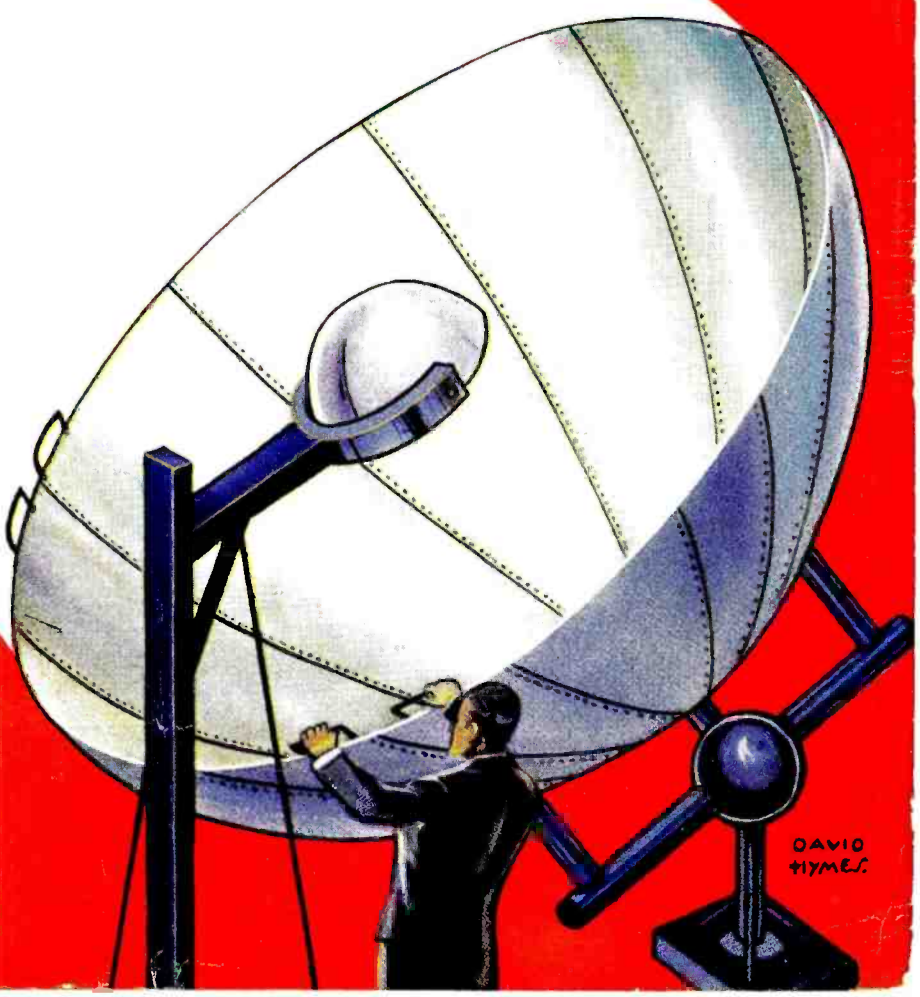
SHORT-WAVE STATION LIST

RADIO NEWS

AUGUST
25 Cents



Searchlight Radio
with the
New 7 Inch Waves

A Unique Set-Analyzer
Mathematics in Radio
With the Experimenters

10 TO 550 METERS WITHOUT PLUG-IN COILS

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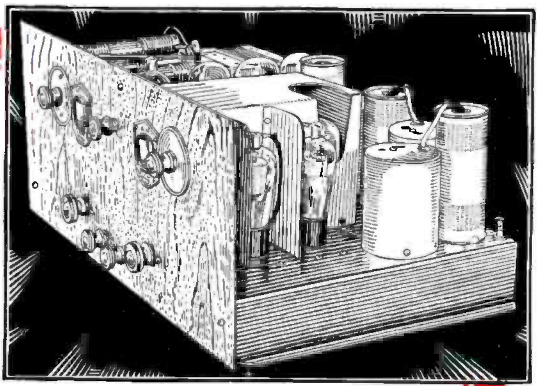

726SW All-Wave Superhet

In the 726SW there is available for the first time a combination of the very latest and most modern superheterodyne broadcast and short-wave designs on one chassis. Logically, it is the product of McMurdo Silver and the Silver-Marshall laboratories—foremost superheterodyne designers in America.

Nine-Tube Vario-Mu Broadcast Super

In the 200 to 550 meter band, the 726SW is a nine-tube vario-mu pentode superhet employing nine tuned circuits. One precedes the '51 r.f. stage, a second is before the '24 first detector, and another with the '27 oscillator. The two tuned circuits ahead of the first detector, coupled with the '51 vario-mu tube, absolutely eliminate all cross-talk or image frequency interference. The two-stage i.f. amplifier, using '51 tubes, has a total of six tuned circuits (three siamese, or dual tuned transformers) which definitely assures uniform and absolute 10 kc. selectivity at short or long waves.

Pentode Tubes in Push-Pull

A '27 second linear power detector feeds a compensated push-pull '47 pentode audio stage delivering from 5 to 7 watts undistorted power output, and in turn feeds a specially compensated electro-dynamic speaker unit.

60 to 100 Broadcast Programs

The broadcast sensitivity ranges from less than one-half to seven-tenths of one microvolt per meter—so great that every station above the noise level can be tuned in easily. The selectivity is absolute 10 kc., and in any large city distant stations on channels adjacent to locals can be readily tuned in. From 60 to 100 different stations can be logged almost any night in any fair location.

Eleven-Tube Short-Wave Super

The short-wave end of the 726SW is the dream of old—a true eleven-tube superhet using "double-suping" on not one, but two, intermediate frequencies. Yet it has but one dial—plus a non-critical trimmer! For short-waves, a '24 first detector and '27 oscillator ganged together are added by a turn of a switch, which selects between short-wave and broadcast band reception. A second selector switch chooses between four ranges (from 10 to 200 meters) at will—and all without a single plug-in coil.

Thousands of Miles of S-W Range

The sensitivity, selectivity on short-waves are exactly equal to the broadcast band—giving thousands of miles of range.

Tubes required: 2—'24's, 3—'27's, 3—'51's, 2—'47's, 1—'80.

726SW All-Wave Superheterodyne, complete as described above, wired, tested, licensed, including S-M 855 electro-dynamic speaker unit. Size 20½" long, 12" deep, 8½" high. To be used on 110-120 volt, 50-60 cycle AC power Price $139.50 LIST.

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Editor

ALBERT PFALTZ
Associate Editor

RADIO NEWS

S. GORDON TAYLOR
Technical Editor

WILLIAM C. DORF
Associate Editor

VOLUME XIII — August, 1931 — NUMBER 2

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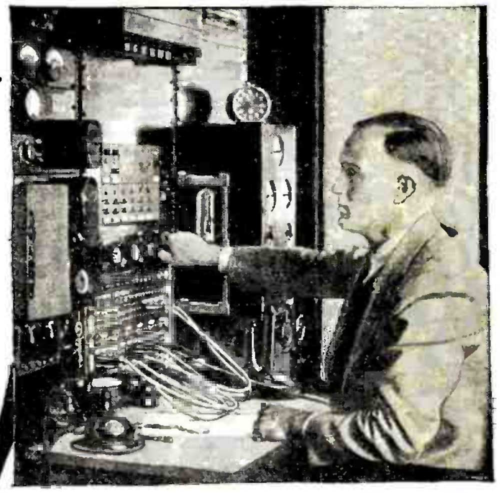

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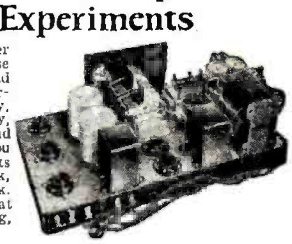

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The Editor—to *You*

SINCE the beginning of the RADIO NEWS series of articles on television, there has been a heightening interest throughout the country in the visual broadcasting art. The Radio News Bureau of Washington, D. C., reports that there are more and more applications for authority to erect television transmitting stations being received by the Federal Radio Commission. The applications are almost invariably made by broadcasters who are already transmitting sound programs. A television map hanging in the offices of the short-wave engineers of the Commission shows a number of stations already authorized in the northeastern states, especially in or near the cities of New York, Boston, Chicago and Washington.

* * *

AND IF the recent applicants are granted licenses there will be new ones in Baltimore, Detroit, St. Louis, New Orleans, Los Angeles and San Francisco. The rules of the Commission require a public showing by each applicant that he is capable of transmitting visual messages that can be suitably received, that he plans a program of research design to improve the art, that he has adequate financial resources and technical facilities for suitably carrying out this program.

* * *

FROM the standpoint of interest amongst experimenters, the RADIO NEWS articles on the television broadcasts in Boston have stimulated the demand for the type of television kits designed especially for receiving these transmissions. The demand has been so great that the radio department sales of chain stores handling this equipment are now stated to be back to normal for the first time during the last two years. This is believed to be an indication that the public really wants television.

* * *

IN THE present issue of "our own" radio magazine will be found a complete description of the apparatus now being used for reception of the New York television broadcasts. The editor has been spending considerable time in the laboratory, during the broadcasts from three of the New York transmitters, and has derived more than passing pleasure in "looking-in" on the comic strip pictures as well as the actual performance of talking and singing before the microphone and "electric eye." During the first transmission picked up on this apparatus he recognized, immediately, a radio announcer that he had not seen for a number of years.

* * *

THE AMATEUR has added another set of important reasons for his recognition and encouragement by the U. S. Government in the work he has been and still is doing in furthering scientific knowledge while acting as a communication base for expeditions that travel to the far corners of the earth. On page 136 there appears an article telling of his latest exploits.

* * *

LIEUTENANT WENSTROM continues his important series on long-wave broadcasting with a number of facts and data substantiating his theories. This series is creating considerable discussion in influential circles and the editor has received many corroborating viewpoints from this country and abroad.

* * *

SHORT-WAVE experimenters will be interested in an article featured on the cover, entitled, "Searchlight Radio on the New Seven-Inch Waves." If and when the new micro-ray tubes are placed on the market there will be opened a new field for scientific experiments on radio wavelengths closely approaching those of heat and light.

* * *

THERE appears also an article on Short-Wave Superheterodyne design which contains many helpful pointers and suggestions for program reception from all over the world.

* * *

A SHORT-WAVE station list which contains important broadcasters and transmitters of interesting material is also included in this issue. Short-wave listeners-in will find it extremely valuable in hooking up with these long distance transmissions.

* * *

THE DESIGN of the modern single-control superheterodyne has made it necessary to use condensers, for tuning, which will "track" over the entire broadcast band, with a frequency difference equal to the frequency of the intermediate transformers used in the set. Zeh Bouck contributes a worthwhile discussion of the engineering features in designed condenser plate shapes to accomplish this end. The plan is not only feasible but accurate. The data advanced will be found important by all designing engineers.

* * *

THE EDITOR continually receives letters from virtually all over the world from our readers. Here is an extract from a serviceman in England. He states: "I find that your articles are much more advanced than the topics in discussion on this side of the Atlantic. I am employed as serviceman with an English furniture dealer, servicing the Yankee sets of which they sell a surprising great number. You can bet your magazine is a very valuable asset to me in this connection.

F. W. HARRIS-PUGH."

* * *

RADIO NEWS has a circulation in countries outside the United States probably greater than most radio trade magazines have in this country itself. Following is a list of the countries in which RADIO NEWS circulates: Africa, Alaska, Argentina, Australia, Austria, Bahama, Belgium, Bermuda, Bolivia, Brazil, British Guiana, B. W. I., Burma, Canada, Canal Zone, Chile, China, Colombia, Costa Rica, Cuba, Czechoslovakia, Denmark, Dominican Republic, D. E. I., D. W. I., Egypt, England, Equador, Estonia, Federated Malay States, Finland, France, Germany, Greece, Guam, Guatemala, Haiti, Hawaii, Holland, Honduras, Hungary, India, Ireland, Italy, Java, Jerusalem, Luxemburg, Latvia, Mani, Malta, Mexico, Netherland, Newfoundland, New Guinea, New Zealand, Norway, Palestine, Panama, Peru, Philippine Islands, Poland, Porto Rico, Portugal, Roumania, Russia, Samoa, Scotland, Siam, South Africa, Spain, Straits Settlements, Sweden, Switzerland, Turkey, Uruguay, Venezuela, Virgin Islands, West Indies, and Yugoslavia.

A large portion of this circulation is among dealers, importers and servicemen who are handling or wish to handle American goods and apparatus.

* * *

THIS ISSUE of the magazine starts a number of departments of special significance to large groups of our readers. "With the Experimenters" is an addition which contains the type of material formerly incorporated in the two departments, "RADIO NEWS Home Laboratory Experiments" and "In the RADIO NEWS Laboratory."

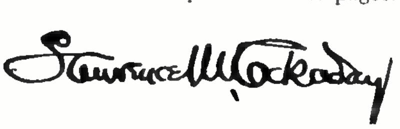
* * *

"Radio Science Abstracts" is a department that combines, in one group, a summary of Institute papers, radio reviews from contemporary technical radio publications and reviews of the current leading books. This department will save technicians and engineers a great deal of time by acting as a *complete* bibliography.

ANOTHER NEW department especially aimed at physics teachers and students will be found of value in school and college work. It contains a number of class assignment questions that can be used by the instructors, covering the text material in each issue. At the same time this department may be useful to any of our readers as a course of instruction in the fundamentals of radio phenomena, design and application.

* * *

As SPACE permits no further description of the remaining informative articles contained in this issue, the editor invites our readers' perusal of its pages.



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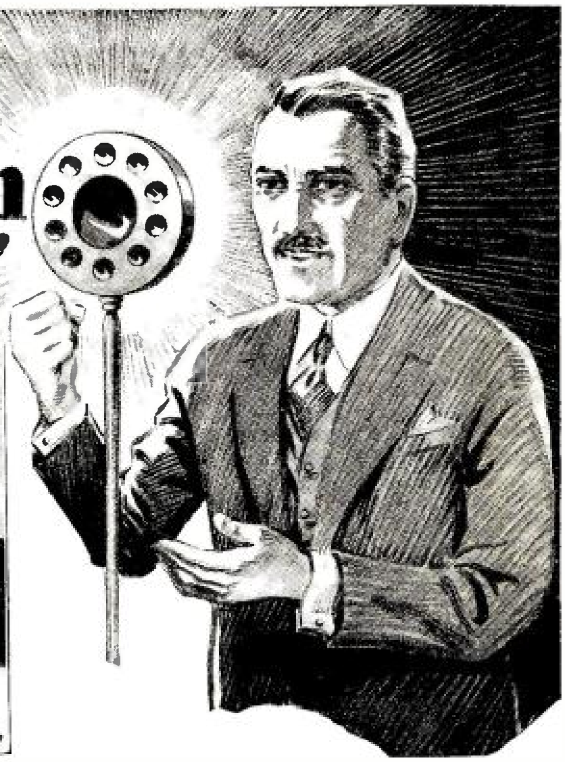

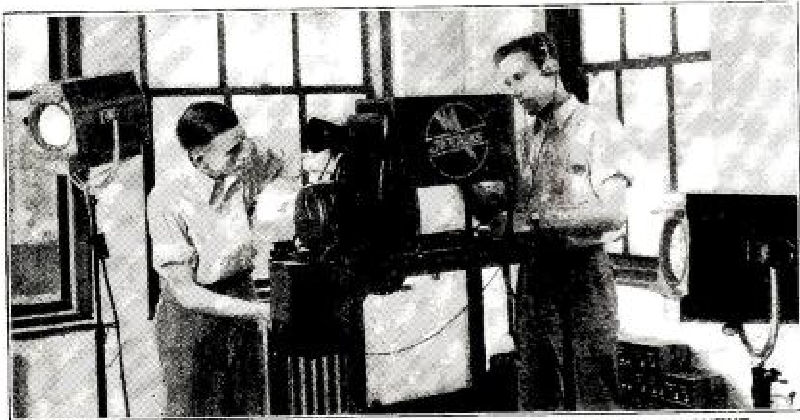

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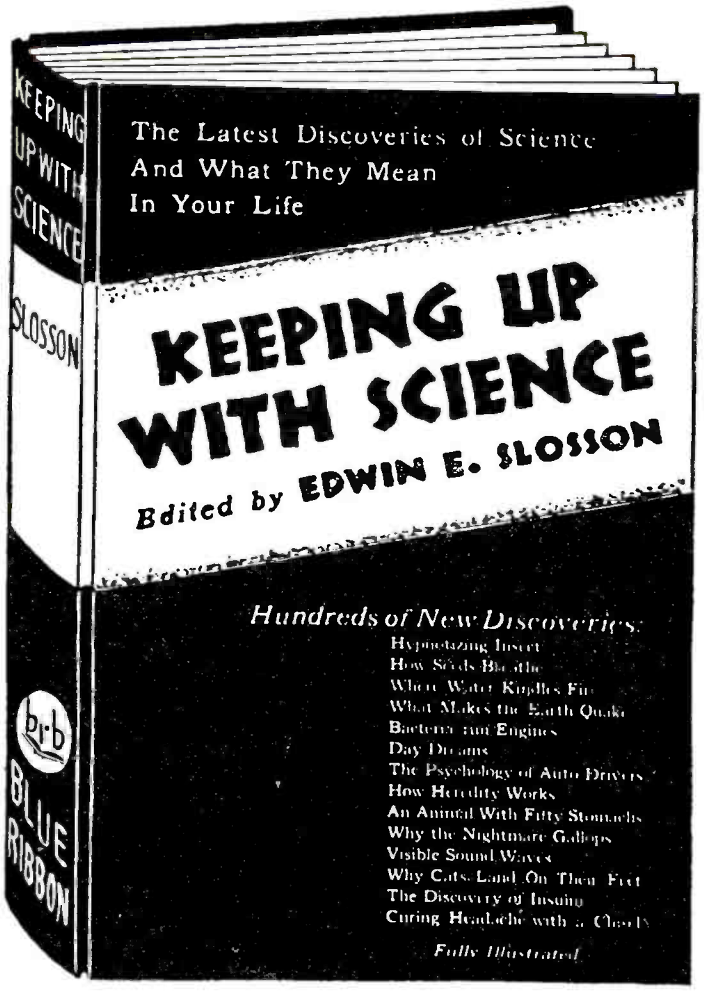

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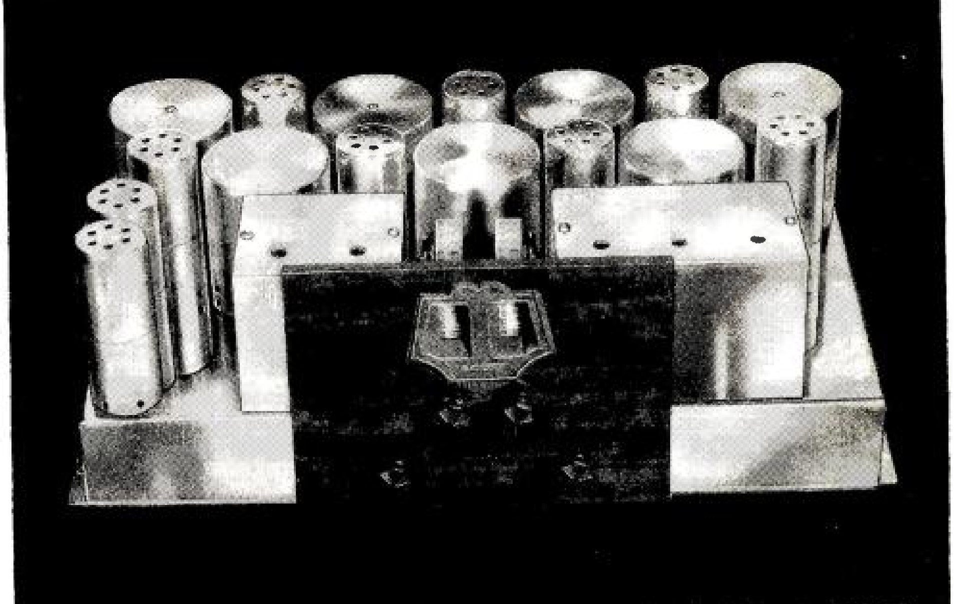

SUPERHETERODYNE

A TRULY international receiver has been the desire of radio enthusiasts for years, and the hope of engineers since radio began. And what listener hasn't wished for a receiver that would bring him—not only the whole of North America—but the major stations on the other continents as well, and as easily? 1931 sees the perfected realization of all such dreams, in the new and genuinely excellent Scott ALL-WAVE Receiver.

The new receiver tunes from 15 to 550 meters. Actually—without exaggeration—it brings in Rome, London and many other foreign stations below 200 meters, just as clearly and with the same volume as a local broadcast. Grand Opera—the *real* Grand Opera, comes in direct from Rome to afford Scott listeners the musical thrill of a lifetime. And Big Ben, tolling off the hours in the House of Parliament in London, sounds as though it were right over head. Such reception is a REGULAR, DAILY event in homes equipped with the new Scott All-Wave Receiver.

New Standards for Short Wave Reception

The performance of the Scott All-Wave below 200 meters is not to be confused with the unsatisfactory short wave reception of the past. There are no sharp edges—no irritating squawks—no mushiness or other disturbing receiver noises to take from the thrill of listening to the other side of the world. The short wave broadcasters unroll their music, voice and song thru the Scott All-Wave, with the same liquid smoothness as those within the 200-550 meter band.

Credit goes to new kind of Intermediate Amplifier

The truly amazing performance—the unlimited range—the actual 10 kilocycle selectivity—all are due to the new type intermediate frequency amplification employed in this receiver. Never before thought of—never before attempted—this system of amplification accomplishes exactly what superheterodyne engineers have sought to achieve, ever since the advent of this admittedly superior receiving circuit.

GIVES A NEW MEANING TO "TONE"

The tonal reproduction of the Scott All-Wave is equally as refreshing as its sensitivity and selectivity. From a whisper to concert volume, every note—every delicate shading is faithfully reproduced. The push-pull audio amplifier employed gives results impossible to otherwise obtain.

5-YEAR GUARANTEE

To simply say that we believe the new Scott All-Wave to be the finest receiver ever built, does not suffice to express our confidence in the engineering and quality construction that makes Scott performance possible. So—we guarantee each Scott All-Wave for five years and agree to replace any part—free of charge—that fails to give perfect service within that time.

Make the SCOTT ALL-WAVE Prove Itself to You

Decide right now to have the ultimate in radio. Plug the new Scott All-Wave into a base board socket in your own home. Tune in Rome—tune in London—tune in Chelmsford—listen to Sydney, Australia—to Buenos Aires—to Bogota, Colombia—enjoy short wave foreign stations to your heart's content. Then step thru the broadcast band for the domestic stations. You'll find them all on dial, and all with far more volume than you can ever use. The price of the new Scott All-Wave is amazingly low. Write for full particulars at once.

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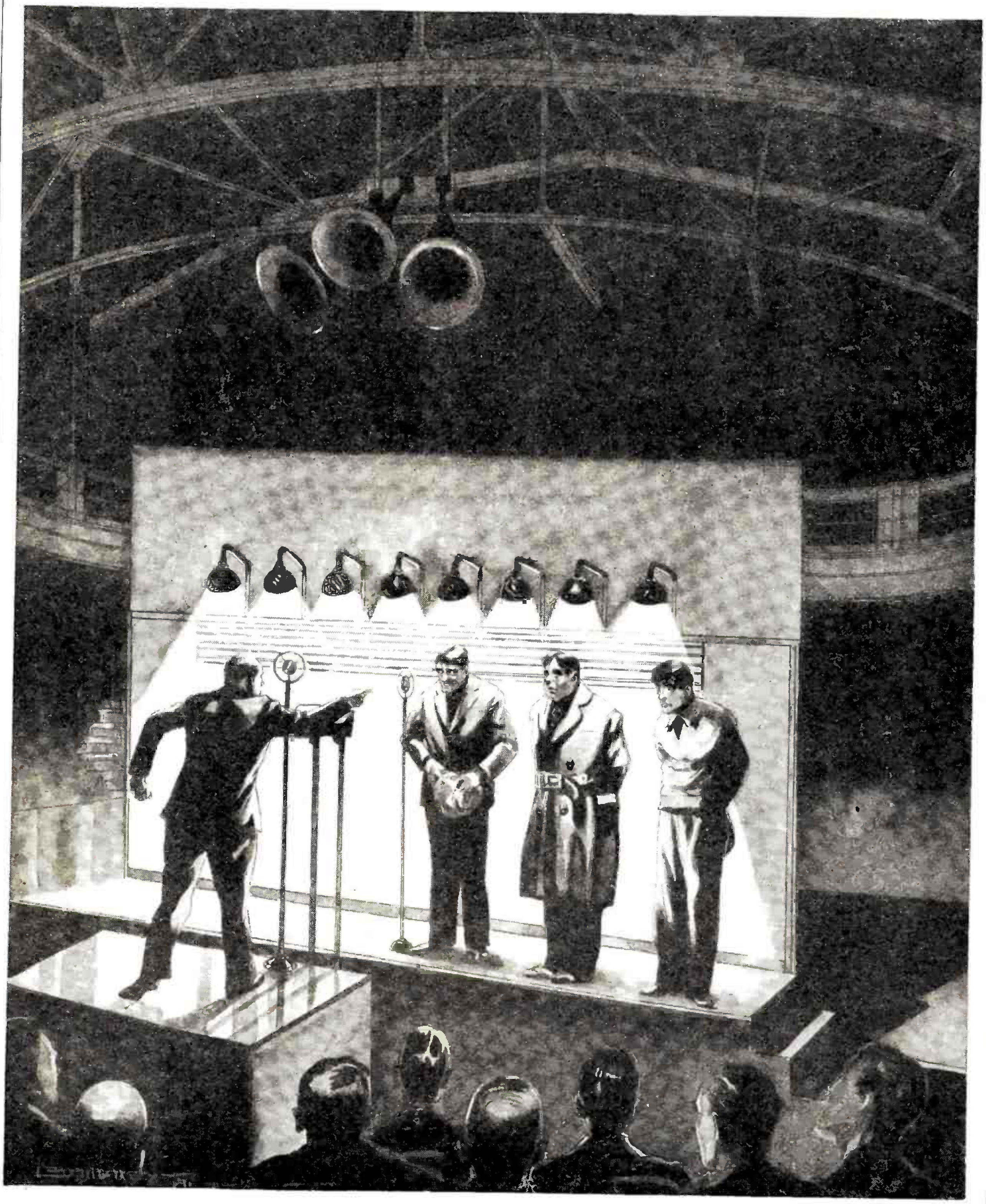


"Where were you on the night of . . .?"

Latest police methods in conducting the criminal line-up make use of radio microphones, loud speakers and amplifiers in the questioning of suspects. The psychological effect of the microphone and the amplified voice of the inspector tends to produce stage fright in the most hardened criminal. Listening detectives hear every word

How the Police Are Using The Radio THIRD DEGREE

Radio is becoming a thorn in the side of the criminal element. Not only does it enable police headquarters to keep in constant touch with police cars on duty, but even in connection with the police line-up, radio and public address systems are proving invaluable

By Samuel Kaufman

THE word "line-up" strikes terror in the heart of a criminal. This is especially true now that the art of radio is abetting the police in the apprehension and conviction of felons. The long used "arm" of the law is now supplemented by radio—the new "voice" of the law.

Once the suspect is captured, he is brought to the line-up gallery for close scrutiny and interrogation. He is grilled by the Chief Inspector of the Detective Division and is analyzed by some 300 of New York's finest. Once a suspect is brought into the line-up gallery, he is never forgotten. His features and characteristics are indelibly impressed in the minds of detectives. Occasionally a suspect is recognized in the line-up as being wanted for some past offense and the old charge is booked against him along with the more recent one. The line-up reveals the suspect's entire past. His aliases are cast aside and his record is fully disclosed. Line-up methods have been drastically altered. Gone are the gruesome masks that detectives once wore during the proceedings. Now, a modern public address system—a product of radio laboratories—enables the utilization of a larger chamber for the line-up proceedings, thus accommodating more detectives than in the past.

New York's Police Headquarters occupy an old but stately structure at Centre, Grand and Broome Streets. The location is midway between the Ghetto and the downtown business section. To the casual passer-by, the landmark has remained unchanged throughout the years. Yet, within the inner sanctums, great changes are constantly taking place. Improvements in police method and procedure must rapidly be applied to cope with the citizen's most powerful enemy—the criminal.

Today, radio and its allied arts play important parts in crime detection and police operation. The radio microphone and the radio key are permanent instruments in police procedure. A sturdy, disciplined organization of 20,000 military men, the New York Police Department finds many practical uses for radio in the daily department routine. The department, embodying patrol, motor, marine and air divisions, needs the central communications force provided by radio.

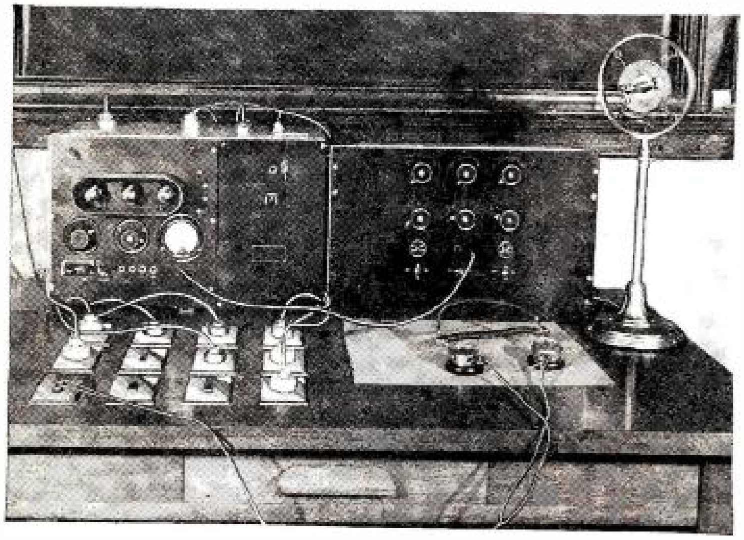
Sixteen years have passed since the antenna mast of old Station KUVS was erected atop Police Headquarters for harbor communication. Two years ago, the antique spark transmitter of KUVS was replaced with modern tube apparatus and the call letters simultaneously changed to WPY. Now, two short-wave channels have been set aside by the Federal Radio Commission for the further expansion of the Police Department's radio division. Police Commissioner Edward P. Mulrooney recently told the writer that, depending on the granting of additional appropriations by the Board of Estimate, the police radio system will be greatly enlarged and extended to motor-car and airplane communication.

Radio communication having long since proved invaluable in police procedure, department officials were quick to recognize the application of radio principles to other police duties. The most important and revolutionary improvement along these lines was the introduction of a public address system into the procedure now known as the criminal line-up.

Although the wheels of activity at Police Headquarters are kept turning all night, it is at 8:45 a.m. that the new day is officially launched. At that hour, prison vans from all boroughs pull up at a rear gate and unload the criminal suspects arrested throughout the city within the past twenty-four hours. Police flivvers arrive in a steady stream bearing officers from various city precincts. Detectives, singly and in groups, flow through the corridors and stairways. All are arriving for that

The short-wave radiophone transmitter of the Los Angeles Police Department used to broadcast orders throughout the city

The radio-receiver-equipped police car in Los Angeles. These cars are constantly in touch with Police Headquarters



Above is a close-up of the public address table in the line-up gallery at the New York Police Headquarters. At the right, Patrolman Charles Francis, designer of the P. A. system, is shown at the control panel

phase of police operation considered the most colorful, interesting and dramatic—the morning line-up.

The line-up gallery, a huge auditorium with a circular balcony, is located atop the building. The room was previously used as the police gymnasium. Three hundred chairs are arranged in rows extending the entire length of the room. Shortly before 9 a.m. every seat is taken. The Police Commissioner and his deputies arrive and take front seats. All window shades are pulled down and the room is in complete darkness with the exception of a platform at the front of the room which is brightly illuminated by nine powerful reflector lamps. Between the observers and the platform is a stand bearing close resemblance to a conductor's rostrum. Microphones are seen on both the platform and rostrum. The visitor may imagine that he's in a theatre, the lights have gone down, the stage is lit, a conductor mounts the rostrum and the show is about to start. But this impression does not last long. The atmosphere is too grim. Nevertheless, real drama—the drama of life—is enacted here. Ironic tragedy, sometimes mingled with farce comedy, is enacted on the platform.

Assistant Chief Inspector John J. Sullivan, chief of detectives, mounts the rostrum and calls for the first case. He talks into a microphone and his voice is carried throughout the chamber by powerful amplifiers. He has a sheaf of papers which he consults under a small light. Three youths—mere boys—are escorted up the front platform. Under the glaring lights thrown on them, all their features can be readily observed. Painted lines on the white wall behind them reveal their exact height. Although they themselves can be clearly studied under the bright illumination, the suspects, blinded by the reflector lamps, cannot distinguish anything in the room.

Their records are read and we find that, despite their youth, they are habitual criminals. One of the suspects, out of the House of Correction only a few weeks, now faces a severe penalty for holding up a storekeeper. He was captured with a loaded revolver in his possession.

"What does your mother think of you?" the inspector asks, his voice thundering through the rooms through the powerful amplifiers. The lad carelessly shrugs his shoulders.

"Is she proud of you?"

"I guess not," the suspect falteringly answers. His voice is low and the public address operator steps up the volume.

Further questioning by the inspector and the young suspect reveals in detail how he and his companions attempted to rob the store. Through with the ordeal, the suspects are ushered into a steel-vaulted stairway and returned to the cells below.

Two white men and a Negro are brought on the stand, charged with extortion. A sabre-like knife, found on the person of one of the suspects, is examined by the inspector under his small light. The three men were arrested at an early morning hour, but deny knowing each other.

Inspector Sullivan recognizes the Negro, who has been in the line-up many times in the past on varied charges.

"I want every detective in this room to take a good look at this man," he remarks. "He is a menace to society. Why he is allowed to be at large, I do not know." The Negro bears a contemptuous, half-smiling expression.

A score of detectives escort a group of five men to the stand. One is accused of murder and robbery; the others are held as material witnesses. A few have long criminal records and the strong guard is considered essential. The men are unkempt and unshaved. They were grilled all through the previous night.

"What were the masks we found in your room for?" Inspector Sullivan asks one of the men on the stand.

"For a masquerade," the captive unhesitatingly replies as a ripple of laughter passes through the room.

"I know that's what they were made for," the inspector remarks, "but that's not what you used them for."

The loud volume of the inspector's voice seems to have a psychological effect on the suspects and tends to break down the wall of restraint that the prisoners obstinately bear.

All through the proceedings, a police stenographer records the questions and answers which go on file in Inspector Joseph J. Donovan's Statistical Bureau. Duplicate reports are turned over to the District Attorney's office and may be introduced as testimony at the trials of the indicted men. Frequently, the police stenographer must testify in court as to the authenticity of the line-up reports. Recently, tests were made to ascertain the practicality of making phonograph recordings of the line-up. Actual recordings of the suspects' remarks may then be introduced at trials as evidence.

An attendant who stands at the platform and adjusts the microphone is a linguist and serves (*Continued on page* 154)

Operating room of station WPY of the New York Police Department. This transmitter is used chiefly for harbor communication

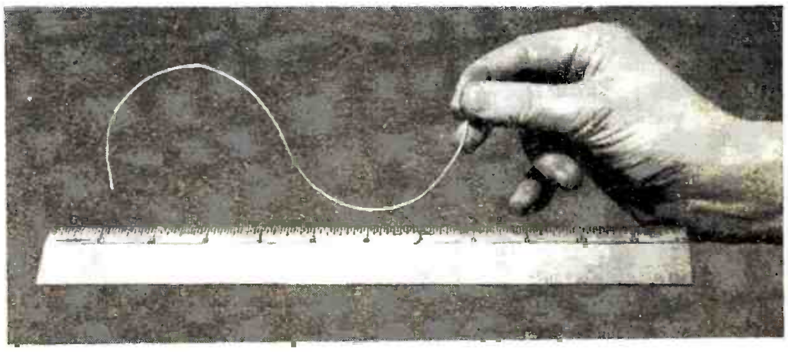
SEARCHLIGHT RADIO with the New 7-inch Waves

Micro-waves, used recently for communication across the English Channel, promise a whole new field of radio uses. Lenses, mirrors, radio-telescopes, radio-microscopes, all become practical possibilities

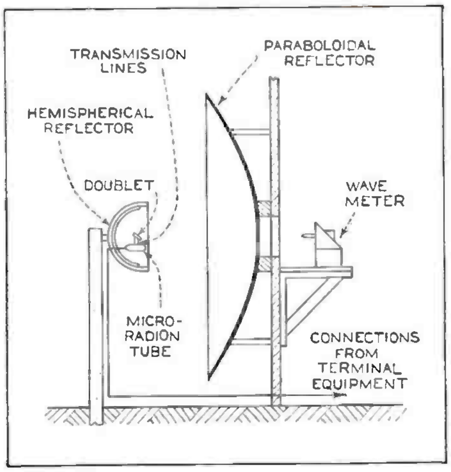
By E. E. Free, Ph.D.

TWO groups of radio engineers stood recently on opposite sides of the English Channel conversing with each other over the shortest radio waves ever used. Narrow pencils of these 18-centimeter waves shot back and forth between reflectors on the two sides of the waterway like beams of light from gigantic searchlights. Over these new beams of "micro" waves radio telephony was conducted, code signals were sent and even picture transmission was carried out successfully, just as over the conventional wavelengths.

Very short radio waves have been produced before in laboratories; they go back, indeed, to the pioneer experiments of Hertz. The recent tests mark the first occasion, however, when these extremely short wavelengths were put to practical use. That the experiments open up a whole new field of radio—more than that, a whole new field of physical science—is unquestionable.



The whole length of a complete wave of the new micro-waves covers only ten centimeters, about seven inches on a ruler. That is why beams like those of an optical searchlight become possible

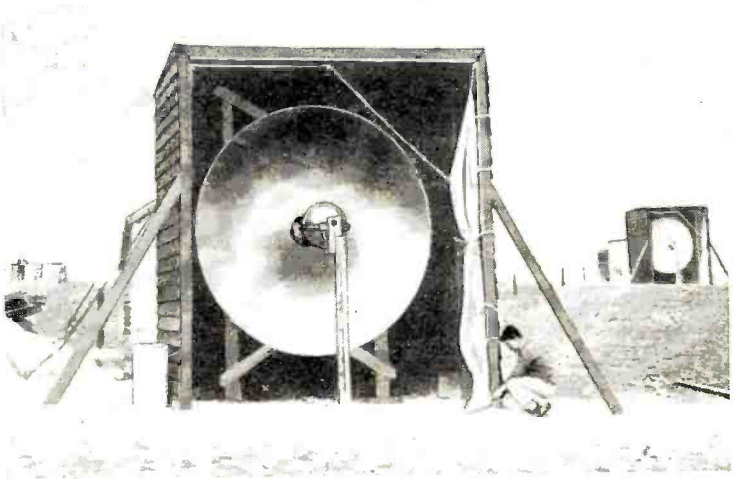


The transmitter is the small doublet attached to the new micro-tube. Hemispherical and parabolic mirrors of reflecting metal concentrate the waves into a beam

Two European Groups Co-operate

As described in news dispatches, two European organizations were responsible for the tests: the laboratories of the International Telephone and Telegraph Company at Hendon, England, and the Laboratoire du Materiel Telephonique of Paris, France. In charge for the English interests was Mr. G. H. Nash and for the French interests Mr. E. M. Deloraine. Associated were the French experimenters, MM. Clavier, Dorbord and Fournier, with Mr. Gibson of the English organization assisting Mr. Nash.

Two radio beams were employed, each operating on the same wavelength of 18 centimeters or approximately 7 inches. Since the beams were separate and parallel, interference between the two was avoided automatically, just as is the case with light beams from searchlights. The distance was approximately 40 kilometers. The total power used by each transmitter was but 25 watts, of which only approximately one-half watt was radiated. In spite of this minute energy, transmission is reported to have been substantially better than in ordinary radio links. Fading was entirely absent. Even the amount of static or other interference is reported to have been much below the average for ordinary waves under similar conditions.



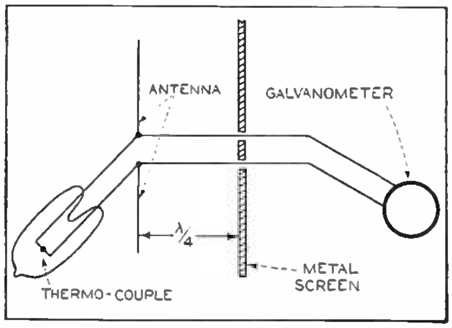
Two similar parabolic mirrors serve as transmitter and receiver respectively at each end of the cross-Channel link, the receiver placed back of the transmitter to avoid interference from the near-by transmitter

The most remarkable feature of the field of wavelengths thus opened up to experimentation is undoubtedly that it makes possible the use of methods and apparatus borrowed from the optical science instead of from electrical engineering. Ever since the epoch-making experiments of Hertz it has been well known that radio waves and light waves are of exactly similar character except that the radio waves are longer in wavelength. The lenses, mirrors and similar optical devices used in telescopes and microscopes could be used equally well for radio waves, every physicist knows, except that the lenses and mirrors might need to be miles in diameter instead of the fractions of an inch which are sufficient for light waves. This is merely a result of the difference in wavelength. To be effective as a concentrator of the waves, a parabolic mirror, for example, must be at least two or three times wider than the wavelength of the waves employed. For really efficient operation mirrors and lenses must have many times the dimensions of one wavelength. For light rays with wavelengths counted by tens of thousands in an inch this is simple. For ordinary radio

Several years ago in Russia Madame Glagolewa-Arkadiewa produced radio waves only a few centimeters long by spark discharges from steel filings, but the radiation was of mixed wavelengths

waves with wavelengths of hundreds of meters it is impossible.

This is why the new micro waves, tamed by the French and British experimenters, promise to be so interesting. For the recent tests the reflectors employed to create the beams of micro waves were of parabolic cross-section, approximately 10 feet in diameter. With the 7-inch wave, therefore, there was room on the reflector for between fifteen and twenty wavelengths. While this is much less than the number of wavelengths handled, for example, by the reflector of a giant searchlight using light waves, it proved still to be sufficient, not merely for the practical trials, but to establish the general conclusion that optical methods will be as useful with these micro waves as they have proved to be with those of light.



The wavemeter, placed behind a hole in the center of the transmitting mirror, consists of a receiving antenna, a thermocouple and a galvanometer. Both the wavelength and the wattage of the transmitted beam are checked continuously

Searchlight radio is already, by these experiments, an accomplished fact. Radio analogues of the optical telescopes, microscopes, magic lanterns, interferometers and other well-known physical instruments may be expected to be developed rapidly by the experimenters in the new field.

The fundamental generator of the new micro waves is a special vacuum tube the characteristics of which have not been described. It is learned from French sources, however, that the tube depends upon the principle discovered some years ago by Professor Heinrich Barkhausen of the University of Dresden and afterward modified by the French experimenter M. Pierret. According to this method, the oscillations which produce the wave do not need to take place throughout the entire plate circuit of the tube but correspond merely to a space oscillation of the electrons between the tube elements—a veritable electronic dance inside the structure of the tube itself.

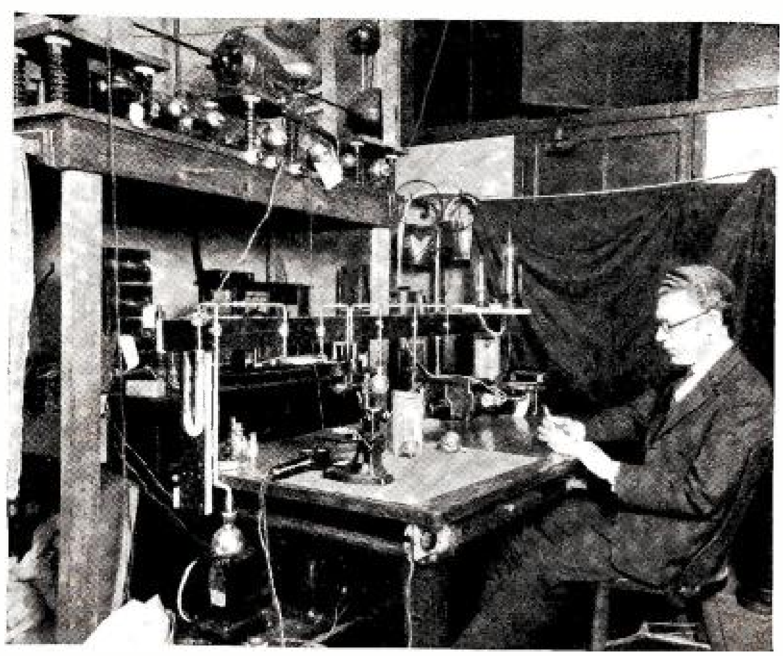
Investigations of Hertz

The original short radio waves, those investigated by Heinrich Hertz, were of the highly damped variety rather than the continuous variety now used in practical radio. Hertz's oscillators and other sources consisted, it will be remembered, of spark circuits producing not merely damped radiation but radiation much mixed in wavelength. Waves in the neighborhood of one meter were produced, were tested by optical methods and were found to confirm the theories of Clark Maxwell and others concerning the nature of electro-magnetic radiation. No attempt to produce what might be called "monochromatic" radiation was possible. The optical analogy of Hertz's generators is a fire containing miscellaneous elements and compounds rather than the pure, monochromatic light emitted, for example, by a tube of glowing helium. For such monochromatic radiation in the radio field what was necessary was some method of obtaining continuous waves.

Other Investigators

As other investigators followed in the footsteps of Hertz this deficiency continued. The Russian physicist, Madam A. Glagolewa-Arkadiewa, succeeded in producing extremely short wavelengths, ranging into millimeters, by the device of creating numerous small sparks between iron filings suspended in an oil medium. In the United States, the late Professor Ernest F. Nichols and Dr. J. D. Tear produced wavelengths in the similar millimeter range and compared these waves with infra-red and heat waves, using as their generators tiny metal points set into oscillation by this same device of intermittent sparking. Although these investigations sufficed to establish, on a firm experimental basis, the identity of the longer heat waves and the shorter radio ones, the radiation produced continued to be mixed and highly damped, not permitting the advantages of continuous wave technique.

Meanwhile numerous experimenters with vacuum tubes, chiefly those working under the famous French radio engineer, General Gustav Ferrié, attempted, by decreasing the size of oscillating tubes and shortening the leads from them, to produce shorter and shorter wavelengths. Captain René Mesny managed, for example, to generate, from such special tube-oscillators, wavelengths shorter than three meters. In the United States, Dr. Philips Thomas of the Westinghouse Laboratories produced substantial quantities of radiation in wavelengths of the order of two meters. It rapidly became evident, however, that this line of development was limited. Wavelengths between one and three meters are not really short enough for the full utility of optical technique.



A distinguished American investigator of very short radio waves is Dr. J. D. Tear. Together with the late Professor E. F. Nichols, Dr. Tear produced radio waves only a few millimeters long and proved that these waves are identical in character with heat waves. Only waves of mixed wavelength were produced, but optical methods, like that of the interferometer, were used in studying them

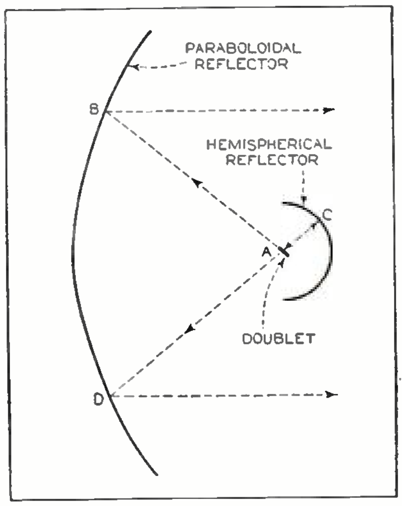
On the other hand, to produce still shorter wavelengths from ordinary vacuum-tube circuits would involve such tiny circuits outside the vacuum tube as to be practically impossible.

This is the difficulty which was solved by Barkhausen's novel idea of producing an oscillation inside the tube itself; the plate of the tube being held negative and the grid positive. instead of the usual arrangement. Just how this internal oscillation of the tube's space charge of electrons has been applied in the new micro tubes used in the French and British experiments, the engineers in charge have not yet disclosed. American experimenters and amateurs will await with the greatest interest either this information or the availability of the tubes themselves.

For the radiation of the output of the micro tubes in the recent European trials. the oscillation inside the tube is communicated by very short leads to a tiny metal structure called a "doublet." mounted immediately above the micro tube and approximately two centimeters long. This serves as a radiating antenna.

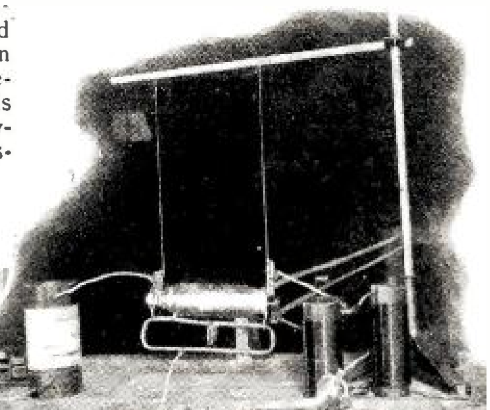
Use of Reflectors

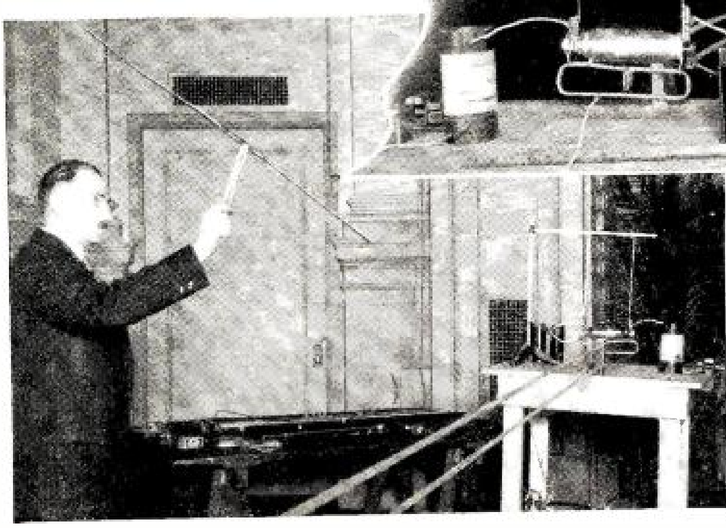
To make sure that as much of the radiation as possible will be concentrated in a single beam, a small hemispherical reflector is used in front of the main parabolic one, with the radiating antenna mounted in the focus of this hemisphere, as is shown on the accompanying diagram. The radius of this hemisphere, its distance from the parabolic reflector and other details of the mounting are arranged, of course, to suit the wavelength of the radiation being used. It is interesting that this entire structure, hemisphere, parabola and all, is almost an exact duplicate of a mounting frequently used for the projection of searchlight beams.



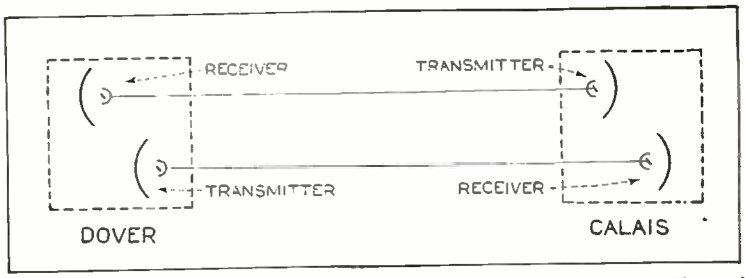
The hemispherical mirror in front of the transmitting doublet increases the efficiency of the transmitting mirror by throwing all frontward radiation back against the parabolic mirror instead of allowing this radiation to waste itself in space

The use of the hemispherical reflector carries with it the disadvantage of a cylindrical hole at the center of the projected beam corresponding to the radiation which strikes the hemisphere and is reflected back against the parabola. This disadvantage is more than made up, however, by the fact that no radiation escapes from the radiating antenna in any other direction than along the beam created by the parabolic mirror.





Dr. Philips Thomas, of the Westinghouse Electric and Manufacturing Company, produced radio waves about two meters in wavelength, from the transmitting tube shown above, and demonstrated these waves in near-by space by the wave antenna which he is holding. These waves were not short enough to permit real radio searchlights



The two radio beams of the cross-Channel link run side by side, interference between them being prevented by the narrowness of the beams and the placement of the receiving mirror behind the transmitting one, just as with searchlights throwing light beams

One important advantage of this arrangement is the possibility of using exactly the same wavelength on the two beams, without the transmitter interfering with the receiver. This receiver is a precise duplicate of the transmitter. the two curved mirror serving to focus the received beam on the tiny antenna attached to the microtube. Thus the microtube serves as the detector instead of as the transmitting oscillator.

The transmitting system and the receiving system, at either end of the recent European trials, were mounted, as is shown in the photograph, close to each other. With any ordinary form of transmitter this would have involved substantial interference by the transmitter with the near-by receiver. This fact, as is well known, is responsible for the usual custom of using two separate wavelengths in such two-way transmission.

With the new micro-wave arrangements this is unnecessary. The receiving mirror is merely placed so that it will be out of the line of the transmitting beam, as though it were in the shadow alongside a searchlight. No radiation from the transmitter is received. The receiver responds entirely to the radiated beam from the distant station. Thus is emphasized another of the substantial advantages of the optical methods possible with these extremely short waves.

An ingenious arrangement used in the recent tests made possible a continuous check on the wavelength of the transmitter without interfering with the energy radiated. As indicated in one of the photographs, the parabolic mirror has at its center a hole slightly smaller in diameter than the diameter of the hemispherical mirror. Behind this hole there is mounted a wavemeter consisting of an antenna and a thermal galvanometer. Radiation moving directly backward through this hole strikes the wavemeter and may be measured either for wavelength or for intensity. No diminution in the general beam is thus introduced, as the hole in the parabolic mirror is exactly opposite to the hemispherical reflector, so that this portion of the parabolic mirror would be useless anyway.

Measurements made on this meter indicated, in the recent trials, that the power radiated was in the neighborhood of one-half of a watt. Similar measurements made with and without the different mirrors indicate that the gain introduced by using the parabolic mirror is approximately 46 decibels, this corresponding to the gain obtained by concentration of the wave spherically radiated from the antenna into the single beam produced by the reflecting system. The addition of the hemispherical reflector produced, it (*Continued on page* 152)

Television Receiver Kit

Easily Assembled at Home

This television receiver kit was designed to simplify the problem of home construction. The finished job combines the appearance of a manufactured chassis with the efficiency of good engineering

By D. E. Replogle*

ARE you telewise? If not, you are missing much profitable entertainment. Television is no longer an experimental mystery, there being a number of powerful stations broadcasting regular features that are picked up by thousands of amateurs who have built their own receiving equipment. W2XCR of New York, W2XCD of Passaic, N. J., and W3XK of Washington, D. C., for instance, broadcast continuous programs from three in the afternoon until a half hour after midnight each day in the week with the exception of the hour from five to six. Other stations located in Boston, Long Island City, Chicago and on the West Coast also have regular program services. All types of entertainment are being featured by these stations; playlets, dancers, important speakers, singers. The voice part of these broadcasts can be picked up by the average good broadcast receiver but in order to pick up the images a special short wave receiver and radiovisor must be employed.

The Federal Radio Commission has designated a special band for television broadcasting, in the range between 100 and 150 meters. As there are fewer television stations per channel in this band than radio stations in their band, the signals are easily picked up without interference. Unfortunately few of the short wave broadcast receivers on the market are suited for television reception. Broadcast receivers are rarely designed to go below 200 meters and most of the efficient short wave sets are designed to operate in the more popular 3000, 7000, and 14,000 kc. bands.

In order to enjoy television programs two pieces of apparatus are required: a short wave television receiver, and a radiovisor. The receiver is similar in design to those used for regular short wave radio reception with certain reservations to be dealt with later. The radiovisor takes the place of the loud speaker in the usual outfit. In this particular article we shall interest ourselves only with the construction of the receiver proper, dealing with the radiovisor later. That article, together with the present one, will cover complete home television equipment.

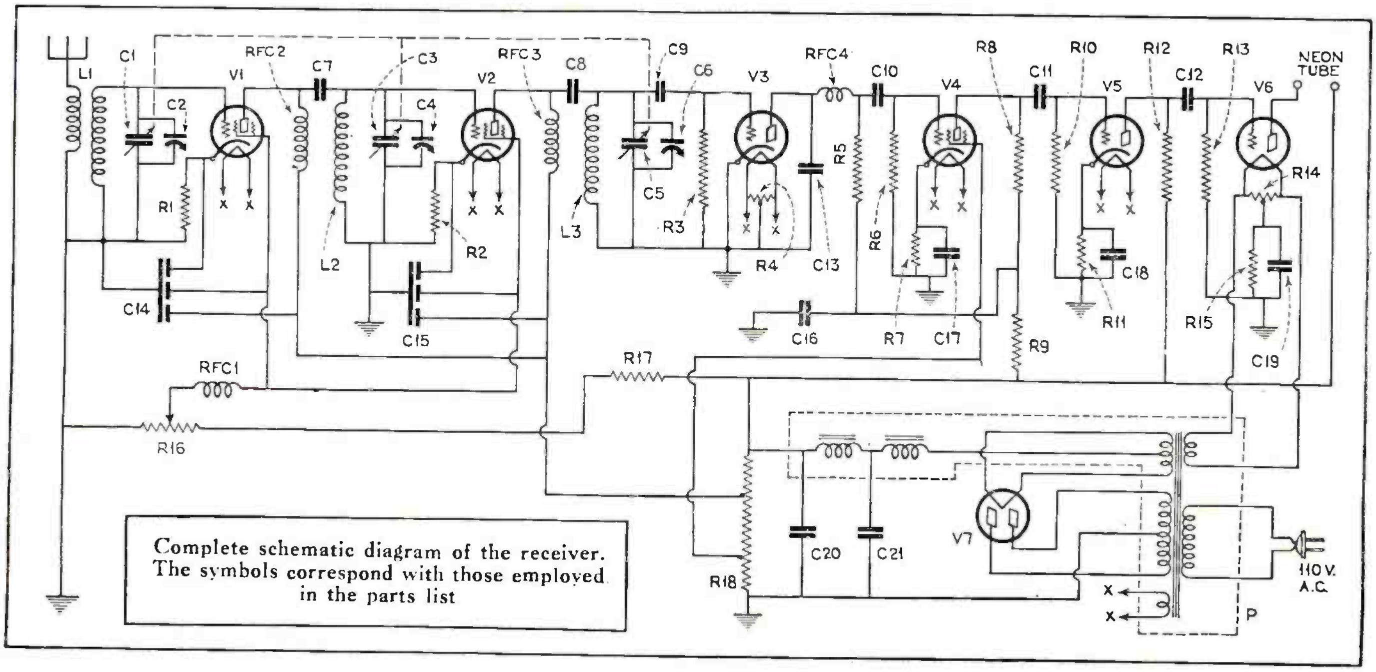
A television receiver kit has been designed by the Jenkins Corporation of Passaic, N. J., which answers the requirements of a good television receiver. The kit includes the complete parts for the receiver, power pack and amplifier. The parts and circuit are especially designed to eliminate distortion. A resistance coupled amplifier has been used, as the best transformer coupled amplifiers cannot cover the frequency range necessary for the detail and shading of radio pictures.

If the experimenter possesses a receiving set that covers a range of 100 to 150 meters, employs a resistance amplifier, a stage of power amplification which employs the type -45 tube, a system of tuning that can easily tune out undesired stations, and sufficient sensitivity to pick up with ample strength the signals from one or more of the television stations now operating, he need only construct the radiovisor in order to procure television programs.

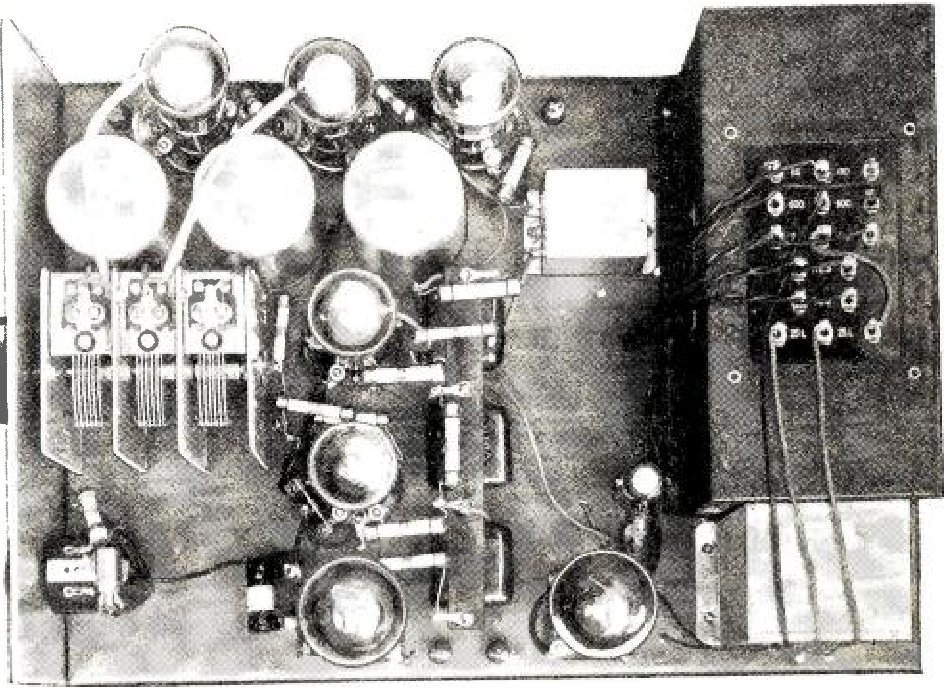
The receiver while designed especially for the Jenkins radiovisor may be used with other standard radiovisors as well. Its price is well within the range of any fan. The assembled set resembles the usual six tube single control short wave set. The power pack, operating with a type -80 full wave rectifying tube, is located in the rear of the set. A tuned radio frequency amplifier with two stages of radio frequency is employed, followed by a detector, two stages of audio frequency and a stage of power amplification. The carefully filtered power pack output supplies all the necessary A, B, and C voltages for the set. Each part in the kit has been numbered for easy identification. With the aid of clear charts and simple instructions the receiver can be assembled in a few hours. Every part is included in the kit so that not even a bolt or piece of wire need be purchased.

The first unit to be considered is the power pack, which in the assembled set will be located in the rear of the receiver.

*Jenkins Television Corp.



Complete schematic diagram of the receiver. The symbols correspond with those employed in the parts list



Assembled Jenkins television receiver, showing locations of all parts

This pack includes a special transformer supplying 2.5 volts and 5.0 volts to the audion filaments, as well as 300 volts to each plate of the rectifier tube. The rectified high voltage is filtered by means of two special 30 henry chokes, enclosed in the transformer housing for simplicity, and a 6 mfd. condenser block. This unit supplies all the power required to operate the receiver and is turned on and off by a switch mounted on the volume control knob on the front panel of the receiver.

The second unit is a radio frequency amplifier and station selector, located on the front portion of the base immediately behind the front panel. This unit consists of two screen-grid tubes operating in three tuned circuits. Tuning is accomplished by means of a single knob that controls the three gang variable condenser.

The three tuned circuits provide ample selectivity, while the two screen-grid tubes amplify the signal sufficiently to provide good pictures when the received wave has a field strength as low as 15 microvolts per meter. Were the receiver more sensitive it would pick up static and other electrical noises to distort the picture when the strength of the received signal drops below 15 microvolts per meter. The radio-frequency amplifier is designed to pass the wide frequency band which is absolutely essential to good television image reception.

The third unit consists of three stages of resistance coupled amplification. The first stage employs a screen-grid audion, and the second the usual three element audion. The third and last stage uses a type -45 audion. This stage provides the power to operate the neon tube of the radiovisor.

The kit contains a base with all holes for mounting drilled. All supports for coils, condensers, tubes, etc., are complete in every detail. Almost every piece of apparatus is fastened on with lock washers so that there is little chance of any of the equipment being jarred loose.

List of Parts

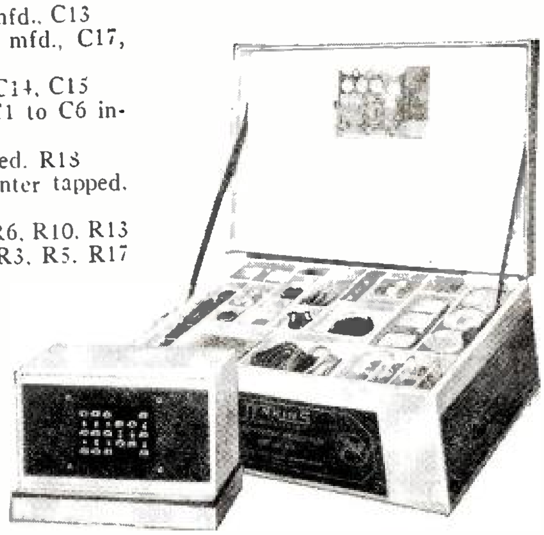
1 power pack, P
1 filter condenser 4.0-2.0 mfd., C20, C21
1 plate by-pass condenser 1.0 mfd., C16
3 audio coupling condensers 0.25 mfd., C10, C11, C12
2 RF coupling condensers .0001 mfd., C7, C8
1 grid condenser .0001 mfd., C9
1 detector by-pass condenser .0001 mfd., C13
3 grid bias by-pass condensers 2.0 mfd., C17, C18, C19
2 RF by-pass condensers 0.1 mfd., C14, C15
1 variable tuning condenser gang, C1 to C6 inclusive
1 bleeder resistor 41,000 ohms tapped, R18
2 hum balance resistors 20 ohm center tapped, R4, R5
3 Coupling resistors 250,000 ohms, R6, R10, R13
3 coupling resistors 100,000 ohms, R3, R5, R17
2 coupling resistors 50,000 ohms, R8, R12
1 coupling resistor 25,000 ohms, R9
1 bias resistor for type -45 tube 2,000 ohms, R15
1 bias resistor for type -27 tube 2,000 ohms, R11
3 bias resistors for type -24 tube 500 ohms, R1, R2, R7
1 volume control resistor 25,000 ohms, R16
1 RF choke 300 turns, RFC1
3 RF coupling coils, RFC2, RFC3, RFC4
1 antenna coil, L1
2 RF coils, L2, L3
5 five-prong audion sockets, V1 to V5, inclusive
2 four-prong audion sockets, V6, V7
1 tuning dial.

Besides the above listed major parts, the kit contains the accessories, such as wire, nuts, insulating mounts, clips, etc.

Mounting of the Parts

In designing the set the engineers have taken great care that the apparatus is mounted so as to give the greatest facility in wiring and the minimum of induced currents in the set.

First the three grid by-pass condensers, C10, C11 and C12, should be mounted in the proper places, next the two four-prong tube sockets on the right hand side of the base panel. The five five-prong sockets are then mounted, three on the left hand side of the baseboard going back and two just back of where the gang condenser is to be placed. The bleeder resistor, R18, should now be placed with great care. The front panel should then be anchored to the base. The two RF coils and the antenna coil, with their accompanying "cans," should be fastened down. The gang condenser is fastened directly on the chassis with the proper screws. It should be noted that the shaft of the condenser should be carefully insulated from the panel. The trimmer condensers on the gang condenser unit should be uppermost so that they will be freely accessible. The entire power pack should be placed at the rear of the baseboard. Binding posts for the antenna and ground should be located in the holes provided near the panel end of the baseboard. The binding posts for the loud speaker or radiovisor should be located on the opposite side of the baseboard near the output audio stage.



The television receiver kit, showing power transformer at left. All necessary parts are included and numbered. Complete instruction book and diagrams are included in the kit

Wiring the Set

The parts having been mounted, we are now ready for wiring. The Jenkins kit calls for long leads to run through holes and under the base panel, but this is optional. The components have already been (*Continued on page* 176)

Practical Short-Wave Super

A discussion of the requirements involved in short-wave superheterodyne design and a description of an a.c. super, designed by the author, which he employs to pick up foreign programs for rebroadcasting purposes

By Frank H. Jones

THIS paper will deal with the design of a short-wave superheterodyne receiver which will reproduce broadcast music with high quality and at the same time be selective to a high degree both as regards adjacent channel and image frequency selectivity. No modern broadcast receiver uses regeneration, as it is destructive of good quality, and so our receiver, which we will describe, will have no regeneration in any of its tuned circuits. Quality is our goal, along with elimination of avoidable interference of all ordinary types.

Certain ideas, well known to the art, we can decide at once as being necessary. Starting at the antenna connection, for instance, we know that loose coupling reduces noise level and increases selectivity. The few turns coupling the band selector to the first tuned radio-frequency stage makes for sufficiently loose coupling. To offset the losses in the band selector and the loose coupling we will use one stage of tuned radio frequency so as to hand on to our first detector a reasonable signal voltage.

On short waves it is difficult for various reasons to obtain very high potentials across the grid circuits. This prevents high amplification, but as we shall get most of our amplification in the intermediate amplifier, this aforesaid difficulty is not so important. Further, this arrangement will give us practically equal amplification throughout the entire short-wave range—a feature which is decidedly worth while.

FRANK H. JONES is well known to American radio fans as the designer and operator of broadcast station 6KW (now CMHC), Tuinucu, Cuba. Of recent years this station has come to depend more and more on short-wave relays from American stations for its program material. Obviously the short-wave receivers designed by Mr. Jones for picking up these relay programs must be not only highly sensitive and selective, but also absolutely dependable, so when he writes on the subject of short-wave receiver design his articles are unusually well worth reading. It is therefore with pleasure that RADIO NEWS *presents this first article from Mr. Jones' pen.*

—THE EDITORS.

Needless to say, the oscillator coupling is an important factor in a s.w. super.

We will adopt the method of frequency change in the first detector as described by Kruse several years ago; namely, couple the oscillator to the first detector by a resistor to the control grid of the first detector and use this tube as a space charge detector. The oscillator coupling resistor also serves to put the correct positive potential on the grid. The screen grid goes to the grid leak and grid condenser.

When one is working up a superhet design it is obvious that one should not overlook the fact that the output voltage of the first detector varies as the product of the signal voltage as applied to the grid of the first detector and the voltage of the oscillator at the point where it is mixed with the signal voltage. With one stage of t.r.f. ahead of the first detector the oscillator voltage should be around six to ten volts. This voltage can be arranged to be varied manually in case you want maximum results on weakest signals.

But quiet operation demands that the oscillator voltage be not too high or too low. With a fixed voltage tap, this voltage for best quality should be adjusted by getting just the right number of turns on the tickler of the oscillator coil.

I am assuming that most of the readers of RADIO NEWS are already familiar with the general principles of superheterodynes, so I will proceed to discuss the intermediate radio-frequency amplifier.

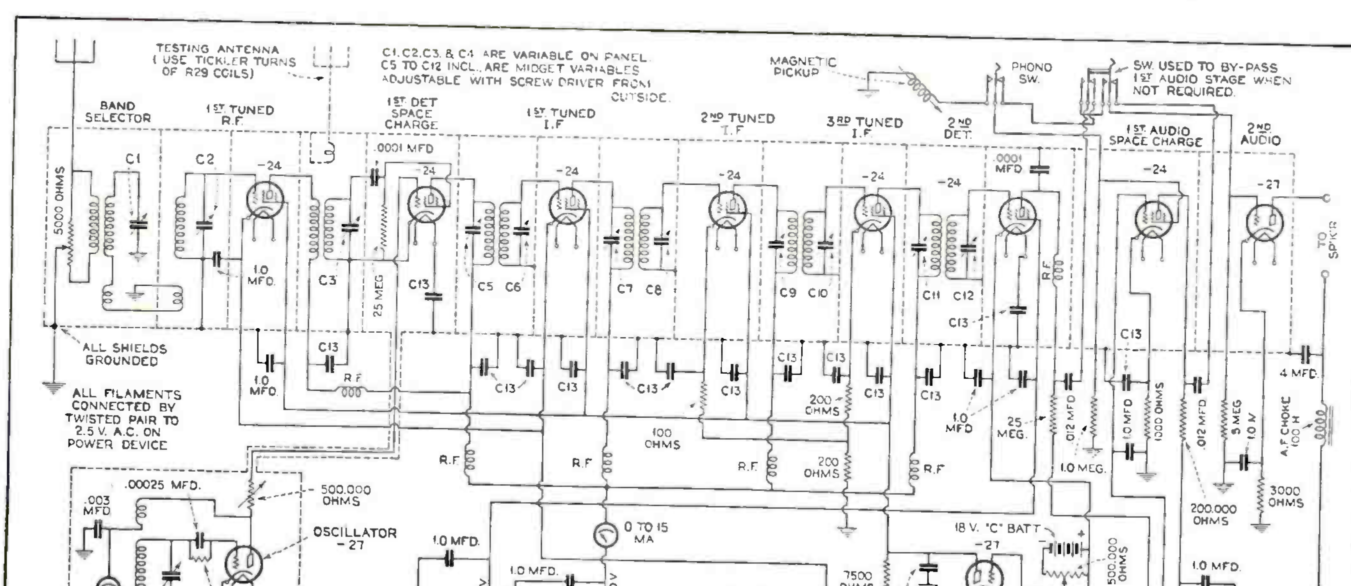


Figure 1. A complete circuit of the author's receiver, including an interesting method of automatic volume control

Design

The Intermediate Amplifier

The selection of the frequency for this amplifier calls for some careful thought. A low-frequency is very stable and capable of very high gain and feed-back is easier to avoid. It is also better for adjacent channel selectivity, which will be discussed in greater detail later on. A high intermediate frequency is better from the standpoint of image frequency discrimination.

However, a high gain is really possible at frequencies around 1700 kc. and others have recently stated that this high frequency is O.K. Curious enough, in the short-wave super I built last year, my experiments on the best frequency to adopt for the intermediate amplifier led me to adopt 1740 kc. This has the advantage, as Hatry has pointed out, of covering two wide bands with only one set of coils, with a few casual repeat points at the extreme ends of the dials. This is very close, also, to the frequency recommended by Schnell.

To illustrate this double band coverage, Figure 2 shows the oscillator dial settings for two bands with a frequency range of over 5000 kc.

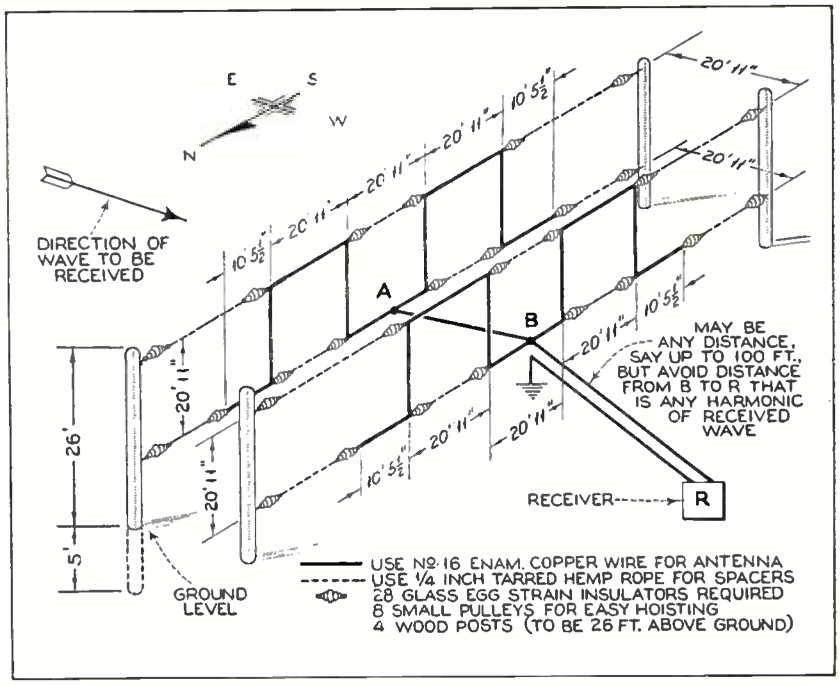


Figure 4. Example of an antenna array for receiving directionally from the east on a wavelength of 25.53 meters

Selectivity

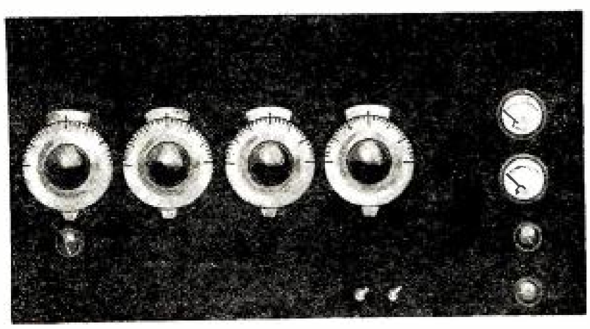
Selectivity in a super for short-wave work has to be considered from exactly the same standpoints as in a super designed for broadcast band reception and in this the intermediate amplifier is important. From certain standpoints the problem is easier and from other standpoints the problem is much more difficult. Three main problems must be given due consideration:

Adjacent channel selectivity. Image frequency or repeat points.

Intermediate frequency channel selectivity with special reference to the audio band that is to be passed.

We wish to pass an audio frequency up to 5000 cycles.

The overall selectivity must be such that the set can tune in a 500-watt station 1500 miles away without interference from another station of 40,000 watts 1500 miles away and in the same general direction and separated in frequency by 30 kc. This is no mean problem, but it can be done. The receiver described in this article does this and even better, if so desired. Selectivity of an extra order may be obtained with the use of special antennas, as described later in this text.



The front view of the Jones a.c. short-wave super-heterodyne, the design features of which are discussed here and will be described in more detail in a later issue

"Arithmetical" selectivity gain. Just what is this animal? McMurdo Silver (RADIO NEWS, October, 1930, page 331) says to consider a 1000 kc. and a 1010 kc. wave. In the tuned radio-frequency set they are practically impossible to separate. The percentage difference is 1 per cent. Changing these two frequencies to 175 and 165 kc. makes the percentage difference about equal to 6 per cent., or, as he says, "six times simpler." The above has reference to adjacent channel selectivity.

The higher the intermediate amplifier frequency, the less trouble from image frequency interference. Now a whole lot of image frequency can be eliminated or largely overcome by pre-selection before the first detector. Pre-selection also overcomes interference when two stations are separated in frequency exactly by the intermediate amplifier frequency.

In short-wave reception the frequencies we are dealing with are so extremely high that, for instance, when we wish to receive a 15,000 kc. wave free from interference from a 15,010 kc. wave, the percentage separation is only 6/100 of one per cent. The separation at 1500 kc. is 6/10 per cent. and the separation at 600 kc. is about 1 6/10 per cent. If we use a 1000 kc. intermediate frequency the per cent. frequency separation is about 15 times better than on the short waves direct and if we use a 1740 kc. intermediate frequency the gain is about 8 times greater. This is O.K., because by using the higher intermediate frequency we can cover two bands of waves with only one set of coils. So 1740 kc. has been selected as the intermediate amplifier frequency, bearing in mind that we are going to get a lot of selectivity in the three-stage intermediate amplifier.

In the receiver herewith described better quality with selectivity was obtained by using three stages of double tuned intermediate-frequency amplification a little more broadly tuned than would have been the case were only two stages used, giving as much selectivity. This receiver actually has twelve tuned circuits.

Selectivity and Short Waves

Let us digress for a moment to consider "selectivity" as it applies to short-wave reception. Inasmuch as short-wave signals usually arrive at a receiver with good signal strength (assuming sufficiently powerful transmitters and proper distance from receiver), the problem of selectivity is nearly the same as receiving local broadcast band signals, in the sense that you should not have to cut side-bands to get distance. Nevertheless, the selectivity, from the standpoint of the "arithmetical gain in supers" is inherently much more difficult, ten to twenty times more so than in the broadcast band. When any radio fan is bragging about the selectivity of his short-wave receiver, he must consider the following:

(a) Is he picking up a powerful transmitter at "best" reception distance, as against, say, a 30 kc. off-wave signal of a weak transmitter or a powerful transmitter at "wrong" receiving distance?

That's no selectivity at all!

Example 1—With a straight regenerative detector circuit using no radio frequency, either tuned or untuned, at a point "X" 1200 miles south of W8XK on 11830 kc. and 4000 miles west of G5SW on 11750 kc., it's not a case of selectivity that lets you listen to W8XK and not hear a peep from G5SW. At point "X" at about 5 p.m. E.S.T. the distance is just right for a wallop of a signal from W8XK. This also happens to be the "best" time for G5SW to point "X," so if your receiver will tune in G5SW under these conditions so you can't hear W8XK you may think you have a fairly selective receiver, but it's not so much for this frequency separation, as you can see, is 130 kc.

If you could not do better than this with a broadcast receiver you'd throw it in the junk pile.

(b) *Example 2*—A receiver is located at point "X," which is 1500 miles south of W2XAF and slightly southwest of W1XAZ on respectively 9530 kc. and 9570 kc. W2XAF uses 30 kilowatts and W1XAZ 500 watts (October, 1930).

Now note this: Each of these stations is located about 1500 miles from point "X." At 5 p. m. they are both just right (also after 9 p.m.) to lay down good signals so that ½ kw. signal is not to be sneezed at, and 30 kw. at the other doesn't mean that the other is 30 times as strong, not by a long sight. Nevertheless, at this period it takes really good selectivity to listen to W1XAZ without a peep from W2XAF at receiving point "X."

Not to make a mystery out of receiving point "X" I'll just say that it is Tuinucu, Cuba, located almost exactly 80° west longitude and midway between the north and south coasts of Cuba.

However, a receiver with low selectivity can, normally, listen at this point to W2XAF with little bother from W1XAZ. And don't forget these frequency separations are 3 to 4 times greater than on the broadcast channels.

Example 3—But now, how are you going to receive PCJ (9590 kc.), 4500 miles easterly from "X," even if PCJ does use 30 kw. when its best time is about 6 p.m., under the barrage of W2XAF and W1XAZ? You only need 20 kc. selectivity to do it. More about this later, under directional antennas and direction receiving. A very powerful transmitter at the right time of day may give your receiver two or three wallops separated 1/7 and 2/7 seconds apart due to "round the world" signals, unless your receiver has directional pick-up suitable to the particular station you want to receive.

Radio Roma Napoli have a slightly lower frequency than W8XK on 11880 kc., and they are 4500 miles east of Tuinucu. They come through here best from 4:30 to 6 p.m. I believe they are using 10 kw. To receive them free from interference from W8XK, your selectivity must be such that when listening to "Radio Roma Napoli" your receiver for W8XK must be "down" at least 50 dbs.

Example 4—W2XE on 6120 kc. is at New York and W2XAL on 6100 kc. is near New York. Both are 1275 miles practically north of Tuinucu. W2XAL uses 11,000 watts and W2XE 500 watts (in October, 1930). Frequency separation is 20 kc. At Tuinucu the "best" times for either of these stations will be the same, so the problem is about the same as tuning in a distant station from a receiver in New York City on a frequency only 20 kc. away, say from WEAF.

These examples are enough to show that listening to "certain" stations with no interference from "certain" other short-wave stations at "certain" times and distances, may show only that one has a very poor receiver. (Note that this discussion of selectivity only refers to music and speech reception and not cw. telegraphy). Thirty kc. selectivity is fair to good, but 130 kc. selectivity is very, very poor. If you do manage to get 20 or 30 kc. selectivity by using regeneration almost to the point of oscillation, you may not be getting much over 25000 kc. in your audio band, which from the standpoint of quality would be strictly rotten.

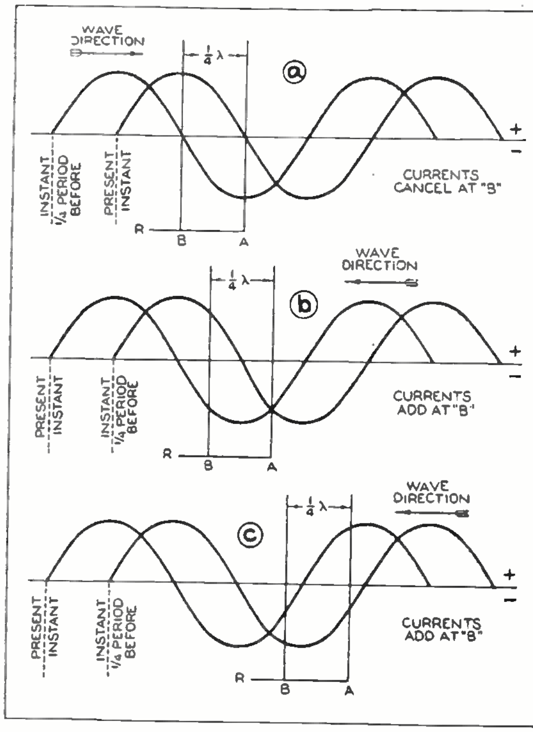


Figure 5. Illustrating the signal voltage relationship which makes the "array" type of antenna strongly directional

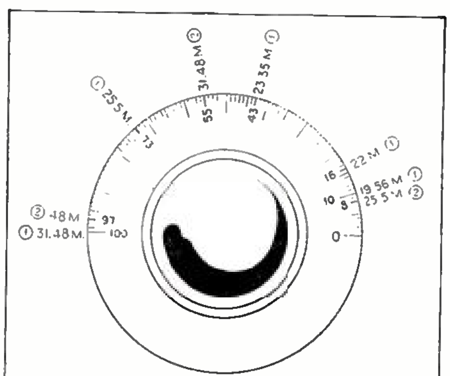
The Need for an R.F. Stage

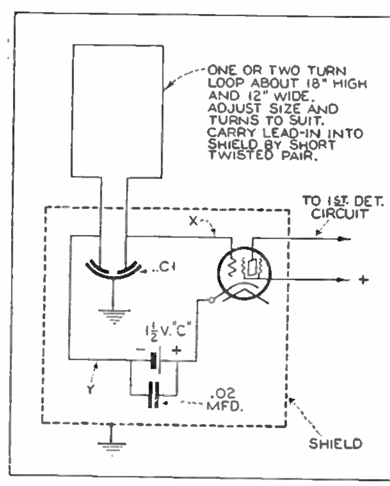
A writer in Radio News recently said "if he is to minimize complication, he is forced to omit r.f. amplification at signal frequency" ahead of the first detector, referring to short-wave superheterodynes (Radio News, November, 1930).

This might have been true before last year, but now the short waves are all becoming pretty well occupied and just about as crowded as the U. S. broadcast band, and will be more crowded from day to day and year to year. So we shall be forced to obtain a high degree of selectivity at signal frequencies just as we have been forced to do in the design of long-wave receivers of the superheterodyne type. As McMurdo Silver says in Radio News for December, 1930, "the real progress in design has been in the selection ahead of the detector" (referring to super design).

Tuning in a distant short-wave station signal at "not just the right time of day" alongside of a powerful signal which is at "just the right time of

(*Continued on page* 153)





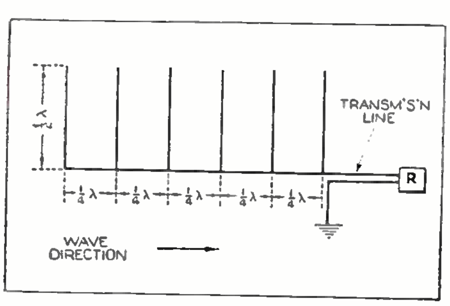


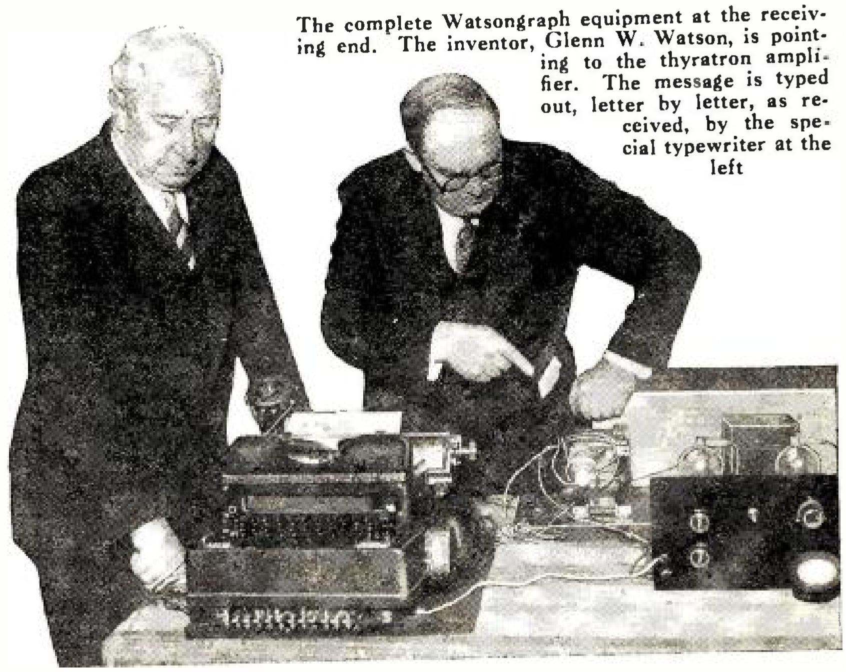
Figure 6 (at left). This type of antenna is strongly directional with wave direction as shown. Verticals can be strung on individual poles and joined by running a wire near the ground. Three or four more verticals give greater directionality and better signal to static or noise ratio. Transmission line may be insulated twisted pair

Figure 2 (left, center). A few approximate settings of the oscillator dial to illustrate double coverage with one set of coils, using 1740 kc. intermediate frequency. Dial settings mark (1) are for the lower curve range; (2) the upper. Figure 3, Above. Arrangement for using a loop antenna with short-wave reception. C1 is a Cardwell "wedge" plate condenser having 11 plates. The center stator plate is cut out, leaving two 5-plate halves with a common rotor. Make leads "X" and "Y" equal in length

A Radio Amanuensis

At last it appears that the dots and dashes are to be eliminated in commercial radio transmission through the development of the device described here which transmits and receives the characters of the alphabet direct

By Frank I. Taylor*



The complete Watsongraph equipment at the receiving end. The inventor, Glenn W. Watson, is pointing to the thyratron amplifier. The message is typed out, letter by letter, as received, by the special typewriter at the left

IT is mildly astonishing that. in spite of the tremendous progress made in all branches of radio during the past few years, we are still using dots and dashes in the transmission of radiograms the world over. This means that a message to be transmitted must first be changed from letters and words into dots and dashes. Then at the receiving end the jumble of dots and dashes must be changed back again into words. This double conversion slows up the whole process and brings in the human element. in the persons of the receiving and transmitting operators, with the attendant possibility of error.

It appears now. however. that the old order will shortly undergo a change as a result of a new device which has recently been developed. This device which is known as the "Watsongraph," is named after its inventor. Glenn W. Watson. It is logically termed a "radio typewriter" because, at the transmitting station the operator simply writes a message on a typewriter and at the receiving end the message appears in type, letter by letter. just as it is written at the transmitter end.

This system has a number of advantages over code transmission. In the first place the only chance for error is in the typing of the message at the transmitter. Secondly. the speed of transmission is limited only by the speed of the typist. and may vary anywhere from forty to eighty words per minute. as against a speed of from twenty to twenty-five words per minute for the usual code transmission. A third and outstanding advantage of the new system lies in the fact that constant attendance of an operator is not necessary at the receiving end. Once the transmitting station has been tuned in on the radio receiver the Watsongraph receiver will continue to type out the messages without attention of any kind.

In the usual code transmission secrecy is obtainable only by the use of a special and private code. or by the use of code words. Either of these systems slows up transmission. The former is seldom resorted to and is really quite impractical except. perhaps. in time of war. The use of code words is common, but has the disadvantage that, in order to insure accuracy, it is usually necessary to send each word twice. With the Watsongraph system secrecy is easily obtainable without sacrifice of speed. as will be explained later. This feature alone would seem to insure the acceptance of this device for all types of transmission.

The operation of the Watsongraph really is more simple than its accomplishment would seem to indicate. To give a clear understanding of the operation. perhaps it will be most simple to follow the cycle of operations in transmitting a single letter —the letter "A," for instance: When the "A" on the transmitting keyboard is depressed a charge from the battery, E, is built up across condenser X1 (Figure 1). This condenser holds its charge until the revolving contact arm. O, makes contact with the segment A. This contact closes the circuit, permitting the condenser to discharge through the relay, R, which is in the transmitter keying circuits. (*Continued on page* 151)

*Adams Advertising Agency

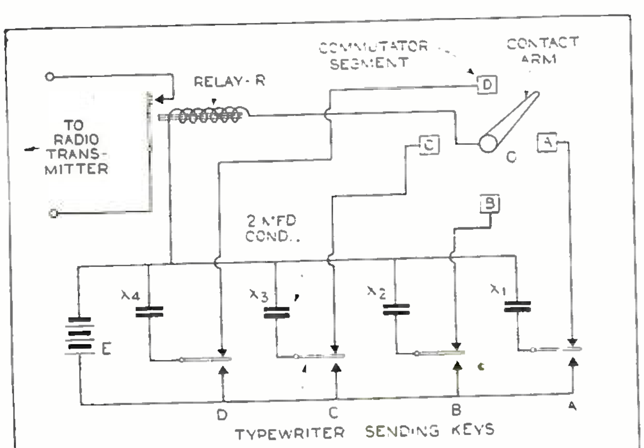


Figure 1. Circuit of Watsongraph unit at transmitting end. For simplicity only four of the keys and segments are shown

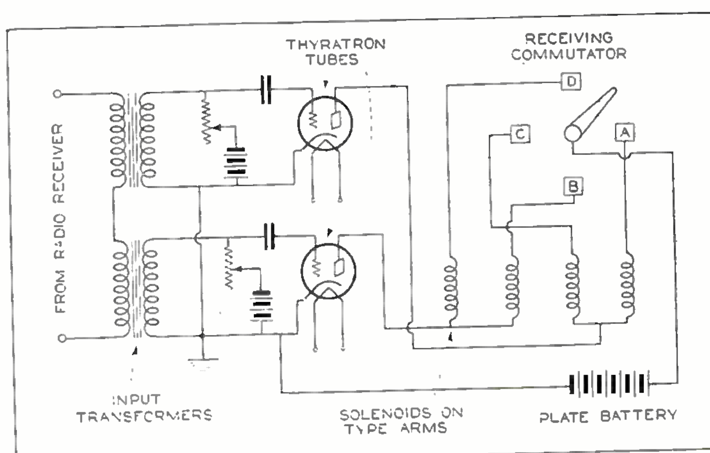
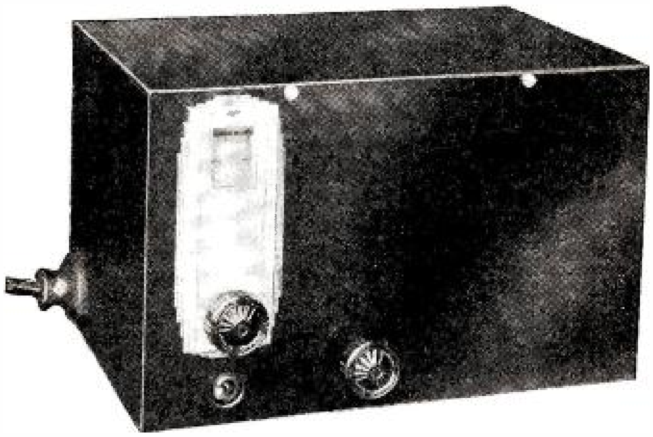


Figure 2. The equipment at the receiving end. The input is connected to the output amplifier of an ordinary receiver



The entire receiver is enclosed in a compact metal case. The tuning control is placed at one end for convenient operation from the driver's seat

A Pentode AUTO-RADIO Receiver

A description of one of the first receivers designed to use the new auto-radio tubes throughout and one which combines good efficiency with surprisingly low cost

By James Millen*

WHILE automobile radio is not in the least a recent development, it was not until last summer that the motoring public in general gave it any particular attention. During its first year of popular use, automobile radio had to go through very much of an adjustment or evolution stage, as none of the manufacturers placing these sets on the market last season had much, if any, previous experience in this field.

Aside from engineering difficulties, the one thing that retarded the popularity and general use of auto radio was its unreasonably high cost. Very few of the various makes listed for under $100, and the majority of them sold, completely installed with batteries and tubes, in the neighborhood of $150. When one stops to consider that the equity the average person has in an automobile is oftentimes not more than two or three hundred dollars, it will readily be seen why such a car owner did not install a radio set in his car last year.

Before a radio of this type can be within the reach of the motorist, it must sell for under $50, and from an engineering point of view there is no valid reason why a very fine set cannot be designed and manufactured to sell for such a figure—and not only must the cost to the average person of an automobile radio be under $50 before it will come into general use, but it also must perform considerably better than most of the sets manufactured last year.

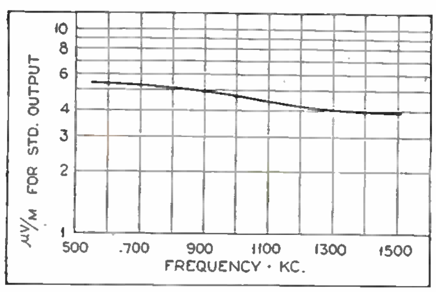


Figure 2. The sensitivity curve of the receiver, plotted against frequency

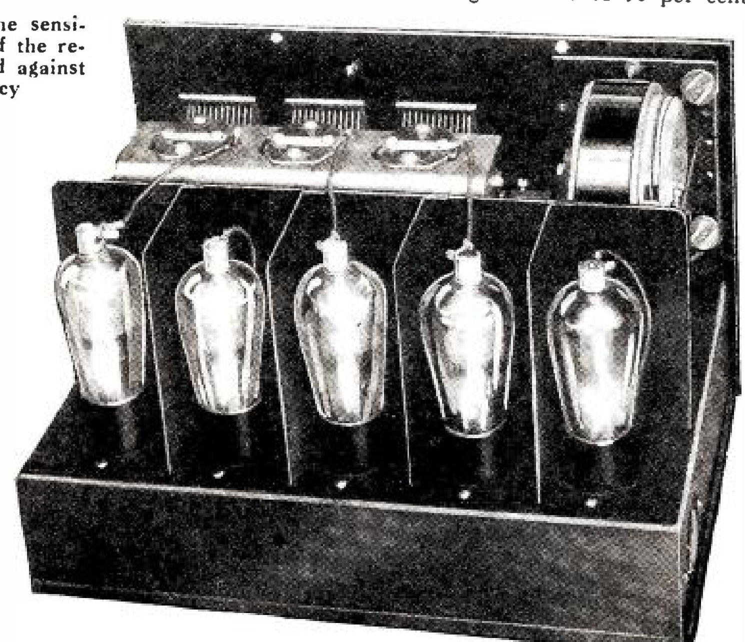
With these facts in mind, the engineers of the National Company, one of the pioneer companies to design and manufacture an automobile receiver, have been working for many months on a new design that would meet this price requirement.

In order to obtain accurate engineering information under actual operation conditions, a test trip of 4500 miles was made this past winter, along the entire Atlantic seaboard as far south as Florida and for a considerable distance inland, during which it was possible to check the different reception conditions encountered in widely separated sections of the country, and also both mechanical and electrical defects that would never be experienced in the laboratory.

Of the several observations made on mechanical items, perhaps the most unexpected was the lack of tube failure when driving over all kinds of roads with a rigidly mounted radio chassis in which no spring suspension of any kind was employed. In fact, this test showed rather clearly that to rigidly fasten the radio set to the engine bulkhead was in every way as satisfactory as the spring suspension which was commonly used in many of last year's models. The rigid mounting resulted in the elimination of many squeaks and other disturbing noises, common with earlier models, and greatly facilitated tuning.

In connection with tuning, it was found important to use a very rigidly constructed variable condenser so that the set would not be jarred out of "trim" when traveling at rather high speed over fairly rough roads.

A somewhat unexpected electrical observation was made in connection with automatic volume control where it was found that unless an unusually fine job of ignition noise elimination was made, the use of an automatic volume control was a detriment rather than an advantage; the noise from the ignition system serving to actuate the volume control and cut down the sensitivity just at the time when it was needed most. While it is not at all an impossible task to secure well night perfect ignition noise elimination, this generally requires the services of an engineer who has had considerable experience doing just this sort of work as the ignition system of each car supplies many individual problems. The average person, however, should have no trouble in eliminating from 75 to 90 per cent.



The receiver employs a total of five tubes, providing three stages of r.f., detector and pentode output stages

*National Company, Inc.

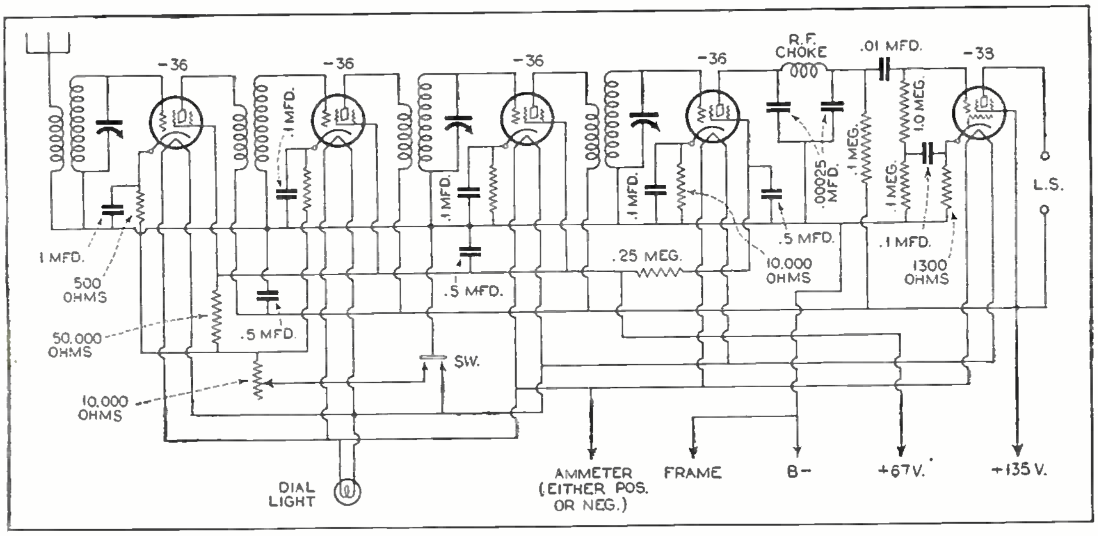


Figure 1. The circuit diagram. Pre-selector circuits are not necessary because at best the car antenna is small and as a result selectivity offers no great problem

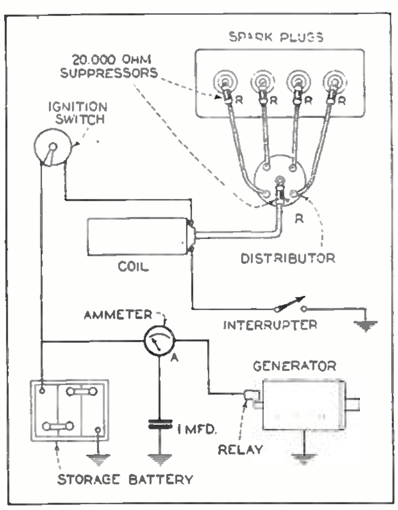
The receiver is designed to attach to the bulkhead as shown. This requires no alteration in the dashboard or instrument panel

of the noise and as the remainder, when not using an automatic volume control, is hardly noticeable, it seemed in line with the policy of bringing the cost of automobile radios within the reach of the ordinary car owner, to eliminate automatic volume control. The extreme variation in signal strength when run without automatic volume control is seldom encountered except in metropolitan areas, and then there is usually little use for the radio except while parked.

During this 4500 mile test trip, there was never a time at which WLW could not be received with good volume, which seemed to verify the slogan used in their announcements, that WLW is "The Nation's Station." In parts of Florida, the reception was most remarkable, it being possible to receive stations from practically any place in the United States, and WEAF, which was extremely difficult to pick up through parts of Virginia and North and South Carolina, was received regularly and with good volume.

One of the main handicaps under which the designers of last year's automobile radios had to work was the lack of proper tubes. As a result, they were forced to adapt the standard a.c. receiver tubes in a none too efficient manner to their requirements. The picture now, however, is quite different in that three new tubes, the -36, -37 and -38, have just made their appearance on the market.

This new group of tubes has been specially designed for automobile use, and comprises a screen-grid tube, a general purpose tube, and a power output pentode. All three are of the high vacuum type and employ coated cathodes, indirectly heated. The cathodes, which are the same for all three tubes, have been carefully designed to insure uniform heating over as wide a range of heater voltage as possible, in order that the tubes will perform satisfactorily under the normal voltage variations of automobile batteries during charge and discharge. This feature, together with that of the general freedom from microphonic and battery circuit disturbances of the heater-cathode type, make these new tubes particularly well suited for use in automobile receivers.



The new -36 screen grid tube may be used either as a radio frequency amplifier or detector. The heater voltage which is obtained directly from the car battery may vary between 5.5 and 8.5 volts during the charge and discharge cycles of the battery without appreciably affecting the performance or serviceability of this tube. No resistor in the heater circuit is required when operated from a 6-volt car battery. As with all screen grid tubes, when operated so as to obtain maximum r.f. gain per stage, careful circuit design with complete shielding, including baffle plates between the tubes, is important. Since the screen current of individual tubes of this type is subject to considerable variation, the use of a resistance in series with the plate voltage source for the screen voltage supply will result in poor

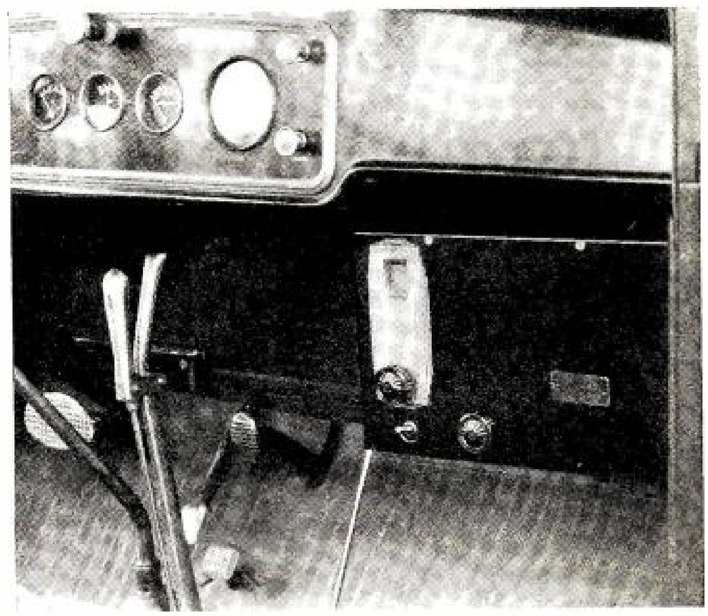


Figure 3. The use of suppressor resistors and a by-pass condenser as shown here will reduce ignition noises to a minimum

regulation and uncertain operating screen voltages. It is for this reason that the definitely fixed screen voltages are used, as shown in the accompanying circuit diagram. Following are the characteristics of this tube:

UY 236

Heater voltage	6.3 volts
Heater current	.3 amperes
Plate voltage	135 volts
Screen voltage	75 volts
Grid voltage	1.5 volts
Plate current	3.5 mills
Screen current	approx. 1.1 mills
Plate resistance	250,000 ohms
Amplification factor	275
Mutual conductance	1100 micromhos

The -37 is a three-electrode general purpose tube, somewhat like the standard type -27 but having the special 6-volt heater and cathode as used in the -36. This tube is not employed in the new National automobile receiver herewith described, and is merely mentioned because of its appearance on the market along with the -36 and -38.

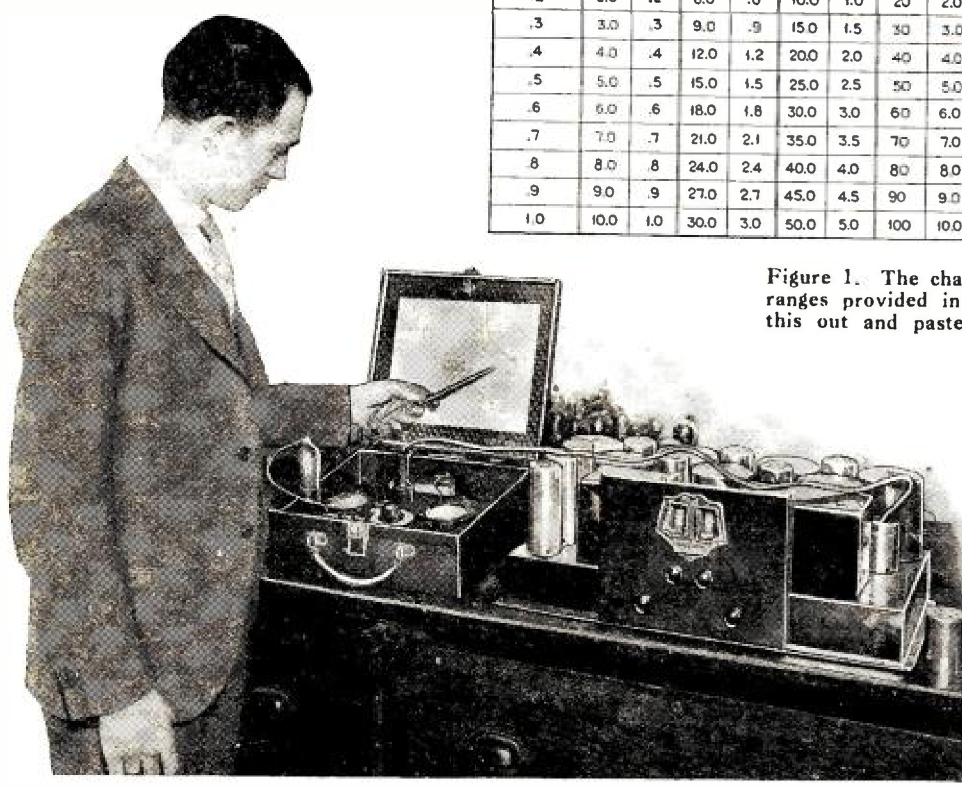
The -38 is a pentode tube designed primarily for giving relatively large audio power output for comparatively small signal voltages impressed on the grid. This is made possible by the use of a suppressor between (*Continued on page* 159)

A SET TESTER

Any Serviceman Can Build This Tester for $20.00

SETTING OF SWITCH S2	POINT 1 (1 VOLT SCALE)		POINT 2 (3 VOLT SCALE)		POINT 3 (5 VOLT SCALE)		POINT 4 (10 VOLT SCALE)		POINT 5 DEAD TAP	POINT 6 (50 VOLT SCALE)		POINT 7 (250 V. SCALE)	POINT 8 (500 V. SCALE)	POINT 9 (1000 V. SCALE)
ACTUAL METER SCALE READING	MILLI-AMPS.	VOLTS	MILLI-AMPS.	VOLTS	MILLI-AMPS	VOLTS	MILLI-AMPS.	VOLTS	-	MILLI-AMPS.	VOLTS	VOLTS	VOLTS	VOLTS
0	0	0	0	0	0	0	0	0		0	0	0	0	0
.1	1.0	.1	3.0	.3	5.0	.5	10	1.0		50	5	25	50	100
.2	2.0	.2	6.0	.6	10.0	1.0	20	2.0		100	10	50	100	200
.3	3.0	.3	9.0	.9	15.0	1.5	30	3.0		150	15	75	150	300
.4	4.0	.4	12.0	1.2	20.0	2.0	40	4.0		200	20	100	200	400
.5	5.0	.5	15.0	1.5	25.0	2.5	50	5.0		250	25	125	250	500
.6	6.0	.6	18.0	1.8	30.0	3.0	60	6.0		300	30	150	300	600
.7	7.0	.7	21.0	2.1	35.0	3.5	70	7.0		350	35	175	350	700
.8	8.0	.8	24.0	2.4	40.0	4.0	80	8.0		400	40	200	400	800
.9	9.0	.9	27.0	2.7	45.0	4.5	90	9.0		450	45	225	450	900
1.0	10.0	1.0	30.0	3.0	50.0	5.0	100	10.0		500	50	250	500	1000

Figure 1. The chart of current and voltage measurement ranges provided in the set tester. The builder can cut this out and paste it in his tester for ready reference



The author demonstrating his tester under actual working conditions in the RADIO NEWS laboratory

THERE are set testers—and set testers. So many of them, in fact, that a description of another one might seem entirely superfluous. However, after a careful study of the various models available I decided that to incorporate the features that I desired in a set tester I would have to design one myself. Inasmuch as my requirements are much the same as those of many other experimenters and servicemen it is likely that the tester described here will satisfy others as it has me.

Now it is my idea that one meter which can be made to serve the purpose of four or five is a lot better than four or five individual meters cluttering up the bench or kit bag. Inasmuch as a set tester requires two meters it seemed only logical to make one of these meters do double duty by designing the tester to function as a universal meter as well. For the most part, the necessary multipliers would have to be included anyway if the meters were to be limited to a total of two—one d.c. and one a.c.

As a result of reasoning along these lines the tester described here is capable of performing all current and voltage measurements required in the operating circuits of all types of tubes. In addition, the instrument serves as a five-range milliammeter with ranges of 0-10, 0-30, 0-50, 0-100, 0-500 ma.; and as a voltmeter (1000 ohms per volt) with eight ranges, as follows: 0-1, 0-3, 0-5, 0-10, 0-50, 0-250, 0-500, 0-1000 volts. An 0-10 volt a.c. voltmeter is included for filament voltage measurements and is also arranged to measure external a.c. voltages within this range. Finally, to make it complete as a serviceman's unit, the tester includes a battery and test prods for continuity tests.

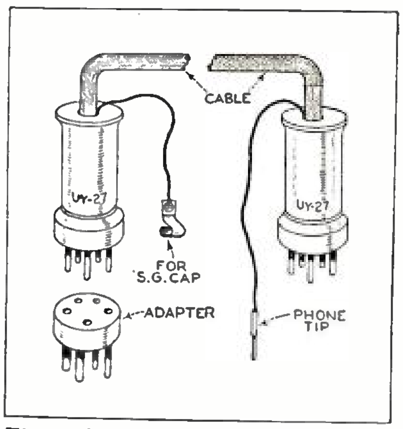


Figure 3. Details of the cable connector used in connecting tester to receiver

Due to limited finances, it was decided in the beginning to use the least expensive parts that would serve satisfactorily, later replacing some to obtain greater accuracy. Actually it did not prove practical to employ poor parts. If the meters were so cheap as to be inaccurate, for instance, they would later have to be replaced, with the result that the money invested in the original meters would then become a total loss. As for the other parts, it was found that, except in the case of resistors, good parts could be obtained just about as cheaply as poor parts if one were willing to do a little shopping around.

The result was that all of the parts originally included in the device were sufficiently good for permanent use except the resistors and a few incidentals such as the test prods and cable connector plugs. As finances permitted, these parts were replaced, and the new prods and connector plugs are shown in the photo of the tester above. The resistors are all concealed underneath the panel and therefore do not show in the illustrations. The reason for not showing a view of the under side is that the tester was not built with the idea of writing an article on it and the result was that the under side view would show little of interest or value to constructors.

Accurate resistors are unquestionably decidedly worth while in a set tester, but they are expensive and the budget simply could not be stretched to cover them at the time the tester was first built. A sacrifice had to be made somewhere, and the resistors were "elected" for the reason that the physical effort involved in their later replacement would be small. Secondly, it was felt that they would allow the tester to func-

You Can MAKE

A set tester, universal voltmeter and milliammeter, tube tester, and continuity meter, all combined in one compact unit which can be built by the experimenter or serviceman for less than twenty dollars

By Bill Stella

tion, even though somewhat inaccurately, whereas an inferior switch or other part might make the job entirely inoperative.

It is not without a blush that I admit buying the original resistors in the bargain basement of a large radio store, at an average cost of a little over ten cents each. This kept the total cost of the tester parts to something under $20.

For the lower resistance ranges wire-wound resistors with sliders were used. The sliders were adjusted as shown in Figure 4, using a flashlight cell bridged with a potentiometer. The potentiometer was then set at its electrical center point, which would provide a voltage of .75. Then the resistor under test, in series with the 0-1 milliammeter to be used in the tester, was connected across points 2 and 3 of the potentiometer (or points 1 and 2) and the slider on the resistor adjusted until the meter read .75 (in the case of resistor R1). This indicated a resistance of 1000 ohms, which is the value desired for R1. For the resistor R2 it was only necessary to use two flashlight cells, without the potentiometer. The meter and the unknown resistor were connected in series, directly across this 3-volt battery, and the slider on the resistor adjusted until the meter showed full-scale deflection. This would occur, of course, when the resistance was adjusted to 3000 ohms.

If fixed resistors were used instead of the variable for these low-resistance ranges they could have been manipulated by adding series or shunt resistances to bring them to the desired values. This was done in the case of the high resistances. One stunt used was that of shunting a too-high resistor with a variable grid leak of the old plunger type, and the latter adjusted until the correct resistance was obtained. This scheme is shown in Figure 5.

It naturally took some little time to make these necessary adjustments of the cheap resistors, but when the job was finished it was found under actual tests that the maximum inaccuracy of the tester was 10%. The objectionable part was that the different ranges were not uniformly inaccurate. One might be a few per cent. high and the next range a little low. But even at that this degree of inaccuracy is not extremely important in many types of measurements. After all, if one simply does not have the money he must expect to put up with some inaccuracy. It is better to have a somewhat inexact tester than not to have any at all, especially as it can always be made exact, when (*Continued on page* 168)

View of the tester in actual operation. Close scrutiny shows that S1 is set for a plate voltage reading, S2 for scale 8 and meter M1 reads 3.8. Reference to the chart, Figure 1, shows that the plate voltage of the tube under test is therefore 190

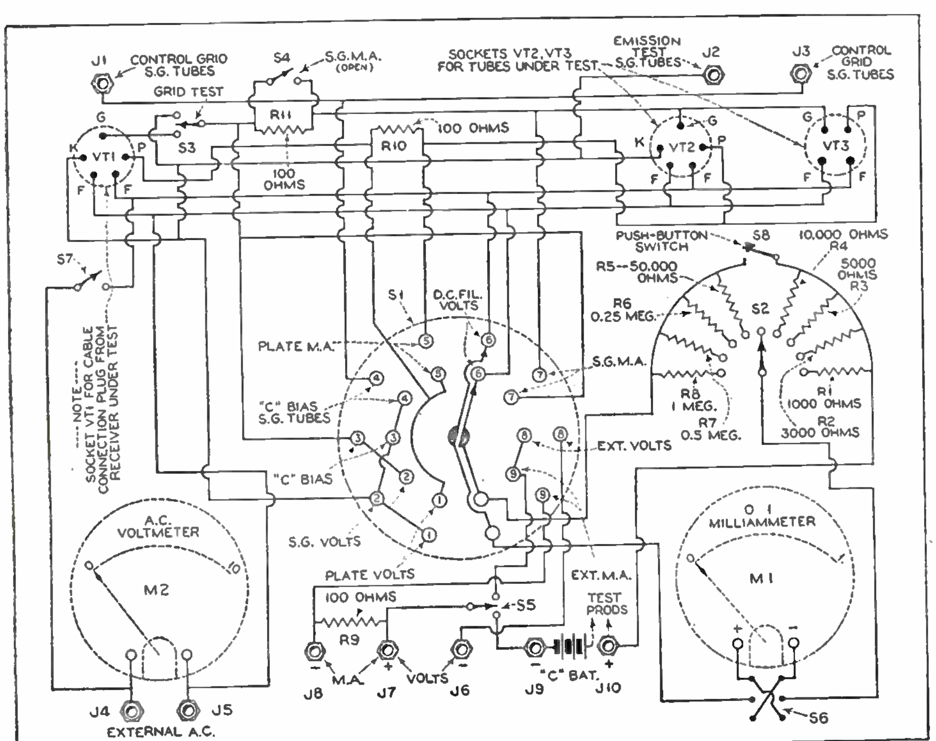


Figure 2. The schematic wiring diagram. Switches S1 and S2 are shown reversed, as they appear from the under side of the panel, when wiring the tester

SUPER BROADCASTING

The advantages and technical problems of long-wave super-power broadcasting were discussed in the April and June issues. This month the author continues with a discussion of the economic aspects of the proposed plan

By Lieut. William

IN two previous articles we have set forth at some length the possibilities of long-wave superbroadcasting—an idea which must be reckoned with in the broadcasting of the future. On our present wavelengths every transmitter, no matter how powerful, begins to fade at a distance of eighty or a hundred odd miles. As a result fifty kilowatts or so is the useful power limit, because true broadcasting service means non-fading service, and power increase is only useful to maintain an adequate signal within a service area arbitrarily limited by the inner fading ring. The first ten years of broadcasting have seen the amazing development of a complex transmitter network within these fading restrictions, which have not been severely felt because the structure was mostly metropolitan. It was tacitly assumed that the inhabitants of large cities, who represent the most concentrated buying power but who need radio least, must have whatever true service there is, and that the rural dwellers must be content with weak signals, fading, static, and all the other vagaries of doubtful space-ray service.

The next ten years should see the extension of true service, non-fading, night-and-day, summer-and-winter broadcasting to those who need it most—the isolated farmers, miners, ranchers, lumbermen, and the millions of town dwellers now beyond effective reach of the metropolitan system.

How is this desirable end to be accomplished? On present wavelengths scores of 50-kw. stations, evenly spaced across the country, would be required. On wavelengths around 1500 meters, on the other hand, the non-fading range to be expected of a transmitter is several hundred miles. Power can therefore be efficiently increased up to perhaps 1000 kw., giving true service to a half-million-square-mile area. About seven long-wave superstations should bring city standards of reception to practically every rural listener, making complete national broadcasting a uniform reality. Connected by wire lines with metropolitan studios, these national long-wave stations should become a powerful factor in the universal spread of culture, the enlightenment of public opinion, and the maintenance of government and national security.

No Receivers Exist Today

One of the most natural arguments against long-wave superbroadcasting is that in the United States there are no broadcast receivers capable of tuning to 1500 meters. Ten or twelve years ago, however, there were no broadcast receivers at all, while today they number some fifteen million. The mere fact that no long-wave receivers exist today, therefore, is no bar to the gradual inauguration of the long-wave system. Two-cylinder automobiles doubtless appeared to their late Victorian owners as the last word in transportation, but these proud owners would look somewhat silly today had they banded together in an effort to prevent automotive development in order to protect the value of their investment. The present radio receiver investment of the American people, about one and one-half billion dollars, is certainly large. But these millions of radio sets in use today are not going to last forever. Under any plan of broadcasting development, in ten years most of them will be obsolete. Since they will in any event be replaced by better sets in time, the inevitable change might just as well tend towards a full realization of all possible technical benefits. One of the most promising of these for the United States, judged from any viewpoint save that of ultra-conservatism or mere inertia, is long-wave, high-power broadcasting.

In addition to the receiver investment there is of course the present near billion-dollar annual income from receiver sales. On what does it fundamentally depend? *On the continual improvement and continual extension of true service broadcasting throughout widespread America, more than on any other single factor, rests the continued prosperity of the radio industry.*

If seven 1000-kw. long-wave transmitters were to be placed simultaneously in full-powered operation, results would naturally be disastrous in more than one direction. Collapse of receiver investment, stoppage of buying, embarrassment of industry—these and other effects would probably follow. Anyone can see that the immediate and complete exploitation of long-wave broadcasting possibilities at the expense of the present system is entirely out of the question.

The truth is that projects measured in importance by the

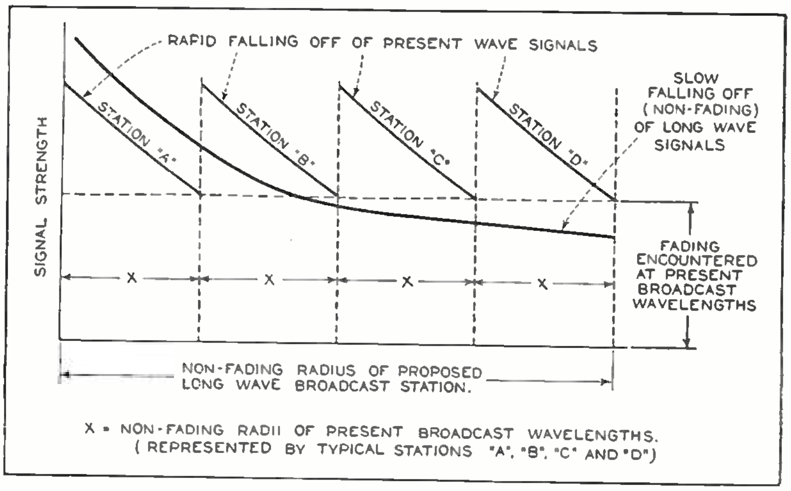


Figure 1. Coverage radius of long-wave, super-broadcasting station as compared with radii of several present wave broadcasters. The non-fading characteristics of the former would make its radius of coverage many times that of present-day broadcasters, even those employing the highest allowable power

expenditure of millions of dollars do not grow with anything like such startling suddenness. As the closest of parallel examples, it is only necessary to examine the development of our present broadcasting system from its beginnings in 1920. Its growth falls naturally into three stages, which may be classed as infancy, adolescence, and maturity.

The first stage began in 1920 when Frank Conrad played phonograph records over his amateur radio-telephone transmitter, and an enterprising department store offered curious Pittsburghers some receivers which would reconvert the city-wide ethereal vibrations back into sound. Through the foresight of H. P. Davis, Conrad was enabled to transfer his experimental efforts to what later became the Westinghouse station KDKA, beginning on election night a schedule which has continued with constant improvements to the present day. In 1921, WBZ at Springfield and WJZ in New York came on the air, KYW went into service at Chicago, and smaller transmitters began to spring up here and there over the country.

While transmitting stations were spreading their tentative signals over mountain and plain, most Americans turned an ear unwillingly deaf. The early radio sets were curiosities in

On Long Waves

H. Wenstrom

What It Might Mean to the Radio Industry

their neighborhoods, but they stimulated an increasing demand which soon outstripped the utmost capacity of the few receiver manufacturers of those days. The result was that most people had to build receivers themselves if they wanted them at all, and in addition the process of home building satisfied a natural mechanical craving. A great wave of public interest in radio, never since equaled, swept over the country. People cared little what they heard in the way of music or speech, so long as they were enabled to hear it by an electrical miracle.

Broadcasting passed from infancy to adolescence when, in 1924, the manufactured set business forged ahead of the parts business. Many people found that most of the widely hailed new circuits were merely old circuits in camouflaged form, and they began to realize dimly that no fundamentally new circuits had been devised since Armstrong had invented the superheterodyne during the World War. The early tinkerer, hearing manufactured sets which surpassed his uninstructed

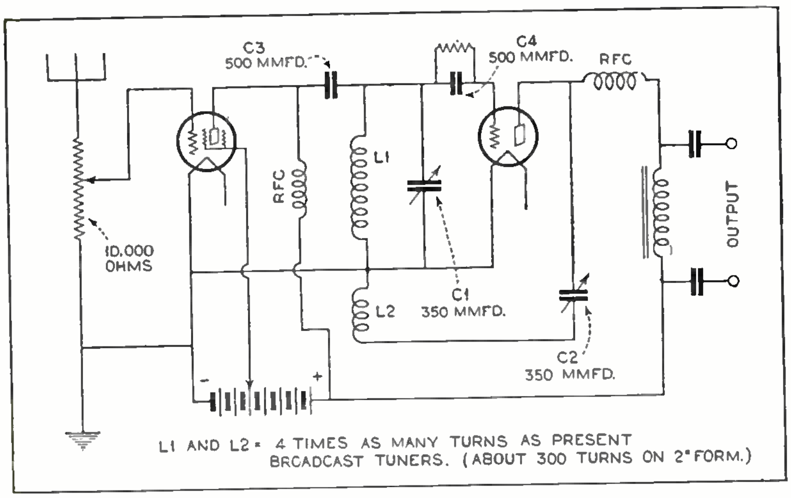


Figure 2. A simple type of tuner which could be used for reception of the long-wave broadcasting, preferably by plugging it into the audio amplifier of a standard broadcast receiver

efforts, lost interest. The necessary year's delay in bringing out technical improvements in manufactured sets, however, still encouraged many experimenters to build their own sets. In addition, high-power metropolitan broadcasting began with WJZ's power increase to 50 kw. in 1926. City listeners, finding a high signal level necessary to override man-made static, shifted their interest from the technical means of hearing to the programs that they heard. In the rural districts where interference levels were lower, listeners were still interested in distance—for one thing, they could pick up better programs from New York and Chicago. In 1926, also, the antiquated governmental machinery for radio control provided under the Act of 1912 broke down completely, and for some months bedlam prevailed in the broadcast spectrum.

In 1927 broadcasting entered its mature stage with the resumption of control by the government through the medium of the Federal Radio Commission. Broadcasting, first the freak, then the free-for-all, was finally defined as a public service carried on in the interests of "public convenience and necessity." The listener was enthroned as the ultimate king of broadcasting. Two great broadcasting companies, the National and Columbia, began to distribute the best in metropolitan programs by way of wire lines to stations all over the United States. The stations, in turn, passed on these programs to their small but widely scattered true service areas. Radio manufacture achieved mass production, making complete receivers at far less than the cost of their parts individually purchased. The custom set builder and the experimenter now find in the broadcast field only the opportunity to build, by the use of lavish design where the big manufacturers skimp for economy, a set slightly better than the manufactured article. Design has stabilized. Aside from vacuum tube and loud speaker developments, there have been no great technical advances in the last few years.

Receiver technology appears to have reached an era of comparative stagnation. In this situation any real innovation which is technically sound should prove constructive rather than destructive. From this viewpoint alone long-wave broadcasting is worthy of careful consideration.

The interest of practically all listeners, even in the rural districts, is now beginning to center on the end rather than the means—on the program rather than receiver technicalities. The local program is giving way before the chain program. Standards of quality are increasingly critical. Fading is not tolerated by city listeners with a wealth of other amusements. Rural listeners have to put up with plenty of it, but they do not like it. Within the limitations of present frequencies, broadcasting has crystallized into the problem of bringing to the largest possible number of homes the nearest possible approach to sounds originating in large metropolitan studios. It is significant to note that even the approach could not be made without one or two great nationwide broadcasting companies necessarily somewhat monopolistic in nature if not in aim.

It is logical to assume that long-wave broadcasting, provided the required preliminary static and transmission experiments prove successful, may follow a somewhat similar course of development as regards listener psychology and receiver design. With the present advanced broadcasting technique as a basis, the evolution of the long-wave system will naturally be more rapid. There is no reason to repeat past mistakes. The development of the long-wave system must be governed by a single aim—the provision of true service broadcasting to the entire United States. The system must be designed and built by competent engineers under the direction of able and public-spirited executives. Every attempt to subordinate public service to local demands, political intrigue, egotistical urges or sordid commercialism must be ruled out.

An attempt to predict at this time the exact sequence of long-wave development is simply an exercise of the imagination. Actual events may prove very different. However, it is necessary to assume some development sequence in order to discuss possible receiver changes.

Let us assume that the long-wave system is inaugurated with a single transmitter radiating about 100 kw. It should be located preferably in the midwestern states, so that its true service area of a hundred thousand square miles or so may cover a large rural territory now without true service broadcasting.

The space-propagated night-time signals of this station should easily reach out fifteen hundred miles or so to both coasts. The location should preferably (*Continued on page* 166)

Don't Write A Letter; *Send A Record!*

The newest application of phonograph recording is found in this slot machine in which one drops a quarter, speaks into the recording microphone and immediately receives a phonograph record of the spoken message

By H. G. Cisin

FORTY years ago Thomas Alva Edison conceived the idea of recording sounds on a metal disc. After considerable experimentation, the wizard of Menlo Park actually succeeded in making crude records entirely by mechanical methods.

Since that time many inventions were developed which have been utilized to make recording a perfected process. Among these may be mentioned the vacuum tube in its present forms, the electro-magnetic pick-up, the electric recording head, the synchronous motor, the microphone and the modern audio amplifier. One of the simplest efficient audio amplifiers was invented several years ago by Commander E. H. Loftin and Mr. S. Young White.

These young inventors have now perfected a new automatic recorder—the Vocamat. This is a coin-operated device for recording voice and music. It is entirely automatic and requires neither operator nor attendant. It turns out records of professional quality, capable of being played back almost indefinitely.

In developing this remarkable machine it was the aim of the inventors to produce a practical commercial device.

The accompanying illustrations give an excellent idea of what the Vocamat looks like. In general appearance it closely resembles a standard telephone booth, except for the machinery cabinet, on the left side, and the playback phonograph turntable at the right.

After a suitable location has been selected for the machine, it is connected by means of a flexible cable, to any 110-volt, 60-cycle a.c. lighting circuit. Thereafter power is always available through the functioning of a relay.

The machine is so simple to utilize that even a child can make records with it. In making a record one simply drops a quarter in a slot, enters the booth, starts to talk, when so directed by means of an illuminated sign, and stops talking when the sign indicates that the time is up. Immediately thereafter, the finished record is delivered through an aperture within the booth. The person making the record can then hear it by playing it back on the small turntable located outside the booth.

It is interesting to note the many diverse operations performed automatically by the Vocamat during the making of a record. When the machine is idle, but ready for operation, the door is locked and a small illuminated "vacant" sign at the left door frame, gives evidence that the booth is unoccupied. Two other small lights serve to illuminate and attract attention to the glass-enclosed upper portion of the cabinet in which the operating mechanism is housed.

The slot for depositing the coin is located just below the "vacant" sign. It is impossible to deposit a larger coin than a quarter, while a smaller coin will fail to energize the mechanism. As soon as a twenty-five-cent piece is placed in the slot, the coin closes an electrical circuit which actuates the main relay. The relay closes the coin slot, unlocks the door, switches on the dome light in the booth, and turns out the "vacant" light. It also connects the audio amplifier to the 110-volt a.c. supply and after a slight time interval it starts the motor located in the lower part of the machinery cabinet. A small neon pilot lamp is also illuminated while the amplifier is in operation.

The person who placed the quarter in the slot grasps the handle of the door, pulls it open, enters the booth and sits down on a small bench facing the microphone. He then closes the door, thus locking it to insure privacy. The door can always be opened from the inside, but can only be opened from without by placing a quarter in the slot. As mentioned before, the slot is closed and no coin can be deposited while the booth is occupied.

The microphone is concealed within a protective grille constructed in the form of a rectangular box. Immediately above this box there is another box of circular cross-section fitted with a ground-glass dial-face. Exactly twelve seconds after the door has been opened the glass face is illuminated, with the exception of a small sector of about 35 degrees at the upper portion. The word "talk" is then visible in large letters across the lower face of the dial. Shortly after the dial becomes illuminated, the shadow of an arrow-shaped hand, somewhat similar to a clock hand, appears at the upper right illuminated portion of the dial. This shadow hand rotates slowly in a clockwise direction, thus indicating exactly when to start talking, how much time is available and when to finish. As the hand approaches the end of its traverse, it arrives at the word "Finish," which is visible in dark letters against the illuminated background. A steel arrow rotating behind the ground glass causes the shadow. The arrow is moved by means of a flexible shaft connected to the

A view of the Vocamat, showing the machinery cabinet at the left and the phonograph turntable for playing back records at the right of the booth motor in the machinery cabinet through a reduction gear. The actual time available for recording is one minute and thirty-five seconds. This represents the time required to make a 6-inch record.

Simultaneously with the appearance of the hand on the illuminated dial face the motor starts up and, as it rotates, the recording head and the centering pin are lowered to the record. During the total time the person within the booth is talking, the recording needle is in contact with the rotating metal disc.

As the hand on the illuminated dial reaches the word "Finish," it moves a slight distance further and the light goes out. At the same time the mechanism lifts the recording or cutting head off the record, then doing the same thing with the centering pin.

Finishing the Record

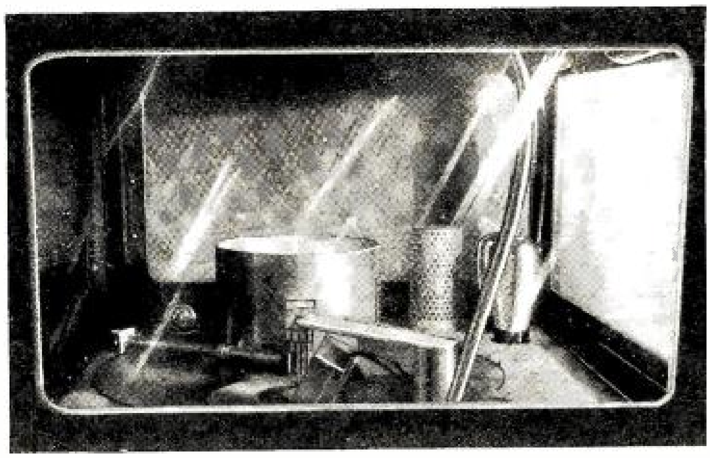
As soon as the recording head and centering pin are clear of the record, the record is removed, through the rotation of a large steel disc. There are two holes in this disc, located 180 degrees apart and of a size such that the 6-inch metal records fit into them. As the large steel disc moves around, the completed record is taken off the turntable and falls into a chute, appearing in the booth, in the opening below the microphone box. An interval of fifteen seconds elapses between the time the record is completed and the time it is delivered.

During the time the record is being removed from the turntable and fed into the chute the opposite hole in the large steel disc slides a record from the bottom of the stack in the cylindrical record magazine and places it in position on the turntable. As soon as this is accomplished a contact on one of the shafts of the mechanism is closed, thus automatically "kicking' the main relay. This shuts off the motor, amplifier and dome light, opens the coin slot and turns on the "vacant" sign light.

If the person who has just completed a recording wishes to make another record, there is a coin slot available within the booth and the entire cycle may be repeated as many times as desired without the necessity of leaving the booth.

After the completed record has been delivered, the person who made the recording steps out of the booth and places the record on a small phonograph turntable fastened at the right side of the booth. Earphones are used for playing back, instead of a loud speaker, thus insuring privacy and also avoiding the possibility of disturbing others. A switch within the pick-up box is thrown automatically as the pick-up is moved over to the starting position on the record, thus starting up the small play-back motor. In like manner the switch is opened automatically when the pick-up is swung to one side to remove the record.

An interior view of the Vocamat booth. The illuminated dial which tells when to start talking, how long to talk and when to stop is plainly visible. The dark sector may be seen and also the hand, which had moved about ¼ of its traverse when the picture was taken. Directly in front of the speaker is the grill box containing the microphone



A close-up of the top portion of machinery cabinet, as viewed through a side window. The large steel disc is shown and also a metal record on the turntable. The recording head is in the center foreground. The centering pin is also visible. The small neon pilot is at the back, towards the left. To the right of this is the cylindrical record magazine. In the right-hand corner are the amplifier tubes. The small lamps for illuminating the cabinet are just visible in the upper right. The black cable, which can be seen at the front, is the flexible drive shaft connecting the synchronous motor with the dial arrow in the booth

The records turned out by the Vocamat can be played back on the old-style mechanical phonograph or on the latest electrical machines. Fiber needles, impregnated with a hardening agent, are recommended for playing back.

Although the various mechanical features which make the Vocamat so completely automatic are quite remarkable, they are by no means as ingenious as many of the electrical devices incorporated within the machine. For example, the electrical system includes a monitor which automatically compensates for differences in the loudness with which various people speak. This enables the machine to turn out uniform records regardless of whether one shouts or whispers into the microphone. Without this new device the Vocamat would not be practicable.

The two-stage amplifier used in the Vocamat employs the Loftin-White direct-coupled circuit. This utilizes a -24 type screen-grid tube in the first stage and a -45 type power tube in the output stage. A full-wave -80 type rectifier tube is used. This amplifier is capable of giving an undistorted output of 1½ watts. In accompanying illustration, showing the recording mechanism, the amplifier tubes may be observed at the right of the record magazine. It will be noted that the screen-grid tube is (*Continued on page* 170)

Short-Wave Station List

Broadcast - Phone - Television

Wave-length	Fre-quency	Call	Location	Service and Time
9.68	31,000	W8X1	Pittsburgh, Pa.	Phone to Rome
9.96	30,105	......	Golfo Aranci, Sardinia	Broadcast, Wd. & Sat. 5:50—7:50 A.M.
13.04	23,000	W2XAW	Schenectady, N. Y.	Broadcast. Relays KDKA
14.01	21,400	WLO	Ocean Township, N. J.	Phone to LMS, Buenos Aires 6 A.M.—4 P.M.
14.15	21,130	LSN	Monte Grande, Argentina	Phone 10 A.M.—2 P. M.
14.50	20,680	LSN-LSH	Monte Grande, Argentina	Phone to Europe. 10:30 P.M.
14.50	20,680	FSR	Paris, France	Phone to Saigon
14.55	20,620	PMB	Bandoeng, Java	Mon., Wed., Thurs., Sat. 5:40—10:40 A.M.
14.62	20,500	W9XF	Chicago, Ill.	Broadcast (WENR)
14.65	20,450	PMB	Malabar, Java	Phone. 10:00 A.M.; 3:00 P.M.
14.70	20,400	GBP	Rugby, England	6 A.M.—2 P.M. Ships.
15.03	19,950	LSG	Monte Grande, Argentina	Phone to Paris and Nauen. 9:00 A.M.; 1 P.M.
15.03	19,950	DIH	Nauen, Germany,	Phone
15.07	19,906	LSG	Buenos Aires, Argentina	Phone to FTM—10:30 A.M.—3:30 P.M.
15.07	19,906	......	Monte Grande, Argentina	Phone to St. Assise 8 to 10 A.M.
15.12	19,830	FTU FTD	St. Assise, France	Phone
15.14	19,780	WMI	Deal, N. J.	Phone to GBU, Rugby, 6 A.M. 4 P.M. GBU
15.30	19,600	DFA-DIH	Nauen, Germany	Phone
15.45	19,420	FRO-FRE	St. Assise, France	Phone
15.50	19,355	......	Nancy, France	Broadcast, 4 to 5 P.M.
15.50	19,355	FTM	St. Assise, France	10 A.M.—2 P.M.
15.50	19,355	PCP	Kootwijk, Holland	Phone
15.50	19,355	VK2ME	Sydney, Australia	Phone
15.55	19,300	FTM	St. Assise, France	Broadcast. 10 A.M. to Noon.
15.57	19,250	PPU	Rio de Janeiro, Brazil	Phone to FTM. 10:30 A.M.—3 P.M.
15.60	19,220	WNC	Deal, N. J.	Phone to GBU, Rugby. 6 A.M.—4 P.M.
15.68	19,100	TCO	Kootwijk, Holland	Phone.
15.85	18,900	XDA	Mexico City, Mexico	Phone 4 P.M.
15.94	18,820	PLE	Bandoeng, Java	Phone daily 10 A.M.—3 P.M. Tuesday 1:40—3:40 P.M.
16.10	18,620	GBJ	Bodmin, England	Phone to Montreal
16.11	18,610	GBU	Rugby, England	Phone to WMI 6 A.M.-2 P.M.
16.12	18,600	PDM	Kootwijk, Holland	Phone.
16.30	18,400	PCK	Kootwijk, Holland	Broadcast Daily 1 to 6:30 A.M.
16.32	18,365	FZA	Saigon, Indo-China	Phone to St. Assise, 6-8 P.M. Sun.
16.35	18,350	WND	Deal Beach, N. J.	Trans-Atlantic Phone. 6 A. M.-4 P. M. GBS
16.35	18,350	GBS	Rugby, England	Phone to N. Y. (To WND) 6 A.M. -2 P. M.
16.38	18,310	FZS	Saigon, Indo-China	Broadcast. 1-3 P.M. Sundays.
16.44	18,240	FTE	St. Assise, France	Phones to FZR—5-9 A. M.
16.44	18,240	FRO-FRE	St. Assise, France	Phone to Saigon. 8-9 A.M.
16.50	18,170	CGA	Drummondville, Ont., Can.	Phone to GBK, England 6 A.M.-2 P.M.
16.52	18,150	PMC	Bandoeng, Java	Phone to PCK—6-10 A.M.
16.54	18,130	GBW	Rugby, England	Phone to WNC 6 A.M.-2 P.M.
16.57	18,120	GBK	Bodmin, England	Phone to CGA 6 A.M.-2 P.M.
16.60	18,070	PCS	Kootwijk, Holland	Phone.
16.61	18,060	KQJ	Bolinas, Calif.	Phone.
16.80	17,850	PLF	Bandoeng, Java	Broadcast.
16.80	17,850	W2XAO	New Brunswick, N. J.	Phone. 11 A.M.-3 P.M.
16.82	17,830	PCV	Kootwijk, Holland	6-9 A.M. Java.
16.87	17,780	W8XK	East Pittsburgh, Pa.	Relays KDKA
16.87	17,780	K7XI	Nautilus	Broadcast
16.90	17,750	HSITJ	Bangkok, Siam	Broadcast. Sundays 7-9:30 A.M.; 1-3 P.M.
17.05	17,750	GDLJ	S.S. "Homeric"	Phone.
17.05	17,750	GMJQ	S.S. "Belgenland"	Phone.
17.05	17,750	GLSQ	S.S. "Olympic"	Phone.
17.05	17,750	WSBN	S.S. "Leviathan"	Phone.
17.10	17,520	G2IV	S.S. "Majestic"	Phone.
17.34	17,300	W2XK	Schenectady, N. Y.	Broadcast. Tues., Thurs., Sat. Noon to 5 P.M.
17.52	17,110	WOO	Deal, N. J.	Trans-Atlantic Phone.
18.10	16,550	G2AA	London, England	Phone to Ships.
18.30	16,380	G2GN	S.S. "Olympic"	Phone.
18.37	16,320	VLK	Sydney, Australia	Phone to England.
18.40	16,300	PCL	Kootwijk, Holland	Phone to Java. 10 A.M.-2 P.M. Broadcast. Sat. 1:40-2 P.M.
18.44	16,250	WLO	Lawrence, N. J.	Phone to LSM. 8 A.M.-4 P.M.
18.50	16,200	FZR	Saigon, Indo-China	Phone to St. Assise (also on 18.76) 11 A.M.-12 Noon.
18.56	16,165	GBX	Rugby, England	Broadcast 4-11 P.M.
18.80	15,950	PLG	Bandoeng, Java	Broadcast.
18.90	15,875	FTK	St. Assise, France	Phones to FZS 9-10 A.M.
19.00	15,760	EAJI	Barcelona, Spain	Phone to Buenos Aires
19.50	15,375	F8BZ	Paris, France	French phone to ships.
19.56	15,340	W2XAD	Schenectady, N. Y.	Relays WGY. 1-3 P.M.
19.72	15,210	W8XK	Pittsburgh, Pa.	Relays KDKA Wed. & Sat. 1-4 P.M. Broadcast Tues., Thurs., Sat. 8 A.M. to Noon.
19.78	15,160	K7XI	Nautilus	Broadcast (Trans-Arctic Submarine Corp.)
19.83	15,120	HVJ	Vatican City (Rome)	Broadcast.
19.99	15,010	CM6XJ	Central Tuinueu, Cuba	Relays Broadcast.
19.99	15,010	LSJ	Monte Grande, Argentina	Phone to WLO and Madrid.
20.50	14,620	WMI	Deal, N. J.	Phone to GBW 6 A.M.-6 P.M.
20.50	14,620	XDA	Mexico City, Mexico	Broadcast. 2:30-3 P.M.
20.70	14,480	GBW	Rugby, England	9 A.M.-4 P.M. WNC.
20.73	14,470	WMC	Deal, N. J.	6 A.M.-6 P.M., GBW.
20.80	14,420	VPD	Suva, Fiji Islands	Broadcast. 10 P.M.-7 A.M.
20.90	14,340	G2NM	Sonning, England	Broadcast, Sundays 1:30-3 P.M. Monday 5-6 P.M.
21.50	13,940	......	Bucharest, Roumania	Broadcast. Wed. & Sat. 2-5 P.M.
22.14	13,620	F8BZ	Paris, France	Phone to ships.
22.38	13,400	WND	Deal Beach, N. J.	Trans-Atlantic Phone. 6 A.M.-6 P.M.
22.50	13,325[1]	GFWV	S.S. "Majestic"	Phone.
22.50	13,325	GLSQ	S.S. "Olympic"	Phone.
22.68	13,225	......	S.S. "Belgenland"	Phone.
22.68	13,225	......	S.S. "Homeric"	Phone.
22.68	13,225	......	S.S. "Leviathan"	Phone.
23.00	13,200	......	Rabat, Morocco	8-9 A.M. Tues., Thurs. & Sat. Broadcast.
23.00	13,200	......	S.S. "Hamburg"	Phone.
23.35	12,850	......	Buenos Aires, Argentina	Phone to Spain.
23.35	12,850	W2XO	Schenectady, N. Y.	Broadcast. Noon-5 P.M. also 9 P.M. Monday to 3 A.M. Tues.
23.86	12,630	......	Rabat, Morocco	Broadcast. 8-9 A.M. 4-6 A.M. Tues., Thurs. & Sat.
24.00	12,490	G2GN	S.S. "Olympic"	Phone.
24.23	12,350	GDLJ	S.S. "Homeric"	Phone.
24.40	12,295	PLM	Bandoeng, Java	Phones to PCK. 5-9 A.M.
24.41	12,290	GBU	Rugby, England	2-7 P.M. WMI.
24.46	12,250	FTN	St. Assise, France	Broadcast. 9 A.M.-1 P.M. Works Buenos Aires, Indo-China and Java. Phone to Rabat—5-9A.M.
24.46	12,250	KIXR	Manila, Philippine Islands	Broadcast. 5-9 A.M. except Sun.
24.68	12,150	GBS	Rugby, England	Trans-Atlantic phone to Deal, N.J. 4-9 A.M. VK2ME-VLK. 2-7 P.M. WND.
24.80	12,090	......	Tokio, Japan	Broadcast. 5-8 A.M.
24.89	12,045	NAA	Arlington, Va.	8:55 A.M.-9:55 P.M. Broadcast time signals twice daily
24.98	12,000	FZR	Saigon, Indo-China	5-6 A.M. 11 A.M.-12. Broadcast.
24.98	12,000	......	Oporto, Portugal	8-9 A.M. 3-4 P.M. 6-9 P.M. Broadcast.
25.24	11,880	W8XK	Pittsburgh, Pa. (KDKA)	Noon—5 P.M. Tues., Thurs., Sat. Sun. (See note) Broadcast.
25.24	11,880	VUC	Calcutta, India	Broadcast. 8-10 A.M.
25.34	11,840	W2XE	New York	Broadcast. 8 A.M.-midnight.
25.34	11,840	W9XAA	Chicago, Ill.	7-8 A.M., 1-2-4-5-6-7:30 P.M.
25.42	11,800	UOR2	Vienna, Austria	Broadcast. 5-7 A.M. Wed. & Thurs., also on Tues. 2 hours later in day.
25.50	11,765	XDA	Mexico City, Mexico	Broadcasts. 3-4 P.M. daily.
25.53	11,750	PK6K	Makassar, Celebes	6:40-9:40 A.M. Broadcast.
25.53	11,750	G5SW	Chelmsford, England	7:30-8:30 A.M. daily; 2-7 P.M. daily except Sat. & Sunday Broadcast
25.62	11,710	K7XI	Nautilus	Broadcast.
25.68	11,670	KIO	Kahuku, Hawaii	Phone.
26.00	11,530	CGA	Drummondville, Ont., Can.	Phone.
26.20	11,440	KIXR	Manila, P. I.	Broadcast. 11:15-12:15 P.M.; 2-4 A.M.; 5-10 A.M.
26.22	11,435	DHC & DHA	Nauen, Germany	Broadcast. 5 P.M. Fri., Sat. & Sun.
26.52	11,430	DDDX	S.S. "Bremen"	Phone.
26.70	11,230	IBDX	S.S. "Elettra"	Marconi's Yacht.
27.00	11,100	OUITH	Vienna, Austria	5:30-7 P.M. Broadcast Mon. & Thurs.
27.27	11,000	......	Posen, Poland	Broadcast. 11:30 A.M. to 5:30 P.M.
27.5	10,800	PCP	Kootwijk, Holland	Phone.
28.00	10,700	VAS	Glace Bay, N. S.	Broadcast. 5 A.M. to 2 P.M.
28.8	10,400	PLR	Malabar, Java	Phone. 6-10 A.M.
28.20	10,630	PLR	Bandoeng, Java	Broadcast. 7 A.M. Works with Holland and France. Starting time sometimes 2.5 hours later.
28.50	10,510	VK2ME	Sydney, Australia	Broadcast. 1-7 A.M.
28.98	10,350	LSX	Buenos Aires, Argentina	Broadcasts 7-9 P.M.
29.00	10,340	......	Paris, France	Broadcast. 1:30-3 P.M. Daily. 9 A.M. Sundays.
29.00	10,330	PCT	Kootwijk, Holland	Phone to S.S. "Columbia" near 1 P.M.
29.15	10,300	LSN	Buenos Aires, Argentina	Phone to GBP, FTN and Rabat.
29.30	10,237.5	TI4	Heredia, Costa Rica	Broadcast. 10-11 P.M.
29.47	10,160	DHC	Nauen, Germany	Phone.
29.98	10,000	......	Belgrade, Jugo Slavia	Broadcast. 3-4 P.M. Monday.
30.3	9,900	LSN	Buenos Aires, Argentina	6 P.M.—6 A.M. WLO.
30.15	9,840	FTL	St. Assise, France	Phone.
30.15	9,840	GBU	Rugby, England	5-11 P.M. WMI.
30.4	9,860	EAO	Madrid, Spain	Phone.
30.4	9,870	WMI	Deal, N. J.	4 P.M.-5 A.M. GBU.
30.57	9,810	LSOR	Buenos Aires, Argentina	Broadcasts 6-9 P.M.
30.6	9,805	GBW	Rugby, England	5-10 P.M. WNC.
30.75	9,750	......	Agen, France	Broadcast. 3-4:15 P.M. Tues., Fri.
30.77	9,750	......	Deal, N. J.	4 P.M.—5 P.M. GBW.
31.10	9,640	......	Monte Grande, Argentina	Broadcast. 10:30 P.M.
31.26	9,600	PCJ	Hiverson, Holland	Broadcast. Thurs. & Fri. 1-3 P.M. 6-10 P.M. Thur.
31.28	9,580	W3XAU	Byberry, Pa.	Broadcast. 4 P.M. 12 midnight daily except Thursday.
31.28	9,580	PCJ	Eidhoven, Holland	Wed. 12-3 P.M.; Thurs. 9 A.M-1 P.M.; Fri. 5-9 P.M.; Sat. 1-3 P.M.
31.35	9,570	W1XAZ	Springfield, Mass (WBZ)	Broadcast. 7:30 A.M., 11 P.M.
31.36	9,560	NAA	Arlington, Va.	Broadcast. 3-7:30 P.M.
31.48	9,530	W2XAE	Schenectady, N. Y.	Broadcast.
31.48	9,530	K7XI	Nautilus	Broadcast.
31.56	9,500	OZ7RL	Copenhagen, Denmark	Broadcast. 7 P.M.
31.60	9,490	OXY	Lyngby, Denmark	Broadcast 2-6:30 P.M.
31.80	9,430	......	Posen, Poland	Broadcast. Tues. 1:45-4:45 P.M.; 1:30-8 P.M. Thursday.
32.00	9,375	EH9OC	Berne, Switzerland	Broadcast. 3-5:30 P.M.
32.1	9,345	CGA	Drummondville, Can.	Broadcast. 6 P.M.-6 A.M. GBK.
32.06	9,350	CM2MK	Havana, Cuba	Broadcast. 5-9 P.M.
32.26	9,300	......	Rabat, Morocco	Broadcast. Sun. 3-5 P.M.
32.4	9,255	GBK	Bodman, England	Broadcast. 6 P.M., 6 A.M. CGA.
32.50	9,230	FL	Paris, France	Broadcast. 4:56 A.M. Time Signals daily. 4-56 P.M. Last 4 min.
32.59	9,110	SUS	Rugby, England	Transatlantic Phone.
32.70	9,175	WND	Deal, N. J.	Broadcast. 5 P.M.; 10 A.M. GBS.
32.85	9,130	HB9OC	Berne, Switzerland	Broadcast. 6:30 A.M.-5 P.M.
33.00	9,090	VK3ME	Melbourne, Australia	Broadcast. 4-6 A.M.
33.25	9,020	GBS	Rugby, England	Broadcast. 6 P.M.-6 A.M. WND.
33.70	8,900	......	Posen, Poland	Broadcast. 11:30 A.M.-5 P.M. Sunday and Wednesday
33.81	8,872	NPO	Cavite, P.I.	Broadcast. 9:55 P.M. Time Signals

Wave-length	Fre-quency	Call	Location	Service and Time
33.95	....	GFWU	S.S. "Majestic"	Phone.
33.95	....	GLSQ	S.S. "Olympic"	Phone.
33.95	8.835	GMJQ	S.S. "Belgenland"	Phone.
33.95	....	GDLJ	S.S. "Homeric"	Phone.
33.95	....	WSBN	S.S. "Leviathan"	Phone.
34.00	8,820	VK3UZ	Melbourne, Australia	Broadcast. 3-5 A.M. Mon. & Wed.
34.50	8,690	HKF	Bogota, Colombia	Broadcast. 5-7 P.M., 11 P.M. to 1 A.M.
34.68	8,650	W2XCU	Ampere, N. J.	Broadcast. Mon. 7-9 P.M.
34.68	8,650	W3XE	Baltimore, Md.	Broadcast. 12:15-1:15 P.M.; 10:15 -11:15 P.M.
34.68	8,650	W2XU	Long Island City, N. Y.	Broadcast. Wed., Fri. 8-10 P.M.
35.54	8.440	G2AA	London, England	Phone to ships.
35.70	8,400	VBS	Khabarovsk, Siberia	Broadcast. 5-7:30 A.M.
36.4	8,240	......	S.S. "Columbia"	Phone approximately at 1 A.M.
36.74	8,160	......	Leningrad, Russia	Broadcast. 2-6 A.M. Mon. Tues.. Thurs., Friday.
37.02	8,100	EATH	Bandoeng. Java	Broadcast. 6-10 A.M.
37.02	8,100	JIAA	Vienna, Austria	Broadcast. 5:30-7 P.M. Mon., Thurs.
37.36	8,030	NAA	Bangkok, Siam	Broadcast. 8-10 A.M. Sunday.
37.43	8,015	......	Arlington. Va.	Broadcast. 8:55 A.M., 9:55 P.M. Time Signals twice daily, lasting 5 min.
38.00	7,890	VPD	Doeveritz, Germany	Broadcast. 1-3 P.M. Reichpost-zentralamt Berlin.
38.56	7,775	F8BZ	Paris, France	Phone to ships.
38.60	7,770	FTF	Kootwijk, Holland	Broadcast. 9 A.M. starts at time given.
39.15	7,660	FTL	Kootwijk, Holland	Broadcast. 9 A.M.-7 P.M.
39.40	7,615	X26A	Nuevo Laredo, Mexico	Broadcast. 9-Noon. 1-2; 4 5 P.M.
39.70	7,550	HKF	Bogota, Colombia	Broadcast. 5-7 P.M., 11 P.M. to 1 A.M.
39.80	7,535	......	Rio Banba, Ecuador	Broadcast. Thur. 9-11 P.M.
40.00	7,500	......	Radio Touraine, France	Broadcast. 4 P.M.
40.20	7,460	FYR	Lyons, France	Broadcast. 10:30 to 1:30 A.M. Daily except Sunday.
40.50	7,400	......	Eberswalde, Germany	Broadcast. 1-2 P.M. Monday. Thursday.
41.00	7,310	......	Moscow, USSR	Broadcast. 7-7:45 A.M.
41.10	....	......	Radio Bangkok, Siam	Broadcast. Mon. 10 A.M. to Noon.
41.70	7,190	VK6AG	Perth, Australia	Broadcast. 5-11:30 A.M.
41.70	7,190	VS1AB	Singapore. S.S. Beds.	Sun. Wed., Fri. 10:30-12 A.M.
41.50	7,220	HB9D	Zurich, Switzerland	Broadcast. 7 A.M. and 1 P.M. first and third Sunday.
42.	7,140	HKX	Bogota, Colombia	Broadcast. 9-11 P.M.
42.70	7,020	EAR125	Madrid. Spain	Broadcast. 6-7 P.M.
42.90	6,995	CT1AA	Lisbon, Portugal	Broadcast. Fri. 5-7 P.M.
42.9	6,995	GBS	Rugby. England	Broadcast. 6 P.M.-6 A.M. WND.
43.00	6.980	EAR110	Madrid, Spain	Broadcast. 5:30-7 P.M. Tues., Sat. 7-8 P.M. Friday.
43.00	6,980	CT1AA	Santos, Portugal	Broadcast. 4-5 P.M. Friday.
43.50	6,900	IMA	Rome, Italy	Broadcast. Noon to 2:30 P.M.
43.60	6,875	F8MC	Casablanca, Morocco	Broadcast. Sun., Tues., Wed., Sat.
43.60	6,875	D4AFF	Coethen, Germany	Broadcast. 4-6 A.M. Sun. 12-2 P.M. Tues. & Fri.
43.70	6,860	KEL	Bolinas. California	Broadcast. 4-6 P.M. Thursdays.
43.84	6,840	VRY	Georgetown, British Guiana	Broadcast. 7:15-9:15 P.M. Wed. 5:45-8 P.M. Sunday.
44.40	6.750	WND	Deal, N. J.	Broadcast. 5 P.M.-5 A.M. GBS.
46.06	6,430	PCM	The Hague. Holland	Broadcast. 3-6 P.M. Sunday. 4-7 P.M. Monday and Sat.
47.00	6,380	CT3AG	Funchal. Madeira Islands	Broadcast. 5-7 P.M. Saturdays.
47.00	6,380	HC1BR	Quito. Ecuador	Broadcast. 8-11 P.M.
47.00	6,380	X1F	Mexico City. Mexico	Broadcast. 7-9 P.M., 11 P.M., 1 A.M.
48.30	6,205	HKC	Bogota, Colombia	Broadcast. 9:45-11:30 P.M.
18.62	6,170	HRB	Tegucigalpa, Honduras	Broadcast. 2-12 P.M. Mon.. Wed., Friday.
48.70	6.160	VE9CL	Winnipeg. Canada	Broadcast. 5:30-11 P.M.
48.70	6.160	HKA	Barranquilla, Colombia	Broadcast. Tues.. Thurs., Sat., Sun. 8-10 P.M.
48.74	6,155	W9XAL	Chicago. Ill. (WMAC)	Broadcast. 11:30-12 P.M. Sat.
48.83	6,140	KA1XR	Manila, P. I.	Broadcast. 3-4:30 A.M., 5-9 A.M. 2-3 A.M. Saturday.
48.83	6,150	W8XK	East Pittsburgh. Pa.	Broadcast. 5 12 P.M. Tues., Thurs., Sat. and Sunday.
48.91	6,125	7LO	Nairobi, Kenya. Africa	Broadcast. 11 A.M.-2 P.M.
48.99	6,120	......	Motala. Sweden	Broadcast.
48.99	6,120	......	Chi-Hoa (Saigon) Indo-China	Broadcast. 6:30-7:30 A.M.
48.99	6,120	......	Toulouse, France	Broadcast. 2:30 4 P.M. Sun.
48.99	6,120	MTH	Rio de Janeiro. Brazil	Broadcast. 5-7 P.M.
48.99	6,120	EAR25	Barcelona, Spain	Broadcast. 3-4 P.M.
49.00	6,120	HRB	Tegucigalpa. Honduras	Broadcast. 7-12 P.M. Sun. 8:30-9:45 P.M.
49.02	6.120	W2XE	New York, N. Y.	Broadcast. 8 A.M. to Midnight.
49.07	6.110	VVB	Bombay, India	Broadcast.j12:30-1:,15P.M. Mon., Wed., Fri.
49.10	6.110	F3ICD	Chi-Hoa, Indo-China	Broadcast. 6:30-10:30 A.M.
49.15	6,100	W3XAL	Bound Brook, N. J.	Broadcast. 5-6:30 P.M., 11 P.M., 1 A.M. WJZ.
49.17	6,095	VE9GW	Bowmanville, Ont.. Canada	Broadcast. 1:45-5 A.M. Daily.
49.17	6,100	W2XAL	Coytesville, N. J.	Broadcast.
49.17	6,100	VQ7LO	Nairobi, Kenya, Africa	Broadcast, 11 A.M.-2 P.M.
49.18	6,100	K7XI	Nautilus	Broadcast. (Trans-Arctic Sub-marine Corp.)
49.31	6,080	W9XAA	Chicago. Ill.	Broadcast. 6-7 A.M.
49.31	6.080	W6XAL	Westminster. California	Broadcast. 11-12 P.M.. 10 P.M. Saturday. 6 A.M. Sunday.
49.31	6,080	HS2PJ	Bangkok, Siam	Broadcast. 6-6:30 A.M.
49.34	6,075	W9XAA	Chicago. Ill.	Broadcast. Daily except Sun. WCFL.
49.34	6.075	W2XCX	Kearny. N. J.	Broadcast. Daily except Sun. WOR.
49.05	6,050	XEVE9CL	Winnipeg. Man.. Can.	Broadcast. 6:?0 P.M. CJRW
49.40	6,070	UOR2	Vienna, Austria	Broadcast. 5-7 A.M., 5-7 P.M. Tues., Sat. 9-10 A.M. Thurs.
49.46	6,065	SAJ	Motala, Sweden	Broadcast. 6:30-7 A.M., 11 A.M.-4:30 P.M.
49.50	6.060	W9XU	Council Bluffs. Iowa	Broadcast.
49.50	6,060	W3XAU	Byberry. Pa.	Broadcast.
49.50	6,060	W8XAL	Cincinnati, Ohio	Broadcast. 6:30-11 A.M., 1:30-3 P.M., 6 P.M.,-1 A.M.
49.60	6.050	HKD	Barranquilla, Colombia	Broadcast. Mon., Wed., Fri., Sun. 8-10 P.M.
49.67	6,040	W9XAQ	Chicago. Illinois	Broadcast. Thur. and Fri.
49.67	6.040	PK3AN	Sourabaya. Java	Broadcast. 6-9 A.M.
49.83	6.020	W9XF	Chicago, Illinois	Broadcast. 3:30-7 and 8:30 P.M. to 11 A.M.
49.83	6.020	W2XBR	New York. N. Y.	Broadcast.
49.97	6.000	ZL3ZC	Christchurch. N.Z.	Broadcast. 10 P.M.—M., Tues.. Thurs., Fri.
49.97	6,000	HRD	Tegucigalpa, Honduras	Broadcast. 9:15-12:15 P.M. Mon.. Wed., Fri. 11-12 P.M. Sat.
49.97	6,000	EAR25	Barcelona. Spain	Broadcast. 3-4 P.M. Sat.
49.97	6,000	RFN	Moscow, USSR	Broadcast. 8-9 A.M. Tues., Thurs., Sat.
50.00	6,000	PK2AF	Djocjacarta, Java	Broadcast. 6:40-9:40 A.M.
50.26	5,975	HVJ	Vatican City. Rome	Broadcast. Daily, 10:30 to Noon.
51.00	5,875	CN8MC	Casablanca. Morocco	Broadcast. Sun., Tues., Wed. & Sat.
51.11	5,870	W6XAF	Sacramento. Calif.	Broadcast. (Dept. of Agri., Calif.)
51.22	5,855	XDA	Mexico City. Mexico	Broadcast. Daily 10-11 P.M.
51.40	5,833	HKO	Medillem, Colombia	Broadcast. 8:30-10:30 P.M. Daily.
55.00	5,450	F8BP	Ruggles, France	Broadcast. 7 A.M.-3 P.M.
58.00	5,170	OK-MPT	Pragur. Cechoslovakia	Broadcast. 1-2:30 P.M.
62.50	4,800	W2XV	Long Island City. N. Y.	Wed. & Fri., 8-10 P.M.
62.56	4,795	W9XAM	Elgin. Illinois	Time Signal.
67.65	4.430	DOA	Doeberitz. Germany	Broadcast. 6-7 P.M. Mon., Wed., Fri. 2-3 P.M.
70.00	4.280	AHK2	Vienna, Austria	Broadcast. 1-7 P.M. First 15 min. of each hour and Sun. only.
70.10	4,280	RV15	Khabarovsk, USSR	Broadcast. 3-9 A.M.
71.77	4,180	WSBN	S.S. "Leviathan"	Phone.
71.77	4,180	GFWV	S.S."Majestic"	Phone.
71.77	4,180	GLSQ	S.S. "Olympic"	Phone.
71.77	4.180	GMJQ	S.S. "Belgenland"	Phone.
71.77	4,180	GDLJ	S.S. "Homeric"	Phone.
72.90	4,110	WGBN	Deal, N. J.	Phone to ships.
72.70	4,120	GFWV	Constantine. Tunis, Africa	Broadcast. Mon. & Fri.
80.00	3,750	I3RO	Rome, It.,(Prato Smeraldo)	Broadcast. 11-1 P.M., 2:30-5:00 P.M.
80.00	3.750	F8KR	Arlington. Va.	Broadcast. 9 A.M.-10 P.M. Time Signal.
82.90	3,620	DUO	Doeberitz, Germany	Television.
84.24	3,660	OZ7RL	Copenhagen. Denmark	Broadcast. 6 P.M. Tues., Sat.
94.76	3.166	WCK	Detroit. Mich.	Police Department.
98.95	3,030	......	Motala, Sweden	Broadcast. 11:30-12 A.M., 4-10 P.M.
105.3	2,850	W2XR	New York. N. Y.	Broadcast. 4-6:30 P.M., 7:30-10 P.M.
105.3	2,850	W3XAD	Camden, N. J.	Television.
105.3	2,850	W9XR	Downers Grove, Ill.	Television.
104.4	2,870	......	Chicago. Illinois	Broadcast. 2 P.M.
	2,750	W9XAP	Chicago. Illinois	
112.1	2,938	W6XAF	Sacramento, California	Broadcast. Dept. of Agri., Calif.
	2,750	W2XAP	Jersey City. N. J.	Television.
	2,750	W7XAD	Portland. Oregon	Television.
121.5	2,468	WRDQ	Toledo, Ohio	
122.0	2,458	WPDG	Youngstown. Ohio	
122.3	2,452	W7XAU	Portland, Oregon	Police Department.
122.3	2,450	KGPP	Portland, Oregon	
122.3	2.450	WRBH	Cleveland, Ohio	
122.25	2,470	KGOZ	Cedar Rapids. Iowa	Police Department.
124.2	2,416	KGPB	Minneapolis. Minn.	Police Department.
124.2	2,422	KGPE	Kansas City. Mo.	Police Department.
124.2	2,440	WNDA	Miami, Florida	Police Department.
124.2	2,422	WMJ	Buffalo, N. Y.	Police Department.
124.2	2.422	WPDE	Louisville, Ky.	Police Department.
124.2	2,422	WPDJ	Passaic. N. J.	Police Department.
124.2	2,422	WPDS	St. Paul. Minn.	Police Department.
124.2	2,440	WPDF	Flint. Michigan	Police Department.
124.2	2,440	WPDL	Lansing. Mich.	Police Department.
124.2	2,440	WPDP	Philadelphia. Pa.	Police Department.
124.2	2,416	WPDH	Richmond. Indiana	Police Department.
124.2	2,416	WPD1	Columbus, Ohio	Police Department.
124.2	2,416	KGPA	Seattle, Wash.	Police Department.
124.2	2,416	W7XP	Seattle. Wash.	Police and Fire Departments.
124.2	2.416	WPDA	Tulare, California	Police Department.
125.4	2,392	W2XCZ	New York, N. Y.	Broadcast. (N.B.C.)
125.41	2.392	W1OXAL	New York. N. Y.	Broadcast. (N.B.C.)
142.9	2,100	W2XCW	Schenectady. N. Y.	Television.
142.9	2,100	W2XCR	Jersey City. N. J.	Broadcast. 8-10 P.M. Mon., Wed., Fri.
142.9	2,100	W1XAV	Boston, Mass.	Television.
142.9	2,100	W2XR	Long Island City, N. Y.	Television.
142.9	2,100	W3XR	Wheaton, Maryland	Broadcast. 8-10 P.M. Mon., Wed., Fri.
142.9	2,100	W2XBU	North Beacon, N. Y.	Broadcast. 1-2 P.M.
142.9	2,100	W2XCO	New York, N. Y.	Television.
142.9	2.100	W2XCD	Passaic, N. J.	Broadcast. 8-10 P.M. Except Sat. & Sun.
150.0	2,000	W1XAY	Lexington, Mass.	Television.
150.0	2,000	W1XY	Lawrence. Mass.	Television.
150.0	2,000	W2XX	Ossining. N. Y.	Television.
150.0	2,000	W3XAD	Bound Brook, N. J.	Television.
150.0	2.000	W2XBU	Beacon. N. Y.	Television.
150.0	2,000	W3XK	Silver Springs. Md.	Television.
150.0	2,000	W2XBO	Long Island City, N. Y.	Television.
150.0	2,000	W2XBS	New York. N. Y.	Television.
150.0	2,000	W2XCP	Allwood. N. J.	Television.

ANYONE interested in short-wave reception will certainly appreciate the difficulty of preparing a complete and accurate list of short-wave stations. In this presentation the Editors of Radio News *have endeavored to give an accurate and complete list—in this case one confined to the short-wave stations, which it is believed are of greatest interest—namely, broadcast, phone, television and police. In preparing the list which appears here the official list of radio stations issued by the International Telegraph Union at Berne, Switzerland, has been employed and all available lists of short-wave stations have been checked against it.*

The time shown is Eastern Standard Time, which is five hours earlier than Greenwich Mean Time, and, respectively, one, two and three hours later than Central Standard Time, Mountain Standard Time and Pacific Standard Time.

Bringing *in* Pictures

With the Home Televisor

The author tells how to put into operation the television equipment which he described in complete detail in his constructional articles in the June and July issues

By Joseph Calcaterra*

IN putting the Baird televisor and television receiver into operation it is well to start with the receiver alone and get this "perking." As explained in the constructional article in the July issue, this receiver is a highly efficient one for short-wave broadcast and code reception. A beginning can therefore be logically made by tuning in some of these types of stations.

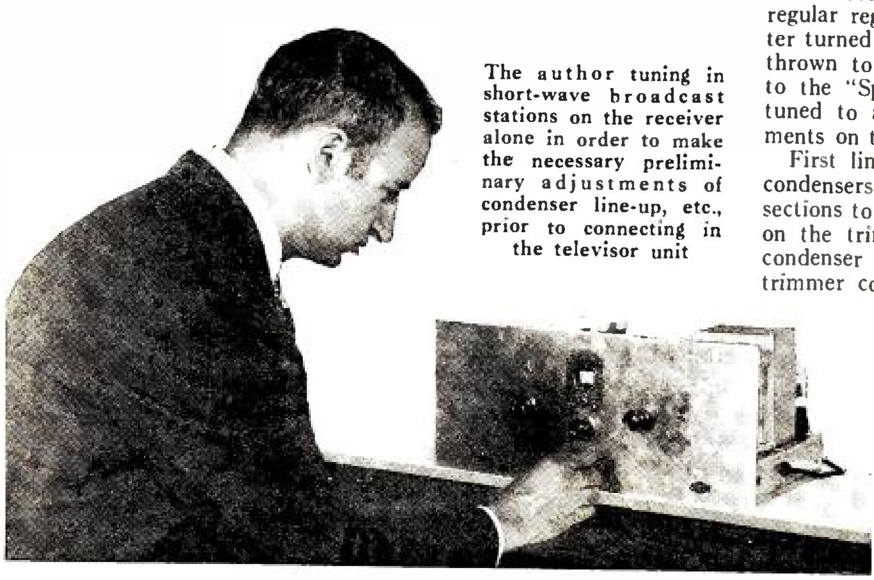
The coils which should be plugged into sockets S9, S10 and S11 of the radio-frequency transformers inside the coil shields will depend on the wavelength range which it is desired to cover and also on whether the receiver is to be used for short-wave voice programs or television reception.

Three Coils Used

A set of three coils is used in the receiver for any given wavelength range—one in the first r.f. stage socket, S9 (Figures 8 and 9, page 40 of the July issue), a second in socket S10 and a third in socket S11 for coupling the second r.f. tube to the detector and also to couple the plate and grid circuit of the detector together when a regenerative detector is desired.

The Octocoils used to cover any given wavelength range are distinguished by the colors of the forms on which they are wound. The green coils are used to cover the range from 16 to 30 meters, the brown coils to cover the range from 29 to 58 meters, the blue coils to cover the range from 54 to 110 meters and the red coils to cover the range from 103 to 225 meters. Octocoils are also available to extend the range of the receiver into the broadcast band above 225 meters.

The television coil is a red coil, since television reception is in the 100- to 200-meter band. It is easily distinguished from the standard short-wave coils by the fact that it is provided with only a single winding while the others all have two windings. For television reception it is necessary to use regular red Octocoils in sockets S9 and S10 and the television, single winding red coil in socket S11.



The author tuning in short-wave broadcast stations on the receiver alone in order to make the necessary preliminary adjustments of condenser line-up, etc., prior to connecting in the televisor unit

If the receiver is to be used only for short-wave work exclusive of television, the television coil is not required, unless it is desired to operate the receiver with a non-regenerative detector. Using a non-regenerative detector gives more stable though less sensitive operation.

The a.c. plug of the receiver should of course be inserted in a lighting outlet supplying 110-volt, 60-cycle a.c. power, the proper coils and tubes should be in the sockets of the receiver, and the antenna, ground and speaker connected.

Adjusting the Receiver

To tune in a signal, turn the knob of potentiometer P as far as it will go in a clockwise direction. This will automatically snap on the a.c. switch and will also serve to put a fairly high voltage on the screen grids of tubes VT1 and VT2.

Switch SW1 should be thrown to the "On" or "Grid Rectification" position. With this switch on or in the closed position, the grid bias resistor R5 in the detector grid circuit is shorted out and the tube operates as a grid rectification detector. For television operation, or for use on very strong signals, it is advisable to throw the switch to the "Off" or "Plate Rectification" position. In that case the detector operates as a power detector and is capable of handling a stronger signal without distortion. The use of plate rectification also decreases the tendency toward regeneration and is therefore preferable when using the receiver for television.

Grid rectification, however, provides greater sensitivity and regeneration so that it is desirable to use the switch in the "On" position when tuning in distant short-wave voice and code stations.

For loud speaker reception, switch SW3 should be thrown to the "Hi" or "Speaker" position, thus connecting the speaker across the output choke CH2.

With the receiver connected to the lighting outlet and the regular regenerative coil in socket S11, the potentiometer turned fully on in a clockwise direction, switch SW1 thrown to the "On" position and switch SW3 thrown to the "Speaker" position, the receiver is ready to be tuned to a short-wave station for making the adjustments on the tuning and trimmer condensers.

First line up the main sections of the variable gang condensers, and tighten the set screws of the various sections to the shaft. Then let out the adjusting screws on the trimmer condensers, C5 and C6 of the tuning condenser sections C2 and C3 respectively, and adjust trimmer condenser C4 to about its midposition.

Next tune in a weak station, on any of the waveband ranges which your log of short-wave stations shows is operating, by adjusting the main variable condenser sections through the dial control knob and by manipulating the regeneration condenser C7 and the trimming condenser C4 until the characteristic regeneration whistle is heard in the speaker. Then adjust the tuning and regeneration control just below

*Aerovox Wireless Corporation

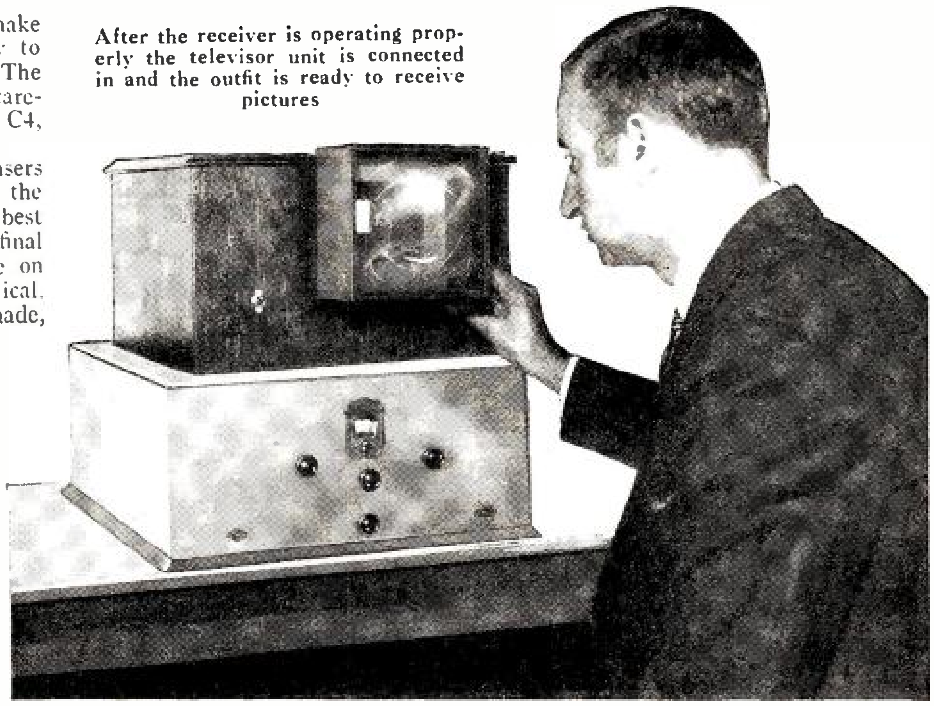
the spill-over or whistling point and make the minor tuning adjustments necessary to get the station in as strong as possible. The final alignment can then be made by carefully adjusting the trimmer condensers C4, C5 and C6.

The adjustment of the trimmer condensers should be tried on different stations in the different wavelength bands until the best average adjustment is obtained. The final adjustments should preferably be made on weak stations since they are most critical.

After these adjustments have been made, short-wave stations within the wavelength range limits of the coils being used can be tuned in with comparative ease.

In tuning in distant stations, especially foreign stations, it is important to know just about where to look for them on the dial settings. This can be learned after the set has been logged on near-by short-wave stations. The fishing foreign stations can then be done at approximately the dial settings at which they should come in.

A little practice, a little patience and ordinary common sense are all that are necessary to tune them in.



After the receiver is operating properly the televisor unit is connected in and the outfit is ready to receive pictures

If you will consult the list of short-wave stations to find the wavelengths on which they are transmitting and their transmitting schedules you will save yourself time and effort.

Television signals, to obtain a good picture, must be stronger than those required for voice reception. This means that for a transmitter of any given power, the range for satisfactory picture transmission is much less than for voice transmission. It is very important, therefore, to use a sensitive receiver such as the Baird receiver and an efficient antenna and ground system for picture reception. No effort should be spared to make sure that the entire receiving system is functioning at highest efficiency.

Excessive line-voltage fluctuation is an important consideration in the operation of this television unit. Generally speaking, the ordinary variations from 110 to 120 volts will cause very little trouble, since the synchronizing unit will take care of such variations, but if there is any possibility of the line voltage varying within wider limits, the use of an Amperite 75-watt automatic line-voltage control is recommended. If such a control is not employed, the pictures will "drift" when the line voltage changes excessively and it will be necessary to adjust rheostat R4 to keep the picture in frame.

The installation of the line-voltage control is very simple. All that is required is to connect the unit in series in the a.c. lead to the television motor. The voltage control can be mounted in the television cabinet, making sure that it does not interfere with the operation of the scanning spider and belt.

The first step in the reception of the pictures is to tune in a strong television signal on the short-wave receiver, using the coils already mentioned for television reception.

It is much easier to tune in the signal on the loud speaker than to attempt to tune it in on the television unit direct. A television signal produces, in the loud speaker, a strong, steady whirring sound.

After a good television signal has been tuned in on the loud speaker (being sure that switch SW1 is in the "Off" or "Plate Rectification" position) snap the switch of the televisor unit "On" and turn the rheostat of the televisor as far as it will go in a clockwise direction. Then switch the signal from the loud speaker to the televisor by throwing switch SW3 to the "Lo" or "Television" position.

It is necessary, of course, that the televisor be connected to the a.c. outlet and that the five-prong plug of the televisor be inserted in the corresponding socket of the receiver.

The adjusting rod LR of the magnet assembly should be moved to a position midway between the front and rear limits of the slot in the side of the cabinet.

As the motor gathers speed, streaks of orange-tinted light will appear through the scanning belt at the front of the cabinet. When the motor has attained full speed, its speed will be higher than the synchronizing speed required to bring the picture into frame.

If the switch S of the televisor is now snapped to the "Off" position, the speed of the scanning belt will gradually decrease. As the speed of the belt approaches the synchronizing speed, the picture will come into view but will at first appear to lean to the left and drift to the right. Then the picture will gradually become upright and stop drifting.

As the speed of the scanning belt continues to decrease, however, the picture will again begin to drift, but this time to the left, and it will lean more and more to the right.

As the picture begins to lean to the right and drift to the left, snap the switch "On" again. Then as the motor begins to pick up speed the drifting to the left will decrease and the picture will again assume an upright position until the speed passes the synchronous speed, when the picture will then again begin to drift to the right, with the picture leaning to the left.

For a short while continue to snap the switch "On" to stop the drift to the left and "Off" to stop the drift to the right.

With a little practice, you will be able to perform this operation automatically and catch the picture in frame very easily. If you do not catch the picture quickly, it may drift out of sight as the speed of the motor increases or decreases excessively.

As soon as this operation has been mastered so that the picture can be kept in sight, the next step is to coördinate the switching operation with the speed adjustment of the motor by means of R4 until the picture remains in frame. To do this, the resistance of the rheostat should be gradually increased by turning it in a counter-clockwise direction until a point is reached where the drifting in one way or the other is very gradual, indicating that the motor speed is about that of the transmitter motor. (*Continued on page 167*)

What We Have Seen

During the last few weeks a television receiver of the type described has been used in the Radio News *laboratory to bring in picture transmissions from the New York stations. It is fascinating to watch the performers and announcers as they stand before the television "eye." We have "looked-in" on the Jenkins transmissions, the N. B. C.'s card announcements and J. V. L. Hogan's radio "movies" with great interest.*—The Editors.

An All-Wave Super
Without Plug-in Coils

This modern receiver, which employs the new multi-mu and pentode tubes, covers from 15 to 550 meters. A simple switch on the front panel permits instant selection of any range within these limits

By McMurdo Silver*

DESPITE certain rather serious practical handicaps, short-wave reception has become increasingly popular with broadcast listeners and experimenters as differentiated from amateurs, as the number and availability of programs, both domestic and foreign, has increased, and it may be said that the coming season will see a very rapid increase in broadcast listeners' use of short-wave receivers, both because of real interest in the now very excellent short-wave programs as well as their distance and foreign variety appeal, and because short-wave receiver design technique has now developed to a point where short-wave receivers may be built and offered that really will make available to the average American home foreign and far-distant domestic programs with a very high order of regularity.

In years past it has been customary to go at short-wave receiver design in terms of obsolete and antiquated broadcast receiver design tendencies, such as three-tube regenerators, or at best, three-tube regenerators with a stage of untuned or tuned r.f. amplification ahead of the first detector. The second disadvantage of commercial short-wave receiver design has been the necessity of plug-in coils to cover the required frequency range, with consequent frequent prying into the set to pull out and put in coils often located inside shielding—for even greater inaccessibility, it seemed to the user.

Coupled with all this was the further fact that in attempting to combine into one single receiver unit both a broadcast and a short-wave receiver usually meant that something had to be sacrificed in one section, and sometimes quite a bit in both—consider, for instance, who would today use a two-tuned circuit, four-tube set for good broadcast reception?

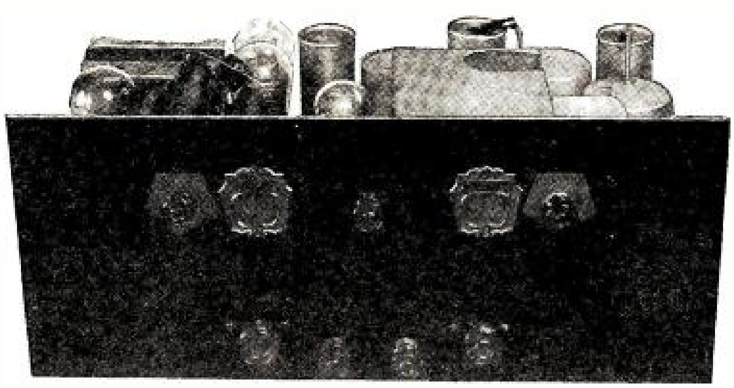


Figure 1. The front view of the receiver. The control knobs, top row, left to right, are: short-wave range selector, short-wave trimmer, selector switch for changing from broadcast to short waves. Lower row, left to right, short-wave tuning, tone control, combined off-on switch and volume control, and broadcast band tuning

The real solution of the whole short-wave problem was obviously in a superheterodyne receiver design, but even here a number of problems thrust up their ugly heads—for instance, the intermediate-amplification frequency commonly employed for the broadcast band is 175 kc., but this is an unsatisfactory i.f. for operation in the range of 2000 to 30,000 kc. How was this to be compromised, and how was a simple, permanent design to be developed that would be at once a fine broadcast receiver, and at the same time a short-wave set that would really show what modern broadcast design technique applied to short-waves would do?.

One of the answers is the new Silver-Marshall 726SW short-wave superheterodyne which covers a range of about 10 to 550 meters or from 550 kilocycles to 30,000 kilocycles, so that it will take in the frequencies of all American broadcast and American and foreign short-wave broadcast stations. As a broadcast receiver it shows exactly the same operating characteristics and curves as the 726 superheterodyne described in last month's RADIO NEWS. As a short-wave receiver, it is the dream of old come to life—a double superheterodyne using two intermediate amplification frequencies.

Before considering some of the design problems and features it may be well to give an idea of the set's actual performance. Located in Chicago, with a ten-foot aerial, broadcast stations all over the country can be tuned in on almost any spring evening. Noise level is extremely low for such a sensitive receiver, and may be further reduced by means of the tone control—no small advantage in summer when static is quite heavy.

On the short-wave bands, practically every American short-wave broadcaster can be tuned in with excellent volume and with surprisingly good tone quality, due to the nearly rectangular response curve of the entire receiver, from antenna to ear. It is not at all difficult to get G5SW in England every afternoon with far more than the volume ordinarily required in the home, while at night foreign broadcasters are received with almost the same ease as the American short-wave stations.

Since the broadcast band portion of the 726SW receiver has been described in the July, 1931, issue of RADIO NEWS, there is little point in reviewing it here, for the previous description applies in all electrical and circuit details, only the mechanical arrangement being different.

The receiver chassis is illustrated in Figures 1, 2 and 3, and a schematic diagram appears in Figure 4. Examining Figure 2, the housing at the right front center contains the broadcast band gang condenser, oscillator coil and oscillator tube. To the right of this housing is the r.f. tube and the first detector, with just behind it and to the right of the oscillator tube, the low-frequency broadcast band trimming condenser C4. The i.f. amplifier is laid out along the back of the chassis with the two –47 pentode output tubes between the power transformer and shielded –27 second detector. The –80 rectifier is at the left front of the power transformer, which, in turn, is seen at the left rear corner of the chassis. The balance of the equipment visible on the chassis is the short-wave portion of the receiver.

As was previously mentioned, the ideal intermediate amplification frequency for operation on the broadcast band of 550 to 1500 kc. and the ideal intermediate amplification frequency for operation in the short-wave band of 2000 to 30,000

*President, Silver-Marshall, Inc.

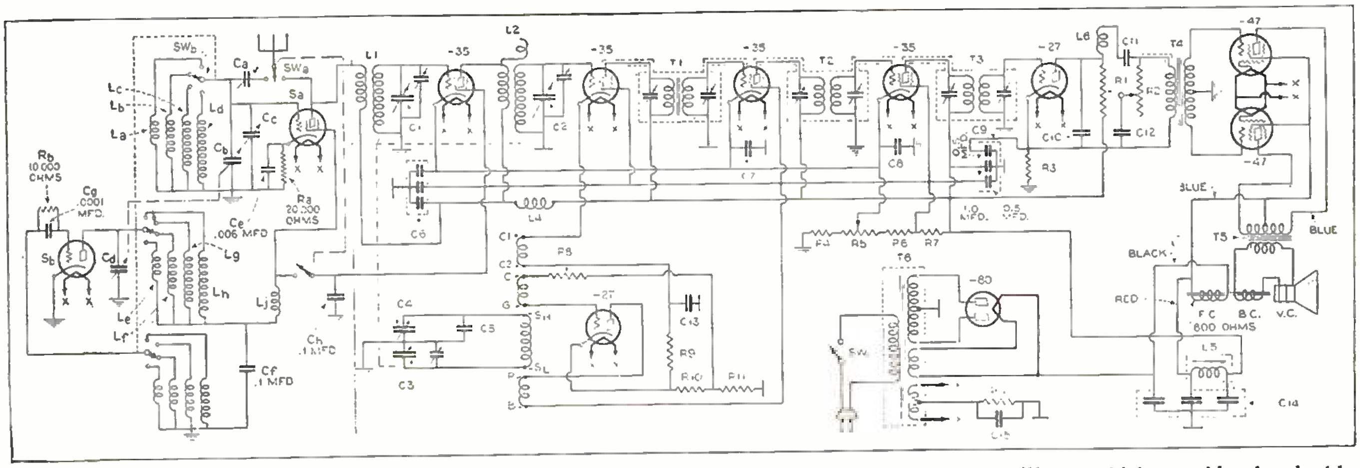


Figure 4. The circuit diagram. The tubes Sa and Sb are the short-wave first detector and oscillator which provide the double heterodyne feature employed for the short-wave ranges

kc. differ considerably. Neglecting maximum gain possibilities entirely in selecting the intermediate frequency for the broadcast band, since adequately high amplification may be obtained at any frequency from 1500 kc. down today, the choice of an intermediate frequency becomes almost entirely a matter of selectivity in terms of image frequency or repeat point interference. If a low intermediate frequency is used, the second station which may be heterodyned by a given setting of the oscillator will be so close to the wanted signal that unless a very high order of pre-selection is employed the unwanted signal will get through along with the wanted signal. This requirement suggested the use of a reasonably high intermediate frequency, say on the order of 300 to 400 kc., but this in turn has its disadvantages, simplest among which is the fact that the second harmonic of such a high frequency falls directly in the broadcast band. This is extremely disadvantageous, since in a high-gain receiver the harmonics of the intermediate carrier frequency necessarily generated by the second detector in performing its rectifying function may feed back into the first detector or r.f. circuit and cause serious trouble. This has been gone into by the writer in several previous issues of RADIO NEWS.

The frequency of 175 kc. is high enough so that for a given oscillator setting the second station which may be heterodyne in addition to the wanted signal will be 350 kc. away from the wanted signal—sufficiently far away so that no excessive precautions of pre-selection at the signal frequency are required to keep out this unwanted signal, two tuned circuits utilized with the new multi-mu tubes being adequate. Moreover, the second and third harmonic of this intermediate frequency fall outside the broadcast band, the third harmonic falling at 525 kc. As the major portion of the harmonic energy developed by the second detector lies in the second and third harmonics of the intermediate frequency, these harmonics can do no harm.

In the case of a short-wave receiver, it being not particularly practical to employ more than one tuned circuit preceding the first detector, the image-frequency problem will be seen not only to be more serious because of this practical limitation on pre-selection, but even were a considerable order of pre-selection employed, more serious simply by virtue of the percentage frequency differences involved. Referring, for example, to the above paragraph and assuming that a wanted signal was at 1000 kc., this in a conventional superheterodyne would mean that the unwanted signal heterodyned by the same oscillator setting (which in this instance would be 1175 kc.) would actually be at 1350 kc. or in terms of percentage, frequency separation 35 per cent.—a separation so large as to permit easy elimination of the unwanted signal by use of two good tuned circuits. Assume for a moment the use of the same i.f. frequency, with in this case the wanted signal appearing at 30 meters or 10,000 kc. The unwanted signal which would be heterodyned by the same oscillator setting would appear at 10,350 kc. or with a percentage frequency difference of only 3.5 per cent. From this it is apparent that a considerably higher intermediate amplification frequency is desirable for short-wave reception if image frequency interference is to be kept within control of a single good tuned circuit. This intermediate amplification frequency for short-wave reception really should be on the order of 500 to 1000 kc., and in the case of the 726SW receiver, a figure of 650 kc. has been selected. Considering again, for this case, a 30-meter or 10,000-kc. signal, the setting of the oscillator to heterodyne this signal will be 10,650 (*Continued on page* 173)

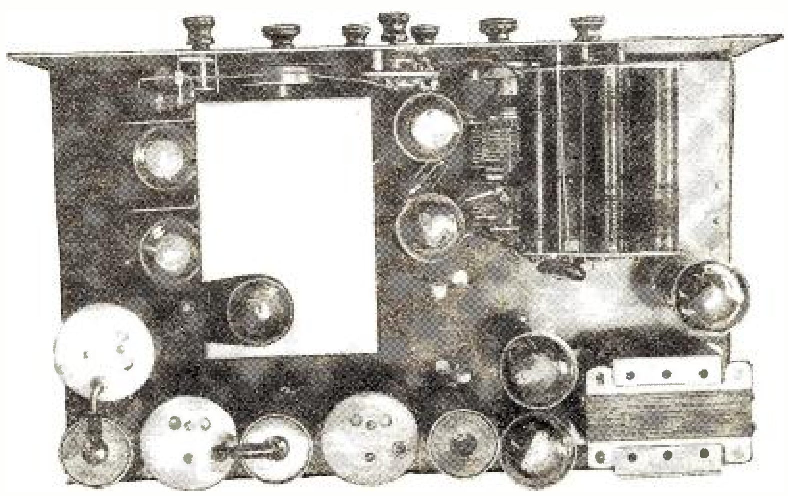


Figure 2. The top view. The short-wave coil assembly is seen at the lower left. The broadcast coils are inclosed in cans at the right and rear of the chassis and below the deck

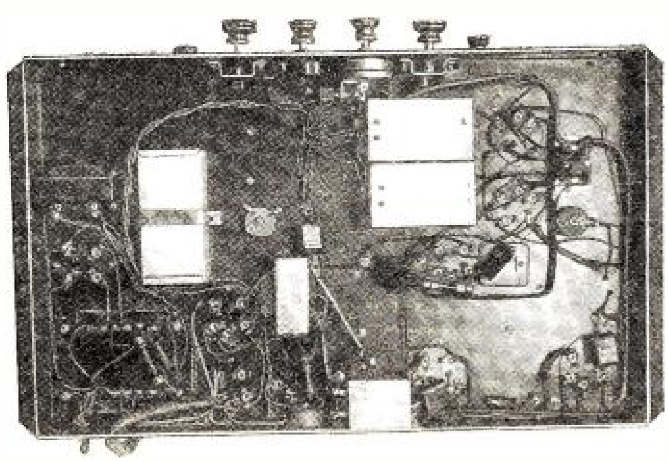


Figure 3. Below deck everything is readily accessible for servicing. The two cans at the right center house the broadcast oscillator and r.f. coils

The JUNIOR TRANSMITTER

This and the article to follow provide the complete constructional and operating details of a highly efficient four-stage transmitter of the master-oscillator, power-amplifier type, using low-power tubes throughout

By Don Bennett

"HELLO, Gus. I've been wondering when you were coming around to explain that m.o.p.a. to me. What's been keeping you all this time?"

"Been busy at work. How's the old set going now?"

"Pretty good, but I'm rather interested in this new layout. Let's have the dope on it in a hurry."

"O.K. The big reason for m.o.p.a. is its steadiness, reliability and its ability to withstand frequency changes due to swinging antennas and feeders and to broadcast fans sticking up antennas near yours that swing back and forth and alter the capacity of your antenna to ground. Because of the multi-stages between the oscillator and the antenna, these variable factors are pretty well wiped out by the time their effects reach the oscillator. If you hear a steady note on the air, you can be reasonably sure it's either crystal control or m.o.p.a."

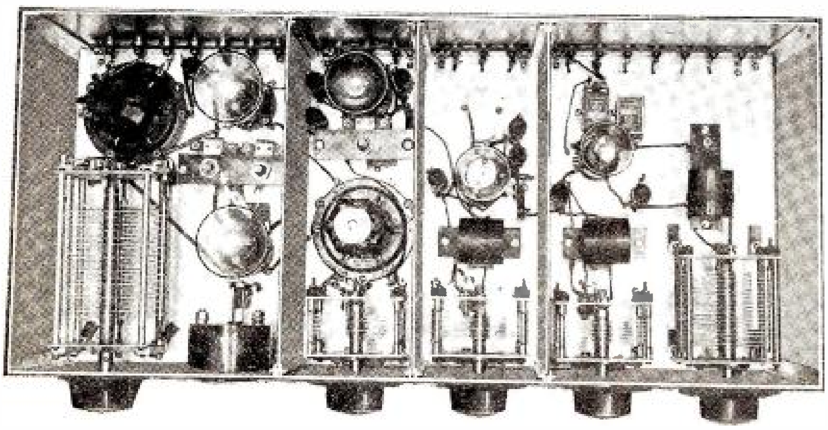
"Why not include a crystal right from the start, Gus, if that is the most reliable of all?"

"Well, crystal has one big disadvantage; your frequency is that of the crystal and you're stuck with it. I'd rather build an m.o.p.a. and design it so that either crystal or self-excitation can be used, as desired. That's a much more flexible rig and you will find it more satisfactory."

"Yes, there's something in that—I do find a dead spot occasionally with no one in it and it's handy to be able to shift into it."

"Another reason for a convertible set is that few hams want to buy more than one crystal, and the one they buy is usually ground for some place in the 80-meter phone band. They can use its harmonics in the higher frequency bands, but for 80-meter c.w. operation they need another crystal. With the convertible set, you need only the one crystal, shifting to a plug-in coil for c.w. operation in the rest of the 80-meter band. Likewise, if you don't want to invest in a crystal right away, you have a transmitter that is steady and that can be used on all bands merely by changing coils. With the set I have in mind, you can do some doubling right in the transmitter and require less coils.

"The line-up I have in mind—remembering the limitations of your present power supply—is a -27 oscillator, -24 buffer, -45 intermediate amplifier and the two De Forest type 510 transmitter tubes you now have in push-pull as a power amplifier. I suggest the intermediate stage so that you will have plenty of power to



The top view with top shield removed, showing location of parts and shield partitions

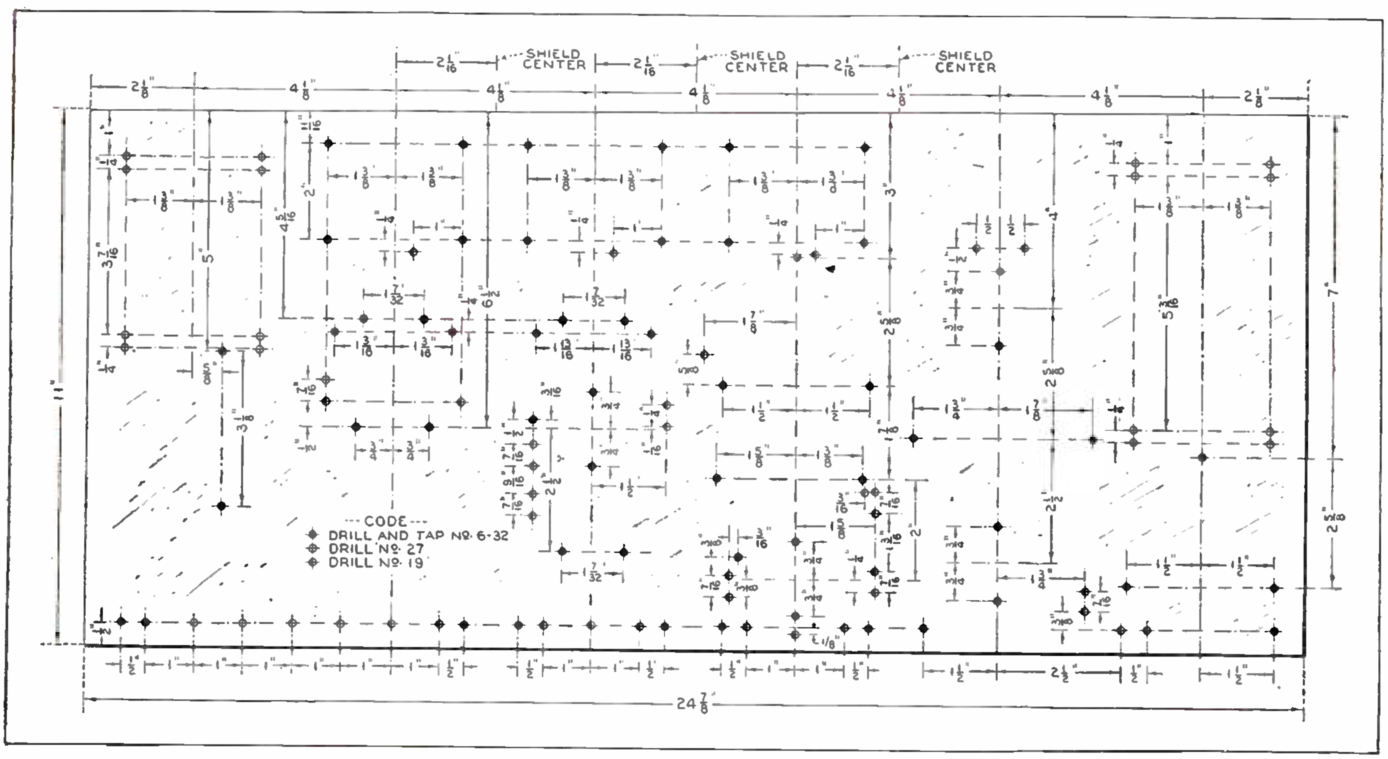
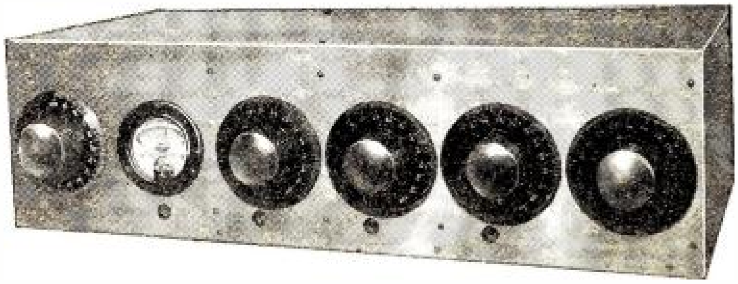


Figure 2. The complete drilling layout for the aluminum base

Grows Up



The front view of the completed transmitter. The tuning controls, right to left, are: oscillator, grid, oscillator plate, buffer plate, intermediate amplifier plate and power amplifier plate

swing the grids of the two 510's. There is a good chance that the -24 wouldn't deliver enough sock to do it. There is this objection to the -45, you can't do efficient doubling in it. However, if you do want to double from your 80-meter crystal, a single -27 stage can be plugged in to enable you to reach the 7- and 14-megacycle bands.

"Here's the circuit I have drawn out for you (Figure 1). You'll notice that the crystal and the coil are interchangeable without disconnecting the condenser. The design of the coil mount takes care of that. All that is necessary (outside of swapping the crystal holder for the coil) is to replace the grid leak with a piece of brass the same physical size as the grid leak, so that the grid condenser is shorted, and connect in the bias voltage for the crystal.

"We use shunt feed for the plate supply instead of the series feed we used in the original transmitter to eliminate the necessity of insulating all the condensers. You'll notice in the circuit that all the variable condensers have their rotor plates grounded except the one that tunes the power amplifier plate tank. You'll need to insulate that one, as I'll explain later.

"As I told you before, the -24 buffer serves to protect the oscillator from frequency changes in the succeeding elements of the circuit and the antenna. Now, if we were going to use a single 510, we could use it as the next tube and the -24 would swing it. However, we are using push-pull for the same reasons we used it when you first built your transmitter (January, 1931, issue, RADIO NEWS). It is therefore necessary that we get more power to swing the grids of these two tubes. Hence the -45. When you go from a single tube into a push-pull stage it is necessary to get a phase difference so that the push-pull tubes divide the work between them and you get the utmost in efficiency. There are several ways of accomplishing this, but probably the most efficient is this inductive coupling—it is really an r.f. transformer—and because we center-tap it, we throw half the load alternately on each half of the secondary coil and its associated tube on alternate half cycles of the r.f. current. The secondary is untuned and contains about three times the number of turns in the primary. This gives you a voltage step-up (r.f. voltage) that will remove all doubts of getting sufficient grid swing on the 510's.

"The buffer stage, because it is a screen-grid tube, does not need neutralizing. You will find it necessary to neutralize the -45 and the 510's so that they won't oscillate and feed back into the preceding stage and upset your frequency (and in a crystal set, even break the crystal). When neutralized they operate simply as radio-frequency (*Continued on page* 170)

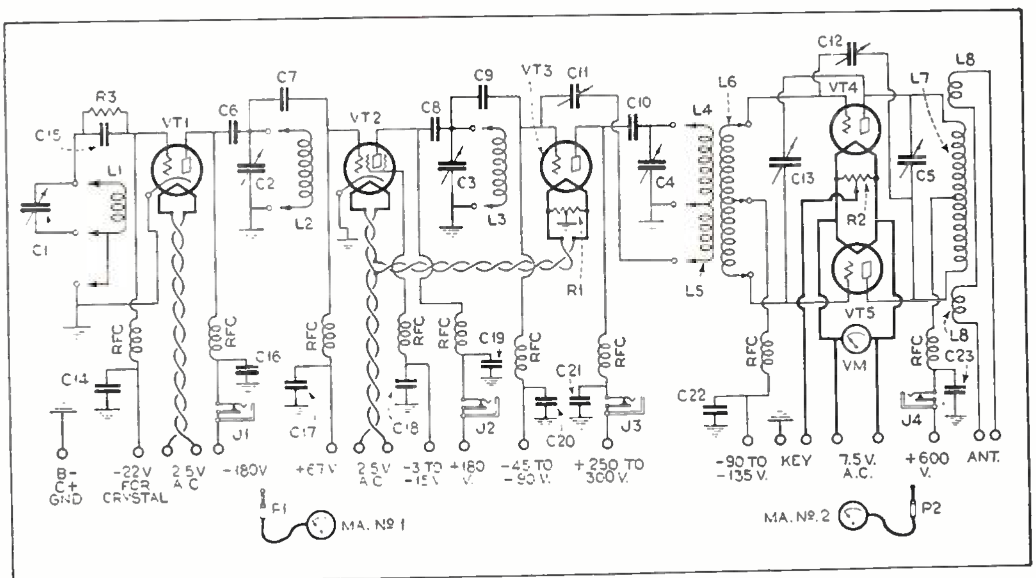


Figure 1. The circuit. All coils are plug-in type. The tubes, from left to right, are: oscillator, buffer, intermediate amplifier and push-pull power amplifier

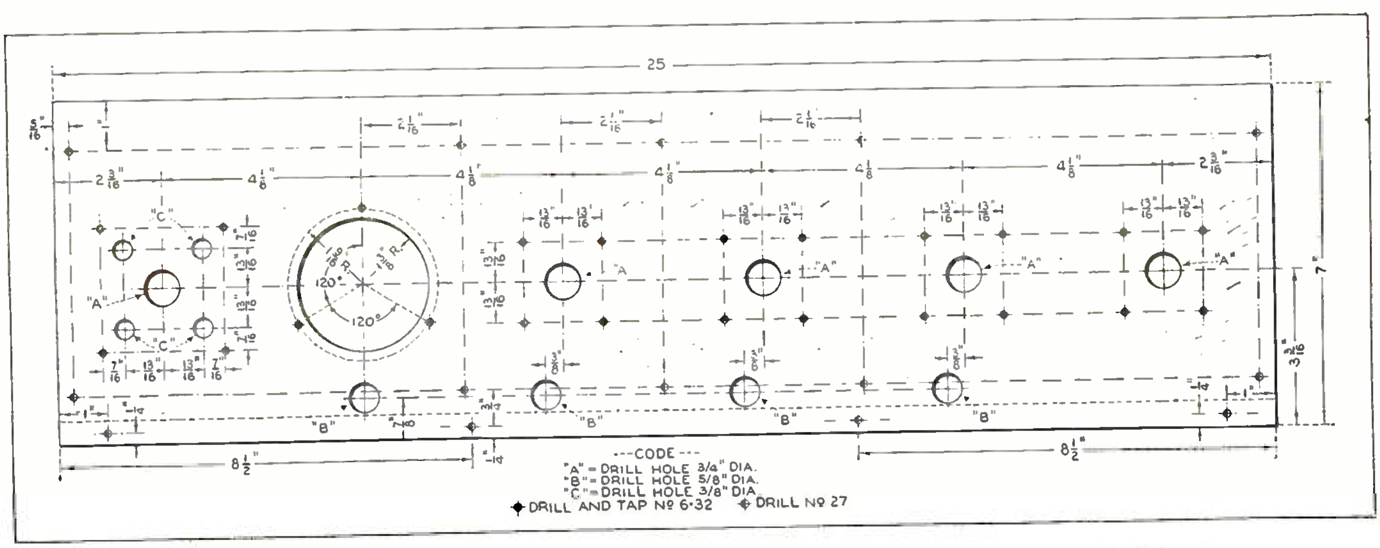


Figure 3. The panel layout, showing all dimensions and the location and sizes of all drill holes

Oscillator Single Control

Gang condenser with the special oscillator "tracking" section on the right-hand end

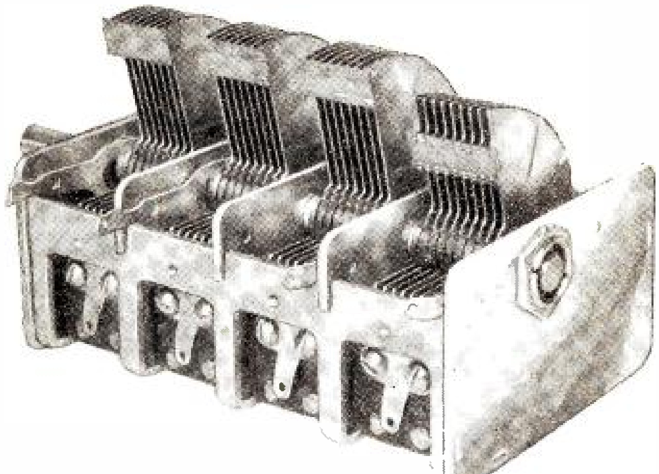
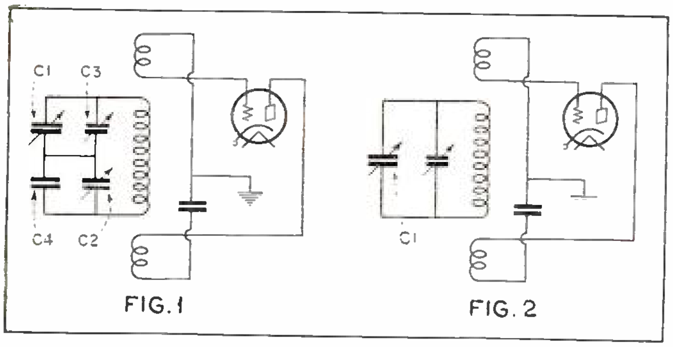


Photo courtesy DeJur Amsco Corp.



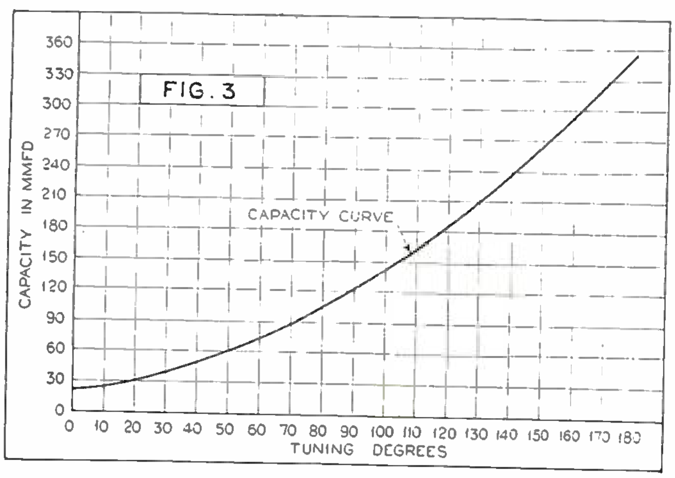


Fig. 1. The familiar superheterodyne oscillator padding circuit. Figure 2. A more simple arrangement whereby the oscillator is tuned by condenser having a special rotor or "tracking" plate. Figure 3. Capacity curve on tuning condenser

Tuning and "tracking" plates for superheterodynes

Photo courtesy DeJur Amsco Corp.

While there is nothing fundamentally condenser, the design of a variable of which cannot be expressed in a graphical solution which should be

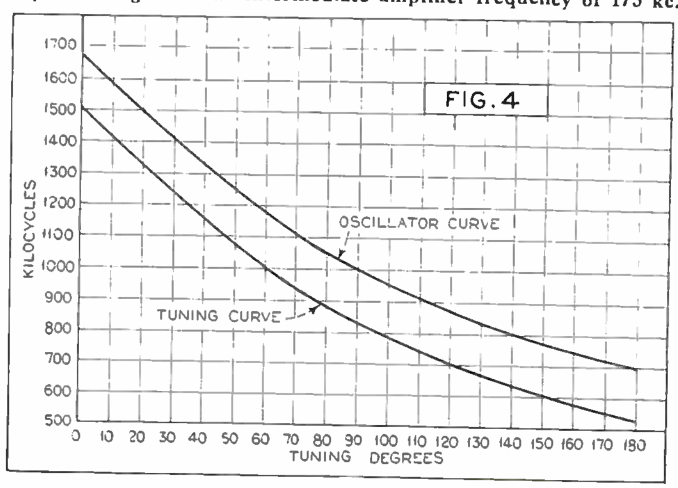
THE rather extended inactivity of the superheterodyne during those years when broadcast receivers were undergoing their most violent development was due, in part, to the difficulties besetting the production of a single-control design comparable in ease of operation with the highly competitive tuned-radio-frequency receivers. While it is true that single control superheterodynes were built as far back as 1924, such receivers employed straight frequency line condensers, which, for reasons not adequately explained to our somewhat obtuse comprehension, were never favorably received by the radio-listening public. The superheterodyne has received a new impetus with the increase in the intermediate frequency and the resulting separation of the oscillator repeat points; the use of preselector stages with the reduction of image interference, and the development of oscillator circuits permitting single control.

Single-Control Design Problem

The main problem involved in the design of a single-control superheterodyne is, of course, the maintenance of a consistent frequency difference between the first detector and oscillator circuits, this frequency difference being the intermediate frequency, 175 kc. in the case of most present-day broadcast superheterodynes. While this is a relatively simple matter where straight frequency line condensers are employed, the problem becomes somewhat complicated when other condensers are used, such as the straight capacity or straight wavelength line, and becomes considerably involved when the popular "midline" condensers are employed which have no mathematically simple curve and represent a hybrid combination of the s.f. line and straight wavelength line types.

Many successful single-control superheterodynes have been developed employing such condensers by use of the familiar padding systems, such as Figure 1. However, this arrangement requires two extra condensers, C2 and C4, is quite complicated to adjust, and often results in a poor approximation of the desired tuning, discrepancies above 10 micromicrofarads

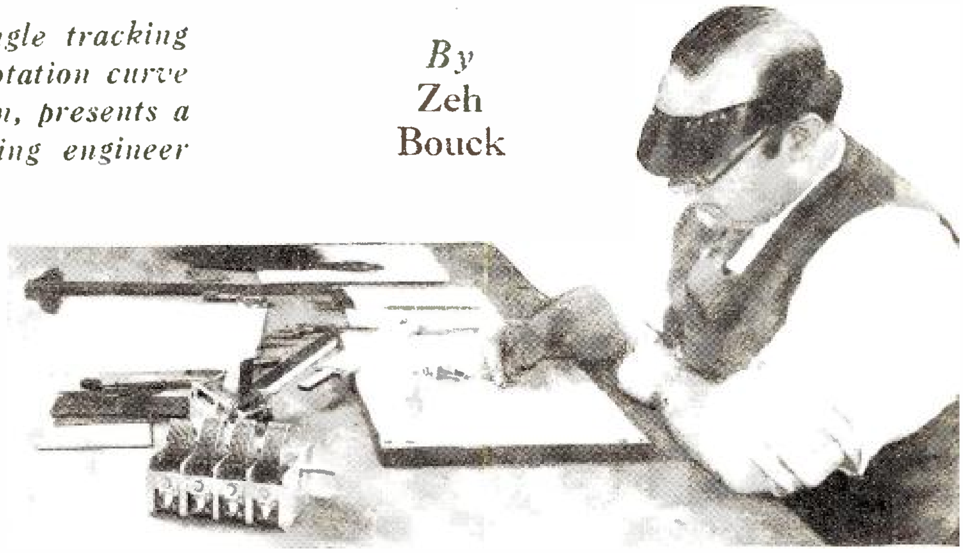
Figure 4. Frequency curves on oscillator tuning circuits required by "tracking" with an intermediate amplifier frequency of 175 kc.



Condenser Design for
Superheterodynes

new in the idea of a single tracking condenser, the capacity-rotation curve simple geometric equation, presents a of interest to the designing engineer

By
Zeh
Bouck



The engineer should check process of building up plate with a planimeter

being not at all uncommon. C1 and C3 are the usual standard tuning condenser and trimmer. C4 is chosen several times larger than C1. With C1 all the way in, C2 is adjusted for the correct frequency. C3 is adjusted at the other end of the scale, having practically no effect on the capacity of the circuit when C1 is at maximum. In favor of this system it must be said that the accuracy of tracking (when properly adjusted) is fairly independent of slight inconsistencies in the variation of C1.

An obviously more simple and ideal arrangement is shown in Figure 2, whereby the oscillator circuit is tuned by a single condenser (with the usual trimmer). However, in a single-control circuit, C1 must be mounted coaxially with the preselector and first detector tuning condensers, and the plates must be so curved that the capacity increases in such a manner that the frequency of the oscillator circuit is always higher than the first detector frequency by the amount of the intermediate frequency.

Such a circuit is obviously more economical and easier to adjust than the padding arrangement, and the accuracy of tracking is of the same order as the gang matching in an ordinary t.r.f. receiver.

Using Straight Frequency Line Condensers

As already intimated, it is fairly simple to secure the desired tracking with straight frequency line condensers. By choosing properly the values of inductance and lumped capacity in the tuning and oscillating circuits, and the number of dielectric spaces in the condenser, the same plate may be employed in both the oscillator and tuning sections. The shape of the plate is determined by the vector radius, and inspection of the following formula will indicate the nature of the compensations required to preserve the straight frequency line, when the lumped capacity number of spaces or inductance is changed to provide the frequency difference:

$$R = \sqrt{\frac{1}{\pi^2 Lnk\left(\frac{df}{d\theta}\right)^2 \left(\frac{1}{2\pi \frac{df}{d\theta}\sqrt{LCo}} - \theta\right)^3} + r^2} \qquad (1)$$

Where—
R is the vector radius in centimeters at θ.
θ is the angle in radians from minimum capacity through which the rotor plates have been tuned.
L is the inductance in henries.
n = the number of dielectric spaces. *(Cont'd on page 164)*

Figure 5. The calculated and measured capacity curve of oscillator condenser

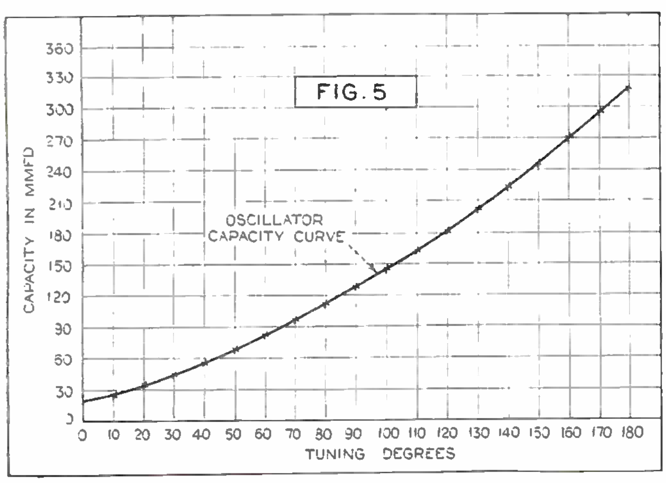
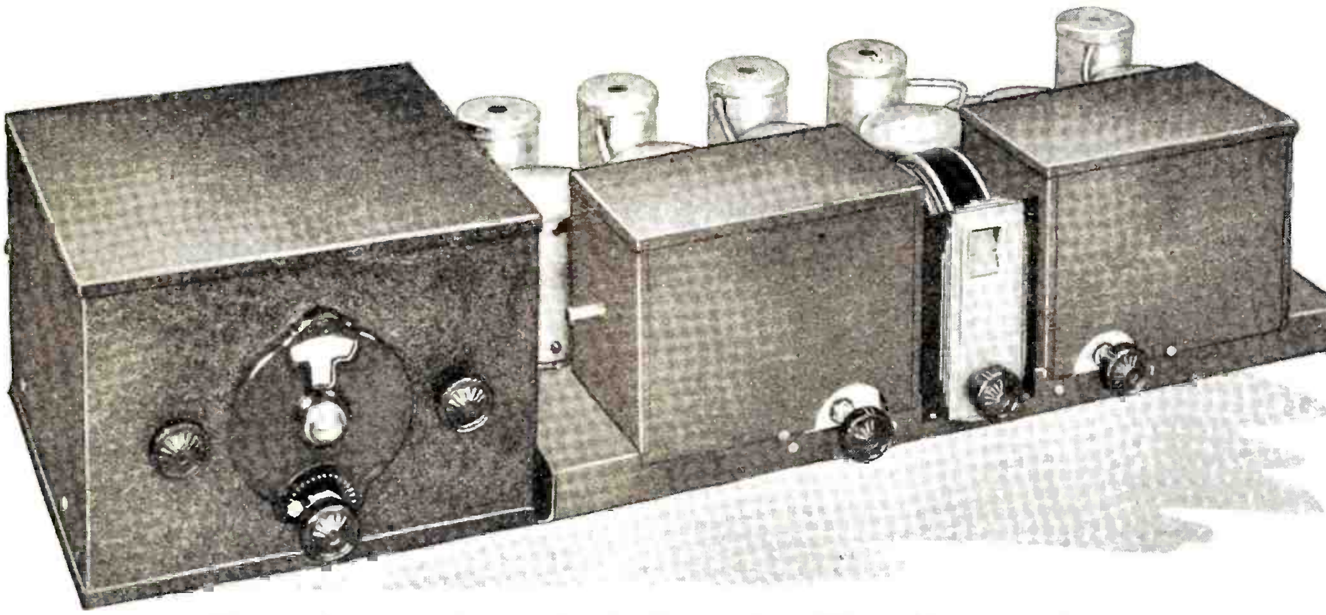


Figure 6. The calculated sequence. This table was made independent of the first table (which was calculated for every ten degrees) as an overall check

TUNING CIRCUIT				OSCILLATOR CIRCUIT			
DIAL IN DEGREES	TUNING COND. CAPACITY	TUNING CIRCUIT CAPACITY	KC.	KC	OSC CIRCUIT DISTRIBUTED CAP	OSC. CIRCUIT CAP	OSC COND CAPACITY
0	18.4	46 90	1500.0	1675.0	44.3	62.7	18.4
20	30.5	59.00	1337.4	1512 4	"	76.9	32.6
40	50.0	78.50	1159.5	1334.5	"	98.7	54.4
60	75.0	103.50	1001.0	1176.0	"	127.2	82.9
80	104.0	132.50	892.5	1068.0	"	154.2	109.9
100	141.0	169.50	789.1	964 0	"	189.3	145.0
120	184.5	213.00	703.9	879.0	"	227.7	183.4
140	235 5	264.00	632.3	807.3	"	269.9	225.6
160	293.0	321 50	572.0	747.9	"	314.5	270.2
180	357.0	385 85	523.2	698 2	"	360.8	316.5
TUNING CIRCUIT CAPACITY = COND + 28.5 MMFD.				FIG.6			



The converter connected to a modern broadcast receiver. This combination constitutes an efficient short-wave superheterodyne receiver

Receiving Short-Waves *on Your* Present Receiver

A compact superheterodyne short-wave converter which may be connected ahead of a broadcast receiver to provide efficient reception on short waves from 13 to 115 meters

By James Wilcox*

AT this time of the year radio reception on the regular broadcast bands is not only practically impossible in tropical countries, but the same situation is true in many of our Southern States. In such locations it has generally been necessary to forego the pleasure of radio broadcast entertainment during the greater part of the summer months.

Within the past year, however, many people in the areas so strongly affected by summer atmospheric disturbances have discovered that very satisfactory broadcast reception can be obtained by the use of short-wave equipment. Not only can the "chain" programs from all three of our main networks be received, but, in addition, excellent reception from a number of distant foreign broadcasters is possible.

In most instances the so-called short-wave receiver, entirely separate and apart from the regular set, has been employed, and the appearance on the market, just about a year ago, of a compact, single dial, a.c.-operated short-wave receiver tremendously increased the number of people enjoying radio reception throughout the year.

There are, however, a great many people who have a considerable investment in their broadcast receivers and who cannot well afford to purchase an additional set.

It was with this in mind that the Lafayette converter was designed for use with the average broadcast receiver, in order to extend its useful frequency range into the short-wave field. Unlike the earlier types of so-called short-wave adaptors, this new unit makes efficient use of all of the tubes in the regular broadcast receiver, rather than just those of the audio stages.

*Wholesale Radio Service Co., Inc.

The overall result is an extremely sensitive yet easily operated short-wave superheterodyne, which, due to the use of the high-grade -45 push-pull audio channel and dynamic loud speaker integral with the average good broadcast receiver, will result in tone performance obtainable from only the best of the strictly short-wave receivers.

While superheterodyne converters are not new, they have had to go through a long period of development before reaching their present state of reliability and overall satisfactory performance.

In designing the Lafayette converter much help was obtained from the experience of the National Company engineers in the development of their short-wave "Thrill Box," as described in the June, 1930, issue of RADIO NEWS. In fact, many of the parts developed by them especially for use in their receiver have, as will readily be seen from the illustrations, been employed in this converter.

Essentially the converter comprises a screen-grid short-wave detector, an oscillator, and a small power supply. Figure 1 gives the circuit details.

The single tuning dial is for adjusting the oscillator condenser, the setting of which is very sharp. The first detector tuning condenser tunes relatively broad and under actual operating condi-

Table 1—Coil Data

COIL NUMBER	L_1	L_2	RANGE IN METERS
11-S	6	12	13-25
12-S	12	12	24-41
13-S	20	15	40-70
14-S	34	15	65-115

tion is employed merely as an auxiliary control.

Having only one major control, and that control being independent of any changes in associated circuits, makes possible the use of a dial such as shown, on which the location of the various stations may be logged for future reference. Such practice is of tremendous help in short-wave reception where the frequency band to be covered is many times the width of the usual broadcast band.

Another aid to easy tuning is the use of the 270° straight frequency line high-frequency tuning condensers. These condensers have been developed specially for short-wave reception and in addition to spreading out the tuning range also incorporate several electrical features of extreme importance. One of these is the constant impedance pigtail for elimination of noisy operation on the ultra-high frequencies and which makes possible the maintenance of accurate logging. Another important feature is the insulated main bearing which prevents the condenser frame from acting as a short-circuited turn in a high-frequency field, which would also contribute considerable noise when the set was being tuned.

As a further important step in the elimination of that bugbear of short-wave reception, noise, all switches in the high-frequency circuits have been omitted for the more reliable plug-in coil system of band changing with its attendant stability and freedom from poor contacts.

The power supply is called upon to deliver but a very few milliamperes to the detector and oscillator and therefore employs a type –26 tube, with the plate and grid tied together, as a rectifier. The associated filter network comprises two 8 mfd. electrolytic condensers and a choke. A filament winding on the power transformer supplies the heater circuits.

It is felt that the inclusion of the power supply in the converter is a really worthwhile feature, as it insures the proper voltages, the elimination of any possibility of overloading the power supply of the broadcast receiver, and, at the same time, this materially simplifies the connection of the converter to the broadcast receiver.

Perhaps it would be well to point out at this time the importance of using a good broadcast receiver in connection with the converter, for, in the final analysis, the converter merely extends the range of a broadcast receiver and unless it is sensitive, selective, and capable of good tone quality, just the addition of the converter cannot be expected to add any of these characteristics.

Any of the good screen-grid receivers manufactured during the past two years, employing two or three stages of r.f. amplification, should give satisfactory results. Do not, however, expect satisfactory results from some of the earlier a.c. receivers, especially those employing the –26 tubes in the radio-frequency amplifiers, as the majority of these receivers had very little r.f. amplification.

Contrary to general opinion, the converter may successfully be used in connection with a number of the present-day superheterodynes, resulting in a "double super" because the frequency is shifted twice and three detectors employed. This combination, strange as it may seem, appears to give very

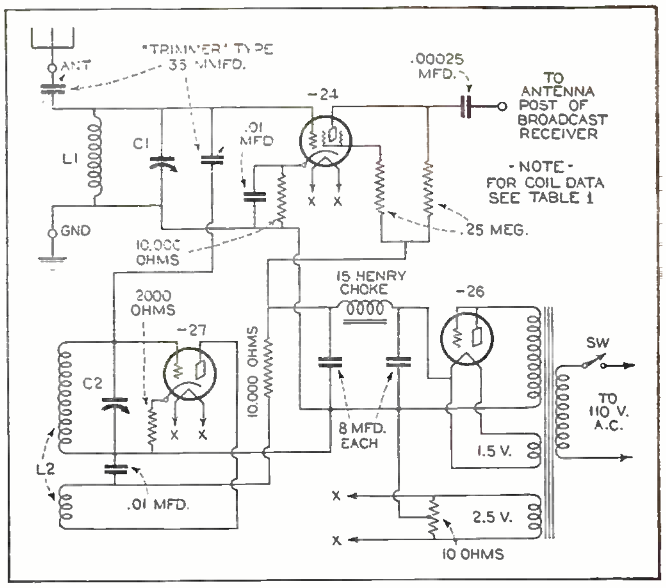
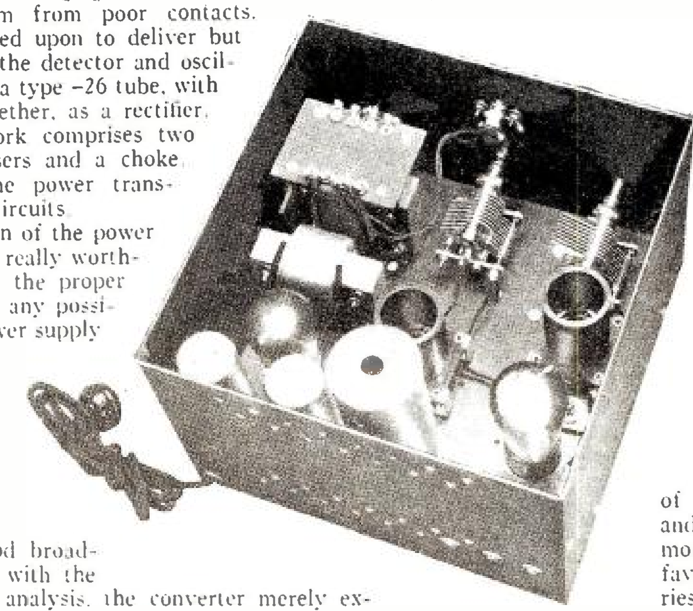


Figure 1. The converter circuit. The –24 and –27 tubes are, respectively, the detector and oscillator. The –26 tube is used as the power supply rectifier



The inside view. At the left is the power supply and at the right the detector and oscillator

satisfactory results. There are, though, some commercial broadcast superhets with which the Lafayette will not give satisfactory performance.

Assuming the use of the converter with a fairly sensitive broadcast receiver, reception of foreign stations should be regular and with good volume, provided atmospheric conditions and location are favorable. Long-distance reception varies greatly with the time of day and with the season, and these facts must be given due consideration. In this connection reference is made to the articles on short-wave reception by Zeh Bouck in the June and July issues of Radio News.

The Lafayette converter is not limited solely to short-wave broadcast reception, for when used with a good broadcast tuner it will be found to make a very practical all-around short-wave receiver for amateur communication, experimental, and other such uses.

In receiving short-wave c.w. signals it is not necessary to employ an additional heterodyne oscillator, but merely to tune the broadcast receiver so that it picks up directly the carrier of a strong local broadcast station and thus uses the broadcast transmitter as a heterodyne oscillator. Of course, if preferred, a separate local oscillator, set to beat with the intermediate frequency or the wave to which the broadcast receiver is tuned, may be used for short-wave reception, and, since this will be unmodulated, it is somewhat preferable to the use of a local broadcast signal as heterodyne.

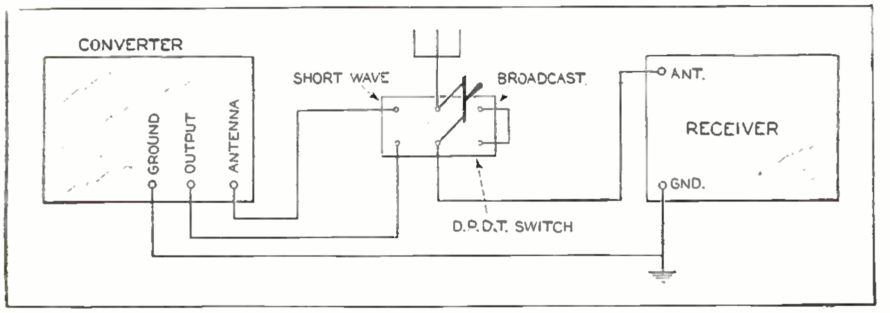


Figure 2. A simple switching arrangement for cutting the converter in and out

Operating Notes

To put the converter into operation, disconnect the antenna from the broadcast receiver and connect it to the antenna post of the converter. Connect the output post of the converter to the antenna post of the receiver, and connect the ground posts of the converter and receiver together. Even if a ground is not required (*Continued on page* 152)

Amateur Radio

Photo courtesy Metro-Goldwyn-Mayer

Radio, like an adequate food supply, is an indispensable part of present-day expeditions, whether the ultimate goal be at the Poles or the Equatorial Jungle. The vast network of 16,000 radio amateurs maintains almost constant contact with exploring parties though they may have reached the ends of the earth

By Everett M. Walker

WHEN in 1923 Captain Donald B. MacMillan decided to take radio equipment with him on his Arctic expedition of that year—he started something. He became the first leader of an expedition to unknown parts of the world to rely on the facilities of 16,000 amateurs scattered widely throughout the United States and Canada for communication with home. It is significant to note that the radio operators of many new expeditions have been drawn from the ranks of these same radio amateurs.

Since the communication success of the MacMillan expedition aboard the schooner *Bowdoin*, amateur radio has achieved the position of being the one and only reliable means of contact with home, from the most remote corners of the globe where explorers seek new discoveries and adventures. With 16,000 trained pairs of amateur radio ears in the United States, and perhaps five or six hundred more in foreign countries where amateur experimentation is permitted, there is little likelihood that communication will fail despite extreme conditions.

Many Expeditions Take Radio

To date no less than fifty exploration parties have included short-wave radio equipment as part of their dunnage. Weight of both transmitting and receiving sets is no longer regarded as a burden. Success may sometimes depend on communication, and in the case of dire emergency it may serve as a means of salvation. Evidence of this has been revealed in a number of instances, where an entire party or group of an expedition making a short exploration trip from a central base has become isolated and flashed word for help which led directly to rescue.

MacMillan's first trip into the Arctic carrying radio equipment demonstrated the reliability of amateur communication. The Arctic explorer's venture was made at a time when amateur communication was limited to reasonably short distances compared with distances now traversed with modern short-wave amateur equipment. When he departed in 1923 practically all amateur communication was effected on a wavelength near 200 meters. Short waves had not yet been discovered. It was while this expedition was in the Arctic that amateurs first began to discover the distance-carrying ability of high-frequency transmissions. It was too late, however, for the operator, Don Mix, aboard the *Bowdoin*, to reconstruct his apparatus for short-wave operation. Despite this handicap, communication was effected between amateurs in the United States and Canada nightly. It thus was demonstrated to explorers that amateurs could supply a means of communication, no matter how remotely situated they were. And to amateurs that they could perform a service which was not only of extensive value to exploration parties, but interesting and dramatic.

Increasing Use of Radio

Following the MacMillan trip, in 1925, there were three exploration parties to venture into unknown territories taking radio equipment. The number increased rapidly in succeeding years. In 1926 five parties carried radio equipment; 1927, six, 1928, nine, and in 1929 and 1930 practically every expedition which made its way to places outside normal communication territory carried equipment. During these latter two

One of the world-famous amateur radio operators—Wells Chapman, of St. Louis, Mo. The station call is W9BUD

Aids *the* Explorer

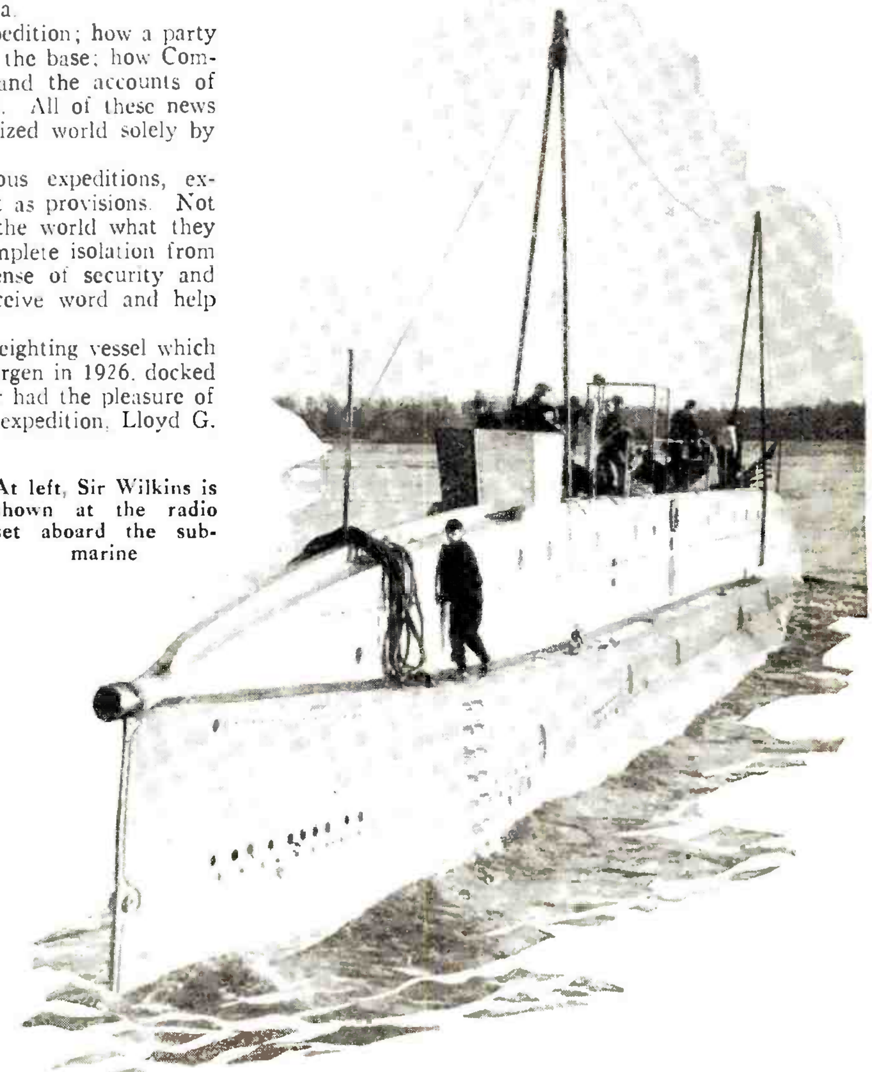
years, sole contact was maintained with Admiral Richard E. Byrd's expedition at Little America, Antarctica.

Everyone has read the accounts of this expedition; how a party became stranded several hundred miles from the base; how Commander Byrd flew across the South Pole, and the accounts of happenings and adventures of the expedition. All of these news flashes were carried to all parts of the civilized world solely by means of short-wave radio.

Because of the success of these previous expeditions, explorers now regard radio almost as important as provisions. Not only does it give them a means of telling the world what they are accomplishing, but it eliminates their complete isolation from the rest of the world. It gives them a sense of security and courage to carry on, knowing they can receive word and help from home.

When the steamship *Chantier,* the small freighting vessel which carried the Byrd Arctic Expedition to Spitzbergen in 1926, docked in New York several months later, the writer had the pleasure of interviewing the chief radio operator of the expedition, Lloyd G.

At left, Sir Wilkins is shown at the radio set aboard the submarine



The *Nautilus,* especially equipped for the daring voyage under the polar ice cap, is carrying complete radio equipment for maintaining contact with the States

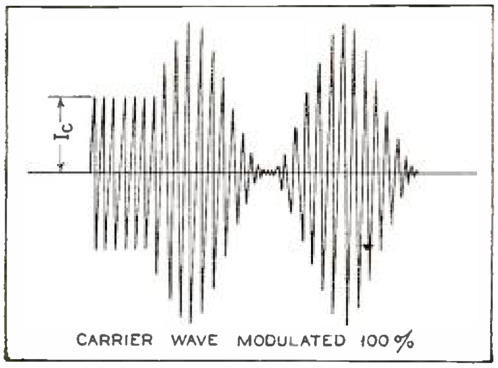
Grenlie, who stated that "radio was the most important piece of equipment taken with the expedition." He also declared that Admiral Byrd, then Commander, was much pleased with the performance of radio and vowed that he would include it as part of the equipment of all his succeeding expeditions. He kept his word.

And so expeditions which are now being promulgated, or which are at present making their way into the isolated portions of the globe, are maintaining contact with home by amateur radio. The American Radio Relay League, the amateur organization which lists among its membership practically every licensed amateur station in the world, keeps this vast group of experimenters informed of the doings of these expeditions. Through the co-operation of the league and the amateurs themselves, the intrepid explorers are never out of touch with home.

Four scientific and several private expeditions for ventures in remote corners of the globe have prepared for departure at the time of the writing of this article. Through the amateurs in all parts of the world are being arranged the important communication links which will contact by radio these exploring parties.

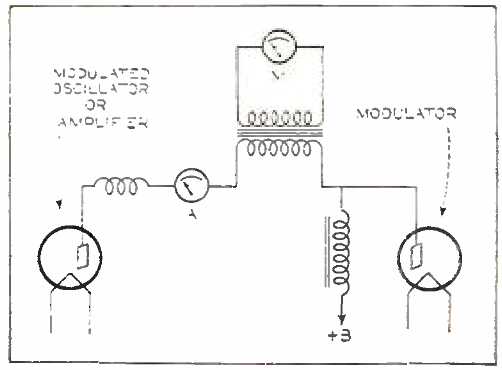
To the top of the world and around also its waistline these parties are going. By now, the daring Wilkins-Ellsworth Trans-Arctic Submarine Expedition, which plans to swim under the polar ice cap in the submarine *Nautilus* from Spitzbergen to Point Barrow, probably will be under way. Radio signals from this expedition, under the charge of a former amateur, will be heard with both code and voice by the listening amateurs back home.

This expedition, which is under the direction of Sir Hubert Wilkins and Lincoln Ellsworth, will carry one of the most complete radio installations taken by any expedition. One of the major problems confronting them is maintenance of communication. Success of this contact will be under the direction of Ray E. Myers, radio operator of the party and former owner of amateur (*Continued on page* 160)



(Left)
Figure 1. Representation of a carrier wave modulated 100%, which means that the amplitude is varied between zero and twice the normal amplitude

(Right)
Figure 3. The connections for the modulation meter and its transformer



Modulation Percentage

And How to Measure It

Here is presented, for the consideration of experimenters and amateur 'phone enthusiasts, a simple and more dependable method for measuring transmitter modulation by means of a direct reading meter

By W. J. Creamer, Jr.*

WHEN in a radio transmitter we have superimposed on the radio-frequency carrier wave an electric wave generated by the sound waves of speech or music, we call the action *modulation*, and the carrier wave is said to be *modulated*. If this action is properly performed, the energy in the carrier remains constant; but the total energy is increased by virtue of the contributions of the modulating wave. It may be demonstrated mathematically that if a frequency f_m is employed to modulate a carrier frequency f_c, the resultant energy is largely contained in the three frequencies of f_c $(f_c + f_m)$, and $(f_c - f_m)$ which are found in the output of the system. For example, a carrier wave of 1,000,000 cycles per second when modulated by a wave of 1000 cycles per second would yield frequencies of 1,000,000 cycles, 1,001,000 cycles and 999,000 cycles per second. Following the illustration further, if modulation is produced by a band of frequencies from 50 to 5000 cycles per second, the products of modulation will, in addition to the carrier, consist of two bands of frequencies, one from 1,000,050 to 1,005,000 cycles per second, the other from 995,000 to 999,950. These are called the side-bands, and the amount of energy contained therein depends on the strength of the modulating waves and the modulation circuit employed. Since the program sounds are carried by energies resident in these side-bands, it is important to concentrate within them as large a proportion as possible of the total output power of a radio transmitter. In fact, the Federal Radio Commission has laid down definite minimum requirements for broadcasting stations in order that they shall make fullest use of their assignments of power.

100% Modulation

ing back to our idea of modulation single frequency (1000 c.p.s.) and referring to Figure 1, we see that the maximum effect on the carrier current I_c will be produced when the amplitude of the carrier is alternately reduced to zero and increased to double its unmodulated value by action of the modulating wave. The resultant current we know is made up of three components, the carrier frequency current I_c, the upper side-band current I_1, and the lower side-band current I_2. In order that the resultant current shall at intervals be zero, it is evident that I_1 and I_2 each must have maximum values of $I_c/2$ if I_c is the maximum value of the carrier. Now since the power in the various components varies as the square of the current, the power will be proportioned as follows:

Carrier power proportional to I_c^2
Upper side-band power proportional to $\frac{1}{4}I_c^2$
Lower side-band power proportional to $\frac{1}{4}I_c^2$

The total side-band power is thus 50 per cent. of the carrier power; and this condition is referred to as 100 per cent. modulation since the carrier current is changed the maximum amount possible. If the carrier amplitude were reduced to only one-half its unmodulated value, the relation would be:

Carrier current = I_c. Carrier power proportional to I_c^2
Upper side-band = $\frac{1}{4}I_c$. Upper side-band power proportional to $I_c^2/16$
Lower side-band = $\frac{1}{4}I_c$. Lower side-band power proportional to $I_c^2/16$

The total side-band power is now $\frac{1}{8}$ or 12½ per cent. This is the condition for 50 per cent. modulation.

We may now set up a general relation for the side-band power as a percentage of the carrier power for any given modulation. Thus

$$P_{sb} = P_c \left\{ \frac{M^2}{20,000} \right\}$$

where P_{sb} is the power in the side-bands, M is the percentage modulation and P_c is the power in the carrier being modulated. (*Continued on page* 169)

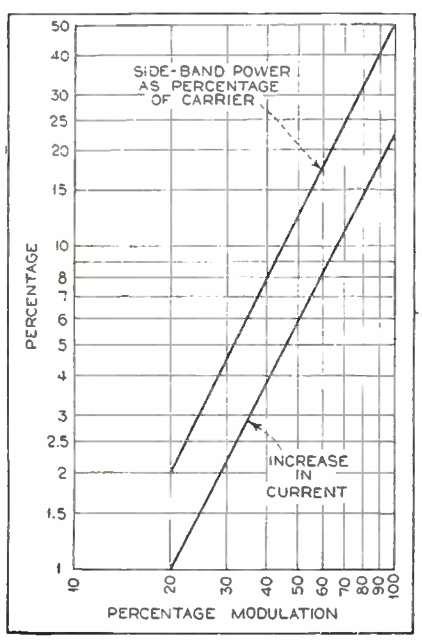


Figure 2. Curves showing the relationship between readings of the modulation meter, as described here, and the observed increase in r.f. output

* ... of Electrical Engineering, University of

Radio Physics Course

This series will deal with the study of the physical aspects of radio phenomena. It will contain information of value to physics teachers and students in high schools and colleges. The teachers' Question-Box will be found helpful in laying out current class assignments

By Alfred A. Ghirardi

THE art of radio broadcasting as we know it today presents a very fascinating subject for study. It has for its main object the transmission of sound programs over wide areas to the homes of millions of people. The programs usually originate as sound waves (speech and music) created by artists in the studios of the broadcasting stations, although they are sometimes picked up in halls, theatres, restaurants or other public places and relayed to the broadcasting stations over special telephone wire lines and networks, often over considerable distances.

It is certain that the popularization of radio television will add to this the necessity for the transmission of visual scenes, possibly in their natural colors. It is fortunate that our present general methods of broadcasting of sound programs are also satisfactory for transmitting television programs. The major portion of this course is devoted to the sound phase of broadcasting. This lays a foundation for the study of television apparatus which is discussed later.

ALFRED A. GHIRARDI, who will conduct this new department, is a well-known technical writer on radio subjects. Mr. Ghirardi was formerly associate editor of *Radio Engineering*, *Radio Mechanics* and *Radio Design* magazines. He is also author of a book on Radio Physics Course. At present Mr. Ghirardi is in charge of the department of Applied Electricity and Radio Communication of the Hebrew Technical Institute in New York City.

Radio Broadcasting System

Considering the purpose of radio broadcasting as outlined above, let us see how and why it is being carried on in the particular way with which we are all familiar today. We know that it is possible to transmit sound waves directly. A common example of this is furnished by one person talking to another. The sound vibrations or waves produced by the vocal apparatus of the first person, travel out directly to the hearing or auditory apparatus of the second person and cause the sensation of sound. This method is not suitable for broadcasting purposes for the following reasons: Sound can be transmitted directly only over very limited distances. Even loud whistles and sirens can only be heard over distances of a few miles at the most. A speaker or singer's voice cannot be heard intelligibly over distances greater than a few hundred feet. Our popular musical instruments such as the piano, organ, violin, etc., are similarly limited in their range. Also if several persons or musical instruments were producing sound waves of equal loudness simultaneously we would have no way of listening to one of them to the exclusion of the others. Nature has not equipped us with any means of selecting or "tuning" the particular sounds we desire to hear; our ears respond to all sound waves lying within certain ranges of frequency or pitch. Imagine the distressing result of hearing the programs from all the broadcasting stations in your vicinity together at one time!

It is evident that some method other than the direct transmission of sound waves must be employed for our broadcasting system. The sound programs originating in the many stations all over the world are to be broadcast simultaneously over long distances and wide areas and must be received in such form that the listener can readily tune to any single station or program desired to the exclusion of all others. These requirements are satisfactorily met by using electricity, and electrical or radio waves as intermediate agents in our radio broadcasting system. It has been found that alternating electric currents of high frequency (carrier current) can be made to produce electromagnetic and electrostatic waves of similar frequency (radio waves) when made to flow in suitable circuits in the transmitting station. These radio waves have the desirable property of radiating or spreading out into space in all directions over great distances without serious decrease in strength. They travel at the rate of approximately 186,000 miles per second. Furthermore, it is possible, by erecting a suitable metallic electrical conductor (antenna wire) at any place through which these waves are travelling, to induce in this conductor electric voltages or potentials which can be strengthened or amplified and then converted back into sound waves similar to those originating in the broadcasting studio. By arranging each broadcasting station to operate with a carrier current of different frequency it is possible to operate many stations at one time without interference. By suitable equipment at the receiving station it is possible to select the signal voltage of any station it is desired to hear, from all of the other stations broadcasting at the same time.

A simple outline picture of this system as it is employed by our broadcasting stations today is shown in Figure 1. Starting at the left, the person speaking sets up sound waves which are made to act on the microphone M. This changes the varying sound vibrations into corresponding electrical current impulses. These are led into the transmitting apparatus B (which will be studied in detail later) where they are made to control the strength of flow of a more powerful steady high frequency current (carrier current) so that it is no longer steady but varies in strength in accordance with the original sound waves. This varying high frequency current is made to flow into the transmitting aerial A where it produces high frequency radio waves of varying strength which immediately travel outward in all directions at the rate of 186,000 miles per second. In any receiving antenna C erected in the path of these waves, weak electric potentials or voltages are induced. These are led to the home receiving set R where they are selected and amplified until they are of sufficient strength to actuate the loudspeaker L so as to produce sound waves which are loud enough to be heard by the listener. These sound waves are very nearly an exact duplicate of the original sound waves.

This outline of the broadcasting system should be studied very carefully, since a thorough understanding of the main function performed by each unit will make the study of the subject more simple and exceedingly interesting. It is evident that the entire structure of radio broadcasting is intimately tied up with sound waves, magnetism, electrical currents, and electromagnetic and electrostatic waves. The latter are commonly referred to as "radio waves" for simplicity. It is essential therefore that we know something about the characteristics of these things insofar as they affect speech, music, and broadcasting. The characteristics of sound waves, speech and musical instruments will be studied first.

Sound waves are produced by the mechanical vibration of a

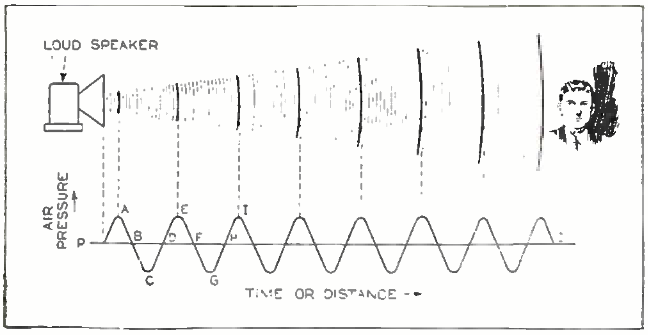


Figure 3. Sound-wave propagation and pressures

material object in an elastic medium. Air is elastic. It can be compressed and will expand when the pressure is released. Air can be set in motion by a body vibrating in it, and its rate of vibration or frequency will be the same as the rate or vibration of the body which set it in motion. For example, if we ring an ordinary electric doorbell so as to set it vibrating, it will produce a ringing sound. We can prove that the sound is caused by the actual vibration of the metal and air around it. If the bell is touched with a finger so as to damp the vibrations, the ringing ceases. If the bell is enclosed in a vacuum, no sound is produced even though it is vibrated as before. The vibration of a loud speaker can be felt by placing the hand on its diaphragm or horn while playing.

Let us study the motion of the diaphragm of an ordinary cone-type loud speaker as used in radio sets, and see how it produces sound waves in the air. At A, in Figure 2, the diaphragm is at rest. The small dots represent a single series of molecules of air moving forward. Air molecule, No. 1, adjacent to its front is pushed onto molecule No. 2. Molecule No. 2 pushes into No. 3. No. 3 pushes into No. 4, etc. These molecules of air are therefore compressed together. Those nearest to the front of the diaphragm are compressed together most. After each molecule has bumped into its neighbor and given up its energy of movement to it, it stops. The wave of compression thus formed, travels along at the velocity of sound. Out some distance in the air, the molecules are not so compressed as yet, and still farther out they have not yet felt the movement, and are their natural distance apart. But they will feel it when this travelling wave of *compression* gets to them as at F. During this time, at the back of the diaphragm an empty space is left into which the adjacent molecules will move forward, since air is elastic, and will fill up all available space. Immediately next to the diaphragm there are few molecules and they are far apart (Nos. 5, 6, 7, etc.). This area where the molecules are far apart is called a *rarefaction*. As the molecules rush to fill the space, the wave of rarefaction travels outward as shown, at the velocity of sound. (About 1130 feet per second in air at 20° Centigrade.)

(As will be discussed later in the chapter on loud speakers, a baffle must be put around the edge of the cone so that the compressed molecules at the front will not travel right around the rim of the cone and neutralize the rarefaction wave behind the cone—thus neutralizing the sound wave—when producing sound of low frequency.)

When the diaphragm reaches the end of its first forward push, it moves back to approximately its original position, C. There is immediately a rushing back of the molecules on the left. They have been tightly pressed together there, but when the diaphragm reverses it leaves an open space in its wake into which the compressed molecules rush. At the right, a wave of compression is being produced at the same instant. The diaphragm continues to the end of its swing at D. A full rarefaction is at the left and a compression wave has already started to move along at the right. The movement back to its original position and next forward swing to the left are shown at E and F. This cycle of events repeats itself as the diaphragm continues to vibrate. Sound waves are set up in air by vibrating bodies in this way.

A complete single sound wave includes an area of compression; the adjacent area in which the molecules are their natural distance apart; the adjacent area in which the molecules are widely separated (rarefaction); and the adjacent area in which the molecules are their natural distance apart. This is illustrated at F. The exact length of this wave in feet or other unit of length is called the *wavelength* of the sound. We may measure the length of a wave from any point to the corresponding point farther on, but it is customary to measure it from compression to compression for convenience.

As the diaphragm vibrates, the complete sound waves travel out in all directions from molecule to molecule in the form of expanding spheres of increased pressures and decreased pressures, as shown in Figure 3. These moving spheres are commonly called *sound waves*. The number of complete waves created in each second is known as the *frequency* or *pitch* of the sound. This is usually referred to as the number of waves or *cycles* per second. It is important to note here, that the individual molecules themselves move only over very short distances. The action may be compared to that occurring when a number of men stand with feet absolutely fixed in a long line. Now the end man is given a push. He sways forward and pushes against the next man, who in turn pushes against the next, etc. The push, or pressure is carried down along the whole line of men without the lower part of the body of any one of them moving from its original position.

The vibrations of the sounding bodies are usually so rapid, that the human eye cannot see the actual motion. The eye is able to see as separate pictures or impressions, movements up to 16 per second. Movements faster than this blend into a continuous scene. (The motion picture depends upon this principle.) This fact hampers somewhat the visualization of the actions taking place, since we do not see either the movements of the sounding body or the sound waves. Movements of sounding bodies can be studied, however, by means of the stroboscope.

Any elastic material such as steel, brass, wood, etc., will transmit sound waves. The speed or velocity at which the sound waves travel depends upon the density of the substance in which they are moving, and the temperature. Accurate experimental determinations show that the velocity of sound in dry air is 1090 feet per second at 0° Centigrade. The velocity

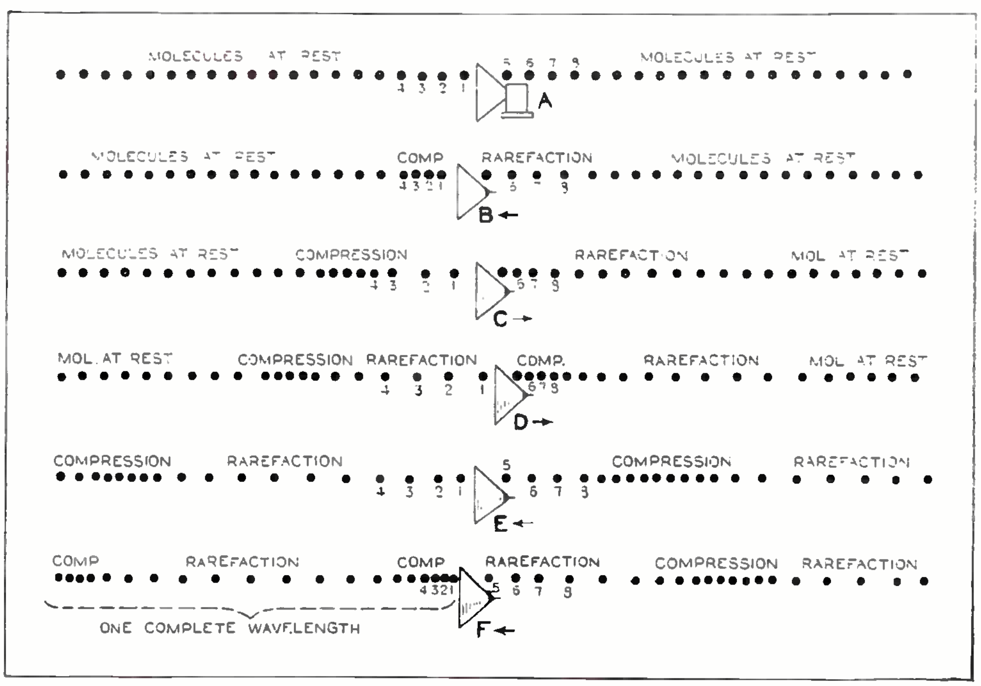


Figure 2. Sound waves produced by vibrating cone of loud speaker

Review Questions

1. *What is the main purpose of radio broadcasting?*
2. *What is the purpose of television broadcasting?*
3. *What is meant by the direct transmission of sound? Give an example of this.*
4. *State 3 limitations to broadcasting speech and musical programs by the direct transmission method.*
5. *Why are radio waves used in the modern broadcasting system?*
6. *Draw a simple outline diagram of the complete system including both the transmitting and receiving stations.*
7. *Explain the purpose of the microphone, transmitter equipment and aerial in the transmitting stations.*
8. *Explain the purpose of the antenna, receiver and loud-speaker in the receiving stations.*
9. *How could you prove that sound is produced by mechanical vibrations?*
10. *Describe what occurs when a body vibrates in air.*
11. *Do the particles of air actually travel outward the entire distance from the sounding body to the ears of the listener?*
12. *Describe two common devices for producing sound waves, and explain just how these sound waves are produced in each case.*
13. *Why is the vibration of a sounding body usually not visible to the human eye?*
14. *What is the velocity of sound waves in air?*
15. *Is the velocity the same in all substances?*
16. *What kind of waves are sound waves? Of what does each consist?*
17. *Explain how sound waves produce the sensation of sound when heard by a listener.*

increases two feet for each degree increase in temperature. Therefore at 20° Centigrade (normal temperature) the velocity is 1130 feet per second. This value will be used in sound calculations throughout this course. The more elastic the medium, the greater is the velocity of sound in it. In lead at 0° Centigrade, it is 1420 meters per second; in glass 4860 meters; and in steel 4975 meters. In radio broadcasting, we are concerned chiefly with sound waves in air. Contrasting the velocity of sound waves in air, 1130 feet (or about one-quarter mile per second) with the velocity of radio waves in air, 186,000 (approximately) miles per second, we can see that radio waves travel about 750,000 times as fast as do sound waves.

If we could devise apparatus for measuring the very small variations in air pressure caused by a very simple sound wave at any particular point, we would find that these variations could be shown in picture form by the wavy line or curve of Figure 3, where vertical distances represent pressure and horizontal distances represent time. The axis or horizontal line PO represents the normal atmospheric pressure. When the sound wave comes along the pressure gradually increases to a maximum from P to A, then decreases from A to B, further to C, then increases again from C to D at which point the pressure is again the same as at the beginning. The next wave would continue similarly along D E F G H. Point A, which is the crest of a wave, represents a point of condensation or compression because at this point the air is condensed or compressed. Point C, which is at the hollow of a wave, is a point of rarefaction since at this point the air pressure is lessened or rarefied. It must be remembered that the wavy line of Figure 3 represents the air pressure and not the movements of the molecules of air.

Sound and Hearing

When the sound waves strike the ear drum of the listener, the terminals of the auditory nerves are stimulated and the sensation of sound is produced in the brain. Note that sound is held as distinct from the term sound waves. Sound is the sensation produced in the brain by sound waves. The waves of air pressure vibrate the ear drum which is a stretched membrane or diaphragm in the outer ear. The number of these back and forth vibrations of the drum per second is the same as the number of pulses of the wave that arrive at the ear per second. The vibrations of this drum are transmitted through a set of oddly shaped bones in the middle ear, the last one of which touches a second diaphragm at the entrance to the inner ear. This is a spiral cavity in the skull bone, filled with a liquid which makes contact with a flexible cone-shaped spiral Basilar membrane somewhat like the form of a snail. Along this are distributed the nerves of hearing. Vibrations of this second diaphragm set the liquid in motion, this in turn affecting the spiral Basilar membrane. Lower frequencies (low-rate of vibrations per second) affect the lower or larger end of this spiral; and higher frequencies affect the membrane toward its smaller end. The motion of the membrane causes the many tiny hair cells to stimulate the nerve endings at their base. These nerve filaments transmit the impression to the brain, where in some mysterious manner these disturbances are interpreted as sound of definite pitch, quality and loudness. For example, a 1,000 cycle sound wave (1,000 vibrations per second) is sensed by the nerve terminals very near the center of the membrane. The pattern carried to the brain by the nerves of hearing depend upon the combination of vibrations or frequencies disturbing the spiral membrane.

The entire mechanism of hearing is extremely delicate, composed of many parts and is quite complex. There is still considerable controversy regarding the exact function of some of them. Slight differences in shape and structure of any of the parts can cause different people to hear the same sounds differently. These differences may be inherited at birth or may be caused by some accident or disease. The mechanism of hearing in some people is as nearly perfect as nature intended it should be. As a result of musical training and practice, minute changes of pressure or frequency are distinguished by ears which would not be noticed by ears and hearing not so delicately adjusted and trained. It is evident that the hearing faculties of different persons may vary greatly. This explains why some radio receivers sound perfectly satisfactory to certain persons and are absolutely unsuited to the delicate and fine appreciation of sound and music of other persons with highly trained hearing faculties.

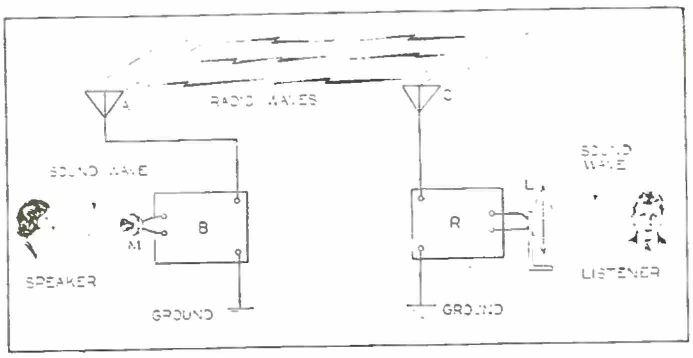


Figure 1. Radio broadcasting system, with transmitter at left and receiver at right

General Quiz
on This Issue

Physics and science instructors will find the review questions given above useful as reading assignments for their classes. The more general questions below will serve the same purpose and will also provide an interesting pastime for readers enabling them to check their grasp of the material which they have read in the various articles appearing in this issue.

1. *Why does the "tracking" of tuning condensers in a superheterodyne involve problems not encountered in tuned r.f. receivers?*
2. *Describe a type of uni-directional antenna array employed in short-wave work and explain why it is uni-directional?*
3. *In what year did regular broadcasting start and in what American city were broadcast receivers first merchandised?*
4. *What practical purposes may be served by radio transmission on ultra short-wave lengths below one meter?*
5. *What is 100% modulation? 50% modulation?*
6. *What advantages does 1740 kilocycles offer over 175 kilocycles as the intermediate frequency in short-wave superheterodynes?*
7. *What main purpose is served by reflectors employed in the antenna systems of ultra short-wave transmitters?*
8. *What purposes would a midget receiver serve if included in a serviceman's kit?*
9. *Is ultra short-wave transmission (one meter or under) influenced by the Heaviside Layer?*
10. *What is the disadvantage of crystal control when incorporated in an amateur transmitter?*

References (answers to these questions will be found in the following articles): Searchlight Radio with the New 7-Inch Waves; Practical Short-Wave Super Design; Super Broadcasting on Long Waves; The Junior Transmitter Grows Up; Oscillator Condenser Design; Measuring Modulation Percentage; Service Bench Dept,

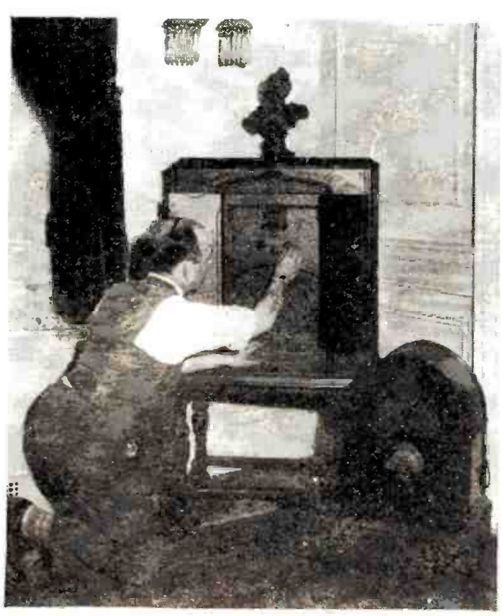
The Midget as a Test Set—Merchandising Tone Control—Installing Auto Radios—Servicing Temple, Westinghouse—Service Kinks and Suggestions That Mean Money to the Serviceman

A Midget in the Test Kit

A MIDGET radio receiver is one of the most useful test accessories, and rightfully deserves a place alongside the socket wrench and milliammeter. Its intelligent use as test equipment will cut down the time of many service jobs, increase profits, insure the satisfaction of the client and provide an additional income.

Select one of the smaller midgets characterized by sensitivity and excellent quality. (There are such midgets, by the way). One or two of these receivers can be carried in the automobile, and we have seen several designs modified with convenient handles, making a portable job even for the serviceman who does not use a car.

The most obvious test use for the midget is the rapid general location of receiver trouble. A complaint. such as noise, that appears both in the midget and in the receiver being serviced, obviously is not due to a fault in the latter, and the house wiring, ground connection, etc., may be inspected without further waste of time. The midget provides a simple and adequate test when a faulty ground or antenna installation is suspected.



Midget Set as Standard of Comparison

Using the midget as a standard of comparison, a far more accurate idea of the general functioning of the receiver being serviced will be obtained than by listening to the latter alone, and difficulties correctly attributed to area receiving conditions are readily identified. The more subtle tube troubles, which are not necessarily evident in the conventional meter tests, show up only when in actual use, and the transfer of the entire set of tubes from the receiver under service, to the midget, will often clear up a puzzling situation (and occasionally will be the only argument convincing enough to sell the customer a new set of tubes).

Occasionally the receiver is poorly located in an apartment or house in reference to both electrical and acoustic effects—the former particularly when the set is inadequately shielded. The midget being portable, it may be moved about conveniently in testing for an improved location. When trying different placements in an effort to reduce electrical interference, remove enough tube or coil shields so that the amount of noise picked up, at the same place as the receiver being serviced, is roughly equal to the disturbance in this receiver. Your client will be considerably gratified to discover that the tone quality of his installation can be considerably improved by choosing carefully its position in the room.

Midget receivers being inexpensive, the serviceman can usually afford to leave one with his customer while his own receiver is being serviced for a major complaint at the laboratory. The customer will be extremely grateful for this courtesy and, in many cases, will be so satisfied with the performance of the small receiver and its low price that he will purchase one as an auxiliary or second receiver.

The sales possibilities of a demonstration of this nature are considerable. The customer's respect for the midget set is given a favorable rise by the fact that you use such a receiver as a standard of comparison. There will be many instances where the customer, convinced that his own receiver is as good as money can buy today (regardless of the fact that it is three years old), and who, in this conviction, would stubbornly refuse a home demonstration for a frank sales purpose, will be definitely convinced of the inadequacies of his old set by listening to the midget under these circumstances not associated with a sales argument.

The serviceman servicing in d.c. areas should, of course, provide himself with one or two d.c. midgets. There are several excellent designs available at very reasonable trade discounts. In many instances the mail order houses provide the cheapest source of good receivers for service purposes and for profitable resale.

This idea of selling midget sets, not to replace the living room console set, but as a second receiver for installation in a bedroom, den, nursery or maid's room, is one to which the serviceman can well give more consideration. Manufacturers and dealers have attempted to put this idea across with the public with only small success, but the serviceman who actually takes a midget into a home as part of his service equipment is in a better position to develop sales of this type. A customer who would hesitate to ask a dealer to send an inexpensive midget out to his home for demonstration will often gladly accept a demonstration by the serviceman when it is so readily obtained without any obligation and without causing any material loss of time to the serviceman or dealer. This is a line of sales activity that is certainly worth being given a trial by any up-to-date serviceman.

In the Day's Work

JAMES A. ROBINSON, of Robinson's Radio Service, Methuen, Mass., sends the following dope on the popular Westinghouse series:

Westinghouse Series WR-5-6-7-8

"One month after the installation of a Westinghouse WR5, a call for service came into the shop. Inspection revealed poor quality and deficient volume. The removal of one -45 from the push-pull stage eliminated the distortion but did not restore volume. Two new power tubes cured the trouble—but not for long. About a month later the set was back with the same complaint. Again two new tubes did the trick. However, two new tubes every month was hardly a satisfactory cure, and a diligent search was made for the trouble.

"A strip of resistors will be found under the chassis. These are mounted in such a position that the expansion caused by heating will cause the resistor to ground at some point, lowering the "C" bias to the power tubes and resulting in loss of emission in a very short time."

Hum Hunting and Tandem Receivers

Commenting on our article on "Hum Hunting" in the March issue, Archie Klingbeil, of Ashtabula, Ohio, writes:

"An early model Temple receiver hummed badly, and a thorough test and inspection failed to reveal anything wrong. It seemed like a freak case, and so we tried a variety of experiments, finally reversing the power wires to the dynamic speaker. This eliminated the hum."

Mr. Klingbeil continues with the following data on operating two receivers from a single antenna:

"Occasionally we are asked to connect two receivers to one aerial, the first receiver being on the ground floor and the second set on the third floor. We find that the ground floor receiver works satisfactorily, but the top floor set lacks volume and tunes broadly. We have overcome this difficulty by connecting a large variable condenser (43 plates) in series with a coil three inches in diameter and wound with one hundred feet of magnet wire. The entire arrangement is placed in series with the lead-in, close to the antenna post on the upper floor set. This may not be an ideal solution, but it works well, is simple and cheap."

Mounting Bracket for the Automobile Radio

There are still several months of vacation time ahead of us, and auto radio holds remunerative possibilities for the serviceman. Russell Woolley of Seattle, Washington, helps to keep the service ball rolling with the following: (*Cont'd on page* 169)

Card Records, Phone Calls, Produce Sales

The Serviceman Merchandises Tone Control

By John J. Mucher
(*President, Clarostat Mfg. Co.*)

RADIO receivers of the past have left much to be desired in the way of musical rendition, especially since they did not compensate varying room acoustics, varying frequency characteristics of broadcast programs, and, lastly, the changing frequency cut-off, at different wavelengths, of the receiver itself. Several years ago our engineers suggested a tone control to loud speaker manufacturers. At that time the loud speaker was still a separate unit, sold for use with any existing radio set. The tone control technique then recommended was nothing more than a fixed condenser, of say .1 mfd. capacity, in series with a variable resistor of approximately 200 to 5,000,000 ohms, the combination being shunted across the loud speaker. Loud speaker manufacturers, however, did not appreciate the merchandising value of this idea, and it was dropped for a time. Today most of the leading set manufacturers include tone control in their receivers.

The present tone control technique comprises either a series

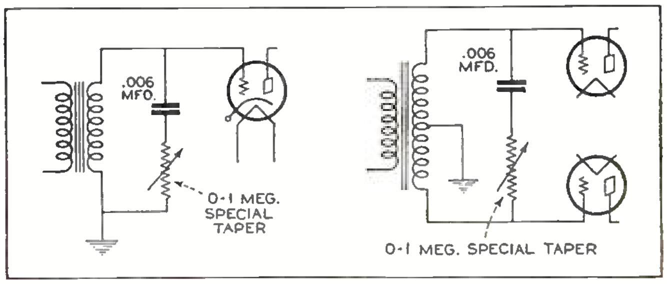


Figure 1. Tone control installed in the first audio stage. It may, of course, be similarly connected with a single power tube. Figure 2. Tone control wired to a push-pull stage. A tone control of this type may be mounted on the panel, or operated from a distance

of condensers in about .0025 mfd. steps, covering the range of .0025 mfd. to .03 mfd. or a single condenser of approximately .1 mfd. in series with a variable resistor of 25,000 ohms, shunted across the grids of the push-pull amplifier tubes. In the case of a single tube, the tone control is shunted across the grid and common ground.

Although most of the present models are coming through with tone controls, there is a profitable field for the serviceman in the installation of tone control in the many thousands of receivers not so equipped. The majority of these receivers will be improved by this change, and a service call for any reason at all is an entree to a possible sale. Suitable accessories are available simplifying the installation. In one form, such a device is arranged for use either outside the radio set, as a table control with long leads connecting to the radio set or as a panel-mounted job taking up very little space. In either case, the serviceman can recommend and install the tone control in any existing set, materially increasing his activities and income.

Some receivers have a small by-pass condenser across one of their audio transformer windings so as to emphasize the bass tones by absorbing the higher frequencies. If this condenser is disconnected, the addition of a tone control is a revelation of the real quality in the otherwise damped audio system. (If this condenser is not disconnected, the tone control does not have a chance to function (*Continued on page* 175)

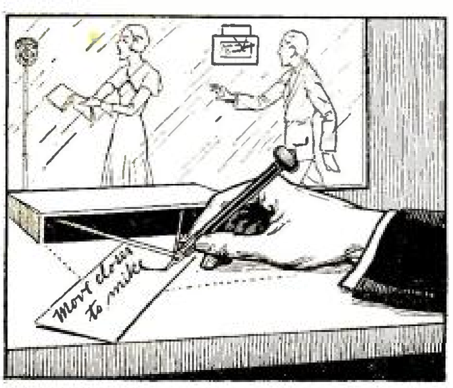
Backstage in Broadcasting

Chatty bits of news on what is happening before the microphone. Personal interviews with broadcast artists and executives. Trends and developments in studio technique

THE network studios are buzzing these days on the topic of television. At this writing the writer is observing the deep interest on that subject. "Will program technique change?" "Will new studios be needed?" "Will present microphone artists be replaced by entertainers with stage and talking-picture experience?" These are typical of the questions asked in the elevators, studios, corridors and offices of the CBS and NBC. Both chains have entered the television field, in the New York area, on an experimental basis. The NBC transmitter at the Times Squàre studios has been supplemented by a second television station of that network atop the new R.C.A. Building. The Columbia television transmitter has been installed atop the chain's New York headquarters. Although officials of both chains maintain that the presentations will be on "an experimental basis," they are busily engaged recruiting and training entertainers for combination sound-and-sight broadcasts.

Dorothy Knapp

The NBC launched a series of "sound" presentations featuring Dorothy Knapp, stage beauty, and a company of players. These programs were presented for the sole purpose of developing television technique. Although only the audible portion of the programs went on the air, the artists went through all the motions of action that would tend to make the programs suitable for broadcasting sight as well as sound to a large audience equipped with television sets.



The control man writes an order

By
Samuel Kaufman

THE duties of studio production men are not only to get programs *into* the microphone; it is equally important that they keep extraneous sounds and conversation *out* of the ever-alert instrument. Since popular broadcasting began, the microphone has gone through many stages of development and the devices used in modern studios are so sensitive, indeed, that special methods must be created to keep out all sounds not intended to go on the air. An important phase of program production is the constant contact between control operator and production man.

In radio's early days a method of hand signals was most generally used. But with programs growing more and more complicated, this system began to show signs of wear. Some studios utilized large blackboards for communicating through the glass-walled partition between the studio and the control room. This method was a bit messy and, at times, the scrape of the chalk against the slate would be picked up by the microphone. Recently William Rainey, production manager of NBC programs, and O. B. Hanson, manager of the chain's plant operation and engineering, solved this problem by designing a telautograph system.

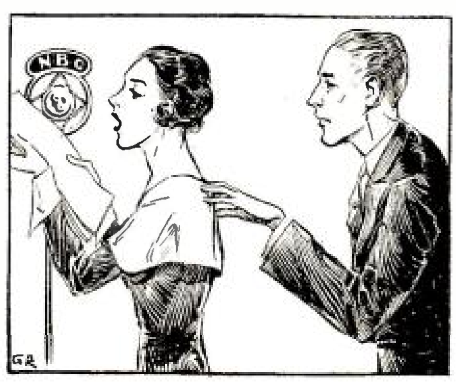
Now the control operator merely writes a message on a device in the control room and it is immediately reproduced on a duplicate instrument at the announcer's side in the studio. The same instrument is used by the announcer in addressing the operator. During rehearsals the NBC utilizes a two-way public address system for communication between the studio and control room. The special telautograph instrument differs from the ordinary device in its silent operation.

IN this age of ping-pong tennis, tom-thumb golf, tabloid newspapers, midget radio sets, bantam automobiles and kitchenette apartments, brevity is being recognized as the keynote of many phases of our day-to-day activities. The radio program, like many other items, has captured this prevailing spirit. Except for certain types of musical and variety programs, broadcasters have long been of the opinion that a full hour is too long for a single radio presentation. Many programs formerly on an hour's schedule now take but fifteen or thirty minutes

Morton Downey

and, in not a few cases, the popularity of the presentations increased as the program time decreased. In many instances sponsors of commercial periods preferred to take several short programs a week rather than a single long one. Among the most prominent changes in recent weeks was the substitution of the daily Camel Quarter Hour of the Columbia Broadcasting System for the older Camel

(*Continued on page* 162)



The studio director executes the order

Radio Science Abstracts

Radio engineers, laboratory and research workers will find this department helpful in reviewing current radio literature, technical books and Institute proceedings

Conducted by

Howard Rhodes

Practical Testing Systems, by John F. Rider. 147 pages. Published by Radio Treatise Company, Inc.

This book supplies complete data on a large number of simple testing units suitable for use in connection with radio apparatus. The book makes no effort to describe precision testing apparatus, but limits itself to units that can readily be constructed and which require a minimum of special apparatus or parts. The first part of the book is devoted to ordinary a.c. and d.c. meters and, following information on how these devices work are explanations and diagrams of how shunts and multipliers can be used to increase the ranges of the meters. The book also covers the construction, operation, calibration and use of various types of oscillators, tube testers, vacuum tube voltmeters, condenser and coil testing units, etc. The book, we believe, will prove a useful addition to the library of the service man or radio experimenter.

Handbook of Technical Instruction for Wireless Telegraphists, by H. M. Dowsett. 479 pages. Published by Iliffe and Sons, Ltd., London, England. Fourth Edition.

As its name implies, this book is intended primarily to provide information for radio operators and others interested in commercial transmitting and receiving apparatus. It contains a number of photographs and circuit diagrams of commercial sending and receiving apparatus and includes a chapter on direction finders and the manner in which they are used. Most of these units are of Continental manufacture and will therefore not prove especially useful to American readers. All of the chapters on commercial apparatus are well done and go into considerable detail regarding the practical problems of adjusting and using such apparatus; the elementary chapters dealing with radio theory and tubes appear to us, however, to be somewhat more complicated in treatment than is desirable, assuming that the reader is a commercial operator. The chapters on radio theory, measuring instruments, alternating current, radiation, the vacuum tube and receiving circuits would, we feel, have considerable appeal to anyone interested in elementary radio theory, provided the reader had a good grounding in algebra since the author does not hesitate to make use of algebraic formulas.

Practical Radio Repairing Hints, by John F. Rider. Published by the Radio Treatise Co., Inc.

Here is another text on radio servicing from the rather prolific pen of Mr. Rider. It is a book written especially for the service man and the experimenter and it is intended to serve as a general guide in making repairs, replacements and adjustments on receivers. It is really not a textbook but rather a compilation of information on the purpose of the various units in a receiver; it follows somewhat the same method of treatment as was used in Manly's "Drake's Radio Cyclopedia," except that Rider's book aims more directly at giving information of a practical nature. The book is divided into many short paragraphs, each of which discusses a different subject. It is an up-to-date text on the modern radio receiver.

The Theory and Practice of Radio Frequency Measurements, by E. B. Moullin. Second Edition. Published in London by Charles Griffin & Co., Limited, in the United States by J. B. Lippincott, Philadelphia.

This second edition of Moullin's book is one of the finest texts on radio frequency measurements that we have ever seen. It is theoretically accurate and complete and at the same time it is essentially practical. The first chapters discuss the electromagnetic field and circuit formulas. Following chapters discuss the oscillator, methods of measuring potential, current frequency, resistance, inductance, capacity, antennas, field intensity, etc. The author follows the very commendable practice of backing up the theoretical discussion with examples of actual measurements made in his laboratory. We are sure that this book of Moullin's will find a definite place on the engineer's desk.

Quality of Television Images, by D. K. Gannett. Bell Laboratories Record, April, 1931.

It is well known that the quality of a television image depends upon the number of unit elements into which the picture is scanned. To illustrate this point and show how the quality improves with increases in the number of elements the author shows reproductions of photographs composed of varying numbers of unit elements from a minimum of about 600 up to a maximum of some 12,000. The 600-element picture is almost unrecognizable, while the 12,000-element picture has quite good detail. Although the illustrations show very clearly the improvement produced by increasing the number of elements they are really rather inadequate representation of the quality given by an actual television system. Looking at a still picture we have time to pick out each individual flaw; a much more pleasing effect is obtained when the eye is following a moving scene. Much the same effect is obtained in the motion picture which admittedly gives high quality. Each individual picture on the motion picture film is quite crude and lacking in detail, but when the picture is flashed on a screen the imperfections almost entirely disappear. If the actual quality of a television image appeared to the eye to be no better than the quality shown by these stills television's future would, indeed, be dark.

Some Optical Features of Two-Way Television, by Herbert E. Ives. The Bell System Technical Journal, April, 1931.

This article gives a rather complete description of the features of a two-way television system. It is pointed out that it is desirable to scan the person being televised with an intense light, but that ordinary light has the disadvantage that it affects the vision of the person being scanned. To eliminate this difficulty use was finally made of an incandescent lamp which gives much more red light in comparison with blue than does the arc. It was therefore possible by means of purple filters (which only pass red and blue light) to eliminate all other light, leaving only the purple to which the eye is relatively insensitive. In this manner intense illumination can be used without causing discomfort to the eyes. The reflected light from the subject is picked up by a combination of potassium cells which are sensitive to blue light and ceasium cells which are sensitive to red light.

The television booth is illuminated by a monochromatic yellow-green light to which the potassium cells are not sensitive and to which the ceasium cells were made insensitive by covering the windows of the cells with a deep purple gelatin. In this manner a satisfactory general level of illumination could be obtained in the booth without introducing spurious signals.

A considerable improvement in the quality of the image was obtained by the use of a combination of blue and red light. Blue sensitive cells used alone render the ruddy face too dark, red sensitive cells alone render the face too light and make it lack in contrast. But the combination of blue and red gives an essentially "orthochromatic" image, similar to that which would be obtained by using ordinary light and a piece of orthochromatic film to photograph a person's face.

Power Pentodes for Radio Receivers, by B. V. K. French. Electronics, April, 1931.

Here is one of the best practical articles on the use of the power pentode that has yet been published. Since this tube is destined soon to come into general use by experimenter and manufacturer alike the information supplied in this article should prove extremely valuable.

The family of Ep Ip curves of the pentode are very similar in shape to those of a screen grid tube; whereas, all other types of power tubes have a low Rp the pentode has a high Rp in the order of 40,000 ohms. But, whereas, the ordinary power tube must be worked into a load resistance equal to 2Rp the pentode must be worked into a load in the order of ¼Rp. The amount of distortion produced by the ordinary power tube is mostly second harmonic; the pentode gives both second and third harmonic distortion. The amount of second harmonic distortion as a percentage of the fundamental can be calculated from the following formula:

$$\frac{\frac{1}{2}(I_{max} + I_{min}) - I_o}{I_{max} - I_{min}} \times 100$$

where Imax is the plate current corresponding to a bias of the normal d.c. bias minus the peak value of the a.c. signal on the grid.

Imin is the plate current corresponding to a bias of the normal d.c. bias plus the peak value of the a.c. signal on the grid.

Io is the normal d.c. plate current.

The amount of third harmonic distortion can be calculated from the formula

$$\frac{I_t - \frac{1}{2}(I_{max} + I_o)}{I_{max} - I_o}$$

where Imax is the same as above.

Io is the same as above.

I_t is current at half operating bias.

Calculating the distortion by the application of these formulas to a typical group of Ep Ip curve we find that the second harmonic distortion reaches a minimum of about 1.7 per cent. with load resistances of from 6000 to 8000 ohms and the third harmonic distortion gradually increases, being about 4 per cent. at 4000 ohms, about 7 per cent. at 8000 ohms and about 10 per cent. at 16,000 ohms load resistance.

Maximum power output is obtained from the pentode at about 8000 ohms load, assuming the input signal to have a peak value equal to the d.c. bias. But at smaller input signals maximum power output is obtained at higher values of load resistance. Since all loud speakers have rising impedance characteristics this feature of the pentode is quite important. It is found, in fact, that the pentode tends to compensate for side band cutting in the r.f. amplifier. The higher audio frequencies are attenuated because of side band cutting but due to the fact that the loud speaker has a higher impedance at the higher audio frequencies and therefore normal power output is obtained from the pentode with a smaller input signal, we have a condition where the pentode characteristic tends automatically to compensate for side band cutting. As a result, it is found that the quality obtained from the pentode is best on a side in which there is a definite amount of side band cutting. If the pentode is used with a set that does not cut side bands (is there any such set?) a terrific amount of distortion is produced.

Bias for the pentode must not be obtained from a resistance connected in the cathode lead unless this resistance is bypassed with about 25 mfds. of capacity. It is much better to obtain bias for the pentode from a resistance connected in the power unit.

The output transformer must be capable of carrying the plate current of the tube without saturating and must have a turns ratio such as to make the loud speaker look like about 6000 or 8000 ohms to the tube at a frequency slightly above the frequency at which the loud speaker resonates; most speakers will resonate around 100 cycles.

A Home-Made Photo-Cell, by Harley Iams. Published in QST, May, 1931.

Ordinary 201-A type tubes can be made into photo-cells because the "getter" material used in degassing the tubes happens to be light sensitive. To make a cell a tube should be chosen which has a clear silvery color; don't use tubes which have a dirty gray or smoky white appearance. Having picked a good tube carefully heat the glass at a point opposite the plate. The silvery "getter" material will be driven from the glass and will condense on the plate of the tube. In this manner a space about an inch in diameter should be cleared. Then allow the tube to cool, and the job is done. The plate of the tube serves as the cathode and the filament and grid tied together serve as the anode. Voltages from about 10 up to about 150 can be used. Since the output from the cell, when a strong light is shown on the plate (through the cleared opening) is only a few microamperes the cell must be coupled to a tube by means of a high resistance grid leak. The author shows the use of a 1 megohm leak but higher resistances may give better results: the value that gives the best results will depend upon the amount of gas and leakage inside the tube. Although this home-made cell may not compare with a manufactured product it can be used for many ordinary experiments.

Looking Ahead

Extracts from the Editor's Schedule for the September issue:

Psychology of Listening In—*Elway*

RADIO NEWS Prize-Winning Receiver

Power Supply for the Junior Transmitter—*Bennett*

Radio in Education—*Kaufman*

The Value of a Radio Reference File—*Glover*

Constructing a Televisor—*Replogle*

Voltage Divider Design—*Jackowski*

Radio Physics Course, Part II —*Gherardi*

Sailing the Seven Seas with "Sparks"—*Griffin*

Sir Hubert Wilkins' *Nautilus*

A New Short-Wave Adapter —*Wood*

Radio Handbook, by Moyer and Wostrel. Published by McGraw-Hill Company. 863 pages and index.

The radio field has long been in need of a handbook, a compilation of existing engineering knowledge, that would serve the radio engineer in the same way that other handbooks serve other groups. While this handbook leaves something to be desired, it does bring together a large amount of useful information that has been presented in various magazines and journals during the past years. The authors acknowledge the help obtained from the engineers of various companies, but apparently most of the text was prepared by themselves. In a book of this sort we consider this somewhat of a disadvantage, for it is difficult for any authors, no matter how well grounded in the subject, to have a thorough knowledge of all phases of the radio and vacuum tube sciences.

While the text covers most subjects of interest to the engineer and serviceman the treatment is such that the book will have its greatest appeal to the latter group and experimenters. Most of the subjects are treated in an explanatory manner rather than in a mathematical or rigorous engineering manner.

To say that the book covers most subjects but does not cover them in sufficient detail is perhaps the same as saying that the first edition of a handbook is seldom complete and without error. Most of the omissions seem to be of the really technical nature and this leads us to feel, again, that the book will prove of little use to the engineer but of considerable value to the serviceman, experimenter and similar groups.

Aircraft Radio, by Myron F. Eddy. Published by The Ronald Press Company, New York City.

Mr. Eddy, formerly an instructor in aircraft radio at Naval Aviation ground schools and subsequently an instructor at commercial aviation schools, has prepared this text to meet the needs of students at such schools and the needs of radio operators, technicians and aircraft designers, all of whom require a fundamental knowledge of aircraft radio problems. The author covers very briefly the history of the subject and then discusses the fundamentals of electricity and radio frequency transmission and reception. Following chapters are devoted to tubes, radiotelegraph and radiotelephone sets, radio beacon systems, and the problems of equipping the plane with radio apparatus.

We believe the book will meet the requirements of the groups at which it is aimed, for it covers quite well the problems of applying radio to the aircraft. It makes no pretense to a technical or exhaustive discussion of the subject. But the practical data on the operation of aircraft radio equipment, and the purpose and use of the beacon should prove helpful to those whose work brings them into contact with such apparatus.

What's New in Radio

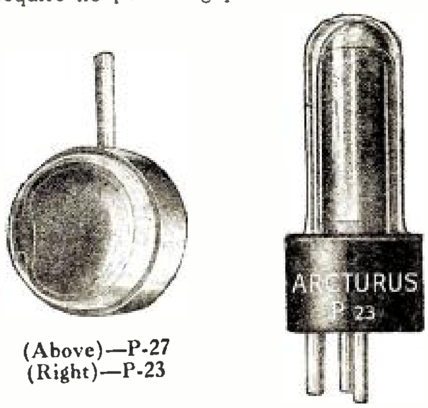
A department devoted to the description of the latest developments in radio equipment. Radio servicemen, experimenters, dealers and set builders will find these items of service in conducting their work

Conducted by

The Technical Staff

Photolytic Cells

Description—The accompanying illustrations show two new types of photolytic cells designated as models P-23 and P-27. Due to their design and rugged construction, these cells are non-microphonic and require no polarizing potential. Because



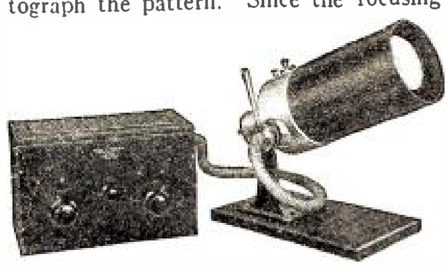
(Above)—P-27
(Right)—P-23

of their low impedance there is no pick-up of parasitic noises. The P-23 type is a tubular cell measuring 2⅝ inches high by 1 5/32 inches wide. The overall measurement for the P-27 model is 1 5/16 inches high by 1 1/16 inches wide.

Maker—Arcturus Radio Tube Co., Newark, N. J.

Cathode-Ray Oscillograph

Description—This instrument comprises the following three parts: the 478-A type cathode-ray oscillograph tube, the 496-A type power supply unit which is operated from the 110-volt 60-cycle a.c. current and the 497-A type tube support. As this new tube may be operated at very high plate potential and employs a special material on the screen, the pattern is unusually bright and may be seen in broad daylight. This advantage makes it possible to photograph the pattern. Since the focusing



of the electron beam does not depend upon the gas content of the tube, it can be utilized for very high frequencies. The patterns are fairly good, even at 30,000 cycles per second, especially when the radio-frequency deflection is used in one direction only. One -80 type tube and one -66 type tube are employed as rectifiers. As a safeguard, the high-voltage supply is automatically cut off when the cover is open or when the tube is removed from the tube support.

Maker—General Radio Co., Cambridge A, Mass.

Light-Sensitive Cell

Description—This photo-sensitive unit, known as the "Cico" cell, is designed to meet the requirements of both the experimenter and the manufacturer. It is sturdily constructed and capable of withstanding hard knocks. This instrument has numerous practical applications, and is especially adapted to industrial problems. The overall dimensions are only one inch in diameter by three-quarters of an inch in height. Complete instructions showing the various methods for mounting the cell and its applications are furnished with each instrument.

Maker—Clark Instrument Company, 119 N. 4th St., Camden, N. J.

Audio Amplifier

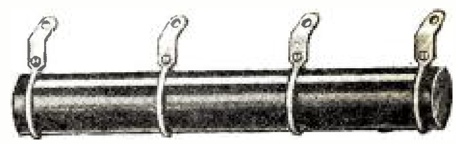
Description—This model LW-545-A power audio-amplifier is designed especially for use in large auditoriums, athletic stadiums, airports, and wherever sound amplifying equipment is desired. This de-

vice is intended to cover an audience up to 30,000 people. The three stages of amplification employ one -24 type tube, one -45 type tube, and two -545 (50 watt) tubes. Two -566 type tubes are used for rectification. Its maximum undistorted output is 50 watts, and its power consumption is 350 watts. This unit is adaptable for use with radio, phonograph pick-up and microphone. The power supply operates from the 110-volt 60 cycle a.c. current, and the complete unit is mounted on a metal rack measuring 30 inches high by 20 inches wide by 12 inches deep.

Maker—Amplex Instrument Laboratories, 132 W. 21st St., New York.

Wire Wound Resistors

Description—A new line of resistors designed to meet the replacement requirements of the serviceman and the radio dealer. The resistance is wound with nichrome wire on a special refractory tube and the contact band is plated to



prevent oxidation at normal temperatures, which assures a positive contact. The resistance is coated with a special compound which is baked on at a temperature of 4000 degrees Fahrenheit, and allows for contraction and expansion of both the tube and the wire without injury to the wire.

Maker—Wellston Radio Corp., St. Louis, Mo.

Antenna Device

Description—The Super-Filtermatic is a device designed to take the place of the conventional type of inside or outside antenna. It is sturdily constructed, compact, and measures only 1¼ inch in diameter by 2 inches in height. As no tools are required, it is an easy matter to install this unit. The manufacturers also recommend it for use with the regular antenna and ground system to improve radio reception. The instructions furnished with the instrument show clearly the simple connections to be made.

Maker—Filtermatic Mfg. Co., 4458 Frankford Ave., Philadelphia, Pa.

(*Continued on page* 163)

With the Experimenters

A Simple Wheatstone Bridge—Grid Dip Meter and Modulated Oscillator—Excellent Fastening for Indoor Aerial—Simple Improvement for Magnetic Speakers—A Direct-Coupled Photo-Cell Amplifier

Conducted by

S. Gordon Taylor

A Simple Wheatstone Bridge

THERE is a very definite trend in this country to make abundant use of resistors in radio design; so much so that the radio serviceman who is not equipped to measure a wide range of resistance with a fair degree of accuracy is likely to waste many hours in a fruitless effort to locate trouble in a receiver which he may be called upon to repair.

It is becoming increasingly true that a resistance test is better than a simple continuity test. The oft-repeated indications of "full" and "half" and "partial" scale readings as found in so many service manuals are not very satisfactory.

Fortunately, it is readily possible to measure resistance in a number of ways with instruments already available. In any such measurements, however, it is necessary to have resistors whose values are definitely known in order that comparison with standards may be made. The percentage of accuracy cannot be greater than the accuracy of the standards so used.

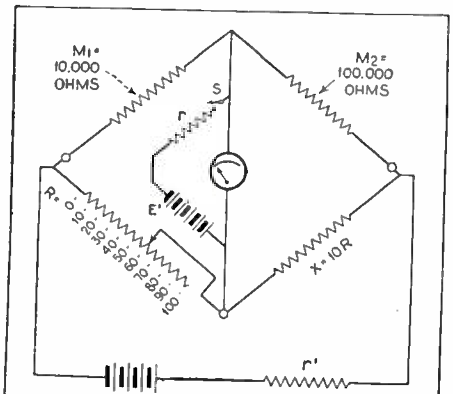


FIG.3

The serviceman's voltmeter provides in its multipliers standards which are sufficiently accurate to meet all the demands which he may make upon them.

It is the purpose of this article to outline a method of adapting a multi-scale voltmeter to the measurement of a wide range of resistance, without the necessity of recalibrating the voltmeter scale as an ohmmeter, and without interfering with its use as a voltmeter.

It is unnecessary to point out at this time the superiority of the Wheatstone Bridge method of resistance measurement over every other method; it is sufficient to mention the fact that, since no current flows through the meter at correct balance, the resistance of the moving coil of the indicating instrument does not enter into the calculation, except possibly in

(*Continued on page* 151)

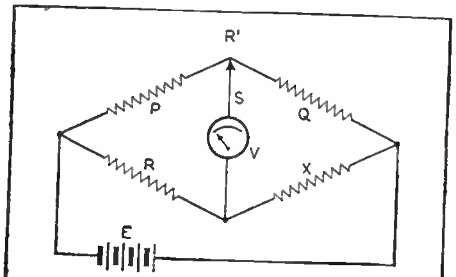


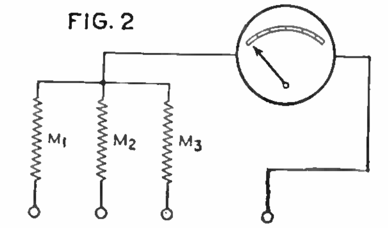
FIG.1

Figure 1. The conventional Wheatstone Bridge circuit

Figure 2. The schematic circuit of a multi-range voltmeter

Figure 3. Schematic circuit of bridge employing the meter multiplier resistors M1 and M2 (Figure 2) as two of the arms. R is the calibrated resistor of known value and X is the unknown resistor under measurement

FIG. 2



Grip Dip Meter and Modulated Oscillator

THE usual type of modulated oscillator cannot be used as a grid dip meter owing to the grid leak and condenser. It is usually necessary to build another set with a consequent duplication of coils, condensers and tubes. Wishing to have both instruments, with a minimum amount of gear, the writer put a closed circuit jack in the grid circuit of a grid dip meter. Plugging in a milliammeter enables

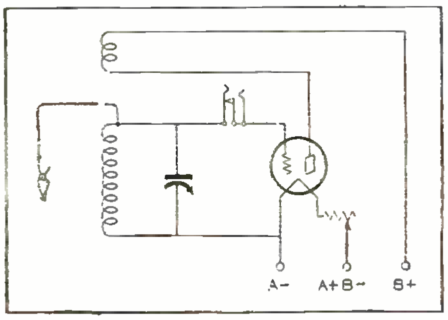


Figure 5. The oscillator circuit includes a jack in the grid circuit to accommodate either a grid-leak and condenser or a meter

one to observe the "dip" and plugging in a condenser and leak combination turns the circuit, Figure 5, into a self modulated oscillator.

A 0.002 mf. condenser and a 2½ megohm leak make a good combination, which may be varied to suit. The writer used unmounted "honeycomb" coils for secondary and tickler, 50 and 35 turns respectively. They can be fastened to the baseboard with clips.

If another closed circuit jack is placed in the positive "B" lead the outfit may be used as a one-tube receiver for testing aerials, in which case regeneration can be controlled by any of the usual methods.

J. E. KITCHIN,
Alert Bay, British Columbia.

Excellent Fastening for Indoor Aerial

WHEN running one of those temporary indoor aerials, a fastening is often necessary at a place or point where a nail or even a small screw of some kind would be out of the question. Get several of the inexpensive suction cup ash trays sold for use in the automobile. Take off the tray portion. The remainder is what you want, the suction cup complete with a small stud and nut moulded in the rubber to hold the wire end, as shown in Figure 6. You can put this up almost anywhere, providing there is a smooth surface. Pull it off when through using. There will not be a scratch or speck on the surface on which you had your insulated fastening. These little affairs stick tight enough and long enough to pull out a bulldog's fighting tooth. A cheaper suction cup is the type employed by storekeepers for hanging signs on show windows.

FRANK BENTLEY,
Missouri Valley, Iowa.

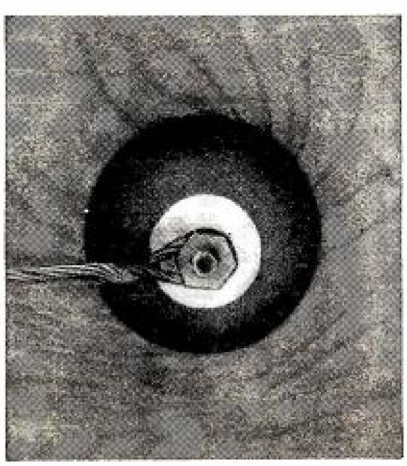


Figure 6. One of the suction cups on a wood surface

Simple Improvement for Magnetic Speakers

EVERY type of loudspeaker has its disadvantages as well as its advantages; so, in spite of the great popularity of the dynamic reproducer, many thousands of the so-called "magnetic" type of diaphragm speakers are still used in all kinds of installations.

Unless specially "corrected," speakers of the diaphragm type often have a "resonance rattle" in the upper pitches, which sometimes becomes quite objectionable to a critical ear.

The photo, Figure 7, shows how easily this type of speaker may be "corrected" to eliminate frequency preference and produce more uniform reproduction of the full musical scale. Simply insert small bits of ordinary rubber bands (of the smallest size) between the armature and the pole pieces. If one small piece of

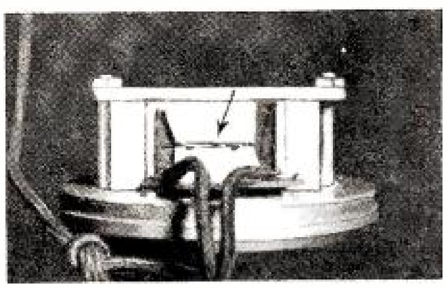


Figure 7. This photo shows a loud speaker unit with three small pieces of rubber band inserted between armature and pole pieces. The arrow indicates one piece above the armature. The other two are under the armature.

rubber does not prove sufficient to satisfactorily "damp" out the resonance, use two pieces of rubber on one side of the armature and one piece on the other. The object of the unequal damping is to break up the resonance vibrations, rather than move them downward in the musical scale—which would happen if an equal amount of rubber were used on each side of the armature.

GLEN MCWILLIAMS,
Detroit, Mich.

A Direct-Coupled Photo-Cell Amplifier

WHILE working with photo cells, the author ran up against the difficulty of working with low values of light in the operation of relays. This is a common occurrence if the light from out of doors is to close a relay on exposing the cell. In such cases, a single tube is not suffi-

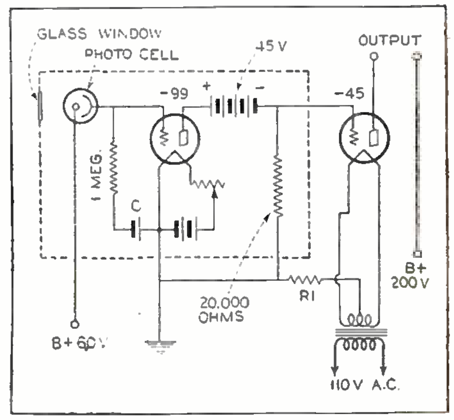


Figure 8. The direct-coupled photo-cell amplifier circuit

cient as an amplifier and a foolproof direct current amplifier is a necessity. The hookup shown in Figure 8 is one of the best of its kind for all around application. A –99 tube was chosen for the first stage because of its adaptable characteristics. The entire first stage, batteries and all, were housed in a shielded box and grounded. This eliminates any trouble due to intercoupling or other effects such as electro-static or electro-magnetic interference. A small window was furnished for the photo cell and light reflected into this window with a mirror. The –45 stage will work under almost any conditions and is not in the least unstable in operation. The resistance R1 may or may not be needed, depending somewhat on the C bias of the –99. This C bias is about 3 volts and is determined while the amplifier is in operation. The maximum amount of light to be used is allowed to fall on the light sensitive cell and the battery C1 is adjusted until the –45 draws about 1 milliampere. When the light source is removed, the current through the –99 will decrease, thus lowering the negative grid bias of the –45. The current will rise to some value in the neighborhood of 4 milliamperes, depending on the amount of light used to "set" the amplifier. Care must be taken to make this quite low as the –45 will draw a dangerous current if the grid bias is removed entirely. It is quite possible to operate a relay working on 3 to 5 milliamperes with ordinary room light by exposing the cell through the glass window in the shield.

It is interesting to note that the current in the –45 decreases with an increase of light. The relay used must be of the release or double contact type. The amplifier may be used at reasonable light levels where large currents are needed, that is to say, an output of from 10 to 20 milliamperes. The author has had as many as 6 stages of the same type of amplifier working to amplify the output

(*Continued on page 166*)

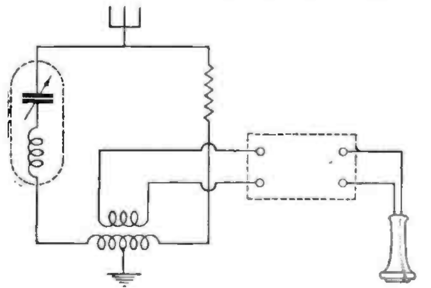
Latest Radio Patents

A description of the outstanding patented inventions on radio, television, acoustics and electronics as they are granted by the United States Patent Office. This information will be found a handy radio reference for inventors, engineers, set designers and production men in establishing the dates of record, as well as describing the important radio inventions

Conducted by

Ben J. Chromy*

1,800,962. ELECTRIC CIRCUIT. WILHELM SCHEPPMANN, Berlin-Tempelhof, Germany, assignor to C. Lorenz Aktiengesellschaft, Berlin-Tempelhof, Germany. Filed Sept. 17, 1929, Serial No. 393,229, and in Germany Sept. 24, 1928. 7 Claims.

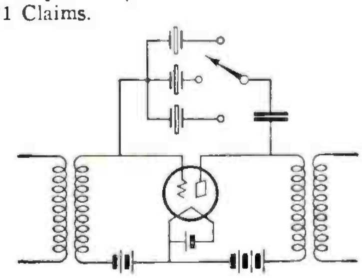


1. In an electrical circuit arrangement for eliminating a current of interfering frequency, comprising input and output circuits, an acceptor circuit, tuned to said interfering frequency, a resistor to balance the residual resistance of said acceptor circuit, two further ohmic resistances to form a Wheastone bridge circuit, together with said acceptor circuit and said resistor, said input and said output circuit is being associated each with a diagonal branch of said bridge circuit.

1,800,760. APPARATUS FOR DISTANT ELECTRICAL CONTROL. MILTON BLAKE SLEEPER, New York, N. Y., assignor to Sleeper Research Laboratories, Inc., New York, N. Y., a Corporation of New York. Filed Apr. 11, 1929. Serial No. 354,271. 32 Claims.

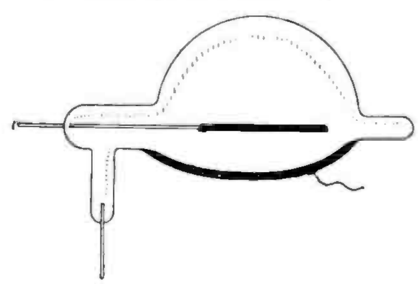
1. In combination, means for executing a sequence of movements so as to produce a continuous sequence of audio impulses of successive frequencies corresponding thereto, and means actuated by said audio impulses for producing similar graphic recording movements.

1,794,889. MULTIPLEX SYSTEM. CHARLES H. FETTER, Milburn, N. J., assignor to American Telephone and Telegraph Company, a Corporation of New York. Original application filed Dec. 3, 1924, Serial No. 753,729. Divided and this application filed June 21, 1927. Serial No. 200,419. 21 Claims.



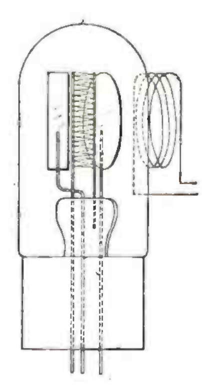
19. A filtering system for discriminating between currents of particular frequencies and all other currents, comprising a plurality of piezo-electric crystals of vibratory frequencies corresponding to the particular frequencies to be discriminated against.

1,803,000. MANUFACTURE OF PHOTO-ELECTRIC CELLS. NORMAN ROBERT CAMPBELL, Watford, England. Filed Jan. 3, 1929, Serial No. 330,156, and in Great Britain Jan. 7, 1928. 5 Claims.



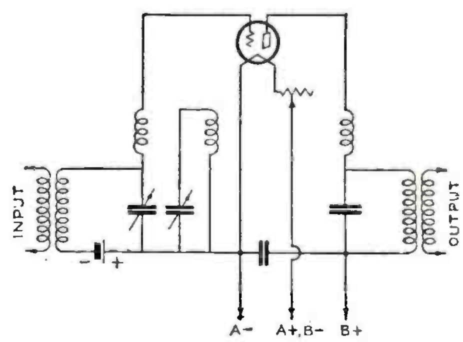
1. In the manufacture of photoelectric cells, the method which consists in depositing on a metal cathode therein a very thin and normally invisible film of photo-sensitive material, sensitizing this thin film by the passage of an electric discharge in hydrogen through the cell, and finally filling the said cell with hydrogen.

1,799,992. INDUCTIVELY HEATED CATHODE TRIODE TUBE. JOSEPH SLEPIAN, Swissvale, Pa., assignor to Westinghouse Electric & Manufacturing Company, a Corporation of Pennsylvania. Filed May 7, 1923. Serial No. 637,146. 6 Claims.



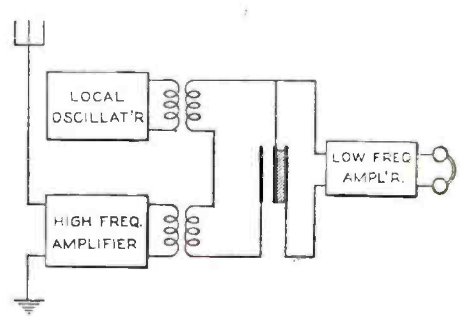
1. A space discharge device, comprising a disc cathode member, an inductor coil associated therewith for heating said cathode member to electron emitting temperature, and an anode means centrally spaced from said disc to receive the electrons emitted therefrom, said cathode disc member being disposed intermediate, said anode and said inductor coil perpendicular to the axis of said coil, and means for controlling said electron current in accordance with relatively weak energy impulses.

1,803,247. OSCILLATING HETERODYNE DETECTOR. JESSE M. GRIGG, Chicago, Ill. Filed Sept. 10, 1928. Serial No. 305,035. 2 Claims.



1. In a stage of radio detection, an input inductance, an output inductance, a vacuum tube, a grid, inductance connected in series with said input inductance and the grid of the vacuum tube, a plate inductance connected in series between the plate of the vacuum tube and the said output inductance, means for tuning said grid inductance, and an intermediate circuit embodying an inductance inductively coupled to said grid inductance and said plate inductance and having tuning means associated therewith for controlling local oscillations at a different frequency from the impulses in the grid circuit whereby heterodyning may be accomplished with a single vacuum tube.

1,794,365. HETERODYNE RECEIVING APPARATUS. HENRI CHIREIX, Paris, France. Filed Mar. 27, 1926. Serial No. 97,876, and in France Aug. 21, 1925. 10 Claims.



1. A high-frequency signaling circuit, comprising means responsive to incoming signals, a motor member connected with said means and including a movable element, and a piezo-electric crystal mounted upon said movable element for changing the frequency of the incoming signals.

*Patent Attorney, National Press Building, Washington, D. C.

A Simple Wheatstone Bridge

(Continued from page 148)

the original determination of the sensitivity of the instrument to small variations in resistance being measured.

Referring to Figure 1, the Wheatstone bridge consists of a known resistance R; a resistance R′, divided by the contact arm S into two parts, P and Q, whose ratio is known; all arranged in circuit with X, the resistance which is to be measured. When the ratio of P and Q is adjusted so that the deflection of the indicating meter is zero, the value of the unknown resistance X may be calculated from the proportion

$$\frac{P}{Q} = \frac{R}{X}$$

from which $X = (QR) \div P$

In Figure 2 is represented the internal arrangement of a multi-scale voltmeter. Most instruments in use by servicemen are of the 1000-ohms-per-volt type and have a sensitivity of one milliampere for full-scale deflection. The usual calibration of the instrument is 10 volts, 100 volts and 750 volts, so that the multipliers M1, M2 and M3 have resistances of 10,000, 100,000 and 750,000 ohms, respectively. Thus such instruments provide a series of resistances whose values are accurately known, and of a known fixed ratio. They may be used, therefore, as the ratio arms of a Wheatstone bridge, as shown in Figure 3 in schematic fashion and in Figure 4 in a picture diagram.

In Figure 3 a resistor r′ is shown in series with the battery E. The purpose of r′ is to serve as a protection of the meter during preliminary adjustment. A short-circuiting switch across the meter movement will serve the same purpose, by reducing the sensitivity. The voltage of the battery E is of no importance, since the voltage does not enter into the calculation. A 4½-volt "C" battery will serve for this battery. A second battery, E′, is shown in the diagram. This battery, in series with the resistor r and the meter movement, serves to bring the needle to some mid-point of its scale, so that right and left deflections may be had. If the meter has a sensitivity of one milliampere for full-scale, then a 1½-volt flashlight cell for E′ and a resistance of 3000 ohms for r will serve this purpose. The point to which this battery brings the needle, whatever that point may be, is considered the zero point of the scale. The resistor r may be added as an additional multiplier, or the low-resistance multiplier M1 may be used with a 4½-volt "C" battery, the multipliers M2 and M3 being then used as ratio arms.

Wire-Wound Resistance

The only additional piece of equipment necessary, in addition to the voltmeter and the two batteries, is a wire-wound resistance of suitable value and provided with a dial marked with 100 divisions for the full range of the resistance. If the variable resistance has a total value of say 1000 ohms, then each scale division on the dial represents 10 ohms.

If the ratio arms, P and Q, are arranged so that P/Q = 1/10, as in Figure 3, then the value of the unknown resistance will be 10 times the value marked on the dial, so that the range of the bridge will be from 100 ohms to 10,000 ohms. If the ratio of P and Q is reversed, which may be accomplished by interchanging the two leads to M1 and M2, the value of X will be one-tenth the value marked on the dial, so that the range of the instrument is from 1 ohm to 100 ohms. Or, again, if the multipliers M1 and M3 are used, values of X will vary from 75 times the scale marking down to 1/75 of that marking, depending upon the value of the ratio.

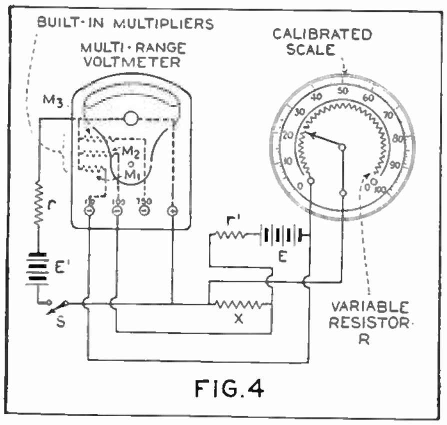


Figure 4. Actual connections of the equipment shown in schematic form in Figure 3

It is thus apparent that a voltmeter having the above ranges may be used to measure with a fair degree of accuracy resistances varying from a fraction of 1 to 75,000 ohms.

The method has several advantages over the series resistance-type of ohmmeter, which depends upon having a battery of known e.m.f. across the voltmeter multiplier in series with the unknown resistance. In the first place, it is difficult to keep a battery of constant e.m.f. Unless an auxiliary meter is available it is difficult to know the percentage of decay of the battery so that the accuracy of the meter may be determined. In the second place, the scale of the voltmeter must be recalibrated. And when calibrated, the scale is difficult to use since scale divisions are unduly crowded at one end and unduly open at the other. The method outlined above provides a scale which has equal graduation divisions and is equally accurate at all parts.

The changes made in the voltmeter in this method do not interfere with its use as a voltmeter. It is only necessary to move the dial scale to point O, which opens the circuit, and to open the switch S. If the connections are made below the panel of the instrument, the ohmmeter will be as quickly available as any other portion of the analyzer.

Robert Neil Auble,
Indianapolis, Ind.

A Radio Amanuensis

(Continued from page 115)

The resulting action of the relay is to close the transmitter circuit momentarily, causing the transmitter to send a single dot out onto the air.

At the receiving end of the communication link, the dot is picked up by an ordinary short wave receiver, passed through an audio frequency amplifier and sent to the thyratron tubes. There are two of these tubes which, in appearance, are very similar to overgrown screen grid tubes. They have, however, the property of taking a small signal input on the grids and using it to release a surprisingly large plate current. A peculiar feature is that once the plate current is started the tube has no power to turn it off again and the dot meaning "A" is sent from the audio amplifier to the input, or grid circuits, of the two thyratrons. If the plate circuits of both tubes are closed, then naturally both tubes will operate. However, an observer watching the two tubes will see one of them suddenly light up with a brilliant greenish-purple flare while the other will give off only a weak glow. This is due to the fact that the thyratrons and solenoids are so connected that the solenoids for alternate letters go to different tubes—tube No. 1 handling solenoids A, C, E, etc., and tube No. 2 handling solenoids B, D, F, etc.

The commutator closes the circuit from the thyratrons and power supply through only one solenoid at a time. As the signal "A" comes into the thyratrons, the commutator arm, due to isynchronous operation of sending and receiving commutator motors, is making contact with the commutator segment which connects to the "A" solenoid, thence to tube No. 1 and back to the power supply. Hence the impulse on the grid of this tube causes current to flow in its plate circuit, actuating the "A" solenoid to which it is connected by the commutator arm. As the "A" solenoid is energized its plunger is jerked downward, depressing the "A" typewriter key to which it is connected, and so the typewriter prints the "A," to be read by the receiving operator a scant fraction of a second after the transmitting "A" key was touched. Meanwhile the commutator arm has moved off the "A" segment, thus breaking the thyratron tube plate circuit and stopping the current through the solenoids. The apparatus is again in a passive condition, the commutators are whirling normally in perfect step at some hundreds of revolutions per minute, ready and waiting for

(Continued on page 167)

Searchlight Radio

(*Continued from page* 109)

was found, an additional gain of approximately 6 decibels.

The optical characteristics of these new micro waves will determine, it is probable, the things for which they chiefly will be used. There seems little advantage, for example, in using these waves for broadcasting. Their real utility will be found under other circumstances where the ability to concentrate the waves into narrow pencils like searchlight beams is of more importance. English commentators have suggested, for example, series of relay stations stretched across the country like telephone wires or still more like the old-fashioned semaphore methods or heliograph methods that were once used in such cross-country signaling.

Since the beams of the new micro waves behave in virtually the same manner as light beams, the range of any one beam is limited by the curvature of the earth. Nevertheless, if the recent trails are an adequate indication, the atmosphere will be much more transparent for the new waves than it is for ordinary light waves. A searchlight using only 25 watts of energy, for example, never could have been seen at the 40-kilometer distance spanned by the micro beam. If this indication of atmospheric transparency proves correct in practice it undoubtedly would be possible to erect a series of micro-beam relay stations on tall buildings or mountain tops across the United States or even across Asia and to use these for telephony just as a loaded telephone cable could be used. It would cost the Russians, for example, very much less to construct, in this fashion, a telephone beam across Siberia than it would to build a telephone cable over the same route.

New Channels Available

Another advantage emphasized by the European experimenters is the obvious one of the very large number of separate channels contained in the wave-band now opened for practical use between, say, ten centimeters and one meter in wavelength. This band contains, it has been pointed out, approximately ninety times as many ten kilocycle channels as are available in the whole of the present broadcasting and so-called "short-wave" ranges from 10 to 550 meters. Since one of the present limitations on practical television is the number of separate channels required for the successful operation of some of the most favorable processes, it is not impossible, as the European commentators suggest, that the micro-wave development may prove also to be the key to successful television.

My own suspicions are that the new field is likely to prove both more useful and more spectacular as a servant to scientific research than in its directly practical utilities. One thing which immediately suggests itself is the possibility of using the new waves to obtain information concerning the weather and the condition of the atmosphere. It is unlikely that the air will prove perfectly transparent to the new waves. Its transparency, on the contrary, may be expected to vary with the humidity, with the amount of dust in the air, with the electrical conditions of the earth and the clouds and probably with other factors. It is not unthinkable that the record, for example, of the hour-by-hour conductivity of a relay beam of micro-waves across the United States and back might be an extremely valuable indication not only of present weather conditions but for weather forecasting.

Some years ago, when Captain Mesny was experimenting with beams of somewhat longer wavelength in the neighborhood of three meters, these were tried with some success for the exploration of the condition and altitude of the Heaviside Layer. Such explorations will be still more significant with the new micro-waves. Indeed, it may be expected that radio "searchlights" of these new waves can be used to examine the electrical characteristics of the upper atmosphere much as ground officers at aviation fields now measure the height and character of cloud layers by means of optical searchlight beams directed upward from the ground.

Nor need the exploratory benefits of the micro-waves be limited to terrestrial levels above the ground surface. There is even greater need, among mining engineers, for some tool which will probe below that surface into the strata of rocks and ores and coal beds and others which the geologist wishes to explore. Even radio waves of ordinary wavelengths or those in the so-called short-wave field between 10 meters and 100 meters have been used successfully, it is well known, for such underground exploration. Once the transparency of various material to the new micro-waves has been studied, these waves may be expected to be still more useful in this field.

Just as the physicist in the laboratory explores the existence of strains or cracks, or inclusions inside optical glass or gem stones or other materials transparent to light, so the geologist may find it possible to study the refraction or other "optical" properties of mountain ranges or of the whole earth by means of powerful beams of the new micro-waves.

Value in Research Work

In physical laboratories the new waves are likely to prove equally important. Studies made in the past of the transparency of water, metals, insulating materials and other substances to these very short varieties of waves have been carried out solely with mixed and highly damped radiation of the type produced by Hertz, Nichols and Tear and others. Just as the optical properties of materials would be but imperfectly understood had physicists been confined to mixed light radiations or their optical tools, so the transparency, refractive index and other "optical" properties which substances possess or electric waves have been but imperfectly studied. No one knows, for example, how the atoms of a crystal respond to electric alternations like those which the new waves represent. In recent years the X-rays, once regarded by physicists chiefly as a tool of medical science, have proved enormously important in uncovering new and unsuspected secrets of atomic structure. It is not too much to expect that the still newer micro-waves will prove equally important in similar studies of the internal nature of many solids and liquids.

The next step is for everybody to get to work. Micro-wave generators must be put, somehow or other, in the hands of laboratory physicists, radio amateurs and even of experimenters on biology, for the secrets of life itself undoubtedly are related to electric forces and probably can be explored importantly by radiations of the new variety. It is much to be hoped that the International Telephone and Telegraph Company or the Laboratoire du Materiel Telephonique either will make available, at once, a supply of the "micro" tubes for use by experimenters or will make public such constructional and operating details as will enable competent engineers to construct and use these tubes for themselves.

Receiving Short Waves on Your Present Receiver

(*Continued from page* 135)

for broadcast reception, it should be used when the converter is operated. A double-pole, double-throw switch may be connected as shown in Figure 2, so that the change from broadcast to short-wave reception may be effected by merely throwing the switch.

Any antenna that gives good results in the broadcast band may be used for short-wave work, although a minimum of twenty-five feet is recommended. The semi-fixed antenna series condenser (having a brown molded base and located at the left of the –24 socket) is adjusted for a 50-foot antenna at the laboratory. If a 75- or 100-foot antenna is used, it should be loosened about half a turn; with a 25- or 30-foot length, it should be tightened about one-quarter turn.

Four sets of coils (two per set) are supplied, covering a range from 13.5 to 115 meters, approximately, as follows:

Black	13.5	to	24	meters
Red	23	to	41	"
White	40	to	70	"
Green	65	to	115	"

No additional coils for extending the range are available at this time.

The dial of the broadcast receiver should be turned to some point where no broadcast station is heard. This may be hard to find if the receiver used is extremely sensitive; in this case, the dial

(*Continued on page* 157)

Practical S-W Super Design

(Continued from page 114)

day" is equivalent to the problem on long waves of tuning in a weak station next to a "powerful local." The selectivity must be such as to hold the powerful local down about 50 dbs. This can be accomplished in short-wave supers by having enough selectivity and amplification ahead of the first detector, and as the noise level is much lower down in short waves, this difficulty is less on short waves than on long waves.

To have a quiet, hissless superheterodyne, it is important to have a high signal level on the first detector. In the receiver shown here the band selector cuts down the signal somewhat, but the stage of tuned radio frequency boosts it up to good value again to pass it on to the first detector and the loose coupling in the band selector and antenna further highly attenuates any off-band frequencies.

Automatic Volume Control

A reference to the circuit diagram Figure 1 shows that the automatic volume control is one that might be called duplex.

I am not now referring to the sensitivity control which is the potentiometer in the antenna circuit. The automatic volume control tube is a -27 and is so biased that the control grids of the first two radio frequency tubes increase their negative bias as signal strength increases, and at the same time all the screen grids have their positive voltages reduced. An inspection of the v.c. tube circuit will show that as the plate of the v.c. tube draws current it lowers the voltage on the above mentioned screen grids. Inasmuch as the 200 ohm resistor in the cathode leg of the v.c. tube is in the plate circuit of this v.c. tube, whenever the v.c. tube draws current, there is a voltage drop in this 200 ohm resistor. This resistor being in the control grid circuit of the above-mentioned r.f. tubes, it follows that their grid biases are increased and thus the output of the receiver is kept quite constant.

This is an instantaneous control device so no time compensation has to be introduced as in some systems that use the audio component as the control factor. In the method described it is the rectified component of the r.f. current that is made use of through the 100,000 ohm resistor in the cathode circuit of the second detector that operates to change the bias on the v.c. tube.

Incidentally, in any circuit using automatic volume control, it is essential to use not more than one audio stage if even volume level is desired.

The receiver I use for relaying to my CMHC 379 meter, 1000 watt transmitter for rebroadcasting W2XAF, W2SAD and W8XK I now have automatic v.c. control as described above and in addition there is another complete receiver of the regenerative type whose rectified detector output also directly controls the grid biases of the r.f. tubes of the first receiver. This added complication is well worth while as the output of the first receiver is then almost perfectly constant for any level to which it is set.

The Bell Telephone people use this method in their transatlantic receivers in a slightly different manner. In their superheterodyne receivers I believe they branch off at first detector with two intermediate amplifiers. One is used to carry through the signal and the other to give a rectified current in its second detector to operate the grid biases on the first detector.

With any of the methods above described, if you place a milliammeter in the plate circuit of the controlled r.f. tubes, the throw of this meter gives an accurate visual indication when you are exactly tuned to the peak of the signal.

Really a visual indicator is almost a necessity when using an automatic v.c. Such control is nearly as effective in the circuit described when the B plus lead for the oscillator is bled through a resistor from the plate of the v.c. tube. If this method is used alone you do not get good visual indication with a milliammeter in the plate circuit of the r.f. tubes, but you can place this low scale meter (scale 0–1½ M.A.) in the oscillator plate circuit. However, this method is better on long waves than on short waves. Its chief defect is that it tends to vary the oscillator frequency.

Also, don't expect quite as good results with automatic v.c. on short waves as on long waves. Fading effects on short waves are so serious at times that a signal will drop in level as much as 60 dbs. in a moment. When the signal drops on short waves it is more likely that the wave is getting to the receiver over different paths and out of phase. This causes low signal strength and what is worse, usually greatly impairs the quality, even though the automatic v.c. holds up the level, at the output of the receiver.

My transmitter, which for many years was known all over the western hemisphere as "6KW, Cuba," is now fitted with new call letters since last year. The call is CMHC. My many relays of distant foreign programs, even those from London, are considered phenomenal by the people here in Cuba, as they never get such fine or interesting programs from any local station in Cuba.

Special Short-Wave Antennas

Now let's spend a few moments on the subject of receiving antennas especially for short waves.

With a good short-wave receiver, any old piece of wire from ten to fifty feet long strung up almost any old way will give pretty good results, almost anywhere, but why in the name of goodness isn't it made right for the service intended, when the antenna system is actually the "doorway" for all the signals that expect to get into your receiver?

Besides the selectivity that we work hard to get in our receivers, don't overlook the fact that some of the easiest selectivity obtainable can be gotten in the antenna alone.

The receiver herewith described has greatly increased selectivity when used with a loop properly constructed. One or two turns about 12 inches wide and 18 inches high with a balanced center to ground to avoid "antenna" effects, will give a certain type of selectivity.

As an example. There is a powerful code transmitter in Mexico City which is due west of Tuinucu. Its wave length is slightly longer than W2XAF on 31.48 meters. Except with a receiver of very high inherent selectivity this code signal will modulate the W2XAF signal in the first r.f. tube. This balance loop is dead to Mexico City with the edge of loop north and south in line with Schenectady, New York.

This same scheme will receive Rome in spite of strong interference from W8XK when the loop is edgewise in line with Rome and Tuinucu. But as loops are bi-directional they won't help against any distortion that might be caused by "round the world" repeat signals. A loop antenna such as described is shown in Figure 3.

A Beverage antenna is very directional but needs a lot of space and has to be constructed for a particular band of frequencies and generally speaking is not practical for the usual back yard. However, those living in the country should experiment with it.

Transatlantic Telephony

The Bell Telephone transatlantic radio system uses uni-directional receiving types of antenna "arrays" that are well worth a little study as these systems may be adaptable to the amateur on a smaller scale. These arrays consist of what amounts to a long wire doubled up and down on itself and hung between a long line of latticed supports. A long array, generally speaking, makes the system still more directional. This type of antenna receives broadside in distinction to the loop and is also bi-directional, but by placing two similar arrays one a quarter wave length behind the other, the combined system then becomes strongly uni-directional. It was only with the advent of the discovery of the great usefulness of short waves that such types of antenna became feasible. Even so, such an array as used by the Bell system may reach dimensions of the order of several hundred feet in length.

Such dimensions are of course impractical for the amateur, but I believe the same system using only a few sections would be worth while to any one who has a reasonably big back yard. Of course these special antennas are not flexible as regards usefulness for any wave except that for which they are constructed.

By referring to Figure 4 you will see a diagrammatic sketch of such an array on a small scale. This shows an arrangement set up anywhere in the United States for uni-directional reception from Europe of a wave length of 25.53 meters. This may

(Continued on page 158)

Radio Third Degree

(*Continued from page* 106)

as interpreter for all suspects who do not, or who pretend they do not, speak English. Some suspects refuse to answer any questions in the line-up "On advice of counsel." Others talk very freely and relate full details of the misdeeds that brought them within the grasp of the law.

These public address microphones have been used in presenting more true dramas than any broadcasting microphone. Many persons who come before the line-up microphones, appear before them for the second or third time. Some suspects who face the microphone will never return—they will be electrocuted. Others may be sentenced to life imprisonment.

Once it was suggested to actually broadcast the line-up proceedings. The public address system is so designed and equipped that it can feed a program to any broadcasting station over wire-lines without the installation of remote control apparatus. The suggestion was ruled out in view of the uncertainty of the suspects' choice of words. The suspects, whether due to ill-breeding or contempt, sometimes respond in obscene language which, of course, would be objectionable on the air. The legality of broadcasting the line-up proceedings was also questioned.

They still tell the story at Police Headquarters of the suspect who refused to answer any questions directed at him. Upon seeing the microphone placed before him, he exclaimed: "I'll be damned if I want to broadcast!" After a brief explanation that his utterances were not being broadcast, but merely amplified in the gallery, the suspect willingly responded to the questioning.

Here the parade before the microphone continues each day, Sunday excepted. The stream is endless. Homicides, robbery, assault, extortion, forgery, picking pockets, dope-peddling—these and many other charges are regularly brought before the line-up.

Six days a week, the public address system serves the line-up. The Monday line-up is usually the heaviest on account of week-end arrests. Commissioner Mulrooney sometimes uses the gallery to address Police College students, business men and other groups and the system is used to amplify his voice throughout the huge room.

The apparatus is so designed that three microphones, placed at vantage points through the room, may be used simultaneously. The tone quality is good and no feed-back occurs, although two dynamic speakers are by necessity close to the microphones. While the gymnasium was constructed without any provisions for sound acoustics, no echoes are discernible during the line-up due to the fact that the room is crowded. The public address operator states that the detectives' clothing deadens the reflection of the sound waves.

A public address system was first tested in the line-up when Grover A. Whalen was Police Commissioner. At that time the present commissioner, Mr. Mulrooney, was chief of the Detective

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Radio Third Degree

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Division and conducted the line-up. Commissioner Mulrooney, who through his personal use of the microphone noted the public address system's value, highly commends its use in police procedure. The New York Police Department is believed to be the only police unit in the world to use a public address system in this manner. Mr. Mulrooney told the writer that some large cities do not conduct line-ups. While acquainted with the police methods of other municipalities, he did not know of any other department using a public address system.

The new public address system was designed by Patrolman Charles Francis, who also serves as its operator. The apparatus, like the radio equipment, comes under the supervision of the Bureau of Telegraph, headed by Deputy Chief Inspector Allen.

The system includes several standard Western Electric units supplemented by apparatus which was designed and constructed by Police Department men. A specially wired table was designed by Francis to meet the peculiar needs of the line-up proceedings. The output of the microphones is fed into a three-channel mixer which permits independent control over each microphone. The impulses pass through a pre-amplifier consisting of three stages of resistance-coupled amplification and, in turn, reach a transformer-coupled power stage. Three magnetic and two dynamic loud speakers then convey the proceedings to every part of the room.

A 550-watt a.c. converter is employed for the main power supply. Batteries are utilized for the twelve-volt d.c. supply for the microphones and the filament current of the pre-amplifier.

The special public address table contains indicators that, at a glance, reveal how the entire system is functioning. In order to prevent any wrong connections, plugs and jacks are so paired that no plug can possibly fit into the wrong jack.

Commissioner Mulrooney, in an interview, told the writer that he was asking for appropriations to extend the police radio service. Besides the long-wave transmitter, WPY, the department expects to have short-wave transmitters for communication with patrol cars and the police air fleet.

The Bell Telephone Laboratories recently co-operated with the Police Department in tests of aviation radio communication. The Police Commissioner's staff participating in the tests included Thomas W. Rochester, chief engineer; Arthur M. Chamberlain, assistant to the Commissioner, and Captain A. W. Wallender, head of the police air service division. Three-way conversation between an airplane, a portable truck radio station and the aeronautical ground station at Mendham, New Jersey, was maintained.

Two years ago the Police Department installed radio receivers in several department cars. These are still used in some of the cars, but they receive mes-

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The Radio Third Degree

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sages on the regular broadcast band. New plans call for short-wave sets in the police cars to receive messages from the planned short-wave station at headquarters. The short-wave transmitter will be more valuable for police work than WNYC, the municipal broadcasting station, on account of the greater assurances of secrecy. The broadcasting of police orders over a regular broadcast channel is also retarded by a Federal Radio Commission ruling that states only programs of general interest may go over a broadcast transmitter.

The first police radio unit, KUVS, was erected at the suggestion of Federal authorities. Police Commissioner Arthur Woods started a radio class of all patrolmen previously experienced in some phase of radio or telegraph work. Duplicate receivers and transmitters were then installed in both Manhattan and Brooklyn headquarters. The Brooklyn station was later scrapped.

Station KUVS won much attention during the World War when it served the newspapers by supplying complete lists of names of American troops on returning ships. This station, and its successor, WPY, have long records of achievements in quelling harbor mutinies, aiding distressed vessels in the harbor and many other deeds. A twenty-four-hour watch is constantly maintained.

The Police Department's radio facilities are supplementary to other communication methods of the Bureau of Telegraph. The Bureau maintains a battery of telegraph typewriters for communication with all precincts. Two thousand police telephone boxes and a lamp-post light signal system are also maintained.

Commissioner Mulrooney sees radio as a permanent ally to the police and believes it has limitless possibilities of application in police methods of detection and procedure.

The use of radio in police routine is growing more and more important in other cities throughout the United States. Several municipalities operate special police transmitters. Other local governments are planning to erect such stations in the near future and have applied to the Federal Radio Commission for wavelength assignments. In some cities, local police departments have special arrangements with privately owned transmitters for departmental use.

From this desk at Police Headquarters, Deputy Chief Inspector Allen (center), Superintendent of the Bureau of Telegraph, directs the communications systems of the New York Police. In addition to radio and public address units, the department utilizes a battery of telegraph typewriters, 2,000 telephone boxes and a lamp-post light signal system for contacting the members of the huge force

Michigan has two police transmitters that have attracted wide-spread attention and comment. The Detroit Police Department Station, WCK, at Belle Isle, and the State Police radio unit at Lansing have already proven their worth by performance and results.

The Detroit Police transmitter, a 400-watt short-wave unit, is used chiefly for contacting police motor cars. The station can be perfectly heard in radio-equipped police cars within a radius of ten to twenty miles. The station has also been heard 2000 miles away on stationary, rather than mobile, receivers. The receivers in the police cars are pre-tuned and locked to the 2416-kilocycle channel. The receivers are of Bosch manufacture. In the older cars, the antennas consist of metal screens in the car tops. New cars come factory-equipped with antenna. Detroit being the center of the American automobile industry, the local police department conveniently arranges to obtain such special radio specifications in the automobiles it purchases.

Radio-equipped police cars are of two types, namely, "scout" cars and "cruisers." The "scouts" are light cars manned by two uniformed patrolmen. The "cruisers" are heavy cars and are manned by four policemen—two plainclothesmen, a detective and a uniformed driver. The latter type of car carries riot guns, tear gas bombs and other emergency weapons.

Police cars throughout Detroit are constantly tuned in to WCK. Every policeman's ear is on the alert for a "run" call—a message that will send him to the scene of a crime, a fire or an accident. The "run" call is the most important type of message and has preference over all others. Next comes the "station" call. Cars are wanted at the precinct station or by the police dispatcher and they are called in by radio.

Emergency calls from all precincts go to a central dispatcher's office. One supervisor covers the "East" cars while another contacts the "West." Whenever they have a message, they merely plug into a telephone line linked to the radio transmitter. This simple action automatically puts their voices on the air.

The State Police Station, WRDS, at Lansing, is a 5,000-kilowatt De Forest unit and is utilized to contact forty-five troopers' radio-equipped automobiles.

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Radio Third Degree

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The State police cars are equipped with Sparks-Withington receivers. This station, too, like that of Detroit, has an excellent record of achievements through the application of radio.

And thus, throughout the country, cities are constantly recognizing the need for special police department transmitters and receivers.

Municipalities licensed by the Federal Radio Commission for the operation of police radio stations include: Minneapolis, Minn.; Grosse Point, Mich.; Cedar Rapids, Iowa; Dallas, Texas; Flint, Mich.; Chicago, Ill.; Cincinnati, Ohio; Cleveland, Ohio; Indianapolis, Ind.; St. Paul, Minn.; Highland Park, Mich.; Tulare, Calif.; Seattle, Wash.; Passaic, N. J.; Louisville, Ky.; St. Louis, Mo.; Columbus, Ohio; Pasadena, Calif.; Richmond, Ind.; Akron, Ohio; Berkeley, Calif.; Buffalo, N. Y.; Milwaukee, Wis.; Toledo, Ohio; Youngstown, Ohio; Vallejo, Calif; Washington, D. C.; Beaumont, Texas; Sioux City, Iowa; San Francisco, Calif.; and Omaha, Neb.

The Pennsylvania State Police operate five stations on a channel of 257 kilocycles. The transmitters are located in Harrisburg, Butler, Wyoming, Greensburg and West Reading. The Division of State Police of the Massachusetts Department of Public Safety operates a station at Framingham, Mass. The California Highway Patrol maintains a station at Bakersfield, Calif.

Construction permits for police radio stations are held by Philadelphia, Pa.; Auburn, N. Y.; Kansas City, Mo.; Portland, Ore.; Oklahoma City, Okla.; El Paso, Texas; St. Petersburg, Fla.; Kokomo, Ind.; Charlotte, N. C.; Pittsburgh, Pa.; San Jose, Calif., and Davenport, Iowa. At this writing, construction permits for police radio stations at Rochester, N. Y., and Los Angeles, Calif., are pending.

Some police officials feel the time will come when there will be a nation-wide network of police transmitters with a unified system of operation.

The microphone has taken its place alongside the nightstick, the revolver and handcuffs, as a practical and permanent weapon for curtailing and wiping out crime.

Receiving Short Waves on Your Present Receiver

(*Continued from page 152*)

should be set either just above or below the broadcast band. If the short-wave stations are tuned in with a whistle, the broadcast receiver is probably tuned to the frequency of some station that is too weak to be heard but is still strong enough to cause interference. This whistle is often helpful in finding and tuning in a weak short-wave signal, however, and is helpful in receiving telegraphic signals. The remedy is to change the dial setting slightly. The volume control should be used in the regular way.

Short-Wave Super Design

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be G5SW in England. The sketch shows the minimum number of bays or sections that could be useful and would require a free open space at least 25 feet by 100 feet in area. More sections in a longer array would be preferable. Arrays for different wave lengths can be calculated on the same method.

The theory on which this system works, as described in Bell Telephone publications, is roughly as follows:

When a wave reaches the front, or A broadside of such an array the voltages which are produced in the vertical wires are in phase and the currents are additive. Voltages developing at central points in any of the vertical wires are also reflected back from the open ends of the antenna array with their phases reversed so that they reinforce just at the right instant, the point on the oncoming wave at the point where the receiver connection is taken off. The quarter wave length connection between the front and back array causes waves to cancel that come from the B side.

When a wave strikes the antenna from either end on, conditions are very much changed. The current produced at any instant by the advancing wave will be out of phase with the reflected waves and will cancel.

To bring out a little clearer this action, refer now especially to Figure 5 in connection with Figure 4. At (a) Figure 5 are shown two positions of a wave with respect to such an antenna. The arrow shows the direction of the wave. One curve shows the position of the wave where it coincides with sections B and A at the present instant.

Remembering that array A is connected to array B through a quarter wave wire, note the instantaneous voltages on the two antennas. The point on antenna A had a potential exactly equal and opposite at an instant just one-fourth period before the present instant, therefore its effect arrives at point B just in time to cancel the voltage there at the present instant.

By studying sketches (b) and (c) it will be seen that waves arriving from the opposite direction or broadside to antenna A will be additive at point B and so reinforce each other at the receiver.

A good explanation of the theory of this class of antenna arrays will be found in the Bell Laboratories Record describing their short-wave transatlantic radio telephone.

Figure 6 shows another form of array which is very directional to waves for which it is designed and will well repay a little time in construction and experimentation.

In the article to appear next month, Mr. Jones provides the constructional details on his receiver for the benefit of readers who may desire to build their own.—THE EDITORS.

RADIO NEWS Short-Wave Design Contest

In the February issue RADIO NEWS offered two prizes of $50.00 each, one for the best short-wave receiver design and one for the best short-wave transmitter design. Contestants were allowed until May 10th to submit their designs, the winners to be announced in the present issue.

The Editors take this occasion to express their appreciation to the judges who served on the committee of awards. The work of this committee was considerably complicated by the excellence of the designs submitted and the difficulty in selecting an outstanding one in each class. It was only through diligent effort that the prize winners were finally selected and the awards made as follows:

Transmitter Award—$50.00
Paul B. King, 3 Linden Avenue, Troy, New York

Receiver Award—$50.00
W. G. Wheat, 1017 Linwood Blvd., Kansas City, Mo.

The complete descriptions of the prize-winning designs will be published, that of the receiver in the September issue and of the transmitter in the October issue.

Auto-Radio Receiver

(*Continued from page* 117)

the screen and the plate. The suppressor is connected inside the tube to the cathode and is therefore operated at the same potential as the cathode. When connected and operated in this manner, the suppressor is effective in practically eliminating the secondary emission effects which limit the power output from four-electrode screen-grid types. In comparison with three-electrode power amplifiers of the same plate dissipation, the pentode is capable of producing greater power output. Furthermore, the pentode has the design feature of much higher gain than is possible in a three-electrode amplifier without serious sacrifice in power output.

Like the –36 and –37, this new output pentode employs a coated cathode of the semi-quick heater type, designed for d.c. operation from the 6-volt car battery without resistors or other current-limiting devices in the circuit. Its characteristics are as follows:

UY238

Heater voltage	6.3 volts
Heater current	.3 amperes
Plate voltage	135 volts
Screen voltage	135 volts
Grid voltage	—13.5 volts
Plate current	8 mils
Screen current	2.5 mils
Plate resistance	110,000 ohms
Amplification factor	100
Mutual conductance	900 micromhos
Load resistance	15,000 ohms
Undistorted power output	375 milliwatts

Aside from the elimination of filament resistors or ballast lamps by the use of these new 6-volt heater tubes, the heater type construction serves to greatly reduce the ignition noise and other electrical disturbances getting into the receiver through the "A" battery supply.

The low battery drain, a total of but 1½ amperes for the five tubes, eliminates any necessity for shifting the charging rate on the generator in the car when the radio is being used quite a bit. It also does away with the necessity, which was frequently encountered when the a.c. type tubes were used for automobile work, of having to replace the standard car battery with one of higher ampere-hour capacity.

Still one more rather outstanding advantage of the indirectly heated cathode construction for automobile radio tubes is the elimination of separate biasing batteries as when the –12 or –71A was used for the output tube. By employing automatic biasing, not only is the first cost for the battery reduced, but good performance will be had over a longer period of time, for the bias will automatically decrease as the "B" batteries drop in voltage with use and age, so that they may be employed for a longer time than when a fixed type bias is employed, which resulted in poor operation once the "B" battery voltage had started to fall appreciably.

From the accompanying photos and the diagram, Figure 1, it will be seen that

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A Pentode Auto-Radio Receiver

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the new National auto radio employs four of the -36 tubes and one -38 in a circuit comprising three radio-frequency stages, a screen-grid detector and an output pentode. The result is fairly uniform sensitivity over the entire broadcast band, of better than five microvolts per meter and the selectivity obtainable from three highly efficient tuned circuits, which is more than ample, considering the limited pick-up conditions and small equivalent effective electrical height of the automobile antenna system. In order to obtain the high gain per stage as shown by the sensitivity curve in Figure 5, it was necessary to very thoroughly shield the entire chassis.

In order to make the chassis easily accessible for replacing tubes or other such purposes, it is so designed that it will slide out of the container cabinet by merely unfastening four screws on the front panel. The container cabinet itself is fastened directly and rigidly to the front bulkhead, or wherever else it is desired to mount it, by means of holes provided for that purpose. The chassis is then slid into place and securely held in position by means of the four screws on the front panel.

The connecting plug in which the leads from the "A" battery and "B" battery box are terminated is plugged into the side, as will be seen from the illustrations.

Several new automobile radio cone-type loud speakers, of both the magnetic and dynamic variety, designed for use in the plate circuit of the new -38 pentode, have already made their appearance on the market and others will doubtless follow.

The dynamic speakers are wound with a 6-volt field coil so that they may be connected directly across the "A" battery.

The location of the loudspeaker in the car will be found to have a great deal of effect on the resultant tone quality and before definitely mounting the speaker in position it should be tried in several different locations. The location under the dash, so commonly used in many installations last season, is one of the poorest places, from an acoustic point of view, in which to place the speaker.

The "B" battery box, in touring cars or sedans, should be mounted under the floor at the rear on the side of the car opposite that from which the exhaust pipe and muffler are located. In roadster and coupe types, there is generally ample space for the battery box in the luggage compartment at the rear.

Many of the new cars are coming through with built-in antennas. Generally these antennas consist of copper screen mesh located under the upholstery in the roof of the car. While it is not an impossible task for anyone to remove the roofing material and install such an antenna, a much simpler method is to obtain a large darning needle and some fine wire and thread the wire through the roof upholstery.

In making battery connections to the receiver, it is recommended that armored cable or miniature BX, especially made for automobile wiring purposes, be employed and that this metal covering be grounded. Not only does this shielding of the battery wires reduce the ignition noise picked up, but it greatly decreases any possibility of short circuits due to damaged insulation and consequent grounding of either plate or filament battery. Due to the use of the heater type tubes throughout, polarity of the connections to the storage battery is of no consequence.

While the actual process of ignition noise elimination is not difficult, merely comprising the necessity of installing a set of suppressors, which are 20,000 to 25,000-ohm resistors connected in series with each of the high-tension leads where they are attached to the spark plugs and to the central lead running to the distributor and coil as shown in Figure 3, in order to completely eliminate all noise it is frequently necessary to do some experimental work in applying several different grounds to the armored wiring of the lighting system. Often, when all other things have failed, a ground located about half-way along the length of the wire to the dome light will remove the last traces of ignition noise.

In many cars, particularly after they have been used for some time, sparking of the generator commutator brushes will cause a disturbance. This disturbance is easily recognized, as it varies in pitch with the speed of the car and is quite readily eliminated by connecting 1 mfd. condensers between the different brush terminals and the generator frame. These condensers should be of a type not affected by heat from the engine and should be so mounted as to receive the least possible amount of engine heat.

Amateur Radio

(*Continued from page* 137)

radio station W3AJZ at Bethany Beach, Delaware. According to Myers, chief reliance will be placed on the United States and Canadian amateurs to "pull the signals through" under all conditions and make the contact unfailing.

Radio facilities of the *Nautilus* were tested last May by Sir Hubert when the craft was being equipped at New York. The leader of the expedition at that time carried on successful radio communication with Lady Wilkins and he was much pleased with the results. Two-way communication was established. The *Nautilus'* transmitting station, WSEA, sent a message to Station WRH, Carlstadt, N. J., and it was relayed to New York offices by automatic transmitters.

Addressing Lady Wilkins as "My Dear Suzanne," Sir Hubert noted that the message was the first sent from the *Nautilus* and said: "It is fitting that this radiogram should go to you with my greetings and love."

The answer flashed back was: "I am very much excited and deeply touched

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Amateur Radio

(*Continued from page 160*)

by your first message and send my love by swift radiogram back to you at once as commanded."

Transmitting apparatus aboard the *Nautilus* has a power rating of 200 watts. Power for operation is derived from either the ship's batteries or its lighting mains. The Federal Radio Commission has assigned the frequencies of 5525, 11,500 and 16,580 kilocycles for calling and working frequencies of 5555, 6620, 8290, 8450, 11,110, 13,240 and 16,660 kilocycles.

For communication when the submarine is submerged under the Arctic ice-pack it will be necessary to drill a hole through the pack for erection of the antenna. Scientists point out that the ice

Ray Meyers, radio operator on the submarine *Nautilus*, pictured at his instrument aboard the craft during the recent journey to New York from Camden, N. J. Meyers will keep the world informed of the doings of the Sir Hubert Wilkins North Pole party during that hazardous journey this summer

in the Arctic seldom becomes more than fifteen feet thick, and this task is expected to be accomplished easily by means of the special drilling apparatus included in the equipment of the submarine. Methods of sending radio messages while the ship is submerged is said to be a Navy Department secret. However, at the time this article was written authorities were considering entrusting this method to Sir Hubert for emergency use.

Haardt Trans-Asiatic Expedition

Along part of Marco Polo's trail, in Central Asia, the Haardt Trans-Asiatic Expedition, one of the most completely equipped expeditions of modern times, is making its way. Its American sponsor, the National Geographic Society, reports radio communication is in progress from the point of departure, Beyrouth, Syria. Many messages and news dispatches are being flashed both to and from the expedition by amateur radio.

Apparatus used by the expedition is perhaps as powerful as that carried by any expedition. The party has a personnel of thirty-five and will travel for eighteen months in the wilds of Asia.

Radio equipment includes a 1-kilowatt short-wave transmitter deriving power from a 500-cycle high-voltage source. Using the call letters of FPCF, the station will operate on frequencies of 8240 and 8000 kilocycles. Communication schedules have been arranged with amateurs throughout the United States by the

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Amateur Radio Aids the Explorer

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American Radio Relay League and are being reliably effected.

The Haardt expedition consists of a caravan of seven caterpillar tractors with all kinds of scientific apparatus. Georges-Marie Haardt, famous French explorer and leader of the expedition, was the first man to cross the Sahara Desert by motor. The expedition will move in two units, the first to cross mountain passes as high as the peaks of the Alps, and the second to traverse the area of "unquenchable thirst" and deadly sandstorms until they meet at Kashgar in the middle of Asia.

The division assembled at Beirut under Haardt is known as the Pamir Unit, and a similar division started at Peiping, China, known as the China Unit, which will drive across the Mongolian deserts and the Plateau of Chinese Turkestan under the leadership of Lieutenant Commander Victor Point and Dr. Tsu Ming-yi, of the Chinese Geological Survey.

From a scientific point of view the expedition is unique. It will not only make a thorough study of the isolated and little-known peoples of North Central Asia, but will record their chants and ceremonies with talking motion-picture apparatus. In addition, meteorological observations will be made in places never before recorded, for the making of weather maps.

The Dickey Expedition

Beginning last May, the Dickey Orinoco River Expedition, under the direction of Dr. Herbert S. Dickey, began its 1600-mile trek up the Orinoco River, in South America. At the base set-up at this point a complete radio station was erected under the direction of William T. Lanz, radio operator with the party. The station, operating under the call letters of DDOE, has already established reliable contact with the United States and, nightly, several hundred stations may be heard on short wavelengths calling the operator of the expedition. From a communication standpoint, this expedition is perhaps the most successful. The signals of DDOE are reported regularly by amateurs through the United States.

Lanz, the operator, is a well-known amateur, having maintained his own station under the call letters 2IV and 2CYT for a number of years. The low-powered transmitter radiating the signals from the heart of the South American interior makes use of two 50-watt tubes connected in a tuned-plate, tuned-grid circuit.

Since the departure, from Los Angeles, of the Second International Pacific Highway Expedition for Mexico City, where the second lap of the trail-blazing journey from California to South America has begun, the high-frequency radio equipment taken by the party has been in constant communication with amateurs in the United States.

During the first trip of the expedition, when it made its way from Los Angeles to Mexico City by automobile, reliable communication was effected by means of portable apparatus. The apparatus was constructed by Bertram E. Sandham, who operates amateur station W6EQF. More powerful equipment than that carried on the trip in 1930 is being taken this year.

Using a pair of 50-watt tubes, deriving plate power from "B" batteries, the station is heard nightly by amateurs and regular schedules are being maintained with stations in California. The call letters used by the expedition are IPH.

Six trucks and a party of six men in this expedition will seek Panama as their goal. The International Pacific Highway Expedition is again sponsored by the Automobile Club of Southern California. In an announcement giving the purpose of the expedition it was stated: "The club is blazing a trail which is ultimately to become an important link in the great Pacific Highway to run from Alaska to South America. Last year the expedition fought its way through rough, rocky, almost impassable 'barrancas,' the most formidable barrier in the highway project. This year the expedition must make its way through the woods and tropical growth of Central America, and amateur radio is again called upon to help."

Capt. Bartlett Goes North

Only last month Captain Bob Bartlett and his historic schooner *Morrissey*, with the call letters VOQH and an amateur in charge of radio apparatus, left for the North. Bartlett, who makes almost annual trips to the Arctic, has for the past several years included radio as part of his equipment. In each instance it has been under the operation of Edward Manley.

The Northern Labrador Expedition of Sir Wilfred Grenfell recently embarked aboard the *Ramah*. Radio equipment carried by the *Ramah* is in charge of E. D. Brooks, Jr., owner of amateur station W1TL.

And again, Captain Donald B. MacMillan, who started the idea of taking radio apparatus on exploration trips back in 1923, will make his way northward this summer in the schooner *Bowdoin*, equipped with radio for communication with amateur stations throughout the United States and Canada. R. E. Brooks, owner of amateur station W9AFA, who accompanied the party as operator last year, will again be in charge.

So with all these parties making their ways to places unknown, truly thousands of pairs of "amateur" ears will eagerly await word of new discoveries and adventure throughout the world.

Backstage

(*Continued from page* 144)

Pleasure Hour, heard over the National Broadcasting Company hook-up. The sponsors of the new fifteen-minute feature did a rare thing by taking three of Columbia's sustaining features—Morton Downey, Tony Wons and Jacques Renard's Orchestra—and merging them into a single, balanced program.

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What's New in Radio

(Continued from page 147)

Transmitting Condensers

Description—A new line of high-voltage transmitting condensers to be known as type ZX. These condensers are rated for continuous operation at 7000 volts d.c. (motor generator) or 5000 rms. volts rectified a.c. The connecting terminals are mounted within heavily bushed glazed porcelain insulators. These condensers are available in 1, 2 and 4 microfarad capacities. The overall measurement for the 1 microfarad size is 10¾ inches high by 5 inches wide by 5 inches deep, the 4 microfarad size measures 6¼ inches high by 21 inches wide by 10½ inches deep.

Maker—A. M. Flechtheim & Co., 136 Liberty St., New York City.

A Flat Cable

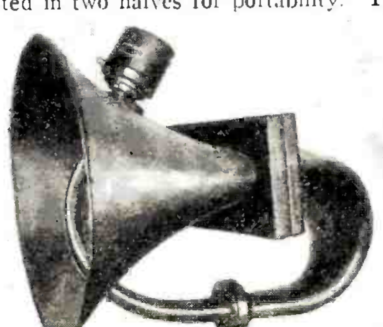
Description—A new type of flat cable suitable for remote control connections to radio receivers, for connecting extra loud speakers and for numerous purposes encountered by the radio experimenter and service man. It consists of stranded copper wire, individually cotton wrapped and rubber covered. These are encased in a

heavy cloth covering, stitched lengthwise between wires to provide flat construction and assist further in insulating the wires from one another. The edges are beveled to prevent it from curling and to permit it to be laid under rugs or carpets without bulging. The cable is available in any desired length and any number of wires.

Maker—The Holyoke Co., Inc., 621 Broadway, New York City.

Portable Horn

Description—The model No. 3320-A horn is designed for use in small theatres or auditoriums. It has wide angle distribution, good projection, and can be separated in two halves for portability. This



same style horn is also available in non-demountable type. The air column length is a little under seven feet, the oval bell

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Oscillator Condenser Design

(*Continued from page* 133)

k = the constant for air condensers $= \frac{10^{-11}}{36\,d}$

d = the dielectric gap.

$\frac{df}{d\theta}$ = the change in frequency in cycles per radian.

r = the cut-out radius in the stationary plates.

Co = total capacity in the circuit at minimum or when θ is zero, in farads.

While space does not here permit the manner of derivation of the above equation, it is given in a slightly parametric form by Henry C. Forbes in the "Proceedings of The Institute of Radio Engineers" for August, 1925.

and C is the capacity in farads.

The capacity, of course, refers to the entire circuit capacity, comprising the condenser capacity, and the distributed capacity of the coil and wiring.

The relationship in equation (2) may be expressed—

$$C = \frac{1}{4\pi^2 f^2 L} \qquad (3)$$

Assuming the highest frequency to which it will be necessary to tune as 1500×10^3 cycles, and L as 240×10^{-6} henries, the capacity at this frequency will be 46.9×10^{-12} farads. The minimum capacity of the condenser being 18.4 mmfd., this leaves a circuit capacity of 28.5×10^{-12} farads. In computing the frequency curve shown in Figure 4,

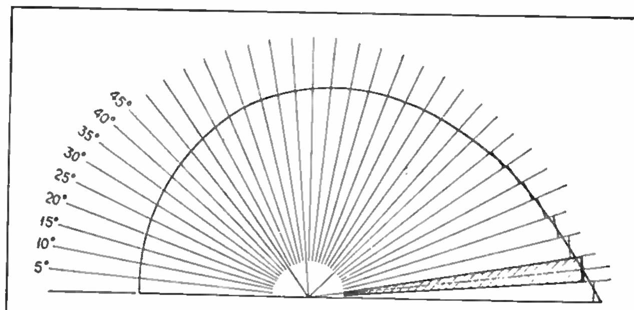


FIG. 7

Figure 7. A continuous curve joining the centers of the sector circumferences will provide a very close approximation of the required plate

With other variable condensers it is necessary to start from scratch and to follow a rather different procedure. In the following discussion, reference to the "tuning condenser" will mean the capacity tuning the preselector and first detector circuits, while the "oscillator condenser" will refer to the capacity tuning the oscillator circuit.

It is essential first to obtain the capacity curve of the tuning condenser. Bridge measurements should be made on a half dozen condensers, the average capacities taken, and the curve drawn. If the irregularity of the curve indicates several errors, and it is not possible to locate them, the curve should be drawn through points giving a smooth, logical curve. All references should now be made *to the curve* (not to the actual measurements). Such a capacity curve is shown in Figure 3.

From a capacity curve it is easy to plot a frequency curve for this condenser with a given value of inductance. The inductance should be of such a value that, with the condenser, it provides an adequate tuning range, and, if possible, is in accord with the standard types and values readily available. The value chosen here is 240 microhenries—or 240×10^{-6} henries. (It is desirable, for the sake of consistency and resulting probability of accuracy, to work conversions with the fundamental units.) The frequency is of course equal to—

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

Where L is the inductance in henries this capacity must be added to the condenser capacity for the total tuning capacity at a given dial setting.

The necessary computations may be readily performed on a slide-rule, but it is desirable to start by solving the equation with logs, and similarly checking at three or four points. As a matter of experience, when the logs of the temporary constants, such as 2π, $4\pi^2$ and L, are noted on the scratch pad, the logarithmic solution is very quick and not at all laborious.

Having obtained the tuning curve of the tuning condenser, we may draw in the oscillator tuning curve 175 kc. above the first. This second curve, also shown in Figure 4, provides us with data from which we shall determine the capacity curve of the oscillator condenser. It is, however, first necessary to determine the value of inductance with which this condenser will be combined. This may be obtained in exactly the same manner as the determination for the tuning inductance, by assuming a reasonable value of minimum circuit capacity at 1675×10^3 cycles. However, the value of this inductor has been fairly well standardized as 144×10^{-6} henries. Therefore, working from equation (3), we find the circuit capacity at minimum to be 62.7×10^{-12} farads. It is safe to assume a minimum condenser capacity slightly higher than the minimum of the tuning condenser. As a matter of fact, the engineer working on condensers will have a good idea of what the minimum should be, in consideration of the frame and other factors.

(*Continued on page* 165)

Oscillator Condenser Design

(Continued from page 164)

In the case under discussion a minimum of 18.4 mmfd. was accurately arrived at. The minimum capacity is subtracted from the total circuit capacity at the highest frequency, the result being the distributed capacity of the circuit which will be a constant. This in turn is subtracted from the total circuit capacity, at say every five or ten dial degrees, the result being the required capacity of the oscillator condenser at that point. The curve of the oscillator condenser may then be plotted as shown in Figure 5.

The entire process is shown in Figure 6, which is an accurate check, every 20 degrees, on the overall calculations of an oscillator tracking condenser actually designed.

It now remains to design a condenser plate which will provide the capacity curve of Figure 5.

There are several possible ways of going about this. In any case the following equations will be helpful:

$$C_\theta = \frac{nkA_\theta}{d} - \frac{nkr^2\theta}{2d} \qquad (4)$$

$$A_\theta = \frac{C_\theta d}{nk} + \frac{r^2\theta}{2} \qquad (5)$$

and

$$a_\theta = \frac{C_\theta d}{nk} = A_\theta - \frac{r^2\theta}{2} \qquad (6)$$

θ = the angle of rotation.

A_θ = the area of the plate θ, without cut-out; *i.e.*, with an axis of infinitely small diameter.

C_θ = the capacity at θ.

a_θ = the active area of the plate.

k = .0885—the constant for an air condenser.

n = the number of dielectric spaces.

r = the radius of the cut-out.

d = thickness of the dielectric space.

Dimensions are in centimeters and centimeters squared, and the angle is in radians. The capacity is in micromicrofarads and refers to the "lateral" capacity of the condenser—the indicated capacity less the minimum capacity.

Perhaps the simplest method is to "build up" the plate graphically in five-degree steps. Compute the required area for the first five-degree sector and the areas required for each additional five degrees. A continuous curve joining the centers of the sector circumferences (Figure 7) will provide a very close approximation of the required plate. The vector radii for every five degrees may also be obtained mathematically from the average radius. Knowing the required area for any angle of rotation, each vector radius, as it is added, must be such that the average of all the vector radii is the radius that would give the required area if the sector was a portion of a circle of that radius. The required vector radius may be computed from the following equation:

$$R_n = nR_a - R_1 - R_2 - R_3 - R_4 \ldots\ldots - R_{n-1} \qquad (7)$$

R_n is the required vector radius.

R_1, R_2, etc., are vector radii that have been drawn before, measured at every five degrees (or smaller if desired.)

R_a is the average radius, or the radius of a circle the same angular sector of which would provide the desired area.

n is the number of vector radii including the one to be drawn.

R_a may be readily calculated from—

$$R_a = \sqrt{\frac{2A}{\theta}}$$

where A is the area required and θ is in radians.

The average radius may also be secured, without computing the areas, by simply comparing the required capacity of the oscillator condenser at θ with the capacity of the tuning condenser at the same degree of rotation. The capacity of the condenser at any angle is equal to the capacity of a condenser made up of the same number of semi-circular plates having a radius equal to the average of the vector radii.

$$C_1 = \frac{n_1kR_1^2\theta}{2d} - \frac{n_1kr^2\theta}{2d} \qquad (8)$$

$$C_2 = \frac{n_2kR_2^2\theta}{2d} - \frac{n_2kr^2\theta}{2d} \qquad (9)$$

Dividing (8) by (9) and simplifying—

$$R_2 = \sqrt{\frac{C_2n_1R_1^2 + C_1n_2r^2 - C_2n_1r^2}{C_1n_2}} \qquad (10)$$

The following values may be conveniently assigned:

R_2 = the required average radius of the oscillator condenser at θ.

R_1 = the average radius of the tuning condenser at θ.

C_2 = the capacity of the oscillator condenser at θ.

C_1 = the capacity of the tuning condenser at θ.

n_1 = the number of dielectric spaces in the tuning condenser.

n_2 = the number of dielectric spaces in the oscillator condenser.

r = the cut-out radius which we assume is the same for both condensers. (This need not be the case, of course.)

d = Width of the dielectric space—also conveniently assumed the same for both condensers.

The value of r_1 may of course be secured by reversing equations (7)—

$$r_1 = R_a = \frac{R_1 + R_2 + R_3 + R_4 \ldots\ldots + R_n}{n} \qquad (11)$$

An interesting and possible method of obtaining the vector radius, directly at any angle, combines graphical and mathematical processes. The area under any polar curve may be expressed as—

$$A = \tfrac{1}{2}\int r^2 d\theta \qquad (12)$$

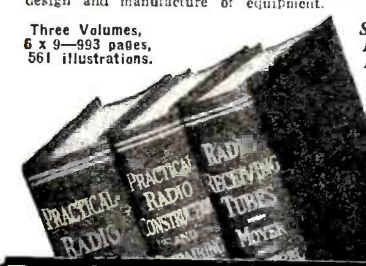
Differentiating—

$$\frac{dA}{d\theta} = \frac{r^2}{2}$$

and

$$r = \sqrt{\tfrac{1}{2}\frac{dA}{d\theta}} \qquad (13)$$

(Continued on page 172)



Super Broadcasting on Long Waves

(*Continued from page* 121)

be one that will fit into the national coverage chain to follow. During much of the first stage, however, this station will have to operate at a loss, considering total listener satisfaction against expense; and it might be preferable from an economic viewpoint to operate a temporary 100-200 kw. transmitter from an eastern point, such as Schenectady or Pittsburgh, already equipped for high-power broadcasting research. Such a station should supply fair space-ray service as far as the west coast on good nights.

The launching of such a station on the air would of course be attended by widespread publicity. To preserve stability in the receiver industry, and to maintain the whole fabric of radio broadcasting at its present high standard of excellence, it must be made clear to the public that the existing broadcast facilities will not be disturbed in any way by the new system. A new service is being provided without taking anything away from the old.

Several thousand experimenters scattered over the country, who now possess either long-wave receivers or the requisite knowledge and materials for building them at short notice, would begin to listen to the new signals. Even at long range some advantages of the new system should be apparent, chiefly in slower fading and less of it. Within three or four hundred miles of the station, where existing service is being markedly improved, there should be some demand for custom built adapters, particularly where they can be added without destroying the attractive appearance of the original set. Even at the 400-mile limit of non-fading service, the signal from a 100 kw. 200 kc. transmitter should be around one millivolt per meter. This is ten times as strong as what most rural listeners consider "good broadcasting service," according to a paper by C. M. Jansky, Jr., in the October, 1928, issue of the proceedings of the Institute of Radio Engineers.

Another advantage of the long waves should be mentioned at this point. It is well known that while a broadcast transmitter signal falls off rapidly near the station, the amplitude curve flattens out so that there is little difference in signal strength between a point one or two hundred miles distant and a point several hundred miles distant. On present waves, as shown in Figure 1, the fading radius is so short that this low attenuation region, represented by the flat part of the curve, is not useful, and high attenuation from transmitter to limit of service area is the rule. On long waves, however, the signal of a high-power transmitter, after dropping off sharply for a hundred miles or so, should remain fairly constant throughout the rest of its enormous service area.

Designing and building tuners and adapters for listeners within the true service area of the first long-wave station should be a simple matter. Selectivity and sensitivity requirements will not be nearly as rigorous as those which govern broadcast receiver design at present. Great numbers of people will be able to pick up programs with a simple crystal detector, or a single tube, used in conjunction with a single tuned circuit. If a regenerative detector is used, it should be preceded by an amplifier tube to block occasional oscillations from the antenna.

Probably the most universally popular long-wave tuner during the first stage would be the circuit used in most short-wave sets. An untuned tetrode is excited from a resistance directly in the antenna circuit; and its output, excluded from the plate lead by a radio-frequency choke coil, is fed by means of a coupling condenser to the grid of a triode detector. The detector grid circuit is tuned, and its plate circuit includes a fixed tickler coil which makes it regenerative. Regeneration is controlled by a variable condenser or a variable resistance. This type of tuner, illustrated in Figure 2, should do not only for listeners in the service area, but for distant experimenters as well. Since the latter have only a space-ray signal available, more complicated and expensive tuner arrangements are scarcely justified during the first stage.

Meanwhile the long-wave transmitting engineers should constantly use the 100 kw. transmitter and its service area as an open-air laboratory. Mobile field strength measurement sets must scurry around the country until the area is completely mapped in terms of the normal signal found in each receiving locality. Fixed observing stations at selected locations must keep a continual record of signal strength and its day-to-day and hour-to-hour variations, as well as the more rapid changes which, if exaggerated, are noticed by the listener as fading.

Outside the service area of the first station, in other parts of the country, transmission tests should go forward with low-power portable stations. These should be set up at various locations and in various districts. If experimenters are kept informed of these tests, they may be of some help. Thus when the time comes to extend the long-wave chain to medium-power national coverage, the best station locations will be available.

In his next and last article of this series Lieutenant Wenstrom will go further into the matter of long-wave broadcast receiver design. He will also discuss the cost of transmission equipment as compared with the cost of present-day broadcast transmitters providing equal coverage; and will demonstrate that better coverage with less cost is entirely possible under his proposed plan.—THE EDITORS.

Photo-Cell Amplifier

(*Continued from page* 149)

of light through a hole the size of a No. 60 drill. The circuit is extremely simple and is very stable in operation. When used without a shield, hand capacity of the cell interferes with the proper working of the device.

C. BRADNER BROWN,
Lawrence, Kansas.

Bringing In Pictures

(Continued from page 127)

A drifting of the picture to the left, with the picture finally fading out of sight to the left (the picture leaning more and more to the right), indicates that the speed of the scanning belt is too slow, a condition that must be corrected by speeding up the scanning belt by adjusting the rheostat R4 of the televisor in a clockwise direction to reduce the resistance in the motor circuit.

A drifting of the picture to the right, with the picture finally fading out of sight to the right (the picture leaning more and more to the left), indicates that the speed of the scanning belt is too fast, a condition that must be corrected by turning the rheostat in a counterclockwise direction to increase the resistance in the motor circuit.

The directions of rotation of the rheostat mentioned above assumes the use of a standard rheostat whose resistance is decreased by clockwise and increased by counterclockwise direction of the adjusting knob.

If we consider clockwise rotation of the rheostat knob as turning to the right and counterclockwise rotation as turning to the left, it is interesting to note that a drift of the picture to the left is corrected by turning the rheostat knob to the right as though pulling the picture back, while drifting to the right is corrected by "pulling the picture back" by turning the rheostat to the left.

When the speed of the scanning belt is correct, the picture will remain in frame without drifting to the right or left.

In some cases, even when the picture remains stationary or practically so, the picture may appear distorted, leaning either to the left or the right. This type of distortion can be corrected by adjustment of rheostat R4 of the televisor.

If the picture is leaning to the right, give the rheostat a slight quick twist in a clockwise direction and immediately return it to its original synchronous speed adjustment. The slight adjustment will cause a slight drifting of the picture with the picture gradually becoming upright. If it does not assume the upright position, repeat the procedure.

If the picture is leaning to the left, give the rheostat a slight quick twist in a counterclockwise direction and immediately return it to its original position, repeating the operation if necessary until the picture remains upright and stationary in frame.

These adjustments should be made carefully to avoid going too far in the other direction, past the proper adjustment.

It will sometimes be found that the lower part of the subject appears at the top of the picture and the upper part of the subject appears at the bottom of the picture similar to the effect sometimes seen at the movies.

This type of transposed picture can be corrected by snapping the switch off and on quickly a few times until the picture appears correctly. In making this adjustment do not leave the switch off for more than a second or two at a time and do not touch the rheostat at all.

Snapping the switch off and on quickly a few times will cause a slight drifting of the picture until finally the picture will be exactly in frame.

If the picture appears with a vertical dividing line down the length of the picture, with the left and right sides of the picture transposed, a slight adjustment backward or forward of the magnet adjusting rod LR at the side of the cabinet will bring the picture exactly into frame.

If the picture appears upside down, remove the scanning belt from the pegs of the spider, turn the scanning belt inside out and replace it on the pegs of the spider again.

When a picture has been tuned in properly and distinctly, the lenses can be put into position and moved back and forth until the proper position is found for clear reproduction.

Indistinct pictures are usually due to improper location of the lenses or to the use of a weak signal.

A little practice at the controls of the short-wave receiver and the television unit will quickly enable anyone to tune in a picture. The operation of the receiver and televisor is actually simpler than it would seem from the length to which it is necessary to go to describe the proper tuning procedure.

The operation of this outfit will provide many thrills for the owner and his friends, for it becomes the center of attraction at any gathering. For those who "get a kick" out of having something that the average man knows nothing about television furnishes a brand-new thrill.

Radio Amanuensis

(Continued from page 151)

the next character to be sent.

The success of the Watsongraph lies in the perfect synchronization of two disc motors or other mechanisms at the transmitting and receiving ends. These revolving discs contain the letters of the alphabet along their edge.

The Watsongraph can be used to great advantage on police cars as the messages can be sent in utmost secrecy without using a code. This is done by changing the order of the letters on both the receiving and sending set. Then, supposing someone did tune in on the same wave length, which now can be done, they would, of course, receive a number of different characters or letters but they would be unintelligible to them. If the sending officer hits the letter "A" the receiving set would of course get the letter "A," but the person tuned in on the same wave length would get an altogether different letter such as "S," etc., which letters put together would not mean a thing. This same operation can easily be applied to aeroplanes as well as ships at sea. Written and oral messages could be sent and received without mistakes and confusion as no dependence would be put upon the ear.

A Set Tester You Can Make

(*Continued from page 119*)

finances permit, by substituting accurate resistors for the makeshift ones.

The features discussed so far do not necessarily point to this as an outstanding set tester. Others have been manufactured, or have been described, which will provide a variety of tests, will function as multi-range meters and as continuity testers. Perhaps the outstanding feature of this particular one is the simplicity and speed with which set tests can be made. Once the cable plug has been inserted in a receiver tube socket and the corresponding tube inserted in the proper socket on the tester, all measurements—filament, grid, screen-grid and plate—are made in quick succession.

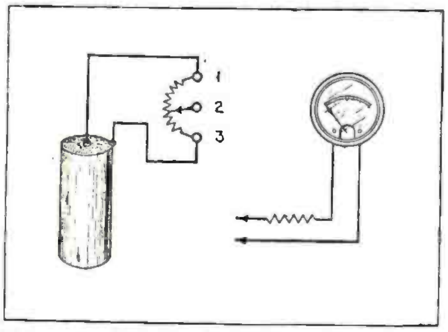


Figure 4. Using a flashlight cell and potentiometer to check values of multiplier resistors, as explained in text

The simplicity is obtained through the use of two multiple switches, S1 and S2. S1 is a nine-position switch, which is the equivalent of a double-pole, nine-throw switch, and S2 the equivalent of a single-pole, nine-throw switch. S1 is used to select the type of measurement to be made, as follows: Point 1, plate volts; point 2, screen-grid volts; point 3, "C" bias volts; point 4, "C" bias volts (screen-grid tubes); point 5, plate current; point 6, d.c. filament volts; point 7, screen-grid current; point 8, to use tester as external voltmeter; point 9, to use tester as external milliammeter.

The switch S2 is employed to select the meter range desired for the particular measurement to be made. Set on point one, the meter M1 covers a range of 0-10 milliamperes and 0-1 volts, as shown in the chart, Figure 1. Point 2 provides ranges of 0-30 ma. and 0-3 volts and so on up to point 9, as shown on the chart.

Thus it is seen that the complete testing of a receiver involves only the manipulation of these two switches. The other small switches are provided for special purposes. For filament emission tests of all but screen-grid tubes the switch S3 is thrown to the "Grid" side. This breaks the grid circuit and connects the grid of the tube under test direct to filament, the resulting increase in plate current giving the indication of the emission. The same test for screen-grid tubes is accomplished by inserting the lead from the control grid in jack J2 instead of in J3, which is its normal position.

The switch S7 permits the a.c. voltmeter to be cut out of the circuit when not wanted. S5 is thrown to the left when using the tester as a universal, external meter, and to the right to employ it as a continuity tester. S6 is included to permit reversing polarity of the meter. Switch S8 serves as a protection against applying high currents or voltages to the meter when it is set for low values. Thus when the switch S2 is set for the lower ranges it is necessary to push the button of S8 to obtain readings. If this precaution were not taken it would be necessary to set the contact of S2 on the dead point before adjusting S1, in order to avoid burning out the meter.

All current readings in receiver circuits are obtained by measuring the voltage drop across 100-ohm resistors in these circuits, as at R9, R10 and R11 in Figure 2. For each volt drop across these resistors there is a current flow of 10 ma. through the resistance. Actually, when the switch S2 is set on point, the 1000-ohm resistor R1 is shunted across the 100-ohm resistor, with the result that for 10 ma. per volt drop across the latter there is approximately 1 ma. flowing through R1, or a total of 11 ma. The meter reading of current is therefore approximately 10% low on this one scale. Currents read with S2 set on point 2 have a factor of error of 3%, on point 3 the error is 2% and on point 4 approximately 1%. The switch S4 is to short circuit the resistor R11 except when screen-grid current measurements are being made.

The socket VT1 is for the cable plug connecting, by means of a plug at the other end, to the tube socket in the receiver. VT2 and VT3 are to accommodate the tubes under test, the former for

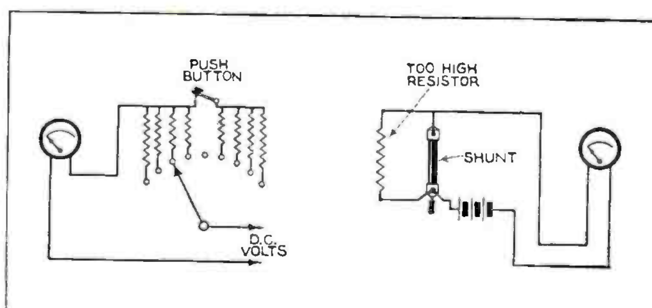


Figure 5. Simple schematic illustration of the meter and multiplier circuit used in the tester. (Right) A simple method of regulating resistance of a fixed resistor by shunting it with a variable grid-leak

(*Continued on page 172*)

How to Measure Modulation Percentage

(*Continued from page 138*)

This increase in power taking place when modulation occurs will be made manifest by an increase in the effective value of the radio-frequency current output, and this increased effective value is given by the relation—

$$I^1 = I\sqrt{1 + \frac{M^2}{20,000}}$$

where I^1 is the value to which the output current will increase from its modulated value of I when the modulation is M per cent. Thus for 100 per cent. modulation the antenna current of a broadcast station would increase by the factor $\sqrt{1.5}$ or 22½ per cent.; and for 50 per cent. modulation it would increase by the factor $\sqrt{1.125}$ or 6 per cent.

The relations for side-band power and percentage increase in current are given in Figure 2 in graphical form, and enable one to estimate the degree of modulation from the observed increase in output radio-frequency current when modulation occurs; and from this to estimate the amount of power in the side-bands.

Unfortunately, certain operating conditions do not make this method of measuring modulation particularly accurate; and a system employing an indicating meter calibrated to read percentage modulation directly is much to be preferred. If we insert a d.c. milliammeter in the plate lead of the modulated oscillator or amplifier as shown in Figure 3, the meter will read the average value of the current supplied to the tube. This current contains as a component the modulating current which supplies the side-band energy; and on inserting an audio-frequency transformer in series with the d.c. meter, audio-frequency voltages will be induced in its secondary proportional to the magnitude of the audio-frequency modulation. We may now connect a thermo-couple type of meter to the secondary to serve as an indicating instrument.

To design the system for accurate and convenient calibration requires the consideration of a few simple principles. First of all, the winding of the transformer which is placed in the plate lead of the tube must carry the average plate current without heating, and its insulation must be sufficient to withstand the surges occurring in the circuit. Second, the meter should be chosen to indicate percentage modulation directly, and for this purpose a one-ampere meter of the thermo-couple type is preferable. Third, the transformer must be designed to operate below the saturation point of the iron, and to have a reasonably good frequency characteristic, especially at low frequencies where deepest modulation is encountered. Fourth, it should have the proper turns ratio to make the 1-ampere meter read percentage modulation directly. The choice of turns ratio is not difficult, as will be demonstrated. Let us suppose that our radio-frequency tube draws 200 milliamperes. For 100 per cent. modulation the peak value of the audio-frequency current component will be 200 milliamperes also, and the root-mean-square value will be 200 × 0.707 = 141.4 milliamperes. Now for this condition the modulation meter should read 100 per cent.; *i.e.*, 1 ampere, or 1000 milliamperes. The turns ratio, therefore, must be 1000:141.4 or 7.07:1.

A very satisfactory transformer for the amateur to use for this purpose is a Jefferson toy transformer. If the 115-volt winding is connected in the plate circuit of the radio-frequency tube, the modulation meter should be connected to the low-voltage side at a tap determined by the average plate current drawn by the radio-frequency tube. For the 200 milliampere tube we would divide 7.07 into 115 to obtain 16.3 as the proper voltage tap to use. The error will be small if the tap on either side of the theoretically correct value is used. For other values of plate current the voltage tap will be in proportion; thus for 100 milliamperes we should use 8.1 volts, and for 50 milliamperes, 4 volts approximately. The va-

(*Continued on page 176*)

In the Day's Work

(*Continued from page 143*)

"The most difficult part of installing a receiver for use in cars is finding space for it. This is true of Ford new models, more so than other makes, because the new Ford has the gasoline tank mounted under the dash—which eliminates the usual space for the car radio.

"However, space may be made in the 'engine room,' so to speak.

"The brackets for mounting the set were made as shown in Fig. 3. These were made of ⅛" strap iron. The size of the brackets depends on the height and depth of the particular radio installed. Allowance, of course, is made for the soft rubber or felt material used between the set and brackets; this material is used to absorb shock and vibration. A soft rubber pad is used under the head of the ¼" bolt which holds the receiver to the bracket; this bolt threads into a nut that is soldered to the angle brass frame of the set case."

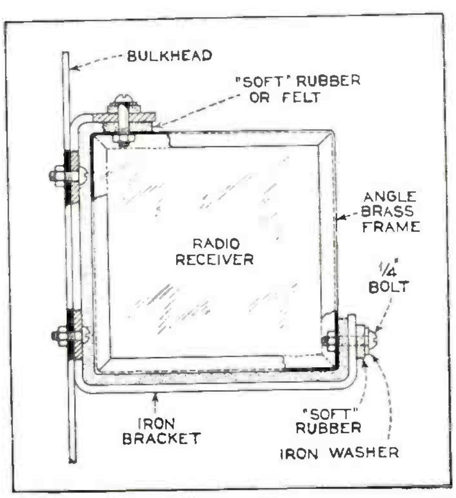


Figure 3

The Junior Transmitter Grows Up

(*Continued from page 131*)

amplifiers, passing on and amplifying the frequency fed into them."

"There is one thing that is very essential in this type of transmitter, and that is an absolutely pure d.c. grid and plate supply for the oscillator stage. I would say very definitely that you should use "B" batteries for this stage. You could use batteries all the way through the buffer and intermediate stages unless you object to the expense, but remember that the tubes are receiving tubes and the current drain therefore is low. Temporarily you can use your present supply to handle the whole set, except the oscillator, which can be fed from the receiver "B" supply, but if you want any sock from the outfit, you'll need another small supply with an –80 rectifier delivering about 400 volts of "B" and "C." More on this next month."

(*Here, if the reader will permit, we are going to cut the dialogue between Don and Gus for a few pages. It will be just a little easier and brief to explain just what Don did in building the transmitter described in this article. Don continues —without quotation marks.*)

The Layout

In designing this set an attempt was made to provide short leads wherever possible. The elements were arranged so that every unit came next in line to the one physically preceding it in the circuit. All parts except the dials and the filament voltmeter are mounted on the base so that the panel and cabinet can be readily disassembled to permit easy access to all parts, not to mention the fact that the original wiring is simpler and easier due to the accessibility and centralization of all the parts. Because all wiring passing through the sides of the shielding goes through notches in the bottom, the shields may be lifted out without disturbing anything, and some parts are made completely accessible by this operation. Total shielding of all stages prevents interaction between the stages and permits complete neutralization.

The layout given (Figure 2) holds true only for the parts specified in the list incorporated in this article. If other parts are used, the drilling plan will, of course, have to be altered accordingly. The set, as designed, measures 7 inches high, 25 inches long and 11 inches deep. Rather compact for a four-stage job, yet there is plenty of room for all parts, leads are short, the longest leads in the set being those running from the binding posts to the plate milliammeter jacks and then to the chokes. As these leads are well bypassed, their length is of little importance.

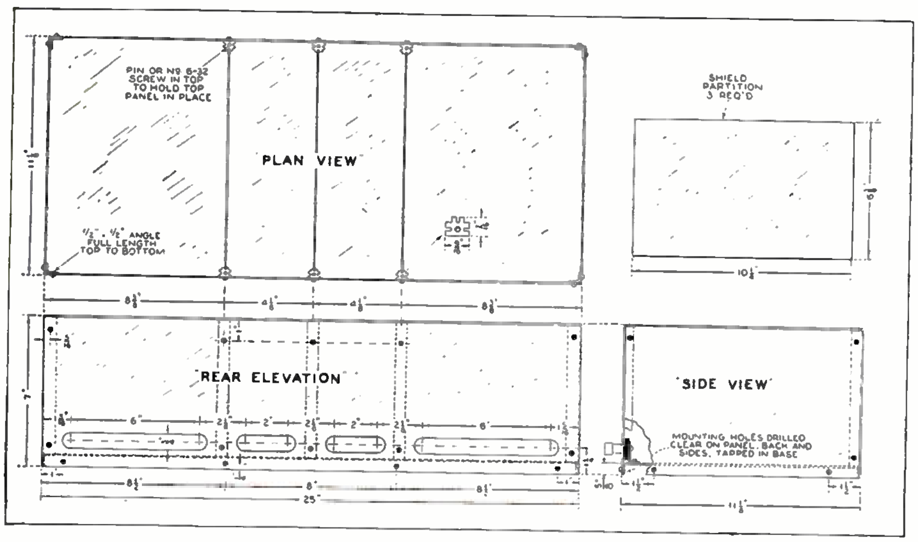


Figure 4. The cabinet and partitions can be made from these plans

The Cabinet

The cabinet (Figure 4) is made of aluminum, bolted together. The base, as can be seen from the drawings, is made by bending half-inch sides from a flat piece of stock. If you make your own cabinet and fear the difficulty of bending squarely, try using three-eighths-inch angle and make the base plate of one-eighth aluminum. This will preserve the one-half-inch height and the panel layout will not be changed. It is essential that the base be exactly one-half inch high over all. Otherwise you must alter the panel layout to suit. If you make the cabinet as shown, all parts may be made of either 14- or 16-gauge aluminum. I found 16-gauge strong and stiff enough, although my panel is made of 14-gauge.

The sides and back are fastened together by means of ½" x ½" aluminum angle with a 1/16th inch web. This thickness is sufficient to hold a thread. Do not use the channeled corner pieces sold for cabinets or you will not be able to take the sides off as readily and the set will be larger, because of the clearance of the tuning condensers from the sides. The shield (partition) strips are of slotted T-shape, fastened to the panel and back but

(*Continued on page 171*)

Send a Record!

(*Continued from page 123*)

shielded. With the exception of the vacuum tubes, the amplifier is mounted out of sight in the lower portion of the cabinet.

The Vocamat utilizes smooth metal discs for records. Although these are giving excellent satisfaction and can be played back as many as 1000 times, the inventors have been experimenting with a new type of record, *coated* with metal, instead of being made entirely of metal.

The cutting or record head is equipped with a diamond stylus capable of making recordings indefinitely. Under the action of the energy from amplifier, the stylus displaces the material on the disc to form a groove at the same time that it produces lateral modulation corresponding to the sound waves impinging on the microphone diaphragm. The illustration shows the cutting head in position on the record. The centering pin is also shown. The metal cylinder at the rear is the record magazine. This has a capacity of 300 records. When the machine runs out of records, the coin slot is locked automatically and the relay is thrown to a position so that it cannot be operated, thus completely shutting off the power until the record magazine is reloaded.

In the lower part of the machinery cabinet, beneath the turntable, there is a fractional horsepower synchronous motor. Other apparatus concealed within this cabinet include a main relay, an auxiliary contact for shutting off the motor and a similar contact for turning on the microphone, gear mechanism, cams, amplifier components and a fuse block fused for 3 amperes. The fuse is connected in the main power line, thus effectually protecting all the equipment from damage due to overloads or short circuits.

The booth is constructed of laminated wood and is equipped with a double-walled door, 1½ inch thick. The booth has a rock-wool lining to make it soundproof. It is 30 inches wide by 30 inches deep by 7 feet high. The machinery cabinet is approximately 24 inches by 30 inches by 30 inches high.

The first Vocamat to be completed was placed in a store on Broadway, New York City, in the theatrical district, for a trial period of three weeks. No effort was made to "sell" the idea to the public, and the machine was displayed without ballyhoo or showmanship. In spite of this fact the machine averaged 150 records a day and in one instance turned out 365 records in fourteen consecutive hours.

The present demand for the machine indicates that it will soon be available in hotels, amusement resorts, motion picture theatre lobbies, railroad stations, public beaches and large office buildings. Aside from its entertainment features, the machine has many important commercial possibilities. Salesmen can utilize it to convey important sales messages to prospects who cannot be reached by other means. Radio performers can employ these records to practice their continuity and inflection. These are only a few of the applications which suggest themselves. In the field of education, and especially in the instruction of music and languages, the machine should find wide use.

The Junior Transmitter Grows Up

(*Continued from page 170*)

not to the base. The top of each T-strip has a tapped hole in it to facilitate lining up the top. In each hole is placed a 6/32 headless screw or a screw that has had the head sawed off and been slotted. These studs line up with holes in the top to keep the top in place. Holes are drilled through the sides of the cabinet and the base, the holes in the base being tapped and those in the sides clearance for 6/32 screws. It is best to clamp the sides and base together, drill through both with a No. 33 drill, tap the base and ream out the side piece with a No. 27 drill to afford clearance for the screw. Round-head nickel-plated screws ¼" long are used here. Attach the panel first. Fasten both sides to the panel with the angle strips mentioned before and then secure the sides to the base. Fasten the back to the base first, lining up the binding post slots so that equal clearance is obtained all around the posts and, last of all, fasten the sides to the back with angles.

In laying out the base, I would suggest actual layout of all dimensions, rather than trying to work from a template. Center punch all holes and check your layout. As there are three sizes of holes to be drilled, I find that putting a tiny prick mark with the center punch alongside all holes to be tapped, and two marks alongside the large holes, help prevent mistakes. You will notice on the drawings that holes to be tapped are marked with a solid dot, clearance holes for 6/32 screws with a small circle, and the larger holes for 8/32 and lead holes for wires insulated with spaghetti are marked with semi-shaded circles. After the base is laid out, drill all the holes at once, first the No. 33, then the No. 27 and then the No. 19. In this way, if you make a mistake, you can always drill the hole out larger.

Check each group of holes after they are drilled. You will find that a drop of light oil on each center punch mark will help your drilling speed considerably. After all holes are drilled, put your tap into the chuck of the drill, oil the holes and tap them out. This is much faster than using a tap wrench, and the stock is so thin that there is little or no strain on the tap. Do not lay out the panel until you have mounted the condensers on the base so that you can be sure the holes will match. You may be an expert mechanic, but it is less work to play safe.

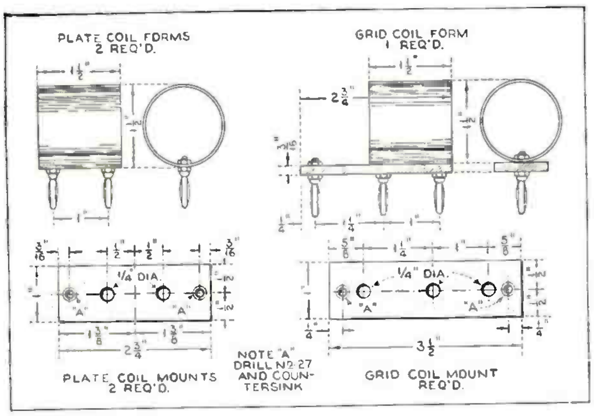
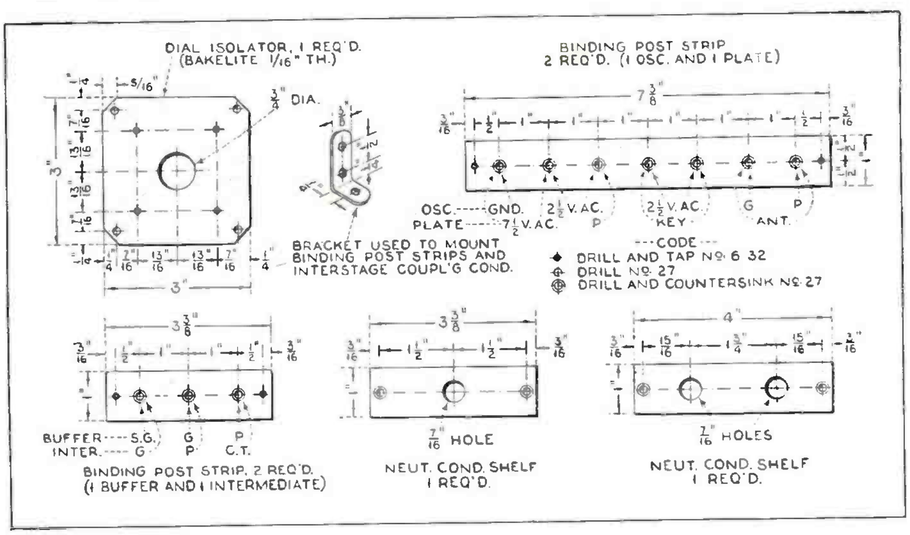


Figure 5-A (left); Figure 5-B (below). The details of binding post strip assemblies, coil mountings and other miscellaneous fabricated parts



Make the bakelite mounting strips for the coils, jacks and neutralizing condensers as shown in Figure 5. Don't drill the holes for the jacks until you have mounted the panel and then locate them by scribing through the panel holes. This assures the jacks being centered properly. When tapping holes in the bakelite strips, you will find it much easier and quicker to fasten your hand drill in the vise with the tap in it, feeding the bakelite with one hand and turning the drill with the other,

(*Continued on page 173*)

Set Tester

(*Continued from page* 168)

five-prong tubes and the latter for four. An adapter is provided for the receiver end of the cable, to permit its use with either four- or five-prong sockets, as shown in Figure 3. Note the separate terminals provided for control grid connections of screen-grid tubes.

To use the tester as an external meter the jacks J6, J7 and J8 are provided. External currents to be measured are connected to J7 and J8 by means of phone tip connections, and S2 is set for the particular meter range desired. For voltage measurements the external voltages are connected across J6 and J7. As the diagram indicates, the switch S1 is set on point nine for external current measurements and on point eight for external voltages. The jacks J4 and J5 provide external connections to the a.c. meter. J9 and J10 are for continuity tests.

There is little need for going into constructional details. The size of the unit and the placement of parts are matters of individual choice. The model shown here was built to the size shown simply because the case of an old portable typewriter was available. The panel was therefore cut to fit the case.

The List of Parts

J1 to J10—Insulated tip jacks.
M1—Jewell d.c. milliammeter, range 0-1 ma., type 88.
M2—Jewell a.c. voltmeter, range 0-10 volts, type 78.
R1—1000-ohm resistor.
R2—3000-ohm resistor.
R3—5000-ohm resistor.
R4—10,000-ohm resistor.
R5—50,000-ohm resistor.
R6—250,000-ohm resistor.
R7—500,000-ohm resistor.
R8—1-megohm resistor.
(R1–R8: Shallcross Super Akra-Ohm (accurate ± 1%))
R9, R10, R11—Electrad type B-1, 100-ohm resistors (25-watt).
S1—Best Mfg. Co.'s 9-tap, non-shorting bi-polar switch.
S2—Weston 9-tap inductance switch.
S3, S5—Toggle switches, s.p.d.t.
S4, S7—Toggle switches, s.p.s.t.
S6—Toggle switch, d.p.d.t.
S8—Push-button type switch.
VT1, VT2—Five-prong tube sockets.
VT3—Four-prong tube socket.
2 Blan test prods (1 pair required).
Cable plugs, 5 prong, spool type.
Tube adapter, 5-4 type.
General Fabricating Co. "Textolite" panel.

Oscillator Condenser Design

(*Continued from page* 165)

Plotting area in square centimeters against θ, and choosing co-ordinates that permit the most accurate observations, the derivative, $dA/d\theta$, is readily obtained from any value of θ by simple inspection.

In designing the plate graphically, it is desirable to quadruple all linear dimensions, remembering that the area is thus multiplied by sixteen, and the design should be frequently checked, with a planimeter, as the plate is built up.

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An All-Wave Super

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kc. so that the unwanted signal which could be heterodyned at this same oscillator setting would appear at 11.300 kc., which represents a 13 per cent. frequency difference—a difference great enough to permit of adequate image frequency selectivity being obtained with a single tuned circuit preceding the first detector.

It is obviously not practical to build a superheterodyne receiver for both short and broadcast wavelengths with two different intermediate-frequency amplifiers, for the equipment cost would be very considerable. This problem has been nicely solved in the 726SW by designing the main i.f. frequency amplifier for 175 kc., this being preceded by the oscillator, first detector, and r.f. tube for broadcast band reception. As soon, however, as the receiver is shifted over to operation in the range of 10 to 200 meters, a scheme popularly known as "double suping" is resorted to—the use of two intermediate frequencies with two oscillators, one fixed and one variable.

Specifically, the broadcast tuning dial is set to some clear channel in the neighborhood of 650 kc.—it may actually be anywhere between 600 and 700 kc. and this done, the broadcast band r.f. amplifier tube and first detector together with their tuned circuits comprise the first level of intermediate-frequency amplification, which takes place obviously at the setting of the broadcast dial or at 650 kc. approximately. A short-wave first detector is then placed ahead of the r.f. amplifier tube which has now become an i.f. amplifier tube, and to this tube is coupled a short-wave oscillator which is arranged to track away from the short-wave first detector by approximately 650 kc. in order to produce the first intermediate frequency. At first glance, it may be a little hard to grasp the exact operation of this arrangement but a little consideration will make it perfectly clear. The only serious problem which comes up in such an arrangement other than the usual problems of coil arrangement, etc., is the possibility of harmonics of what we may term the first intermediate-frequency level oscillator (actually the broadcast band oscillator of the set) reacting upon the short-wave oscillator. By dint of careful shielding and isolation of the two oscillator circuits in the receiver design, this problem has been practically completely eliminated with the result that in normal operation there will be no noticeable "tweets" or squeals. For the sake of clear understanding, this entire arrangement may be likened to the combination of a short-wave superheterodyne adapter with a broadcast band superheterodyne receiver, and this is actually what it is.

The short-wave portion of the receiver, then, consists of first detector and oscillator circuits, a -24 first detector being employed and a -27 oscillator. The antenna is capacitively coupled through the small screw type trimming condensers Ca seen just in front of the -24 first detector (extreme front center tube) in Figure 2. It is contemplated that this

(Continued on page 174)

Junior Transmitter

(Continued from page 171)

rather than clamping each strip in the vise.

You can buy a sheet of bakelite and cut it into one-inch strips, but I found it simpler to buy some strips of one-inch-wide scrap. Scraps of 1/8" and 3/8" bakelite are often obtainable also. Incidentally, nine strips of the one-inch bakelite about eight or nine inches long were sufficient for all I needed, including the 80-meter band coil mounts.

As far as insulating is concerned, it may prove necessary to further insulate the plate condensers of the final stage and its dial when we start modulating for phone, but that can easily be taken care of without changing the basic design in the slightest. We'll cross that bridge when we come to it.

List of Parts

C1—1000 mmfd. National variable receiver condenser, type No. EM-1000.
C2, C3, C4—250 mmfd. National variable receiver condensers, type No. EM-250.
C5—350 mmfd. National variable transmitter condenser, type No. TM-350.
C6, C7, C8, C9, C10, C14, C16, C17, C18, C19, C20, C21, C22, C23—.002 mfd. Flechtheim midget receiver condensers.
C11, C12, C13—50 mmfd. National type ST-50 midget variable condensers.
C15—.00025 mfd. Flechtheim midget receiver condenser.
J1, J2, J3, J4—BMS single closed-circuit fantail jacks.
L1, L2, L3, L4, L5, L6, L7, L8—Coils (see text).
MA1—0-50 Jewell type 88 milliammeter.
MA2—0-200 Jewell type 88 milliammeter.
P1, P2—Bakelite insulated phone plugs.
R1, R2—General Radio type No. 437 center-tapped filament resistors. 60 ohms.
R3—10.000-ohm S. S. White grid leak resistor (1 watt, clip-on type).
RFC—9 R. E. L. type 132 r.f. chokes.
VM—0-15 Jewell type 78 a.c. voltmeter.
V1, V3, V4, V5—General Radio type 349 sockets.
V2—General Radio type 348 socket.
1 special aluminum cabinet, 7" x 25" x 11". (See illustrations.)
5 National velvet vernier dials, type VAC-C4.
20 General Radio type 1384 binding posts.
9 strips bakelite. 1" x 8". (See text.)
12 3/4" x 1/2" brass angles.
1 gross 6/32 x 1/4" R.H. nickel-plated screws.
2 dozen 6/32 x 1/2" R.H. machine screws.
1 dozen 6/32 x 3/4" R.H. machine screws.
1 dozen 6/32 x 3" flat-head machine screws.
1 box solder lugs.
1/2 pound No. 18 enameled wire (for coils).
2 R.E.L. coil bases (receiver type).
2 R.E.L. coil forms (for each band).
1 foot 1" bakelite tubing.
1 foot 1 1/2" bakelite tubing.

Note: In the next article Don will continue the constructional description of his transmitter, including details of the coils and power supply.—THE EDITORS.

An All-Wave Super

(*Continued from page 173*)

condenser, being non-critical in operation, will be permanently adjusted when the receiver is first installed to adapt the particular antenna employed to best operation with the receiver. This condenser connects directly to the grid of the –24 first detector, the grid circuit itself consisting of one section of the midget gang condenser controlled by the left-hand dial of the receiver and shown as Cb in the diagram. This condenser tunes one coil at a time, which coil may be either La, Lb, Lc or Ld, depending upon the frequency range it is desired to tune the receiver through. With coil La in the circuit, the range is 9.4 to 19.94 meters, with coil Lb in the circuit 16.16 to 41.6 meters, with coil Lc 33.3 to 87.5 meters and with coil Ld 68.9 to 200 meters.

Thus it is seen that there is plenty of overlap between the bands with consequently no possibility of skipping over any used portion of the short-wave frequency spectrum due to failure of coils to overlap. The coils are selected by means of the four-position switch SWb, controlled by the upper left-hand knob in Figure 1. This same switch selects one of four oscillator coils, in proper order to work with the four first detector tuning coils. In each case the oscillator coil is wound upon the same tube as the first detector tuning coil and is spaced away from it by exactly the proper distance to insure the optimum value of oscillator coupling for best efficiency of frequency conversion. In the first detector circuit only the grid lead is shifted from coil to coil as different ranges are selected but in the oscillator circuit both the grid and plate leads are shifted. Since the tickler required for satisfactory operation over the entire range of 10 to 200 meters will vary considerably, separate ticklers must consequently be employed for each one of the short-wave ranges. For reasons of convenience, frequency stability, and power output, the short-wave oscillator employs a tuned plate circuit with the tickler connected in the grid circuit rather than in the plate circuit as is conventional in broadcast receiver design.

The entire group of short-wave coils with their switching mechanism is mounted in a single assembly with the switch in the center, and with the four coils placed about the periphery of the switch in such manner that leads to respective switch contacts are not only short and direct but permanent and of calculable value. The tuning condensers, as can be seen, are placed very close to these coils so that the leads to them and in turn to the tubes are as short as possible and very direct. This is quite important, since any variation in lead length in the 10-meter band, for instance, will seriously affect the tuning of the receiver and consequently its frequency range. The whole coil assembly is simple and rugged and the switch contacts positive. All coils are space-wound by machine, and represent unusually efficient short-wave coils.

This range selector switch itself only selects between the four available ranges falling between 10 and 200 meters, a second switch serving to shift from the range below 200 meters to the broadcast band. This switch is seen at the lower right of Figure 2, the assembly actually consisting of two switches marked as SWa in the diagram of Figure 4. The upper one of these switches shifts the antenna from the short-wave first detector to the broadcast band r.f. transformer primary, while the second section of this switch cuts off the screen voltage to the short-wave first detector and the plate voltage to the short-wave oscillator when in the broadcast band position.

Since it is impossible to make the short-wave first detector and oscillator circuits track with the same degree of accuracy as do the broadcast band circuits, a trimmer condenser, Cc, is provided for the short-wave first detector. This is visible as the front center knob in Figure 2 or the upper center knob in Figure 1.

The two tuning dials are identical in exterior appearance and in mechanical structure but differ considerably in ratio. The short-wave or left-hand dial has a much higher ratio than has the broadcast band dial in order to permit of easy and simple tuning in the short-wave ranges. Also, since it is required to cover four different ranges, it is calibrated in degrees from 0 to 100, whereas the broadcast band is calibrated directly in kilocycles for the range of 550 to 1500 kc.

In addition to the high ratio of the short-wave tuning dial, an additional vernier effect is obtained by means of the broadcast band dial, which it is assumed will be set on a clear channel somewhere between 600 and 700 kc. A slight adjustment of this dial in operation will give a very satisfactory and pleasing vernier effect when receiving short-wave stations. This can be understood by considering the frequency range covered respectively by the short-wave and broadcast band dials. On short waves, for instance, in the 10-meter band, the frequency range covered by the short-wave dial is approximately 15,000 kc. and whereas the whole frequency range covered by the broadcast band dial is only 1000 kc. or a little less than 7 per cent. of that covered by the short-wave dial.

The balance of the short-wave circuit presents nothing unusual and its details are made clear in the schematic diagram, Figure 4.

The overall size of the receiver chassis is 12" deep by 19½" long and, like all modern extremely sensitive and selective superheterodyne receivers, the chassis must be supported upon rubber cushions to prevent mechanical reaction from vibrations set up by the speaker, which may be housed in the same cabinet. This is provided for by flanges on the ends of the chassis under which rubber cushions may be placed when the receiver is installed in its cabinet. The overall height of the set is 9 inches. The front panel is of walnut-finished steel to harmonize with customary console cabinet designs. The entire receiver may be installed in a

(*Continued on page 175*)

The Serviceman Merchandises Tone Control

(*Continued from page 143*)

because much of the intermediate and high tones have been absorbed by the condenser itself).

Practically every set that has a power tube will benefit by the addition of tone control. Those without power tubes do not have sufficient audio response to justify the installation. The power tubes referred to may be the -12 and -71 types used mostly in battery sets, or the -45 and -50 types universal in a.c. receivers.

The recommended circuits are shown in Figures 1 and 2 and are the same whether adapters are slipped under the tubes or whether the tone control is wired to the sockets or audio transformer. The arrangement in Figure 1 is to be preferred.

Midget set manufacturers in general seem to have neglected the tone control feature in their mad dash to supply something at a low list price. Here is an opportunity for the aggressive serviceman to jump in and add tone control to these sets, either before or after they are sold. The neat little panel mounting clarostat graphotones, which are entirely enclosed in bakelite, mount through one 3/8-inch hole and there are only two wires to run to an audio transformer secondary or to tube sockets direct.

Those last season receivers which the dealer still has on hand may be improved by adding this feature which is helping to sell radio this year. Why not make a profit out of a lot of those free service calls and minor complaints? In some cases a portable unit such as the clarostat tone control will be preferred so that the control itself may be located at a distance from the set or because no tools are required for the installation. However, when convenient, it is preferable to use the panel type as it is permanently wired and places all knobs on one panel. The double set of nuts and long bushing on clarostat graphotones compensate any thickness of panel.

There is an excellent opportunity for the serviceman as well as the radio merchandiser to handle the tone control as an accessory, either installing same as an integral part of the radio set by means of panel mounting or as a convenient accessory at the very finger tips of any listener. Check your records, get in touch with your old customers. They'll be glad to listen to your story of how you can improve their receivers at a nominal cost.

What's New in Radio

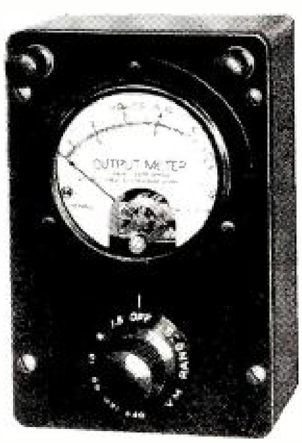
(*Continued from page 163*)

measures 27 inches by 35 inches and the depth is twenty-seven inches.

Maker—Racon Electric Co., Inc., 18 Washington Place, New York City.

Output Meter

Description—The Model 571 output meter is a portable instrument, especially adapted to checking radio receivers, sound projection equipment and other measurements of output voltages. It employs a 5-range copper oxide rectifier type volt-



meter with ranges of 1.5, 6, 15, 60 and 150 volts. This model has a non-inductive impedance of 4,000 ohms for all ranges. The instrument is enclosed in a bakelite case measuring 5½ inches by 3⅝ inches by 2⅛ inches.

Maker—Weston Electrical Instrument Corp., Newark, N. J.

An All-Wave Super

(*Continued from page 174*)

standard cabinet together with its loud speaker, and so installed may be placed in any home living room without a single sign of the laboratory or workshop effect usually associated with short-wave receivers of the past.

The same type of loud speaker is employed with the 726SW receiver as is employed with the previously described 726 model. It is a 10½" electro-dynamic type, carefully compensated to produce the substantially rectangular overall response curve previously referred to. Its 800-ohm field is employed in the filter circuit from which it obtains excitation at the same time that it contributes to the extremely low hum level of the set.

No provision has been made in the receiver for continuous-wave code reception, it being assumed that it will be used primarily for broadcast, amateur phone, or modulated cw. telegraph reception. Provision can be made, however, for continuous-wave code reception by the addition of a small oscillator operating slightly away from the second intermediate-frequency level—sufficiently far away only to produce the desired audio beat note. Data upon such an oscillator made up of a couple of small honeycomb coils and a compression type trimmer condenser together with -27 oscillator tube and operating directly from the receiver power supply are available. This small oscillator can be placed directly in the receiver cabinet, and is coupled to the second or, in the case of short-wave reception, the third detector, represented as tube S6 in Figure 4.

Television Receiver Kit

(*Continued from page* 111)

arranged so that they are in the best relative positions for close wiring. The theory of the straight line is the best one to follow in any wiring job. Many short wave broadcast and amateur enthusiasts operate with hay wire outfits but good television results cannot be expected with hay wire methods. A list of don'ts that every set builder should follow:

Don't make wires or leads longer than necessary.

When connecting leads to binding posts don't leave ends dangling over.

Don't leave great hunks of solder on leads.

Don't solder connections without first scraping the parts to be soldered.

Don't splice a broken lead; use a new one.

The above don'ts are an old story to the experienced amateur set builder and are followed closely by the best of them, but they cannot be repeated too often.

For the convenience of the builder all cathode wires have been made yellow, grid wires green, plate wires red, and all other wires black. First the complete filament is wired according to the diagram. When this is completed plug the audions in their proper sockets and connect the receiver to the electric lighting current. When the switch is turned on the audion filaments should light up showing that the wiring has been done properly. Next the grid circuit should be wired, followed by the plate and cathode circuits.

Let us now assume that the set is completely wired, audions in place and ready for operation. Attach antenna and ground and connect the loud speaker to the correct binding posts. Plug in the lead from the power pack to a convenient socket of your 110-volt lighting current, wait a moment for your tubes to light up. Turn the volume control half way and tune the receiver until a high buzzing noise is picked up in the loud speaker. Turn the volume control on more and the buzzing should become very loud. Everything is now in readiness to connect the radiovisor in place of the loud speaker.

Modulation Percentage

(*Continued from page* 169)

riation in accuracy of the Jefferson transformer over a frequency range from 200 to 1500 cycles is within three per cent., and the effect of saturation with plate currents from 50 to 250 milliamperes is very small.

The amateur will find this system a relatively inexpensive and satisfactory one to employ in his phone transmitter; and, having installed it, he will be interested to check the readings of the modulation meter against values obtained from the curve of Figure 2 as determined by observation of increase in radio-frequency output current. Any marked difference in the two values should lead to an investigation of the operating conditions obtaining in his radio-frequency circuits.

Backstage in Broadcasting

(*Continued from page* 162)

B. A. Rolfe

IF you are one of the privileged few who ever witnessed the production of B. A. Rolfe's thrice-weekly Lucky Strike Hour, you will realize that street parades are not the only occasions for musicians to play while standing up. Mr. Rolfe's elaborate musical organization of 75 men is the largest dance orchestra on the air, and two or more NBC studios are utilized for the presentation of each program. The colorful effects to his selections are obtained by having his musicians silently arise and take carefully rehearsed positions around the microphone. Thus, throughout each program, musicians, singly and in groups, rise and hasten to the microphone for their renditions. Despite the crowded condition of the studio, the musicians hop about with skilled precision. Specialty numbers by the South Sea Islanders and others are presented from studios other than the one housing the large orchestra.

WHEN Morton Downey shifted from a daily CBS period to the Camel Quarter Hour, network officials assigned the bright fifteen-minute sustaining program spot to Kate Smith, stage star. Miss Smith, a comparative newcomer to radio, recently joined Columbia after a brief affiliation with the NBC. She was born in Washington and, believe it or not,

Kate Smith

studied medicine before following a theatrical career. She appeared in vaudeville for the first time six years ago and shortly after appeared in the musical show "Honeymoon Lane." Her latest Broadway appearance was in "Flying High." She was recently featured in the stage presentations of the Capitol Theatre.

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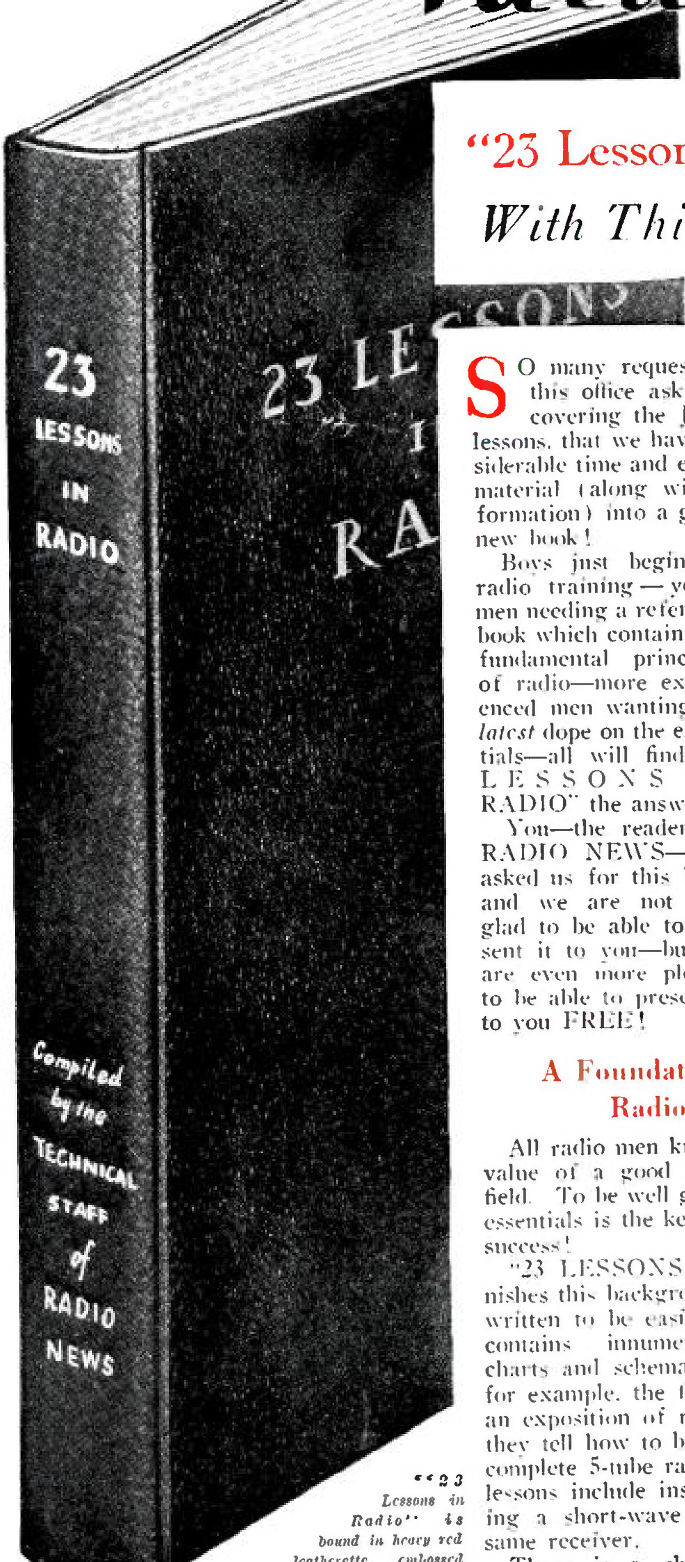

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- The How and Why of B-Power Units
- Breaking into the Amateur Game
- How to build a code test outfit
- Circuit, constructional and operating details of a Low-Power Transmitter
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City .... State ....

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