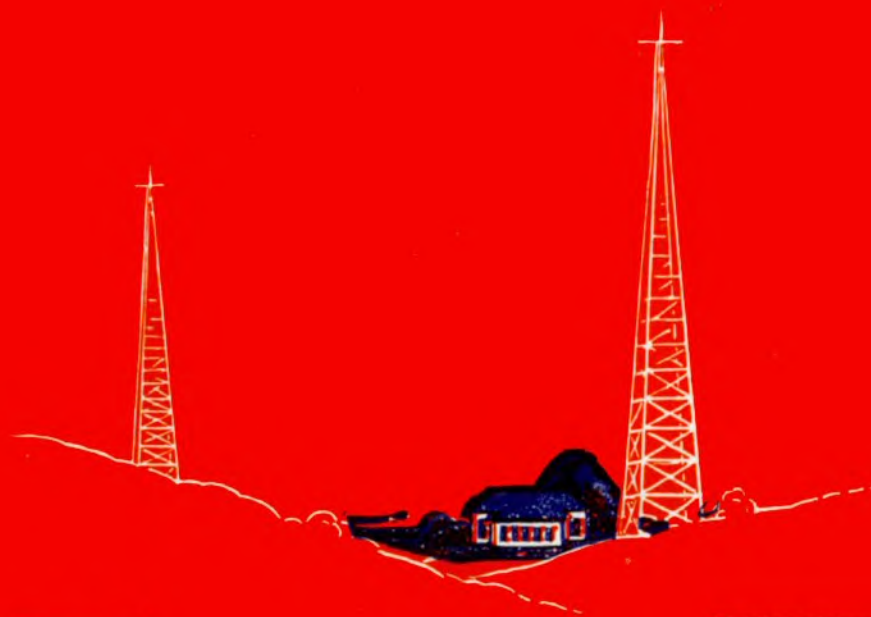


RADIO Engineering

The Technical Magazine of the Radio
Trade ~ Edited by M. B. SLEEPER



MARCH 1926

20c

VOL. VI NO. 3



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Battery, \$3.75.



No. 771, 4 1/2-volt "C"
Battery, 60c

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For the new Non-Regenerative Browning-Drake Receiver, KB-8, described in this publication, use three Eveready "B" Batteries No. 772, and two Eveready "C" Batteries No. 771. If, on the average, you listen in two hours daily, these batteries will last eight months or longer. Naturally, if you listen more, they will have a somewhat shorter life, but in any event, they will give you maximum service at least cost.

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Radiotron UV-201-A

is the standard tube for storage battery sets. UX-201-A is exactly like it, but has a new base.

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New York Chicago San Francisco

RCA Radiotron

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RADIO ENGINEERING

Edited by M. B. SLEEPER

VOL. VI

MARCH, 1926
Sixth Year of Publication

No. 3

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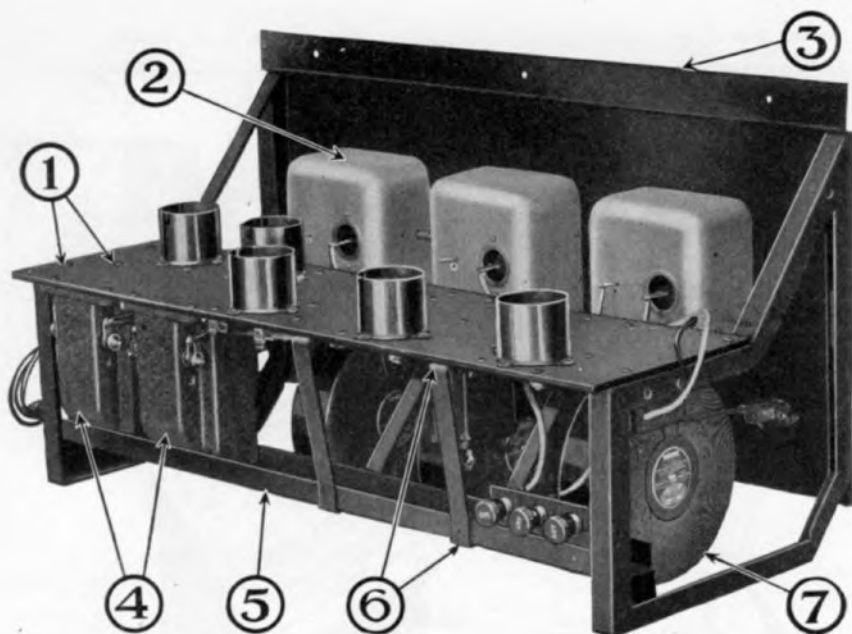
To say that the development of Radio Engineering, as the result of a conservative editorial and business policy, has been continuous and substantial is to describe accurately the history of the publication.

It has not been promoted or high-pressured into the position it now holds in the industry. From the first issue of eight pages to the big size in which it will appear next month it has grown thru sheer merit.

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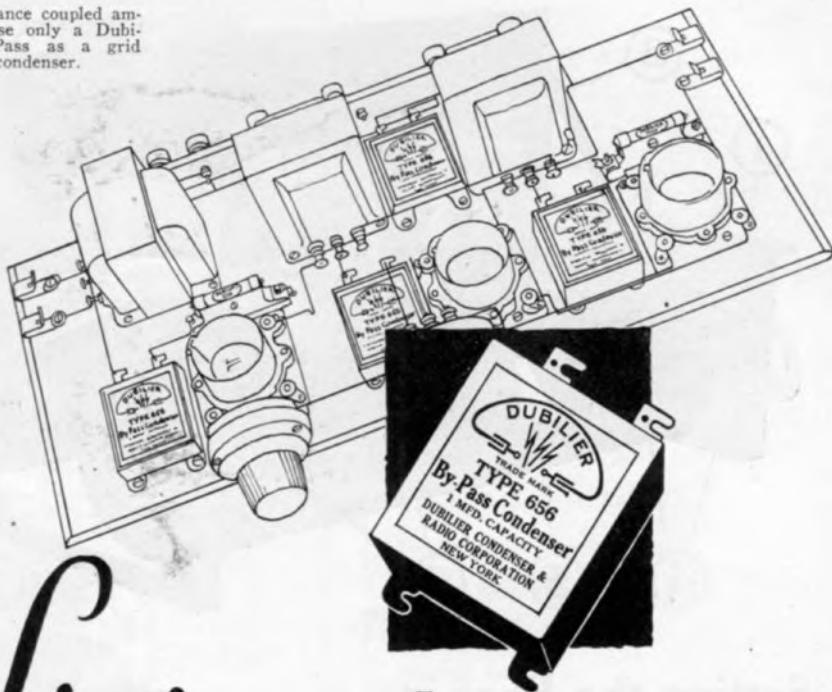
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Fig. 1. The simpler the design, the more accurate the wavemeter

Accurate and Convenient Type of Portable Wavemeter

Old-style, multi-purpose wavemeters no longer meet present-day requirements of testing—By S. W. Nichols

BECAUSE a wavemeter is primarily a scientific instrument, many experimenters and technical men have not taken the time to study into the requirements of a meter sufficiently accurate to measure wavelength and frequency as closely as the present-day frequency-separation requires.

The first wavemeters were made as jacks-of-all-trades—that is, they were intended to transmit or receive oscillations, and in addition to measure decrement, capacity, and inductance.

A wavemeter which has connected to it a buzzer for transmitting is now entirely unsuitable because it is much too broad. For accuracy, it must have nothing in it except a variable condenser and coil and a thermo-ammeter for current measurements.

The inductance must be connected to the meter in such a manner that there is no variable capacity or inductance introduced. The meter is necessary, and is in no way objectionable since the R.F. re-

sistance is constant. Either a hot wire or thermo-ammeter can be used, altho the thermo type is much to be preferred because of its constancy of calibration and accuracy, features which cannot be achieved in the ordinary small hot-wire ammeter.

The wavemeter shown in the accompanying illustrations has the instruments just specified, plus binding posts which allow the introduction of an additional non-inductive resistance box of constant R.F. resistance. For accurate measurements of frequency or wavelength, the resistance box would not be used, and, when it is cut out, the constants are not altered because a short-circuiting switch is built into the meter, and connected across the binding posts.

Fig. 2 shows the rear of the instrument panel, together with the case, coil, and connectors. The case was obtained from the General Radio Company, who manufacture the inductance coil and connectors. A Yaxley switch short circuits the

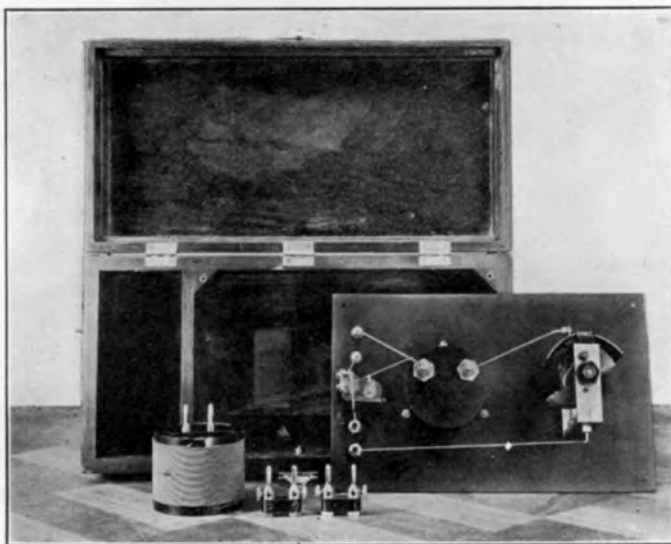


Fig. 2. Details of the wavemeter. Note that the bottom of the cabinet has been cut out to accommodate the Samson condenser. By using different plug-in coils, any range can be covered

binding posts provided for the resistance box. The meter is a Weston thermogalvanometer or current-squared meter, and the 0.00035 S.L.F. condenser is from the Samson Electric Company. This condenser was chosen because of its permanence. The bearings are unusually substantial, and the very small plates make it unlikely that jarring would shake them out of alignment.

In Fig. 1 you can see the assembled meter. A National variable-ratio dial is used to control the condenser. This is very convenient, because it gives the high ratio for extremely fine adjustment and the low ratio for quick setting.

The inductance coil can be mounted on the side, as it is in the illustration, by plugging one connector into the side of the other, or it can be mounted vertically by plugging it into the top of the connector which goes into little jacks on the panel. The connectors are not furnished with holes at the sides, but they can be drilled readily, altho care must be taken so that the Bakelite mounting will not be cracked.

When the meter has been calibrated, the wavelength or frequency of a transmitter can be measured readily by adjusting the condenser until a maximum deflection is obtained on the galvano-

meter. It is important, however, to move the meter far enough away from the transmitter or oscillator so that the deflection on the meter at resonance is not more than 20 on the scale.

To calibrate receiving circuits a separate oscillator is required. That does not need calibration, however. The practice recommended by the Bureau of Standards and all precision laboratories is to adjust the oscillator to resonance with the circuit under test. Resonance is indicated by the deflection of a thermammeter in the output of the oscillator. Then the wavemeter is adjusted to resonance with the oscillator, and the reading of the wavemeter shows then the constants of the test circuit.

In the next issue of RADIO ENGINEERING there will be a description of an audio-modulated R.F. oscillator designed after one built by Mr. Edwin B. Dallin, of the Acme Apparatus Company, and some interesting experiments will be described in which the oscillator and the wavemeter are used.

Unlike other types of oscillators, the one to be described next month does not require a B battery. It operates entirely from six volts. The same methods can be applied to short range transmitters, also.

Engineering Notes on Loud Speaker Units

Discussing points which are not often considered by engineers in selecting units for loud speakers—By A. W. Harris*

THE engineering side of a broadcasting station consists of a collection of precision instruments of a highly scientific nature, the functions of which are to convert sound into electrical energy. It is in this form that it is sent into space. A very minute portion of this electrical energy is picked up by the receiving set through its aerial and amplified until it is of sufficient strength to operate the loud speaker which in turn converts it back into sound waves.

In order to transmit the entire musical scale which consists of sound waves varying from about 50 to 5000 vibrations per second, it is necessary that each and every note should be reproduced with equal volume and accuracy. Assuming that the broadcasting station has converted the original sound into electrical energy without undue distortion it follows that the quality of reproduction will depend upon the ability of the receiving set to collect and amplify all of these electrical vibrations without distortion and on the success with which the loud speaker is able to convert them into sound waves.

Many loud speakers are only capable of converting certain frequencies back into sound so that these inefficient instruments will never produce perfect tone. In fact, however perfect your receiving set may be, the resultant sound will always be tinney and unmusical, if a poor speaker is used.

There are several standard makes of loud speakers on the market made by firms of undoubted reputation and which can be relied upon to give good reproduction. They may be divided roughly into three classes, the simplest of which is the bi-polar magnet type which magnetically vibrates the diaphragm without the use of any intervening moving parts. Next there is the moving armature type in which a separate armature is magnetically vibrated, these vibrations being mechanic-

ally conveyed to a diaphragm by means of a connecting rod or wire. The third type is the cone speaker and varies only from the previous type in that the vibrations of the armature are conveyed by the connecting rod to a large cone instead of to a metal or mica diaphragm and horn.

We will now deal with some of the defects which may occur in the various types.

Unquestionably the bi-polar magnet type speaker is the most foolproof and least likely to get out of order. In tone and volume it is not surpassed by any other type when used in conjunction with the ordinary commercial set.† The adjustment nut on the back of the case permits the relation of the pole faces and great volume. When looking for faults, it must be remembered that the loud speaker is a very sensitive instrument which indicates immediately if there is anything wrong with the receiving set. Nine times out of ten the fault is in the set and the result of this fault is only demonstrated by the loud speaker.

One of the chief causes of poor reception and one which is generally blamed on the loud speaker is roughness or vibration on certain notes, especially when considerable volume is desired. To cure this fault it is necessary to start with the receiving set. Examine carefully all terminals to see that none of them are loose, test the B batteries to see that their voltage is correct, experiment with the grid bias on loud reception. The set may require more or less. Finally, if this has not improved reception, test the tubes. It must be remembered that the ordinary 201-A type tubes, when used for the last stage of amplification, are only intended to give sufficient volume for an ordinary living room. To attempt to force the volume much above this means overloading the last tube and

† Under certain laboratory conditions the cone will respond to a wider band.

* Chief Engineer, Amplion Corp. of America.

creating distortion and roughness. If you need sufficient volume for a large dance room, substitute one of the power tubes for the last 201-A. The new UX-112 tube is very good, and is capable of handling quite a considerable volume without distortion.

If you are then satisfied that the set is in order, and there is still a rattling noise in the speaker, it generally denotes that the diaphragm is too close to the pole pieces. To obviate this the adjustment nut should be turned just sufficient to draw them clear of the diaphragm. Do not turn this nut farther than necessary, or the volume and sensitivity of the speaker will be reduced. A second cause for this rattling noise may be that some foreign substance has been allowed to settle in the speaker and lodged between the diaphragm and cap. In this case it is wiser to return the unit to the factory.

A third and frequent cause of a rattling diaphragm is a weakened permanent magnet in the unit. A weakened magnet is generally caused by coupling the unit to the receiving set without due regard to its polarity. If you examine the binding posts on the unit you will find one of them marked + and the other —. It is essential that the positive lead from the set should be coupled to the positive binding post and the negative lead to the negative binding post, as otherwise the comparatively strong D.C. current from the B battery, as it passes through the magnet, will tend to de-magnetize the permanent magnet instead of assisting to build it up. In this instance also, the only remedy is to return the unit to the factory and have it re-magnetized. These remarks regarding polarity do not apply to the moving armature type.

If you have reason to believe that the unit is dead because no sound can be heard from it, you can easily prove it by touching the leads from the 6 volt battery against the terminal posts of the unit when, if no click is heard, the unit must be returned to the factory for repair.

It sometimes happens that, when tuning in a station, a loud speaker will howl. This howling grows in volume

until all reception is drowned. This is not a defect in the loud speaker but is caused by the nearness of the speaker to the set, permitting it to vibrate mechanically the elements in the tubes. This can generally be cured by moving the speaker farther from the set, or else mounting it on a sponge rubber pad. If this does not have the desired effect, it will generally be found that one of the tubes is very microphonic and must be replaced.†

Most of the above defects are likely to appear in both the moving armature and cone type of speaker. With both these types however, when there is a rattling sound it can only be cured by cutting down the volume from the set, or using a power tube in the last audio stage as no adjustment is provided on these types of speakers. When pronounced rattle still continues on low volume with these speakers, all that can be done is to return them to the factory, as it generally denotes that some of the moving parts peculiar to this type are showing signs of wear.

In the case of the cone type it is as well to release the little screw on the apex of the cone, allowing the rod to take its natural position and then tighten the screw again. This set screw should always be released on a cone speaker during transit.

The cone speaker has another peculiarity in that it produces a decided scratching noise on many sets. This scratching noise is caused by a harmonic from the amplifying tubes which is passed to the speaker at a frequency within the range of the cone diaphragm but too high for the metal diaphragm to respond to. This defect can be very much lessened if this high frequency note is by-passed through a condenser of about .005 mfd., placed across the terminals of the speaker. The value of this condenser will have to be found out by experiment, as it varies on different receiving sets. A power tube in the last audio stage is a decided advantage with these speakers.

These notes on loud speakers would not be complete unless we mention a

† The Bremer-Tully socket fitted with "muffs" is frequently used to stop this trouble.

very important point which is frequently overlooked when choosing the right type of speaker for a receiving set. We refer to the pitch of the speaker. For the benefit of the layman who does not wish to go into technical detail we would state that no speaker made is capable of transmitting the full musical scale, that is to say, the lowest bass notes and the highest treble notes, with equal volume. If the speaker converts the low bass frequencies into sound waves of full volume, it will not be able to convert the highest notes with equal volume. Consequently, when a speaker is said to be low pitch, it seems that it favors the low frequency or bass notes, slightly to the detriment of the high notes, and when it is said to be high pitch the opposite is the case.

Exactly the same peculiarities apply to the receiving set. It therefore follows that no speaker of any particular pitch is suitable for all receiving sets. It may be that your receiving set favors the low frequencies and consequently it reproduces the high frequencies with less volume. If this is the case you can readily see that when coupled up to a low pitch speaker which also favors the low pitch notes, the reception will be very strong on these low frequencies, but weak on the treble notes. The result will be a deep muffled reception lacking clarity. Such a set requires a high pitch speaker to give the best balanced reception. The difficulty is that in most cases the speaker manufacturer has not taken into consideration this very important factor and its relation to "better radio reception." There are, however, some high class firms making the bi-polar

magnet type of speaker, who have an efficient Service Department willing and able to alter the pitch of their units to suit the sets.

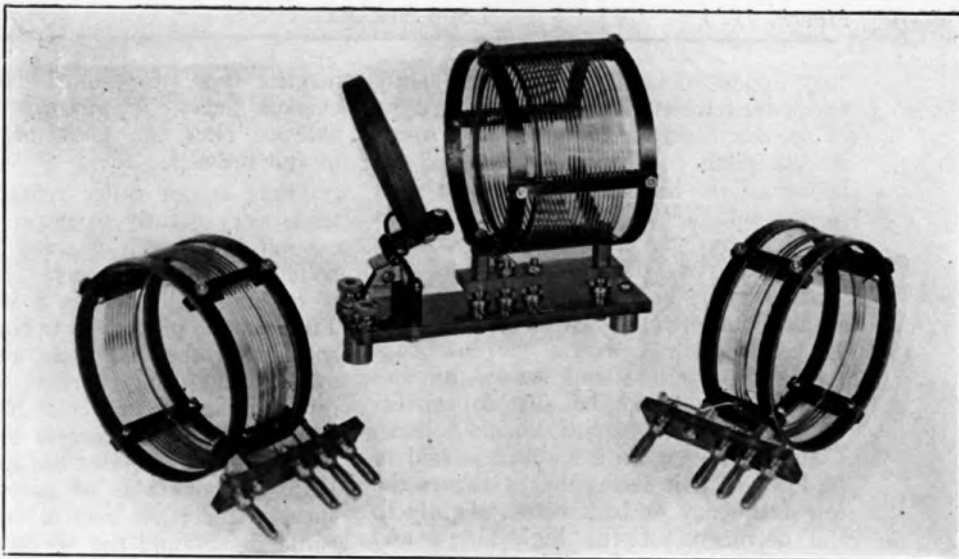
There is one other refinement which tends very greatly to improve radio reception but which is very seldom embodied in receiving sets. This is what is commonly known as a sifter circuit. The common practice is to couple the loud speaker in the last plate circuit. This means that the current which flows through the speaker coils has two components, the D.C. current and the A.C. current which operates the speaker. This D.C. component is of no value to the speaker and is, in fact, a decided disadvantage. Should the speaker have been coupled to the set with the reversed polarity, this D.C. current tends to weaken the magnet. If this D.C. current is flowing in the right direction through the coils it adds an extra and unnecessary stress to the diaphragm, requiring a wider adjustment of pole faces in relation to the diaphragm and thus reducing sensitivity. The sifter circuit consists of a suitable impedance placed across the output terminals and a condenser of suitable capacity in series with one of the leads to the speaker. The impedance provides a path for the D.C. current from the B battery to the plate, while the condenser still passes the alternating current which operates the speaker. As no D.C. current now gets to the coils of the speaker, the question of polarity when coupling up does not arise. This sifter circuit is now being put on the market in a very convenient form by one of the leading speaker manufacturers.

A. F. Amplifier Expert Needed

ONE of the largest manufacturers of radio equipment in the United States is dividing its radio research branch into separate divisions and requires the services of a practical, thoroughly experienced audio engineer, one who has both vision and ability, and is well versed in the practical side of the audio division of radio and in audio frequency reproduction. He must be

capable, wide awake, and have sufficient vision to keep this department ahead of the art, not following it.

Applications for this position should be addressed to A. F. Engineer, Radio Engineering Magazine, A-52 Vanderbilt Avenue, New York City. Complete data concerning experience, age, and expected salary should be given. These letters will be forwarded directly to the radio company.



The secondary and tickler for each wavelength range are in a plug-in unit, making them interchangeable in the mounting

Interchangeable Units for the Short Wave Receiving Set

Just the thing for those who are experimenting with shortwave reception. These coils work from 15 to 33, 30 to 63, and 60 to 130 meters.—By P. C. Cordell*

SINCE regular schedules have been established for short wave broadcast transmission, there has been a surprising amount of interest in equipment for reception on high frequencies. In addition, many B. C. L's who have tired of working for DX which may range up to two or three thousand miles have taken up the telegraph code, and are bringing in stations five and six thousand miles away with short wave sets.

It is not possible to make one tuner that will cover the whole short wave band. Consequently, to meet this new demand, a special set of three tuning units has been developed, covering 15 to 33 meters, 30 to 63 meters, and 60 to 130 meters, when used with a 0.00014 mfd. variable condenser.

The inductances are made up of an antenna coil mounted on a hinged bearing, coupled to a secondary and tickler unit which plugs into individual jacks.

The secondary, wound with bare spaced wire, is tuned by the 0.00014 mfd. condenser. The fixed tickler, mounted inside the secondary, is regulated by a 0.00025 mfd. condenser. This is the standard Reinartz circuit.

Any one of the secondary-tickler units can be plugged in, depending upon the wavelength range to be covered.

For the benefit of those who are not familiar with this hookup, the tickler is connected on one side to the plate of the detector tube, the other side goes to the 0.00025 mfd. condenser, and the other terminal of the condenser goes to the A—binding post. Then a radio frequency choke coil is connected directly from the plate to the B+ binding post. This allows the radio frequency current to flow from the plate through the tickler and variable condenser, but no direct current can pass. The direct current goes through the choke to the B+ terminal, but the choke will not pass the radio frequency currents.

* Aero Products, Inc.



Fig. 1. M. B. Sleeper, checking the voltage on the tubes with a Jewell table-meter, before installing the set in the cabinet—Photographed in a corner of the library in the New York Laboratory

Non-Regenerative Browning-Drake **KB-8 Receiving Set**

A set which will give you all that you can ask of a receiver—
and results which can be obtained without recourse to
controlled regeneration

WHEN a B.C.L. asks a dealer or set builder to construct a receiving set for him, he generally has uppermost in his mind one specification—the set must be satisfactory in operation and results. An experimenter, on the other hand, buying parts to make an outfit, generally wants something unusual in the way of operation or design.

The non-regenerative Browning-Drake receiver, type KB-8, was designed to meet the requirements of both the B.C.L. and the experimenter.

For the former, the KB-8 has been made irrefragable in operation; that is,

there are two adjustments for tuning and that is all, once the rheostats and neutralizing condenser have been regulated. The set can be tuned quickly, for it requires only two hands, and there are no auxiliary controls to play with and which will cause the set to howl by throwing it into oscillation. Therefore, the set is not open to criticism for its bad manners, either by the operator or his next-door neighbor, who resents so strongly the presence of sets which are tuned by putting the set into oscillation in order to pick up squeals. The system of audio frequency amplification is equal to any

other, and made doubly satisfactory because distortion cannot be introduced by putting the circuit into the unstable condition which is encountered just under the point of oscillation. The current consumption is extremely low, so that good B batteries will give such long life that no one can complain of expense or dissatisfaction from that source. The construction is rugged and permanent, precluding the development of loose parts and broken connections. The range is sufficient to bring in, at full volume, any broadcasting that can be received without distortion on a super-sensitive receiver.

ducing the Donle detector tube. This tube operates on a principle recently discovered by Mr. Donle, and in a recent series of tests demonstrated a degree of sensitiveness which has not been approached previously by any other tube. The electrical characteristics are somewhat similar to the D-21 Sodion. It does not require a potentiometer, it can be operated without a gridleak or grid condenser, and the plate impedance is very high. With 22 volts, the plate current is only 0.1 milliampere. The filament takes 0.25 ampere at 5 volts.

The sensitiveness of the detector is not only important in DX reception, but it

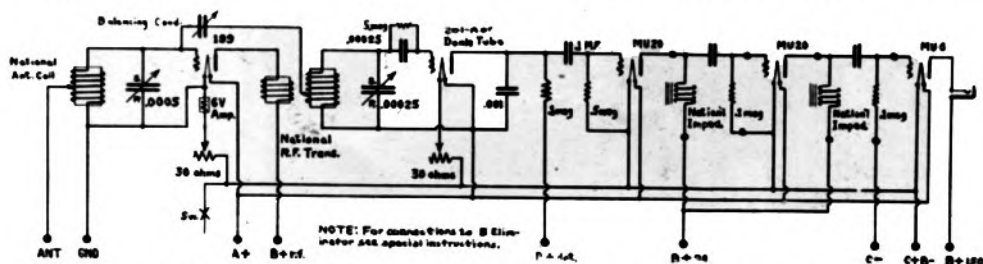


Fig. 2. Only two tuning controls are employed. The rheostats do not require readjustment, nor can they be used to put the circuit into oscillation. Sometimes tuning is sharper if the grid return to the first tube is put on the other side of the Amperite.

The experimenters will quickly recognize a number of innovations. The non-regenerative circuit, developed by RADIO ENGINEERING, is a conclusive demonstration of the fact that sensitiveness, sharpness, and quality are not confined to sets using regeneration control in one form or another. The National S.L.F. condensers, running over a compass of 270 degrees, are brand new, as are the National impedaformers which contain the chokes and stopping condensers, and mountings for the gridleaks. The Electrad rheostats, switch, and phone jack are just being put on the market, the Walbert neutralizing condenser is an innovation, and such mechanical features as the arrangement of the amplifying units and the pin-jack panel for voltage readings are shown for the first time.

Of special importance is the introduction of the new Donle detector tube. Harold P. Donle, formerly chief engineer of the Connecticut Telephone and Electric Company and inventor of the Sodion detector, the most sensitive type which has ever been made, is now pro-

has a marked effect upon the quality. When a fairly high minimum voltage must be applied to the grid in order to make it function, it is obvious that a part of the received speech must be lost. Increasing the sensitiveness of the detector reduces the amount of modulation which does not go into the A.F. amplifier.

Description of the KB-8 Set In the description of the KB-8 receiver, the various units and features have been sub-divided so as to make them as understandable as possible. This is a most satisfactory way since the unusual features of this set can be best explained by discussing them individually. This set is entirely unlike any other that has been shown and the features are well worth careful consideration.

As to the actual construction details, blue prints are available which give the panel patterns and picture wiring diagram in full size, step-by-step assembly instructions with explanatory notes, terminal checking list by which the possibility of wrong or omitted connections is obviated, and a complete list of the

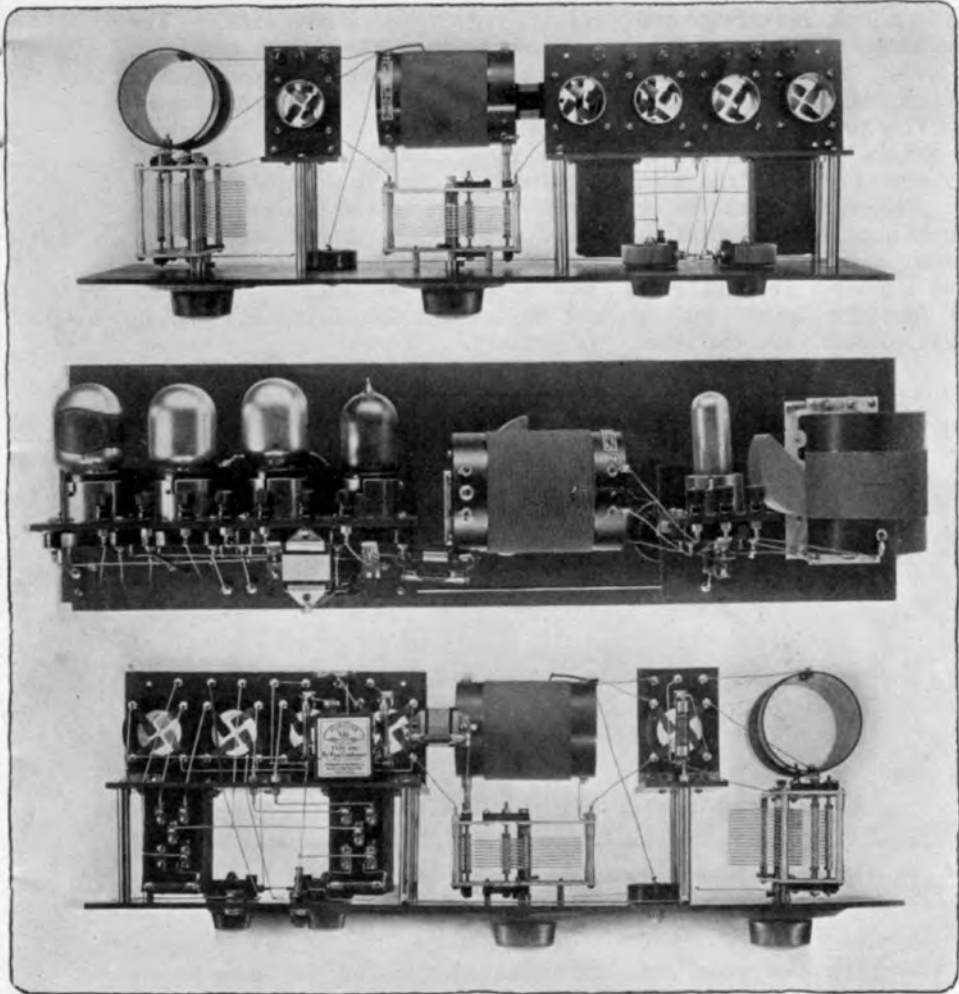


Fig. 3. Top, rear, and bottom views of the KB-8. Notice the beauty of the mechanical design, worked out in a way to make the leads of minimum lengths, with all terminals readily accessible

parts used in the original set, as well as the electrical constants.

This was done in order to devote the space in *RADIO ENGINEERING* to a complete discussion of the set, with the construction data available in blue print form to those who want to build it.

The R. F. Amplifier Unit In the circuit of the R.F. amplifier there is the left hand tuning unit, looking at the set from the front, R.F. tube panel, and neutralizing condenser.

The coil is identical in dimensions to that which has been furnished in the standard Browning-Drake units built by the National Company, but the 0.0005

mfd. variable condenser is of S.L.F. design, turning through 270 degrees. A Velvet vernier is employed, with a dial having 150 graduations. This gives an effective reduction ratio of 7 to 1.

Two panel support pillars, $3\frac{3}{8}$ -ins. long by $\frac{3}{8}$ -in. in diameter carrying a vertical panel $2\frac{1}{2}$ by $3\frac{1}{2}$ ins., $\frac{3}{16}$ -in. thick, to which another panel, of the same size, is secured with 1-in. angle brackets. An Amsco socket is mounted under the horizontal panel. Instead of fastening the socket with two screws as was originally intended, the socket is held to the panel by $\frac{5}{8}$ -in. 6-32 R.H. screws running through the panel, socket base,

and into Lastites. The clips were taken from a single gridleak mounting, and fastened to the socket through the regular mounting holes. The clips are held by $\frac{1}{2}$ -in. 6-32 R. H. screws threaded into Lastites. This provides a convenient mounting for the 6V-199 Amperite.

If a UX199 tube is used for the R.F. amplifier, the Amperite, which is in series with the 30-ohm rheostat, makes it impossible to burn out the tube by turning the rheostat too far. The UX tube can be fitted into the socket with a Pacent Isolantite adapter. On the other

condenser substituted for the S.L.C. or S.L.W. types previously used. The mechanical details can be seen in Fig. 5.

It has been observed by some engineers that it is difficult to build a non-regenerative R.F. transformer which, without regeneration, gives a high degree of amplification over the entire broadcast range. Tests on the Browning-Drake transformer show that the loss at high wavelengths is practically negligible. This is due to the design of the coils and the method of winding and placing the primary.

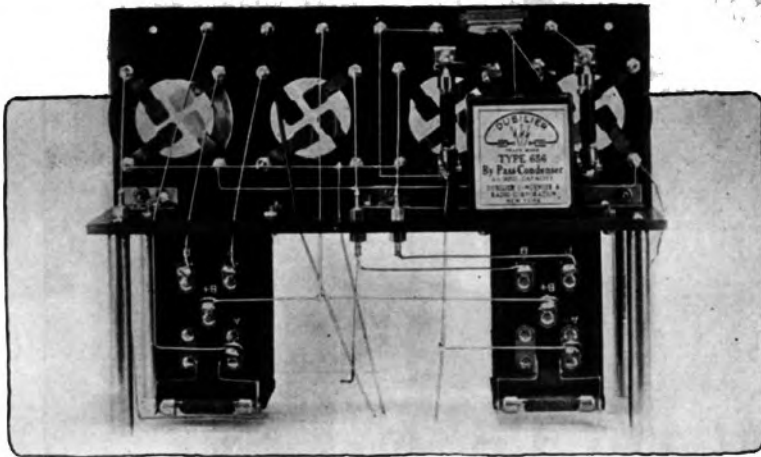


Fig. 4. Detector and amplifier unit removed from the set. The leads for the resistance stage are mounted on the two right hand sockets

hand, some people prefer the UV-201-A for an R.F. tube. In that case, the Amperite terminals must be short circuited. Then the rheostat gives the usual filament control.

A Walbert neutralizing condenser is mounted between the pillars which hold the R.F. tube panel. This is a very convenient type of neutralizing condenser for it can be adjusted from the front of the panel. However, since the adjusting screw is covered by a cap nut, there is no tendency to play with it, as is the case with types having a regulating knob. The connection of the neutralizing condenser is shown in Fig. 2.

Detector Tuning Circuit No change has been made in the inductance for the detector circuit. The standard regenerator coil is employed, but the tickler is omitted, and a 0.00025 S.L.F.

In other words, regeneration increases the signal strength over the whole wavelength range. However, the design of this set is such that, even with a 201-A tube for a detector, a very high degree of sensitiveness is obtained. Using the Donle detector tube, the set showed a response equal to that of the Browning-Drake receiver equipped with a tickler. Instead of using transformer or impedance coupling after the detector, the coupling for the first stage is resistance. Results shown by hundreds of reports from RX-1 owners confirmed our judgment in deciding upon resistance for the first stage. Moreover, because of the high impedance of the Donle tube, greater amplification is obtained in the first stage with resistance than with either transformer or impedance coupling.

Fig. 3 shows the Donle tube in the set, while Fig. 4 illustrates the method of mounting the plate resistor and grid-leak for the first stage. The 0.1 mfd. stopping condenser is fastened between the resistances on to the vertical panel. The clips were taken from two single resistor mountings, and fastened to the regular mounting holes of the sockets just as the clips for the Amperite were put in place. Additional details will be found in Fig. 6. The 0.001 mfd. by-pass condenser can be seen in Figs. 3 and 6.

tites have been used for practically all of the connections. When a screw is too long to take a Lastite, put the screw in place and fasten it with an ordinary 6-32 nut instead of the Lastite. Then cut the screw off and remove the nut. That will leave the screw just long enough to go into the Lastite. A 1/4-in. Spintite wrench makes this work a great deal easier. In two or three cases it is necessary to cut the head from a screw in order that one end can go into a Lastite or coil mounting pillar, with a Lastite

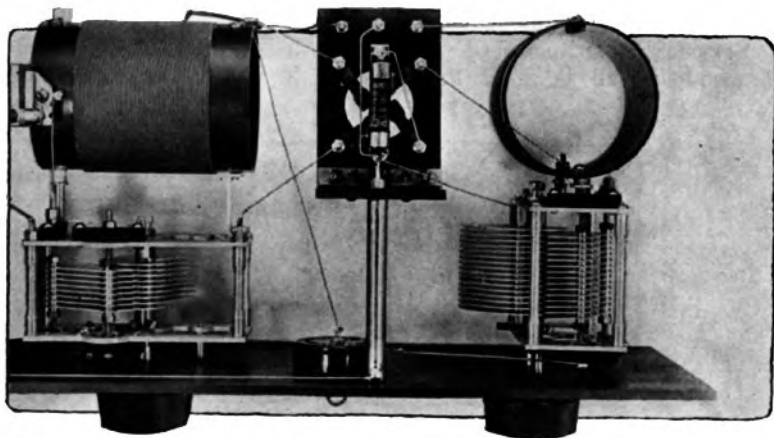


Fig. 5. The non-regenerative Browning-Drake coils mounted on the new National S. L. F. condensers. The R. F. tube, controlled by an Amperite, is located between them

Description of the A. F. Amplifier The two stages of impedance amplification are connected in the conventional manner, altho the combination of impedance or transformer amplification following a first stage of resistance coupling, first shown in the RX-1 receiver, was originated by RADIO ENGINEERING.

The impedance transformers are fastened to the vertical panel. The outer mounting screws at the top, looking at the set from the front, also hold the angle brackets which fasten the horizontal panel to the vertical panel. This detail is explained in the blue prints. The photograph in Fig. 4 was taken of the amplifier unit removed from the front panel after it had been connected in the circuit. You can see that this unit can be entirely assembled and almost completely wired before it is put on the front panel. These pictures show the manner in which Las-

on the other end. All these details are explained on the blue prints.

Fig. 7 illustrates the mounting of the rheostats, jack, and filament switch. These three items have just been developed by the Electrad Company and are of a type which will appeal strongly to those who look for mechanical excellence as well as convenience.

When the set is mounted in a cabinet, it may be well to arrange a small wooden block at the back of the cabinet so as to support the two corners of the large tube panel. The construction is very sturdy, however, for three angle brackets hold the horizontal panel in place. The vertical panel, in turn, is fastened to the front panel by four heavy panel support pillars.

Panels and Panel Material The front panel measures 7 by 24 ins. The original model was made with Celo-

ron, 3/16-in. thick, altho the Crowe Name Plate Company is furnishing a metal panel, beautifully engraved and finished, which can be used in this set without any loss of efficiency.

In the rear there are two panels 2½ by 3½ ins. and two 9½ by 3½ ins. all of 3/16-in. Celoron.

The full size blue prints show the locations of the centers for the holes. Unless otherwise specified, the holes are made with a No. 18 drill. A double circle indicates countersinking. The necessary engraving is also indicated on the panel patterns. If you do not know where to have your panel engraved, the Service Department of RADIO ENGINEERING will be glad to tell you the

We do not recommend the UV-199 with an adapter because adapters for UV-199's too often develop contact troubles.

The UV-201-A as a detector is entirely satisfactory in this set for all ordinary purposes but, as has been stated previously, the Donle tube gives a very definite increase in distance, volume, and quality, certainly more than enough improvement to justify the increased cost.

The first and second amplifying tubes should be Daven MU-20's, with a Daven MU-6 for the last stage. These tubes were chosen because they operate directly from 6 volts and do not require a rheostat. For this reason, it is well to watch the storage battery so that it will not drop appreciably below 6 volts.

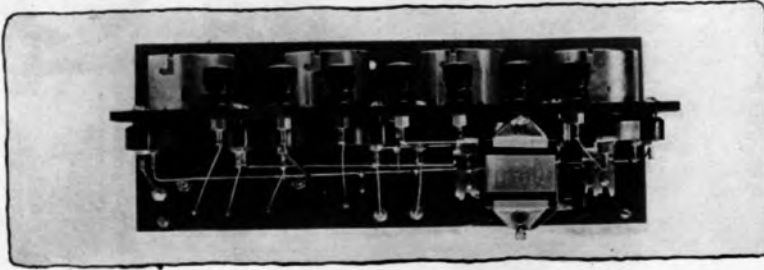


Fig. 6. Rear of the detector-amplifier unit. Note the simplified system of wiring made possible by the use of Lastites

location of the nearest concern that handles this work.

No engraving for the binding posts is called for, for Eby posts have been used throughout. If you can't get a binding post engraved B— C+, use a plain binding post and scratch the markings on it yourself, filling them in with white crayon.

Just to bring the binding post arrangement right up to the minute, we used a red Eby binding post for the 135 volts. As a matter of fact, it is well to be a little careful in handling that lead for, altho 135 volts is not dangerous, it is possible to get a slight kick from it.

Selection of the Tubes Either a UX-199 tube with a Pacent Isolantite adapter or a UV-201-A tube can be used in the R.F. stage.

We are inclined to prefer the UV-201-A as being more sensitive, altho it may be easier to neutralize the UX-199.

Other types of amplifier tubes can be used provided they are the equivalent of the Daven tubes in their electrical characteristics.

A and B Battery Supply Binding posts on this set call for 22½, 67½, 90, and 135 volts. For B battery operation, the National Carbon Company recommends three No. 772 B batteries and two No. 771 C batteries.

The current drain on the set with 9 volts C battery for the last tube, with a UV-201-A for the R.F. amplifier, Donle detector tube, two MU-20's and one MU-6 is divided as follows. R.F. tube, 1.75 milliamperes, Donle detector tube, 0.1 M.A., first two A.F. tubes, 2.75 M.A., and the last power tube 5.25 M. A.

It is interesting to note that strong signals decrease the current in the last tube, instead of increasing it. Therefore, the total drain fluctuates between 7 and 10 M.A.

The Acme B eliminator is quite satisfactory for this outfit. The low voltage binding post on the eliminator should go to the B+22 volts binding post on the set and the high voltage tap should be connected to the B+67½, B+90, and B+135 posts. That puts the full voltage on the R.F. and A.F. tubes.

Fig. 7 illustrates the power supply used in the permanent set-up for the KB-8 in the library of the New York laboratory. We have had excellent results with the 6-volt Gould Unipower A and it is most convenient to use for it requires practically no attention. Complete de-

partment houses where an outdoor antenna is not practical.

Any standard 7 by 24-in. cabinet can be used for the KB-8, allowance having been made around the edges of the panel so that the parts behind will not interfere. A depth of 7 1/6-ins. is required.

On general principles, we do not recommend a cabinet which has a loud speaker chamber built as a part of the cabinet. Often times mechanical vibration from the loud speaker causes the tubes to howl. However, a cabinet such as the Jewett Radio Highboy, which has a separate papier maché sound chamber

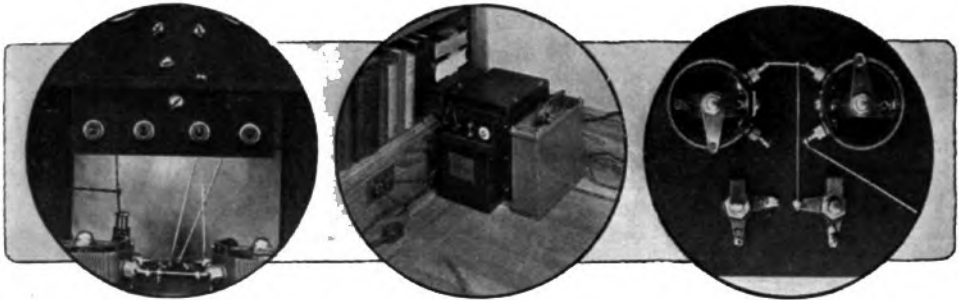


Fig. 7. Left, the tip jack panel, for voltmeter connections. Centre, the Gould Unipower A and Acme B eliminator for A. C. operation. Right, details of the Electrad rheostats, Jack, and switch

tails on the Gould Unipower were given in RADIO ENGINEERING for December, 1925.

Notes on the Installation Thirty or forty miles from New York City, the KB-8 gives as sharp tuning as anyone can ask of a set, even when it is operated on a 100-ft. single wire antenna. This is a convenient size, not too big, but large enough for good pick-up. With a 75 or 100-ft. antenna the range is equal to any of the very best receivers.

In congested areas where there are a number of broadcasting stations operating simultaneously, it is necessary to reduce the antenna to 25 or 30 ft. The ground lead should not be more than 10 or 15 ft. If it is necessary to use a longer ground lead, reduce the length of the antenna accordingly. Then the tuning will be sharp enough to cut out local interference. The ability to use the KB-8 on such a short antenna makes it particularly well suited for installation in

mounted at the back of the cabinet, with the bell coming up to a screened opening, does not develop that trouble.

It is advisable to have the B battery eliminator mounted a slight distance from the set itself, and not directly behind it in the same compartment, altho we have not had any difficulty with the Acme eliminator in this respect.

Neutralizing and Tuning When the set has been completely assembled, put in the tubes and adjust the rheostats so that the correct voltage is applied to the terminals of the R.F. and detector tubes. The voltage must be measured directly at the socket contacts and not at the binding posts. A UX-199 should have 3 volts at the socket, or 5 volts for a UV-201-A or Donle detector tube. As a matter of fact, the Donle detector tubes which we have tested generally operate well below their rated filament voltage, from 3½ to 4½ volts. This is an excellent feature about the

tubes because it not only gives them unusually long life but also reduces the current drain on the A battery.

Test the voltage on the three A.F. tubes. This should be not less than 5½ or more than 6.1.

To neutralize the set, remove the cap nut from the Walbert neutralizing condenser on the front panel, tune in a station, and turn the left hand condenser dial back and forth, while you adjust the neutralizing condenser screw with a short stick sharpened at one end, until no whistle is heard while the condenser is varied. It is well to adjust the set on a fairly low wavelength. If you have a UX-199 tube for the R.F. amplifier, cut the R.F. tube rheostat out before you start neutralizing. Then you can reduce the volume by increasing the resistance in the rheostat. Once the set is adjusted, tighten up the cap-nut on the neutralizing condenser and leave it alone forever after. It may require re-adjusting if you change the antenna or the R.F. tube. Otherwise it should not be touched. The dial readings on the KB-8 run quite close together. On any set with conductive coupling to the antenna it is not possible to make them run perfectly true but the difference should not be appreciable.

Choosing the Loudspeaker In our installation we used an Amplion loud speaker type AR-19. Few set builders or engineers have considered the effect of the loudspeaker on the plate current consumption in the last tube. Quality being equal, it is wise to choose a loudspeaker which gives as low current consumption as possible. In the tests made on this set it was found that different types of loudspeakers varied the plate current as much as 4 M. A. The Amplion unit gave the lowest current consumption. This factor is well worth keeping in mind, for a difference of 4 mils in the plate current, if a set is run from B batteries, makes quite a little difference in the life of the batteries. The current of 5.25 M. A. previously noted for the power tube was obtained with the Amplion unit in the circuit.

Suggestions about the Assembly The non-regenerative Brown-ing-Drake set has been designed with the utmost care,

and every bit of useful information included in the dataprints. It is only fair, then, to expect the constructor to be just as careful in his workmanship when he assembles the set. It is not possible to make any design proof against carelessness. No set can be made successfully unless the instructions are followed accurately, the correct parts used, and real thought and care put into the work.

The original model has been wonderfully successful in its operation, even beyond our expectations, and these results can be duplicated by anyone who will follow the instructions. If, however, the parts are thrown together in an ex-

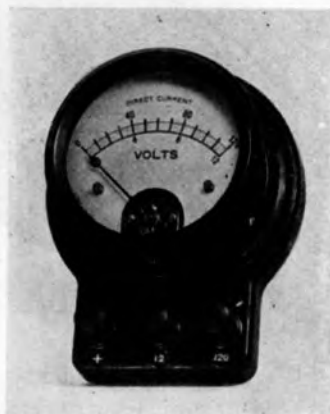


Fig. 8. Double-reading Jewell voltmeter for checking A and B batteries

perimental set-up, it is not fair to complain if you are disappointed in the results.

The design of radio sets has become a real art, and we have done everything possible, at the same time, to present the designs in a way which anyone can copy if he will make the effort. Do not try to wire up the set from the schematic diagram. The picture wiring diagram has been made to protect you from mistakes. If you use the terminal checking list also, marking each terminal as you solder it, you will be able to tell when you finish the job if any wires have been omitted or if they have been connected in the wrong places.

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EDITORIAL

IT IS a striking coincidence that the design of the non-regenerative KB-8 is disclosed directly after the conclusion of the Trans-Atlantic sending tests, for nothing could have demonstrated more forcefully the fallacy of regenerative sets.

And there is pardonable satisfaction in bringing out through RADIO ENGINEERING the first truly non-regenerative sets of high power to meet the problem, particularly because in our predecessor, *Everyday Engineering*, we inaugurated, with the co-operation of the *Wireless World of London*, the first Trans-Atlantic sending tests, in the early spring of 1921, the year which marked the official inauguration of broadcasting.

However, while it's fun to help make radio history, it is more to the point to work for the future.

Here is the situation as we find it to-day: Thousands of B. C. L.'s, hundreds of experimenters, and dozens of manufacturers, after making elaborate plans for bringing in foreign stations, report that if the European stations could have put signals into the United States, which they were not able to do because of most unusual atmospheric conditions, no one could have picked the signals out of the wild stampede of local interference from oscillating receivers.

The joker is that the majority of the sets which cause the howls and squeals

were bought or built as non-radiating. When radio magazines get around to the point of learning the truth, and then telling it, they will admit what is axiomatic—any set which has controlled regeneration is an offense to the radio public.

There never was an operator, and there never will be one, who doesn't pick up stations by their squeals if he can make his set oscillate. The only way to take squeals off the air is to take them out of the sets.

How can radio manufacturers talk about selling the enormous potential radio market when, as they create the demand, they will meet it with more oscillating receivers, to confuse their new customers and doubly confound their old ones?

Is the radio entertainment which manufacturers are selling, produced at an expense running into hundreds of thousands of dollars annually, to be travestied by a blanket of cat calls?

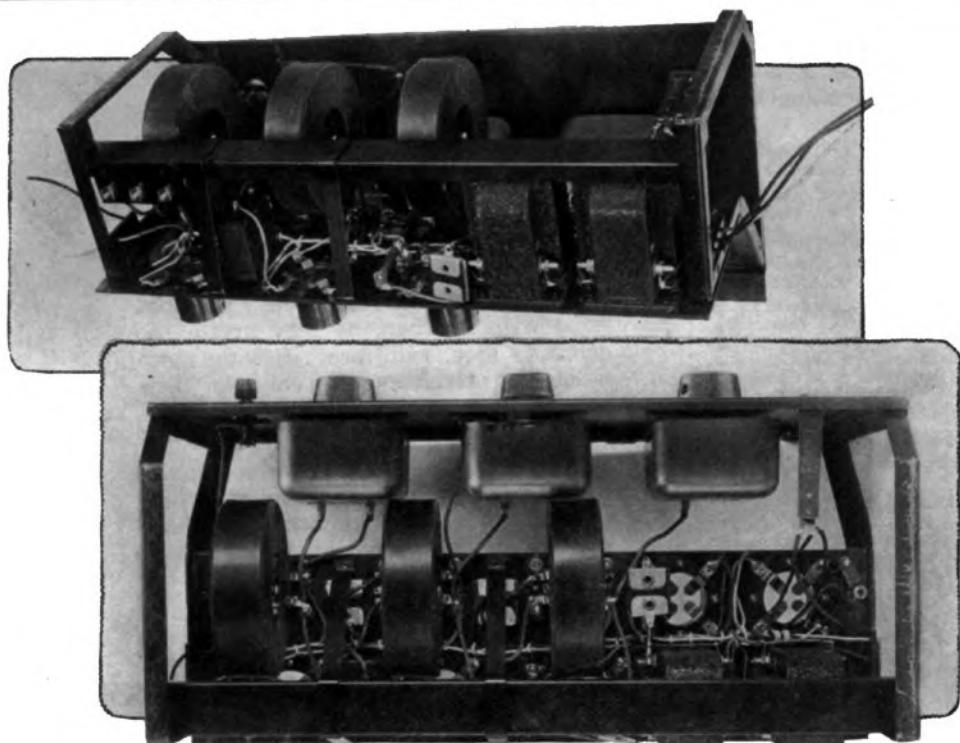
Conditions during the Trans-Atlantic tests, if not typical of the present, are only a sample of the future. Controlled regeneration, any means for putting a set into oscillation, is an added hazard in the industry.

The neutralizing idea is excellent when applied in the manner originally intended, but the original idea was not to use a step of neutralized R.F. ahead of an oscillating detector to keep the set from radiating. On such a receiver it is possible to bring in local stations with the antenna disconnected and the R.F. tube out. Radiation, sufficient to cause considerable disturbance to sensitive sets, takes place directly from the coil in the grid circuit of an oscillating detector.

The only way to keep squeals off the air is to take oscillations out of receiving sets.

Dealers, when they decide upon sets to handle next fall should remember that the shape of the cabinet, number of tubes, price, and all the other things are of relatively less importance than the answer to the question, "Can it oscillate?" which everyone will ask. And the first test which dealers should make is to determine this characteristic.

M. B. SLEEPER,
Editor.



This is one of the most substantial set assemblies ever designed. All the metal parts are spot-welded together.

Serviceman's Checking Chart for the All-American Model R Receiver

If anything goes wrong with this set, the exact location of the faulty wire or terminal can be determined

ALTHO it has taken several years to sell installation and repairmen on the idea, the voltmeter test is the only satisfactory way of checking up connections. Obviously, running your eye over the wire will not tell the story of the high-resistance contacts, and in many sets the wiring runs out of sight where it is practically impossible to follow the leads through. The following data on the All-American Model R receiver has been prepared so that, by following it through, a broken or short-circuited lead can be located exactly.

To make these tests, connect a 22½-volt B battery, on one side, to a high-

resistance voltmeter, such as the Jewell or Weston types. Put a flexible lead on the other side of the meter and on the other side of the B battery. These should be fitted with stiff wires so that they can be readily touched to various parts of the receiving set. When these leads are put on the terminals of the set, indicated in the list below, the voltmeter should read approximately what the tables show.

Where the table specifies "Full," the meter should show about 22½ volts, indicating a direct or low-resistance circuit. Through the transformers there is naturally a drop, bringing some

of the readings down to about 16 volts.

All these tests are made with the tubes out and the batteries disconnected.

Connect:

GND to ANT 1 — full
GND to ANT 2 — full

Put the filament switch in the Off position.

GND to A+ — 0 volts
GND to A— — 0 volts
GND to B45 — 0 volts
GND to B90 — 0 volts
GND to B— — 0 volts
GND to Rheostat+ — 0 volts

Rheostat+ side is the terminal not grounded.

GND to C1+ — full
GND to C1— — full

C1, C2, and C3 are the tuning condensers, from left to right, looking at the set from the bottom at the rear. C+ is the side not grounded and C— is the grounded side.

GND to frame — 0 volts
A+ to frame — 0 volts
B— to frame — 0 volts
B45 to frame — 0 volts
B90 to frame — 0 volts

Turn the switch on.

A— to frame — full
C2— to frame — full
C3— to frame — full

Turn the rheostat on.

C2+ to frame — full
C3+ to frame — 0 volts

Switch or rheostat on or off.

A+ to B— — full
A+ to B45 — 0 volts
A+ to B90 — kick

On some terminals, such as above, the meter gives a slight kick but returns to zero.

A+ to C3+ — full
B45 to B— — 0 volts
B45 to B90 — 0 volts
B45 to T1B+ — full

T1 and T2 are the audio transformers, left to right, from the bottom, looking at the set from the rear.

B45 to S3p—16 volts

S1, S2, S3, S4 and S5 are the sockets, from left to right, looking at the set

from the bottom at the rear. The terminals are indicated as g, grid—p, plate.

B90 to T2B+ — full
B90 to S4p— 16 volts
B90 to Jack — full
B90 to S5p— 0 volts
S5g to S4p— 0 volts
S5g to frame— 10 volts
S4g to S3p— 0 volts
S4g to frame— 10 volts
S3g to C3+ — 0 volts
C3+ to S2p— kick
S2p to B90 — full
S2p to B— — kick
S2g to S1p— 0 volts
S2g to Rheostat+ — full
S1p to B90 — full
S1p to B— — kick

It will be noted that no connections are given for the tube filament contacts on the sockets. If these tests have been carried out and all check O.K., and the tubes light, obviously the filaments circuits must be O.K. If the tubes do not light when the batteries are connected, the switch turned on, and the rheostat run up, something must be wrong in the filament circuit or in the tubes themselves.

The only thing that these tests do not show up is short circuits in the variable condensers. It is very unlikely that shorts will take place in the condensers, and if the plates do touch, the set will operate at some settings and not at others.

Operating from a checking table of this sort is very satisfactory because, if all the tests give the correct results, it is certain that the fault must lie in the batteries, tubes, loudspeaker cord or jack, or in the antenna and ground.

The dealer should take upon himself the responsibility, in fairness to the manufacturer, of going through all these tests before shipping back a set as defective. That is a very expensive matter and oftentimes creates prejudice against the set which is unwarranted. Manufacturers report that the majority of sets returned could have been repaired readily by the dealer or else that the set was not defective at all but was not used properly.

Suggestions About the Use of Fixed Condensers

No matter what kind of a set it is, it must have fixed condensers. Therefore, they must be used correctly—By M. Kevelson*

IN every radio set, fixed condensers are a practical necessity. The diversity of uses to which they are put, and the part played electrically in each of its positions, make it important for the manufacturer and builder of radio sets to know the why and wherefore of fixed condensers.

It is difficult to classify these uses in the order of their relative importance because in practically every instance, if the condenser is properly located in the circuit, the part that it plays electrically is so important, that it is almost indispensable. In fact, in many cases it is an absolute necessity.

The most important use of fixed condensers is in the position of grid condenser in the detector circuit where it so modifies the action of the vacuum tube, which is normally an amplifier, as to make it a very superior form of rectifier; in fact, not only a rectifier, but a very efficient form of audio detector. Radio waves as sent out by a broadcasting station are continuous waves modulated according to the speech or music signal. These modulations consist of an aggregation of frequencies from about 100 to 5,000 cycles per second, having various amplitudes and phases. The continuous waves, known as carrier waves, are of such high frequency, that they are not directly audible. Even if it were possible for the human ear to respond to such rapid vibrations, we could find no mechanical contrivance, such as a telephone diaphragm capable of vibrating at this rate.

It becomes necessary, therefore, to take these high frequency currents and convert them into currents of audible range, for which purpose it is necessary to rectify the incoming pulses, that is, to say, make them uni-directional. Varia-

tions in these uni-directional pulses are of audible frequency and can therefore be heard in the head-set. There are several methods of rectifying these radio frequency pulses, the most efficient of which is by means of the grid condenser. It must not be supposed that the grid condenser of its own accord acts as a rectifier, since from the electrical nature of a condenser this is impossible. The effect of a grid condenser used with a vacuum tube is to allow the tube to rectify the incoming pulses and amplify them at the same time. This is really the chief advantage of the grid condenser rectification scheme. It permits of simultaneous rectification and amplification by one tube. The size of the condenser used for this purpose is either .00025 mfd., or .0005 mfd., depending on the characteristics of the vacuum tube used, and the range of frequencies being received.

Another use to which fixed condensers are put is as a by-pass for radio frequency currents. In practically every circuit, such as the regenerative, neutrodyne, or reflex, it is absolutely necessary to pass currents of two different frequencies simultaneously from the output of one tube to the input of a succeeding tube. Audio frequency transformers when placed in the plate circuit of a vacuum tube, cannot pass currents of a very high frequency because of the choking effect they exert on such currents. This choking effect is caused primarily by the iron core in the transformer. Since it is necessary to pass radio frequency currents in this same circuit, the only means by which this can be accomplished is by placing a small fixed condenser across the primary of an audio frequency transformer. This condenser will allow currents of radio frequency to pass through it, but will deny

* Dubilier Condenser & Radio Corp.

the passage of audio frequency currents. Conversely, the primary of the audio frequency transformer will pass audio frequency currents and prevent the passage of radio frequency currents. Thus, the necessity of a condenser across iron core inductances is apparent.

In addition to this use of fixed condensers across inductances, there are other uses, such as by-pass across resistances and batteries. An example of the former use would be as by-pass across a potentiometer, while an example of the latter would be as by-pass across the A battery. This latter connection is to shunt out the radio frequency resistance of the battery leads when the batteries are situated at some distance from the set.

Sometimes in transformer coupled amplifiers it is possible, by the judicious use of a fixed condenser across the secondary of the transformer, to improve the quality of reception. Such use would be advisable where a transformer is of very high ratio, and in consequence the voltage amplification very high at high frequencies giving a peaked amplification curve. It is then possible by placing a condenser across the secondary to flatten out this upward characteristic, and thereby reduce the distortion at the higher frequencies.

The proper use of fixed condensers in a resistance coupled amplifier makes this type of amplifier, without doubt, the most faithful of reproducers. This item is so important in the design of resistance coupled amplifiers that the use of an incorrect capacity will result in distorting to an even greater extent than transformer coupled amplification. One of the most important problems is the avoidance of communicating the B battery voltage drop across the external plate circuit resistance to the grid of the succeeding tube. Under these conditions, the grid will have a very large positive potential. Since the best operating point on a tube is at a slightly negative grid potential, the simplest remedy lies in the use of blocking condensers in the grid leads. This solution, however, introduces a difficulty, for regardless of the size of condenser used, its reactance will vary with the frequency. It is the real cause of distortion in any resistance

coupled amplifier. The larger it is made, the less the distortion. The reason for the distortion is that since the voltage drop through the condenser varies with the frequency, the voltage impressed on the succeeding grid is different with different frequencies from the voltage output across the plate resistance. It is entirely possible by the use of a very small condenser to cut off nearly all of the voltage at certain frequencies, thus causing considerable distortion. The proper blocking condenser to use in a radio frequency amplifier is not necessarily as high as 1 or 2 mfd. Condensers as small as .006 mfd. can be used without appreciable distortion. However, for best results, a capacity of .02 mfd. is recommended. With a well constructed amplifier the grid resistance should not be less than 0.5 megohm, with a fairly heavy negative bias on the last tube. The faithfulness of reproduction of this type of amplifier is about as perfect as is possible to obtain at the present time. It is quite apparent therefore, that the blocking condenser in this type of amplifier is of paramount importance.

In choke coil amplification the blocking condenser serves the same purpose as in resistance coupled amplification and it should be of approximately the same size.

There are many special circuits in which fixed condensers can be used as coupling condensers, such as the Browning Drake, super-heterodyne, super-regenerative, reflex, and the like. In most of these circuits they serve as by-pass condensers.

R-29 Bakelite

Engineers who are planning to use molded bakelite to a greater extent than ever in equipment for fall production will be greatly interested in the new low-loss material which has been developed by the Bakelite Corporation. Research data on this material will appear in April.

Everyone will welcome the complete data on B battery eliminators, the special feature of the April number. The information has been compiled in such a way that engineers can readily determine the suitability of various types of eliminators for complete sets which they are developing.

With the Manufacturers



Saturn Mfg. & Sales Company, New York City, is now producing this very trim little filament switch.

DAVEN Radio announces the resignation of Mr. K. R. Moses who has been General Sales Manager, effective January 18th. Until further announcement, W. D. A. Peaslee, Assistant to the President, is acting as Sales Manager.

Daven Radio has added an interesting adjunct to their sales department. To assist inexperienced dealers who are asked by their customers to install Daven amplifiers in their sets, to replace those already provided, service men are being sent out, at the request of the dealers, to show how this work is done. The dealer simply calls the factory at Mitchell 6740, and an appointment is made for the Daven man to call on the dealer. If the Daven man actually does the work, a small charge is made, but if he simply instructs the dealer's service man, there is no cost.

Rathbun Manufacturing Company, Jameson, New York, has issued an interesting pamphlet on the use of the Rathbun S. L. F. converter, explaining how this dial is used to change S. L. C. condensers to give S. L. F. tuning. Dealers are reporting a very large amount of business on the S. L. F. converter replacement parts, particularly for neutrodyne and tuned R. F. sets.

Ralph Bretzner, representing Van Horne and Musselman, Airway Electric, and Selector Company, announces the change of address from 28 West 42nd Street, to 160 West 45th Street, New York City. Phone, Bryant, 0459.

Alden Manufacturing Company reports an unexpected amount of interest in the Connectoralds. This is a special adapter, equipped with flexible leads, for adding the extra B and C batteries necessary for power tubes. The type 420 fits the 120 tubes. This adapter is designed for the semi-portable Radiola superheterodyne and the Radiola VIII. This makes the operation of these sets practically equal to its year's model.

The 920X Connectorald is for the 120 tube portable Radiola 26, and such sets as the dry battery operated Atwater Kent and Adler Royal.

The 112 Connectorald permits the use of the 112 tube in any storage battery operated neutrodyne or tuned R. F. receiver.

On Radiola III and IIIA sets the 42IX adapter makes it possible to use 199 tubes and the 120 in combination. This improves loud-speaker operation surprisingly.

C. A. Englebeck, widely known in the automobile industry, through his connections with the Cadillac Division of General Motors and the Peerless organization has been elected Vice President of the Zenith Radio Corporation, and is now the Director of Sales.

His first affiliation with Zenith was in the capacity of assistant to E. F. McDonald, Jr., a position which he took up while on temporary leave of absence. However, radio apparently proved so interesting that he did not want to give it up to go back to automobiles.



Sangamo Electric Co., Springfield, Ill., is making a line of by-pass condensers in 0.1, 0.25, 0.5, and 1.0 mfd. sizes.

H. H. Eby is distributing a very interesting novelty by way of a display for radio dealers. It is a mammoth binding post, reproducing exactly the Ensign type Eby binding post. As carefully made and as beautifully finished as the real posts themselves, this mammoth measures 6 ins. in diameter by 10 ins. high. They are being sent free to Eby dealers who ask for them.

Diamond State Fibre Company, Bridgeport, Pa., announces that C. M. Bogert is now District Manager for Connecticut, with offices at South Norwalk. W. R. Eisenbrans has been moved from the home office to 822 Drexel Bldg., Philadelphia, where he is District Manager for Philadelphia.

No matter what circuit— Far, Far Better Results

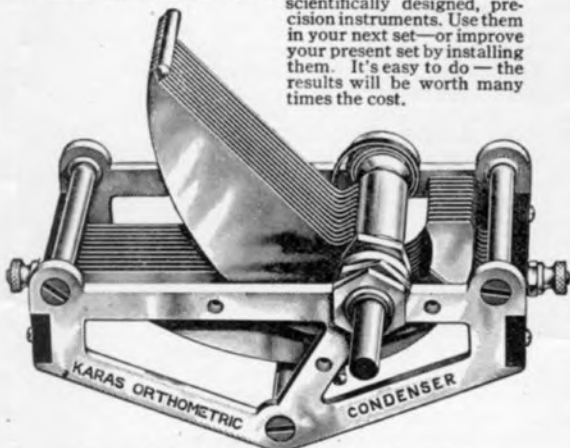
with

KARAS

Orthometric Condensers and Harmonik Transformers

Karas instruments have been tested and recommended by leading technical editors for use in all types of sets from the most elaborate supers to the simplest low loss 3-tube receivers. The most exacting home set builders, the country over, demand Karas Transformers and Condensers—and will use nothing else. Nothing can take the place of these

scientifically designed, precision instruments. Use them in your next set—or improve your present set by installing them. It's easy to do—the results will be worth many times the cost.



Spreads Stations Evenly Over the Dial —No Crowding Whatever

The Karas Orthometric Condenser positively separates all adjoining wavelengths by EQUAL distances on the dial—giving you full benefit of the 10 Kilocycle frequency separation fixed by the government. Ordinary condensers jam 70 of the 100 Government allotted wavelengths into the first 30 points on the dial—even straight-line-wavelength condensers crowd 57 of them below 30. But with Karas Orthometrics, each point on the dial corresponds to one of the 100 allotted wavelengths. The result is marvelous simplicity in tuning—and better, clearer reception—all side bands without interference.

Brings in KDKA at 53

Not at 17—or 28, but at 53 where it belongs, leaving lots of room for the 52 wavelengths that must come in below it. The Karas Orthometric is a "precision job"—entirely of brass. Every joint soldered. Plates patent-levelled and securely bridged.

If your dealer is out of Karas Instruments Order Direct on This Coupon

Most good dealers everywhere sell Karas parts. If your dealer happens to be one who doesn't, we will supply you direct at no trouble on your part—on our 30-day money back guarantee. Just fill in and mail this coupon at once. Send no money. You can pay the postman on delivery.

KARAS ELECTRIC CO., Bldg., Chicago, Ill.

For more than 30 years makers of PRECISION Electronic Apparatus



For Long Distance with Big Volume and Keen Musical Quality

Karas Harmoniks deliver perfect music with loads of volume from stations one to two thousand miles distant. DX broadcasting becomes really enjoyable. "Fishing" for distant stations is only a matter of finding programs you want to hear—not straining to catch only the bare announcement and making up a list of call letters.

Even from far away points, Karas Harmoniks bring out full, round musical tones. All the vital harmonics and rich overtones are fully retained. Low bass notes pour forth, rich, sweet, sonorous.

If you want music like this, you must have Karas Harmoniks in your set. Get a pair TODAY! The best transformer money can buy.

Karas Electric Co.

Mfg. Plant: N. Rockwell St.,

Office: 1063 Association Bldg., Chicago, Ill.

Please ship me the instruments checked below. I will pay the postman prices listed; plus postage upon delivery. It is understood that I have the privilege of returning these goods, for full refund, within 30 days, if they do not prove entirely satisfactory.

..... Karas Harmonik Audio Transformers. (\$7.00 each)

..... Karas Orthometric Condensers: Size.....
(23 plate \$7 ea.; 17 plate \$6.75 ea.; 11 plate \$6.50)

Name.....

Address.....

If you send cash with order, we'll send package postpaid



Victoreen rheostat marketed by Geo. W. Walker Company.

Geo. W. Walker Company, Cleveland, Ohio, is distributor for the new Victoreen rheostats, made in resistances of 6, 10, 20 and 30 ohms. Manganin wire, having zero temperature coefficient, is used for the element. There are about twice as many turns on this rheostat as on other types, giving a much finer adjustment of the filament.

National Carbon Company has issued a new schedule of prices and discounts on the type 7111 6-in. dry cell. This is a special battery intended for radio work. Although the list price has been advanced from 40c to 50c, a wider margin of profit is allowed to dealers.

Storad Manufacturing Company, Cleveland, Ohio, is now manufacturing an automatic radio power supply, consisting of an automatic storage A battery charger and a complete B power supply unit. This unit is connected to the A. C. circuit and, in the usual manner, to the receiving set. When the tubes are in operation, current for the A circuit is drawn from the storage battery and for the B circuit from the B power supply. As soon as the set is turned off, the charger immediately recharges the A battery, bringing it back to full capacity, and cutting off when the battery is charged.

Everyone will be interested to know that J. Chester Johnson, much to the surprise of the radio trade, has resigned as Vice President and General Manager of the American Radio Exposition, a position which he has held for four years, to become associated with U. J. Herman and G. Clayton Erwin, Jr., in conducting the radio exhibits under the auspices of the Radio Manufacturers Show Association. The New York Show to be held by this organization will be at the new Madison Square Garden from September 13th to 18th inclusive.

Ernest Walker Sawyer, formerly Vice President of the Electrad Company, is now to be found at 1915 Sante Fe Avenue, Los Angeles. Here he is representing Silver-Marshall, Amsco, Radiotive, and other manufacturers.

He is also working on the Pitts underground antenna which has been introduced recently in Los Angeles. Mr. Sawyer reports that business in Oregon and Washington is developing steadily, but is much handicapped by lack of good local broadcasting.



Radio Foundation variable grid leak can be adjusted from $\frac{1}{2}$ to 7 megohms.

Van Horne Company has given out the details concerning their method of guaranteeing vacuum tubes.

When the consumer purchases a Van Horne tube, providing the right type is bought and used in accordance with the tube equipment for the set in question, if the tube proves to be unsatisfactory or burns out within thirty days, replacement will be made without question, argument, or delay. If the tube lights, but does not operate properly, it will be replaced within 90 days after purchase.

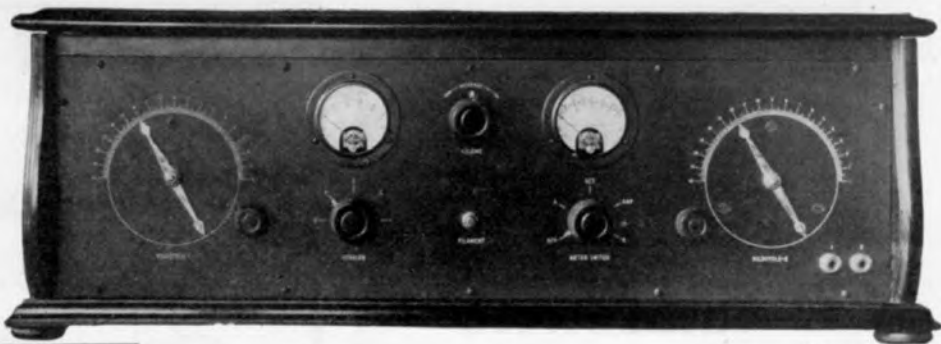
In commenting on these guarantees, Mr. Bretzner, New York representative of Van Horne, said that this kind of guarantee will mean a great deal to his trade because it does actually protect the public and eliminates red tape of unnecessary disputes by the dealers or jobbers in replacing tubes which do not function correctly. Records show that 75% of the tube complaints are from the failure of the filament.

This is certainly a fair and liberal guarantee to the consumer and it should mean much to dealers to be able to guarantee the filaments for 30 days and the life of the elements for 90 days. It is a courageous step on the part of the Van Horne Company, and one which should be taken by all other tube manufacturers. This may seem like a considerable burden to put upon the manufacturers, but it is probably not unreasonable in view of the tremendous economies which have been effected through the use of automatic machinery, in assembling tubes.



R. P. Cunningham Electric Co., Chicago, is producing a variable grid leak in which adjustment is obtained by a thumb screw.

Amplion Corporation of Canada, Ltd., 130 Richmond Street, West, Toronto, Canada, has been organized recently to handle the distribution of Amplion loudspeakers and units in Canada.



The Best in the World

No Batteries

are required even to operate the most powerful 10-tube receiver pictured above, if you use the new laboratory type

Model A
Power Unit

One Customer Telegraphs: "Receiver assembled, performing like a thorobred."

The Amateur or Experimenter with his ultra-modern high-powered receiver is years ahead of Commercial Radio.

It is significant that unsolicited testimonials are constantly being received from even the far corners of the earth, where Norden-Hauck Engineers have furnished the finest radio apparatus known to the art today.

Quotations gladly furnished on radio parts and apparatus having non-infringing uses.

Write for Literature

NORDEN-HAUCK, INC., Engineers

1617 Chestnut St., Philadelphia, Pa.

Chief Engineer:—Do you specify service and quality or price?

The chief engineer of one of the largest concerns manufacturing radio sets specified

Samson Helical Wound Transformers

last Spring because of their quality of reproduction.

At the end of the 1925 radio season, after selling more than 13,000 sets containing Samson Transformers, the chief engineers reported that to date no Samson Transformers have proven defective in consumers' hands and that are yet to have their first complaint. *Truly a remarkable record.*

When you specify Samson Transformers you guarantee not only quality of reproduction but service.



SAMSON ELECTRIC COMPANY



Manufacturers Since 1882

CANTON, MASS.

COMPARE
THE NEW
CARTER
"IMP"
RHEOSTATS



FULL
SIZE

ALL RESISTANCES
3 to 50 ohms

\$1

OPERATES with great efficiency in ALL circuits.

SMALL—only 1 3/8" dia.

ALL METAL FRAME

STURDY—no moulded parts to crack or break.

SMOOTH in operation.

ONE HOLE MOUNTING.

SPECIFIED as standard in leading sets and kits.

SOLD BY BEST DEALERS EVERYWHERE



DURHAM With labels that give ranges accurately
Variable
GRID LEAKS

75c.

STANDARD Type shown above fits all regular clips. Use them to adjust variations in tubes; also for audio control.



\$1.00 Takes less space than a dime on the panel. Making close control convenient means better results—a satisfaction that lasts!

Both types in these sizes

No. 100—1,000 to 100,000 ohms

No. 101—0.1 to 5 megohms

No. 201 A—2 to 10 megohms

DURHAM Bases—three styles, 30 to 45c

Use DURHAMS in all sets

Order by type and size number

DURHAM & CO., Inc.
1930 Market St., Philadelphia

Test These Coils



TRF Kit
LIST \$1200

Scientific measurement of an Aero Coil shows it to have a much lower high frequency resistance than other types of inductances.

Comparative broadcast reception tests show Aero Coils capable of performance in exact accord with their electrical characteristics.

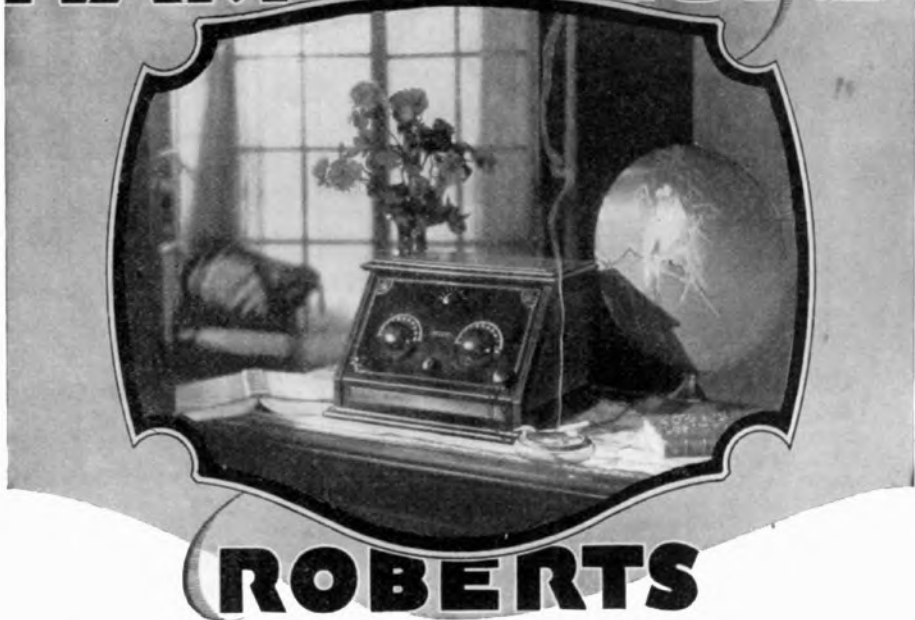
Substitute a set of Aero Coils in any set now using other inductances. You will note an immediate tremendous increase in power, a degree of selectivity which is almost unbelievable and a quality of tone which is perfect—despite the very narrow and sharp resonance peak which Aero Coils show at each frequency.

Manufacturers interested in improving their sets or fans desirous of getting the very limit of performance out of any circuit will do well to look into the Aero Coil proposition at once. There is an Aero Coil for every type of circuit.

Write for the free Aero Booklet.

AERO PRODUCTS, INC.
217 No. Desplains St., Chicago.

HAMMARLUND



FOR a long time to come, there will not be evolved a more efficient circuit than that in the new Hammarlund-Roberts Receiver.

Ten leading radio engineers devised it as their composite ideal. The result is a receiver, operating on only five tubes, which possesses the sensitivity of a standard eight-tube receiver, plus a high degree of selectivity which minimizes interference.

Tuning is simplicity itself. The volume and tone are exceptional, the receiver being designed

HAMMARLUND MFG. CO.

UNIT 2 — "Hammarlund, Jr." The Precision Midget Condenser.

UNIT 3—The New Hammarlund Straight-Line Frequency Condenser.

UNIT 4—The New Hammarlund Low-Loss Space-Wound Coils.

UNIT
4



For Better Radio
Hammarlund
PRECISION
PRODUCTS



424-438 W. 33 St., New York

FOUNDATION UNIT

The Foundation Unit contains all special parts needed to build the Hammarlund - Roberts Receiver, including drilled and engraved panels, brackets, wire, screws, etc. \$7.90, at your dealers.



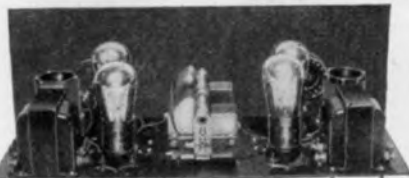
UNIT
4



Send for this
New Hookup



Four-Tube Receiver



The outstanding receiver development of the season, in which is combined the genius of two of the most distinguished radio engineers. A receiver for the home builder that will represent for several seasons to come a far greater value than any other design available.

Several outstanding features place the design in a position far in advance of anything available or contemplated. Unlimited wavelength range, with interchangeable antenna and detector coils; marvelously improved audio transformers; a special self-contained wiring harness; but one tuning or station selector control, are special features.

Over-all design is rugged and solid. Adapted to practically any standard cabinet, any standard tube, any battery or eliminator source of supply, outdoor antenna or loop.

Only a screw driver and pair of pliers necessary. The set can be built at an extremely low cost and parts are readily available at all radio dealers.

Represented Manufacturers:

Belden Mfg. Co.—S-C Wiring Harness
Central Radio Laboratories—Centralab Resistance
Polymet Mfg. Corporation—Fixed Condensers, Leak and Leak Clips
Poster & Co.—Drilled and Processed Front Panel and Drilled Sub-Panel
Silver-Marshall, Inc.—Variable Condensers, Coil Sockets, Coils, Tube Sockets, Vernier Dial, Mounting Brackets
Thordarson Elec. Mfg. Co.—R200 Power Transformers
Yaxley Mfg. Co.—Rheostat, Jacks, Switch

Get the hand-book at your radio dealer's, or clip the coupon and send with 25 cents to

S-C MERCHANDISING COMPANY

109 So. Wabash Avenue, Chicago

S-C MERCHANDISING COMPANY

109 So. Wabash Avenue, Chicago

Herewith please find 25 cents for which send me the hand-book of the new S-C Four-Tube Receiver.

Name

Address

for radio aerials —COPPER wire

COPPER combines the essential qualities of—

**resistance to corrosion,
tensile strength,
high conductivity.**

**COPPER & BRASS
RESEARCH ASSOCIATION**
25 Broadway, New York

PATENT SERVICE

FOR THE MANUFACTURER —

We have retained experienced patent lawyers to create patent situations around the manufacturer's products.

FOR THE INVENTOR —

We aid and assist in the development of his inventions and represent him in negotiations with manufacturers. In meritorious cases we finance the work.

RADIO PATENTS CORP.

INC. 1917

247 Park Ave. New York City.

C-10

Super-Heterodyne

Full set of official blueprints, giving all construction data, parts list, dimensions, hook-up.

Price \$5.00

M. B. SLEEPER, INC.

A-52 Vanderbilt Ave. New York City



15 Parts Manufacturers Have Endorsed the KB-8 470 Jobbers Are Distributing Parts for It

RADIO ENGINEERING is doing its share to help by supplying dealers with dataprints at a reduced list price, and at the full discount.

You know how wonderfully popular the Browning-Drake Five still is, tho the design was first introduced thru Radio Engineering a year ago.

The KB-8 is a modernized Browning-Drake,

brought right up to the minute by incorporating the most advanced features.

Most important of all, the tickler coil is eliminated, and no regeneration in any form is employed.

KB-8 Dataprints give the full-size* panel patterns and picture wiring diagrams, parts list, step-by-step assembly instructions, and all information.

BE THE FIRST DEALER IN YOUR CITY TO DISPLAY KB-8 DATAPRINTS

Non-regenerative KB-8 Dataprints, in individual mailing tube, \$1.00. Lots of 6 or more, 50%. If you have not opened an account already, send check with order to avoid delay in looking up references.

M. B. SLEEPER, Inc. TECHNICAL PUBLISHER

A-52 Vanderbilt Avenue

New York City

NATIONAL

ANNOUNCING BD-3B

— a new National Tuning Unit embodying the wonderful
BROWNING-DRAKE TRANSFORMER
 and an innovation in condenser design

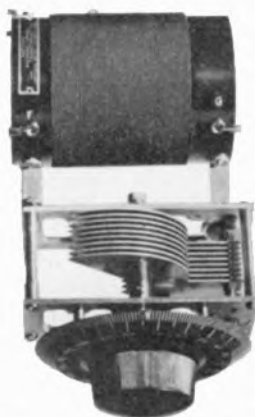
NATIONAL EQUICYCLE CONDENSER

The novel shape of the plates spaces the station groups at equal intervals of 10 kilocycles in a true straight frequency line.

The useful range of rotation has been increased from 180° to 270°. This has been accomplished without the use of gears, cams or levers, thereby eliminating consequent lost motion.

This unit possesses the same electrical efficiency and mechanical stability that have always characterized NATIONAL DX Condensers.

BD-3B Tuning Unit Price \$12.75



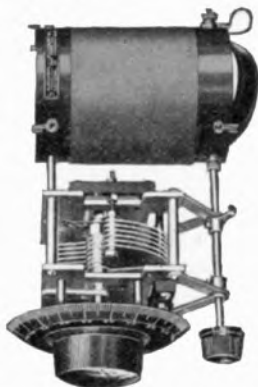
National Tuning Unit BD-3B
 Send for Bulletin 110

These National Tuning Units Give Supreme Satisfaction

BD-1 A

Patents pending

BD-2 A



These time-tested units include the (genuine) BROWNING-DRAKE Transformer and the NATIONAL EQUI-METER (straight line wave length) Condensers and also the NATIONAL Velvet Vernier Dials. How well they excel in receiving range and volume is well known. They are the acknowledged standard; their efficiency proved.

NATIONAL Tuning Units are now made in the following types:

BD-1A—Includes the NATIONAL EQUI-METER (straight line wave length) Condenser and the (genuine) BROWNING-DRAKE Inductance Coil with the NATIONAL Velvet Vernier Dial. Price \$9.25.

BD-2A—Includes the NATIONAL EQUI-METER (straight line wave length) Condenser and the (genuine) BROWNING-DRAKE Inductance Coil with the NATIONAL Velvet Vernier Dial. Price \$12.75.

BD-1B—Includes the NATIONAL EQUICYCLE and the (genuine) BROWNING-DRAKE Inductance Coil with the NATIONAL Velvet Vernier Dial. Price \$10.25.

BD-2B—Includes the NATIONAL EQUICYCLE Condenser and the (genuine) BROWNING-DRAKE Transformer with the NATIONAL Velvet Vernier Dial. Price \$13.75.

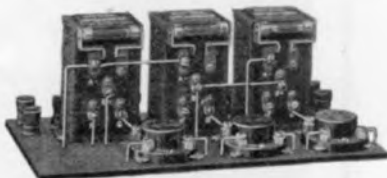
BD-3B—Includes the NATIONAL EQUICYCLE Condenser and the (genuine) BROWNING-DRAKE Transformer, without tertiary coil, and NATIONAL Velvet Vernier Dial. Price \$12.25.

Prices quoted are for Type A Velvet Vernier Dials. If so specified, Type B Dials will be supplied without extra charge.

RADIO PRODUCTS

NATIONAL IMPEDAFORMER (Patents pending)

— radio's most recent contribution to faithful tone reproduction



The illustration shows the assembly of three Impedaformers as they would appear in a set

With these units an impedance coupled audio amplification system can be constructed which will truthfully and uniformly reproduce in all its richness and purity each and every note sent out by broadcasting stations.

The tone quality is superb and the volume is greater than with resistance coupled amplification. This is accomplished with no more B battery voltage than is

usually used on a transformer system and with a minimum of storage battery consumption.

Made in two types: Type A embodies National Choke Coil only. Price \$4. Type B contains Choke Coil with grid condenser and grid leak, combined in a single unit. Price \$5.50. Connections are the same as for an ordinary audio transformer.

NEW TYPE B VARIABLE

National Velvet Vernier Dial

*Variable
Ratio*

*Velvet
Smoothness*

Ornamental



*Positive
Control*

*Easily
Mounted*

Gearless

(Patents pending)

A modified application of our "Velvet Vernier" mechanism. Easily mounted on the 1/4-in. shaft of any standard type of variable condenser. Replaces plain dials on any receiver where sharper tuning is desired.

PRICE LIST

Specifications	Price
Clockwise 200-1 (360°)	Nickel finish \$2.50 Gold finish \$3.00
Counter-Clockwise 1-200 (360°)	Nickel finish 2.50 Gold finish 3.00

Reduces to any ratio from 6-1 to 86-1. This aids greatly in the separation of stations operating on the lower wave lengths. Moulded from black bakelite in ornamental design with perfectly uniform graduations.

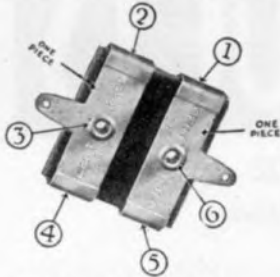
NATIONAL COMPANY, INC.

W. A. READY, President

110 Brookline St.

Cambridge, Mass.

ELECTRAD



*"The Six Point
Pressure Condenser"*

A REVELATION IN DESIGN

A dependable condenser of certified accuracy for careful set builders. Ingenious, rigid binding and firm riveting fastens parts securely at *six* different points, insuring positive electrical contact. Impervious to moisture — unaffected by temperature and climatic variations. Exerts even pressure upon the largest possible surface — cannot work loose. Binding strap and soldering lug is in one piece. Accuracy and quietness are assured always and value is guaranteed to remain within 10% of calibration. Standard capacities, all types. Insist on Electrad—look for the novel six point construction.

Price 30 to 75c at all radio stores.

ELECTRAD

INC.

428 Broadway, New York City

Electrad
Certified Grid
Leaks



These dependable units are made of solid high resistance material, rendering them strong and unbreakable — unaffected by climatic changes. They are quiet and smooth in operation and are obtainable in ranges from $\frac{1}{4}$ to 10 megohms.

Price 50c each at all good radio stores.

Other "Electrad" products are Audiohms, Vari-ohms, Lead-Ins, Royalty Variable High Resistances, Lightning Arresters, Lamp Socket Antennas and Resistance Coupled Amplifier Kits.

AMPLION

For
Better
Radio
Reproduction



The Product of
38 Years' Experience

Due to supremacy of performance this creation of Alfred Graham & Co., England leads in sales throughout the world. Six models, including phonograph units, equipped with cords and panel plugs, \$12 up. Nationally advertised. Write for "Amplion Pedigree" and proposition to trade.

THE AMPLION CORPORATION of AMERICA

Executive Offices:
Suite W, 280 Madison Avenue, New York City
Chicago Branch: 27-29 No. Morgan St.
In Canada: Burndep of Canada, Ltd., Toronto

Celoron Panels

already drilled and engraved for the new Browning-Drake KB-8 Receiver

(Non-Regenerative)

They are specified

When first the Browning-Drake set, illustrated and described in Radio Engineering, was made, Celoron Panels were used. These same panels are now recommended by Browning-Drake for the KB-8 model. This is because the developers of this hook-up found complete insulation necessary to the absolute balancing of this set. They found that Celoron had the insulating qualities necessary to perfect operation of the new Browning-Drake Receiver.

Celoron Panels come drilled according to Browning-Drake templates and are finely decorated—complete with dial and rheostat markings.

Your dealer will supply you with these drilled and decorated Celoron panels. There are six in the complete set, consisting of two vertical sub-panels, two horizontal panels, test terminal panel and front panel. Price complete—3/16 in. thick, \$8.35. Or drilled and decorated panels can be purchased separately as follows:

Small vertical sub panel.....	\$.30
Large vertical sub panel.....	1.00
Large horizontal panel.....	1.00
Small horizontal panel.....	.35
Test terminal panel.....	.20
Front panel	5.50
	\$8.35

These Celoron panels can be purchased wherever you buy the other parts of your Browning-Drake Kit.

Diamond State Fibre Company

The oldest and largest manufacturer in the vulcanized fibre-laminated technical products industry

Bridgeport, Pa., and Chicago, Ill.

CELORON

In Canada

Diamond State Fibre Company of Canada, Ltd.
Toronto, Ontario, Canada, 235 Carlaw Ave.
Montreal, Canada, 84 St. Francois Xavier St.

FOR THE NON-REGENERATIVE KB-8 SET



New—

We assume that those who are interested in designing radio sets have received one of our No. 776 circulars, describing our new line of 2 inch radio instruments.

We believe that engineers will all be interested in our new 135-A and 135-6 instruments for plugging into sets supplied with phone jacks on the panel.

Send for Circular No. 739

Jewell Electrical Instrument Co.

1650 Walnut St. - Chicago

"26 Years Making Good Instruments"



Crowe Metal Panels

for

BROWNING-DRAKE KB-8

are now in preparation and will be available through leading distributors and radio dealers. Carefully packed in individual containers, with insulation and instruction sheet, completely drilled, ready for use.

Inquiries Invited from Responsible Jobbing Houses

ADDRESS

CROWE NAME PLATE & MFG. CO.

1749 Grace Street

::

Chicago

You—*who know Radio* will welcome these *pertinent facts* on *permanent "A" current supply*

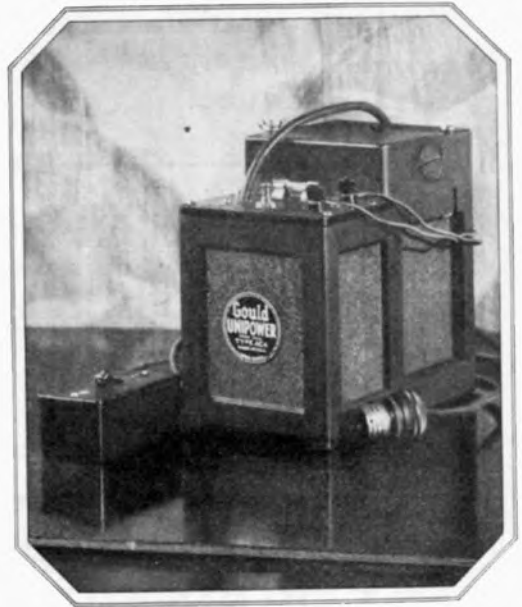
Both the Institute of Radio Engineers and the Associated Manufacturers of Electrical Supplies have unqualifiedly endorsed the "trickle charge" principle as the best source of permanent "A" current power.

THIS principle was first developed three years ago by the engineers of The Gould Storage Battery Company and resulted in the creation of Unipower—radio's first complete "A" power unit.

Attempts have been made to duplicate Unipower. But the reliability of such a "trickle charge" installation depends upon the proper relation of all the elements involved. Simply to approximate the "trickle charge" principle does not mean that the battery will not become overcharged, or that the "A" current supply will not fail when it is wanted most.

Unipower stands out as embodying every mechanical and electrical feature necessary to the efficient and economical performance of the "A" circuit in any radio set, from a simple one-bulb outfit, to the most elaborate multi-tube superheterodyne.

Unipower not only assures the set owner of continuous quiet "A" power, always at full voltage; but the Unipower master control switch—an exclusive feature—makes it possible to coordinate both



Illustrating the 4-volt Unipower, designed for sets employing R. C. A. 199 tubes or equivalent.

the "A" and "B" circuits under one control.

In Unipower only, are all these features incorporated. In Unipower only, have those qualified to know, found the final answer to the "A" power problem.

THE GOULD STORAGE BATTERY CO. Inc.
250 Park Ave., New York

Unipower contains a Balkite charging unit of special design.

4 volt model, \$35—60 cycles, 110-125 volt A. C. Designed for radio sets using R. C. A. 199 tubes or equivalent.

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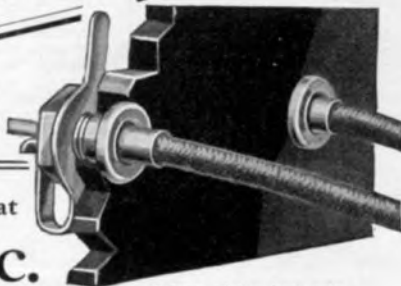
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2-3 1/2"	by 9 1/2" by 3/16" Celeron-Bakelite Panel		10-	Eby Ensign engraved binding posts	1.50
2-3 1/2"	by 2 1/2" by 3/16" Celeron-Bakelite Panel		1-	Electrad or Walbert filament control switch	.40
1-	National B-D S.L.F. tuning unit	22.50	1-	Electrad open circuit jack	.25
1-	National B-D R.F. unit	11.00	2-	Electrad or Pacent 30-ohm rheostats	2.50
2-	National Impedafomers B-type		1-	Walbert balancing condenser	1.25
1-	Radiall Amperite 6V-199	1.00	3	ft. No. 4-21-40 R.F. copper cable	.25
5-	No. 100 Amsco sockets	3.00	1-	length No. 7 varnished tubing	.15
3-	No. 50 Daven mountings	1.05	40	ft. Wirtd (2 coils)	.50
1-	5-megohm Daven resistor	.50	50-	6-32 Lastites	1.00
1-	1-megohm Daven resistor	.50	6-	Durrant terminal pillar supports	1.80
3-	0.1-megohm Daven resistor	2.25	10-	1/2-in. 6-32 F.H. lacquered screws	.15
1-	Type 640 G Dubilier micadon	.50	30-	3/8-in. 6-32 R.H. nickelled screws	.30
	0.00025		6-	1/2-in. 6-32 R.H. nickelled screws	.05
1-	Type 640 G Dubilier micadon	.45	20-	5/8-in. 6-32 R.H. nickelled screws	.20
	0.001		20-	6-32 .041 nickelled nuts	.20
			10-	Durrant soldering lugs	.10

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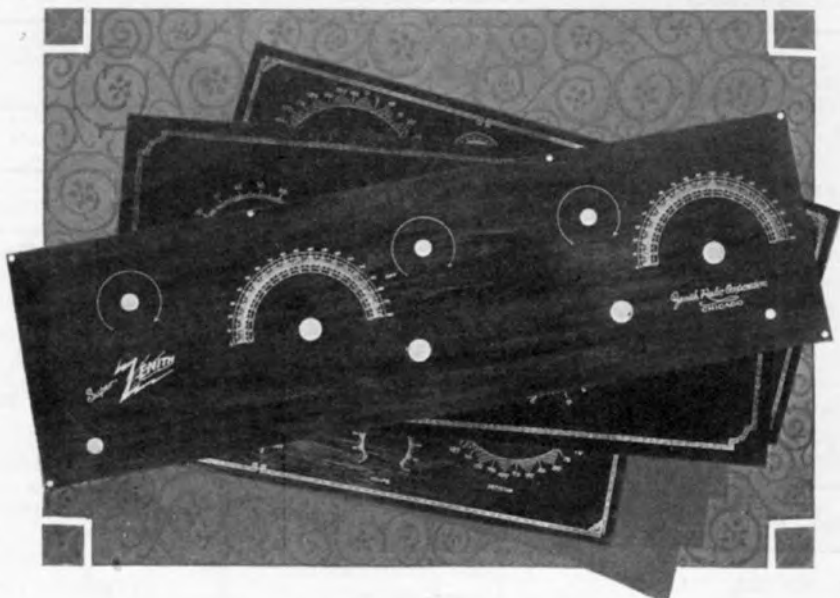
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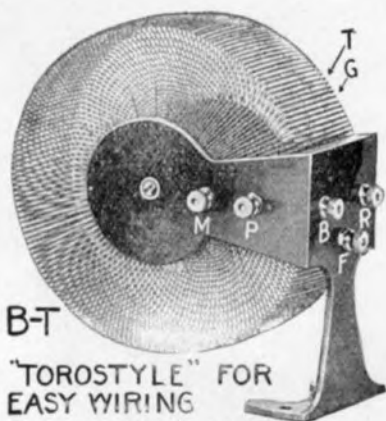


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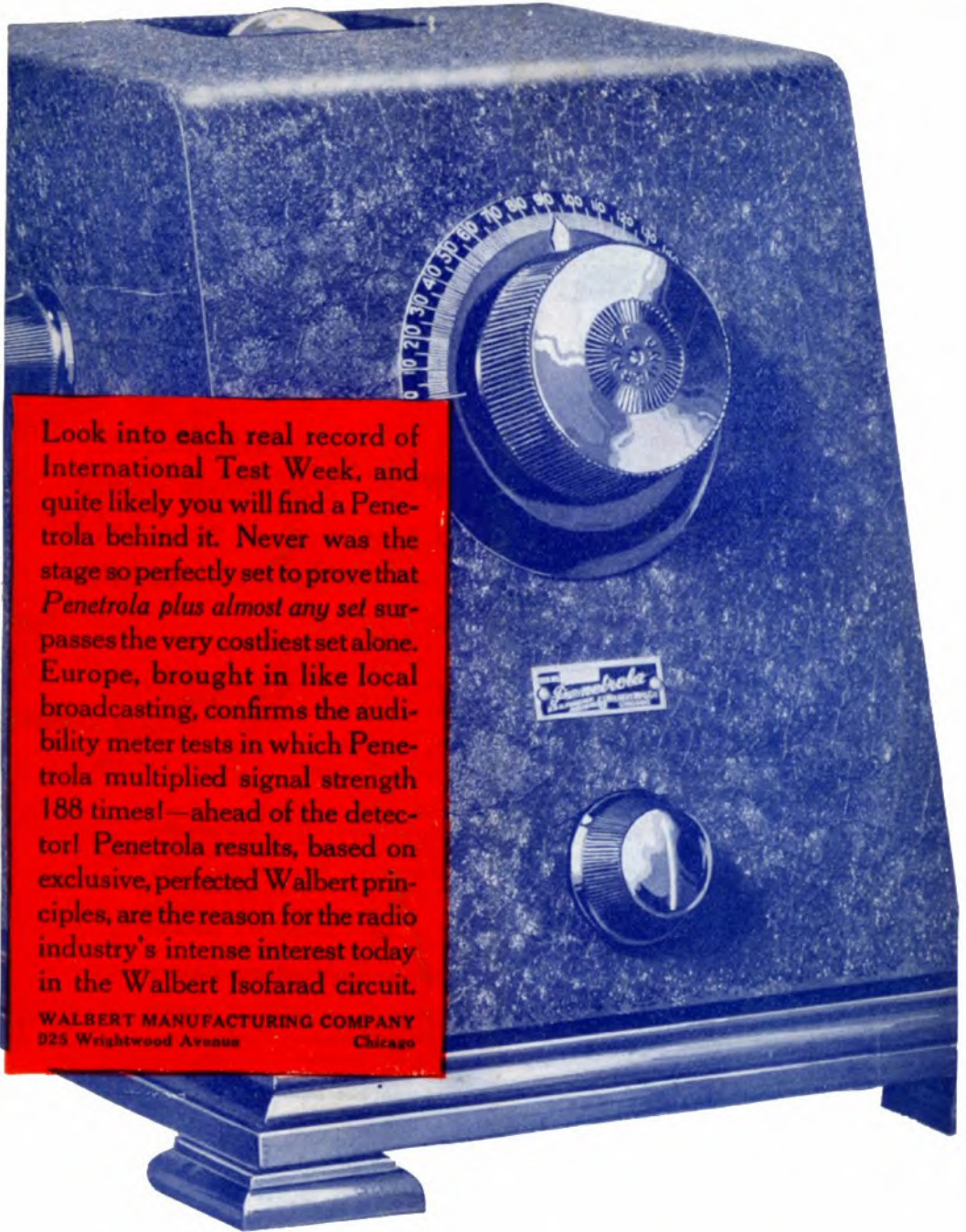
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