he was seeking. He stepped across the entrance, remained about two seconds, and came out in one wild leap, his face red and perspiring and his clothes drenched with moisture. He had walked into the hottest and wettest place any side of the Equator, the place where all Pilot parts and sets are tested under conditions far worse than any they will encounter anywhere in the world.

SAWDUST INSULATION

This chamber is a windowless structure ten feet square and seven feet high. It consists of two double-layer shells of wood separated on all sides by an insulating layer of sawdust *four inches* thick. The inside of the inner compartment is lined solidly with heavy galvanized sheet iron. Along the bottom are several rows of steam pipes, which, by the aid of automatic thermostatic controls, maintain the chamber evenly at any desired temperature. An open steam jet provides moisture, the humidity being registered by a wet and dry bulb recording humidity meter.

The door is of the same overall thickness as the walls, and closes up tightly. During a test it is kept locked, so that the temperature and humidity will remain unchanged.

PROGRESSIVE TESTS

The "Torture Chamber" is used progressively. First the individual parts of a receiver are placed inside. After they have been corrected for any slight defects disclosed by the test, they are built into complete receivers and the latter are then put under observation. A set that survives this hot box will work any place.

After a set of approved design has gone into production, random samples are taken out of the stock room at regular intervals and are sent back to the chamber for checking. This system produces uniform and dependable receivers.

CONDENSER OVEN

Connected with the "Torture Chamber" is a special oven used for the testing of condensers of all kinds. The condensers are kept at a temperature of 140 degrees and at the same time they receive *four times* their normal rated operating voltage. As with sets, condensers are taken out of stock regularly and subjected to oven tests for strength. This oven is heated by gas, and its temperature is also thermostatically controlled.

A special power pack, mounted on the side of the "Torture Chamber," supplies the high voltages required for the condenser tests. This uses two 866 mercury-vapor rectifier tubes and is capable of attaining an output of 2,000 volts D. C.

With both the "Torture Chamber" and the gas oven it is possible to make accelerated life tests on radio apparatus of all kinds. These tests simulate several years of actual operation, and reveal interesting facts unobtainable in other ways.

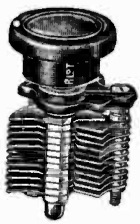
NO MORE UNCERTAINTY

Before this equipment was built, it was necessary to send experimental sets out into the field, and to wait for reports for places often thousands of miles away. Now the sets are built, broken down, rebuilt, broken down again, rebuilt a second time and further tested, all under the supervision of trained engineers working in one laboratory. There is no worrying about how the receivers will stand up in Southern California, Mexico, Panama, Brazil, Egypt, Siam or Australia; the engineers know very certainly and confidently that they *will* stand up, because the "Torture Chamber" tests have told them more than they could learn if they spent six months touring the world.

Looking through the door of the "Torture Chamber" into the iron-lined inside. Two receiver chassis are on the table undergoing a heat and humidity test.

Handy Condensers

For neutralizing purposes in a master-oscillator-power amplifier transmitter, the Pilot midget variable condensers are extremely handy, and many amateurs are using them.



There are four sizes: the J-5, having a maximum capacity of 15 mmf.; the J-7, 25 mmf.; the J-13, 50 mmf.; and the J-23, 100 mmf. The catalog numbers indicate the number of plates. The instruments themselves are approximately 1½ inches on end and 1 to 1¾ inches deep, depending on capacity. The plates are readily removable, and odd capacities or double-spaced units can easily be built up.

The midget condensers mount in a single hole. They are supplied with molded bakelite indicating knobs.

Use the Right Meter

For the measurement of the D. C. output of "B" power packs, it is necessary that the voltmeter be of the high resistance type. There are many small, cheap voltmeters on the market which are sold for work of this kind, but unless they are plainly labelled as having a resistance of 750 or 1,000 ohms per volt, they are worse than useless. They will give readings, but these will be false and misleading.

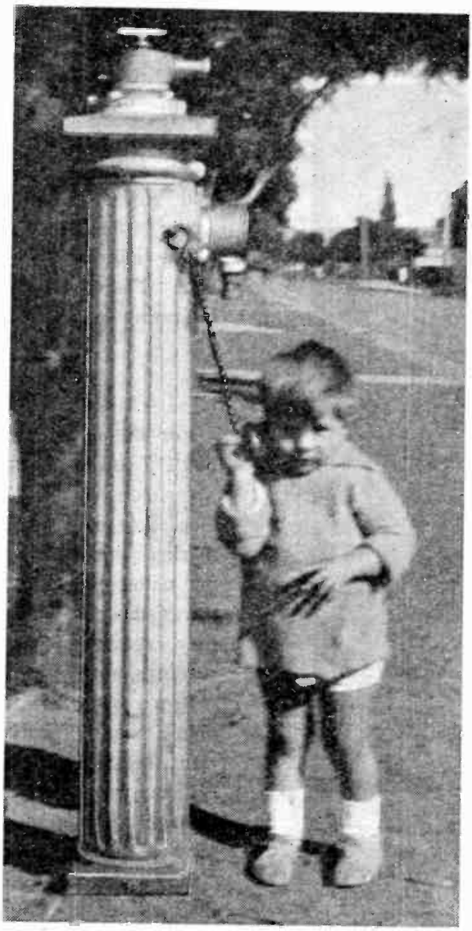
Low resistance voltmeters draw an appreciable amount of current for their own operation; because of the characteristics of most "B" supply circuits, this load causes the output voltage to drop appreciably, and the meter reading then means nothing because the actual voltage will be different when the meter is disconnected.

From Far Off South Africa

The picture at the top of this page shows the very fine display of Pilot products arranged by Electrical Supplies, Ltd., at a recent fair held in Durban, South Africa. Pilot receivers and parts are well known and widely used in South Africa.

At the right is a charming picture of little Dennis Wells, of Pretoria, South Africa, snapped while he was listening to a water hydrant, of all things! He evidently thought it was a Super-Wasp like his daddy's. There is a spring catch underneath the nozzle which Dennis was busy turning with his left hand and at the same time patiently waiting to hear a short-wave station in the United States. This photo was taken by James Black, proprietor of the Wireless House and Photographic Stores, of Pretoria.

Both these photos were sent to RADIO DESIGN *by Mr. J. L. Cathro, Pilot representative in South Africa.*



New Parts for the Constructor

SUPER-HETERODYNE COILS

FOR the benefit of the man who wants to build his own super-heterodyne broadcast receiver, the Pilot company has placed on the market the essential parts of its ten-tube de-luxe Consoles. The No. 241 kit consists of three intermediate frequency amplifying transformers, accurately matched to a frequency of 175 kilocycles and packed in a single box. These transformers embody the latest advances in super-heterodyne design, and provide maximum amplification at 175 kc. The No. 242 coil kit consists of one band pass coil, one oscillator coil, two special fixed condensers of 740 mmf. capacity and one trimmer condenser of 750 mmf. capacity. These coils are designed for a circuit comprising a band pass or pre-selector tuning stage coupled to a screen grid R.F. stage ahead of the first detector. They must be used with the Pilot No. 3160 four gang condenser, and will not work with other condensers.

The No. 241 I.F. transformers are inclosed in neat aluminum cans 2 13/16 inches high and 2¼ inches in diameter. The band pass and oscillator coils are 1¾ inches in diameter by 5¾ inches, and 4 inches long. Non-shrinking formalite tubing is used.

The hook-up on page 17 is that of the chassis used in the Pilot models No. C-153 and C-154 Console Super-Heterodynes and is recommended for these new coils. This is a ten-tube job using four P-551 variable mu tubes, three P-227's, two P-247's and one P-280. The circuit comprises one stage of screen grid T.R.F. amplification, first detector and oscillator, two stages of intermediate frequency amplification, second detector, and a push-pull output stage, with full automatic volume control.

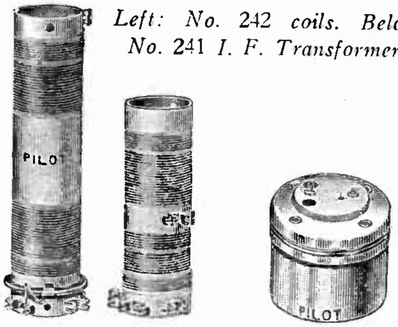
In this circuit L-1 is the band pass coil of the No. 242 kit, and L-2 is the oscillator coil. C-1 is the Pilot No. 3160 four gang condenser (the dotted lines indicate the common rotor). C-2 is the special trimmer condenser furnished with the No. 242 kit. The position of the 740 mmf. fixed condensers in the oscillator circuit are clearly indicated. Please note carefully that there is no actual connection between the two sections of the band pass coil L-1, the transfer of energy from the aerial circuit to the grid of T-1 being accomplished electro-magnetically. The apparent lack of a connection at this point is very confusing to many set builders. Also note that there is no direct connection between the oscillator section of coil L-2, connected to tube T-2, and the grid coil of L-2, connected to tube T-3. Here also the transfer of energy is accomplished electro-magnetically. Coils L-1 and L-2 must be thoroughly shielded.

It is necessary, of course, to adjust the trimmer condensers on the four gang condenser C-1, and also the special trimmer condenser C-2.

The intermediate frequency transformers F-1, F-2, and F-3 are connected to tube T-3, T-4, T-5, and T-6 in a straight forward manner. The variable condensers indicated within the dotted lines are enclosed in the shield cans and are properly adjusted at the factory. The amplifier is a straight push-pull unit.

The power pack shown in this diagram is the special one used in the Pilot Console receivers. Of course any standard power pack of suitable capacity may be employed. In order to obtain satisfactory results, it is necessary to follow only the essential radio frequency wiring in the upper section of the diagram. The audio system and the power pack can readily be changed to meet the individual builder's requirements.

The values of the various resistances and condensers are marked. One or two little features of this set require explanation. The switch marked "LD Switch," connected between tubes T-3 and T-4, is a local-distance switch. It is a special double-pole switch, which short circuits either of two pairs of contacts. In the local position, it connects a 40,000 ohm resistance across the primary of I.F. transformer F-1 and at the same time puts a 500 ohm damping resistance in the secondary circuit. These resistances reduce the sensitivity for local reception and help eliminate background noise. In the bottom or distance position, both of these resistances



Left: No. 242 coils. Below: No. 241 I. F. Transformers.

are removed from the circuit and the receiver functions at full sensitivity.

The tuning meter connected between the cathode of tube T-4 and ground is 0 to 10 milliammeter. When the set is turned on and no station is being received, the needle of this meter will assume a certain position. The use of this meter is very simple. Turn the volume control down to zero and tune the main tuning condenser C-1, until the needle has the greatest deflection from its normal setting. When you turn up the volume control, you will then find the station tuned in perfectly.

Super-heterodyne coil kit—catalog No. 242................code: YIGHA
Super-heterodyne intermediate frequency transformers (Kit of three) catalog No. 241....code: YIFGA

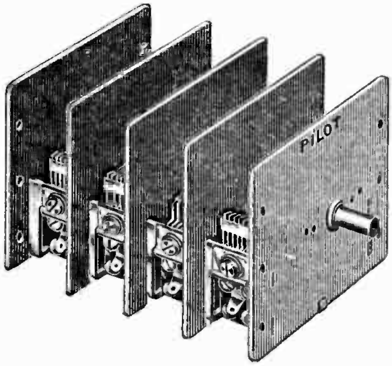
SHIELDED VARIABLE CONDENSERS

The new Pilot shielded variable condensers are the heaviest and most rigid variables ever offered the radio constructor. They were designed originally for the Pilot De Luxe super-heterodyne receivers, the requirements of which are very strict.

They are made in single, double, triple and quadruple units, the maximum capacity per section being .000365 mf. The minimum capacity is unusually low, and permits full coverage of the broadcast band. Dimensions: 4½ by 3¾ inches on end; depth, 1½, 3, 4½ and 6 inches. Shaft: ¼ inch.

Single shielded condenser—
No. 3115...................Code: YIGIK
Double shielded condenser—
No. 3130...................Code: YIHAJ
Triple shielded condenser—
No. 3145...................Code: YIJKA
Quadruple shielded condenser
No. 3160...................Code: YIKOP

Below: The No. 3160 four-gang variable condenser.



VERNIER DIAL

Remember that smooth-working drum dial used on the Pilot TRF midget receiver? So many constructors wanted to buy it separately that we have placed it on the market as a regular parts item. Intended particularly for the Vaultype condensers, but will work with any others. Scale is marked in kilocycles, 550-1500. Handsome bronze panel plate.

Single Drum Dial—No. 1273..Code: YAKID

R. F. CHOKE

The No. 131 is a 30-millihenry radio-frequency choke coil for general use in short wave and regular broadcast receivers. Its choking effect extends from about 15 meters up to 600, its distributed capacity being very low. Dimensions: 1½ inches high, 1 inch diameter, molded bakelite case.

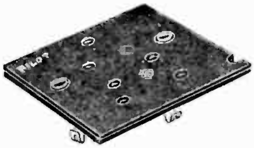
R.F. Choke—No. 131.........Code: YEMIL

TUBE SOCKETS

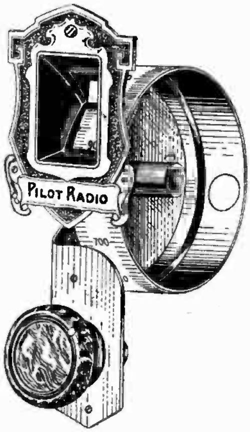
The new Pilot manufacturer's type tube sockets are thin and flat, and particularly well suited for use on metal sub-panels. Contact springs and connection lugs are one piece, and hold the tube firmly. Bakelite insulation. Four-prong socket is 2 inches by 1 7/16 inches; five-prong, 2 inches by 2⅛ inches.

Four-prong socket—No. 218...Code: YIDGE
Five-prong socket—No. 219...Code: YIEWZ

No. 131 R. F. Choke



No. 219 Socket



Right: The No. 1273 Drum Dial

MIDGET FIXED CONDENSERS

The new Pilot midget fixed condensers use mica for the dielectric, and are hermetically sealed in molded bakelite in the same manner as the well-known No. 50 series. By improved manufacturing technique the width has been reduced by half for the same capacities. This feature will appeal to builders of compact sets, as the condensers may be mounted by their own lugs in spaces too small to accommodate the regular size condensers.

Midget Condenser

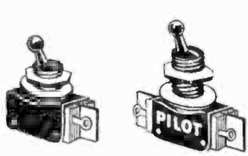
Overall dimensions are as follows: width, ⅝ inch; thickness, ¼ inch; length of condenser proper, 1¼ inches; length between connection lugs, 2⅜ inches. The condensers are made in thirteen different capacities, as follows:

No.	
83	.00002 mf.
84	.00004 mf.
85	.0001 mf.
86	.00015 mf.
87	.0002 mf.
88	.00025 mf.
89	.0005 mf.
90	.001 mf.
91	.002 mf.
92	.003 mf.
93	.004 mf.
94	.005 mf.
95	.006 mf.

TOGGLE TYPE SWITCHES

The new Pilot toggle switches have the clean, sharp snap that characterizes good switches. They are made with rigid steel frames and bakelite insulation, and have a roller movement that assures good contact. They mount in a single half-inch diameter hole, and occupy an area ⅝ inch by 1⅝ inches behind the panel. The finish is old bronze, which is durable as well as good looking.

There are three models. The No. 47 is of the single-pole-single throw type; the No. 48 is a special two-way switch that will close either of two single circuits, but has no open position; the No. 49 is of the double-pole-single throw type. They are useful for a wide variety of purposes in radio receivers and control apparatus.



New Snap switches

Cartridge type condenser

CARTRIDGE TYPE BY-PASS CONDENSERS

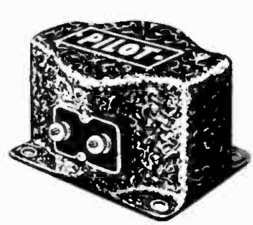
The new cartridge type by-pass condensers are unusually strong because they are rolled tight against an impregnated wooden core, and are then covered with a special pitch that makes them absolutely moisture proof. They are fitted with brass end caps and tinned connection wires. They are of the non-inductive type and may be used for high-frequency work with the greatest satisfaction. Dimensions: 2⅝ inches long, ⅝ inch diameter.

Made in two sizes: No. 96, capacity 0.1 mf. and No. 97, capacity 0.25 mf. Working voltage, 300; flash tested at 1200.

NEW 412 SERIES TRANSFORMERS

The case of the popular No. 412 series Pilot audio transformers has been redesigned for greater strength and better appearance. The new design is illustrated herewith. No change has been made in the electrical characteristics of the instruments, which are fully described on page 6 of the Pilot catalog.

Small metal case audio transformer, 2-1 ratio—No. 412	Code: ZWARF
Small metal case audio transformer, 3½-1 ratio—No 413	Code: ZWAWK
Small metal case audio transformer, 5-1 ratio — No. 413Y	Code: ZOALM
30-henry filter choke, 45 milliamperes capacity — No. 414	Code: ZYFAY
30-henry output choke—No. 415	Code: ZYGZA
Audio output transformer—No. 418	Code: ZICZE

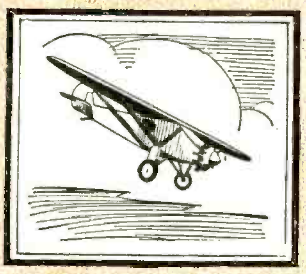


Appearance of new transformer case

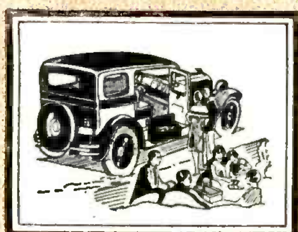
Printed in U. S. A., Servwel Printing Co., 270 Lafayette St., N. Y. C.

for

DEPENDABILITY



Pilotron Tubes furnished Transmission and Reception on Pilot flight communication.



The Auto Pilot uses up least car space, is easiest to install.

Licensed Amateurs, Custom Set Builders and Radio Engineers endorse Pilotrons.

UP IN THE AIR—flying across great open stretches of sea to the little isle of Bermuda, to the furthermost ends of South America, making world records and keeping in touch with New York every minute of the day and night with a Pilot Super-Wasp Set, relying all the time on the Dependability of Pilotron Radio Tubes.

Camping miles from anywhere—enjoying some favorite program with your Auto-Pilot Screen Grid receiver and knowing that you can depend on your Pilotron Radio Tubes under all conditions.

The Professional—operating on world wide reception—keen and alert, must avoid confusing tube noises—crackles and distortion—and with dependable Pilotron Radio Tubes in every socket he enjoys the thrill of "pulling in" messages from far away.

You too—under all conditions—on any set will appreciate the difference that dependable Pilotron Radio "long life" Tubes give to the reception of radio broadcast programs.

PILOTRON

RADIO TUBES

ENDORSED BY PROFESSIONALS

LICENSED BY RCA

PILOT RADIO & TUBE CORP.
Lawrence, Massachusetts
Chicago Office: 234 S. Wells St.
San Francisco Office: 1278 Mission St.

The Big, Smashing Thrill of MODERN RADIO

"Programs from All the World"

PILOT "ALL-WAVE"

Super-Heterodyne

10 TUBE
SUPER-HET.
$128 COMPLETE

CONSOLE
7 TUBE SUPER
$89.50 COMPLETE

11-TUBES

Pilot's new ALL-WAVE is two sets in one! A standard 7-tube super-heterodyne chassis and a 4-tube converter. Pulls in everything between 11 and 550 meters with more power than ever before available. No coils to plug in—nothing to change. As simple to operate as an ordinary receiver. Converter has own power pack and rectifier tube. Six tuning stages. No regenerative distortion. Ask your dealer to demonstrate the power of this new 11-tube ALL-WAVE super-heterodyne.

Table Model

$99.50

Complete with Tubes

MODERNISTIC
7 TUBE SUPER
$79.50 COMPLETE

PILOT RADIO & TUBE CORP.

LAWRENCE, MASS., U. S. A.

5 TUBE
T. R. F. MIDGET
$42.50 COMPLETE

PILOT VALUE IS MORE THAN PRICE DEEP