



MODERN SHORT WAVE APPARATUS

FOR
**EXCLUSIVE AMATEUR
PURPOSES**

MULTI-STAGE TRANSMITTERS

MASTER OSCILLATOR OR
CRYSTAL CONTROLLED TYPES

LINEAR POWER AMPLIFIERS

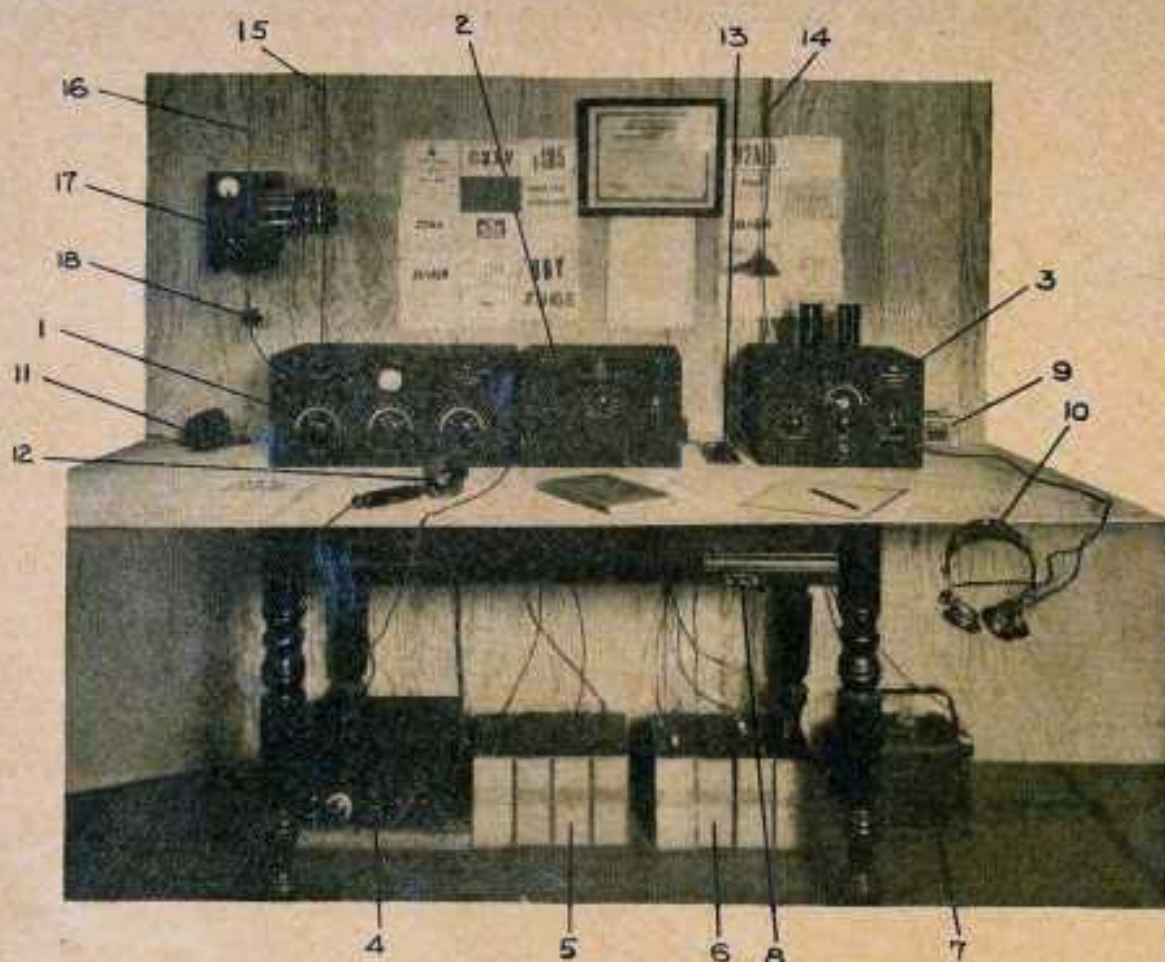
50 OR 75 WATT TYPES

POWER SUPPLY UNITS SHORT WAVE RECEIVERS

SCREEN GRID R. F.
WIDE SPREAD TUNING

AMATEUR ANTENNA DATA PRECISION FREQUENCY METERS

DESIGNED AND BUILT BY
RADIO ENGINEERING LABORATORIES, INC.
100 WILBUR AVENUE
LONG ISLAND CITY, N. Y., U. S. A.



TYPICAL REL AMATEUR STATION LAYOUT

The above illustration shows how the amateur may lay out various parts so as to have both symmetry and efficiency in his station. The arrangement allows flexibility, ease of operation and ready access. If space does not permit the above arrangement, the amateur will have to use his own judgment and place the apparatus so that the general overall efficiency will not be impaired. A brief description of the apparatus necessary to complete this modern telephony and telegraph station is given below.

(1)—REL CAT. NO. 215, MULTI-STAGE TRANSMITTER UNIT. This set is regularly supplied with one set of plug-in coils for the 80 meter band. Additional sets of coils to cover the 40 or the 20 meter bands may be purchased extra. Kit Price \$56.00

The following tubes are required for the 215 unit:
 1—UY-257 or equal oscillator tube.....Price \$2.50
 1—UX-224 or equal buffer tube.....Price \$4.00
 1—UX-245 or equal power amplifier tube.....Price \$5.50

(2)—REL CAT. NO. 225 MODULATOR AND SPEECH AMPLIFIER UNIT. Kit Price \$42.00

The following tubes are required for the 225 unit:
 1—UX-220 or equal modulator tube.....Price \$11.00
 1—UY-257 or equal speech amplifier tube.....Price \$2.50

(3)—REL CAT. NO. 231 AMATEUR BAND RECEIVER. This set is regularly supplied with three plug-in coils to cover the 30, 40 and 20 meter amateur bands. Kit Price \$36.00

The following tubes are required in the 231 receiver:
 1—UX-222 or equal RF amplifier tube.....Price \$4.50
 1—UX-201A or equal detector tube.....Price \$1.25
 1—UX-212A or equal audio amplifier tube.....Price \$2.25

(4)—REL CAT. NO. 185 PLATE SUPPLY POWER UNIT. This power pack is supplied completely assembled and wired. Price \$35.00
 The following tube is required in the 185 power pack.
 1—UX-281 or equal rectifier tube.....Price \$7.50

(5)—TRANSMITTER "C" BATTERIES. A total of 180 volts C battery is necessary for operating the No. 215 and No. 225 units. If the station is only to be used for telegraph purposes, that is, if the No. 225 modulator is not used, the total C voltage necessary must be only 90 volts. These C batteries may be of the smallest type purchasable similar to Eveready type No. 772's.
 4—Eveready No. 172, 45 volt batteries or equivalent. Price \$8.00

(6)—RECEIVER AND LOW VOLTAGE TRANSMITTER PLATE SUPPLY BATTERIES. Four standard 45 volt heavy duty B batteries are used to supply the oscillator and buffer tubes in the transmitter and also all tubes in the receiver. The S. P. D. T. switch "S" is used to shift this battery bank from the transmitter to the receiver or vice versa.
 4—Eveready No. 770 heavy duty 45 volt batteries or equivalent. Price \$16.00

(7)—6 VOLT STORAGE BATTERY. Any type of standard battery can be used. This supplies the filaments of the receiver tubes.
 1—Eldis 6 volt 100 ampere hour storage battery. Price \$15.50

(8)—PLATE BATTERY CHANGEOVER SWITCH. Any small size S. P. D. T. switch can be used for this purpose.
 1—Midex size S. P. D. T. switch. Price \$6c

(9)—RECEIVER C BATTERY. Any small 0 volt battery will serve this purpose.
 1—Eveready No. 771, 4 1/2 volt C batteries or equivalent. Price \$1.60

(10)—RECEIVER HEADPHONES. Any good make of headphones will be satisfactory.
 1—Pr. Federal Brandee headphones. Price \$3.50

(11)—REL CAT. NO. 215 FILAMENT HEATING TRANSFORMER. This transformer supplies the filaments of all tubes in both the No. 215 and the No. 225 units. The primary is designed to operate from any standard 110-120 volt 50 to 60 cycle single phase power supply line.
 1—Cat. No. 215 filament transformer. Price \$6.00

(12)—HAND MICROPHONE. Any standard make of single button carbon microphone will serve the purpose.
 1—Pratt hand microphone. Price \$10.00

(13)—TELEGRAPH KEY. Any standard make telegraph key will be satisfactory.
 1—Mounted Bunnell telegraph key. Price \$5.00

(14)—RECEIVER ANTENNA LEAD-IN WIRE. Wherever possible a separate receiver antenna is recommended. This will eliminate the necessity of switching the antenna from the transmitter to the receiver and it will also allow duplex operation.

(15) and (16)—TRANSMITTER ANTENNA AND COUNTER-POISE LEAD-INS. Two lead-in wires are shown in this particular layout. However, the actual number of lead-in wires will depend upon the antenna system employed.

(17)—REL CAT. NO. 173, 80 METER AMATEUR PRECISION FREQUENCY METER AND REL CAT. NO. 150 FREQUENCY METER INDICATOR. These measuring instruments are absolutely essential if the amateur desires to know the exact frequency at which the transmitter is operating. By means of this instrument the amateur can quickly and accurately shift his frequency. For 40 and 20 meter measurements it is simply necessary to replace the frequency meter. The indicator functions with any of the amateur band frequency meters. This meter may be mounted in such a position that it will always indicate when the station is functioning.
 1—REL Cat. No. 173—80 meter frequency meter and indicator. Price \$11.00

(18)—FILAMENT TRANSFORMER PRIMARY SWITCH. Any standard S. P. S. T. map switch will be satisfactory.
 1—S. P. S. T. map switch. Price 40c

The amateur, no doubt, has many of these parts now available which may be used to good advantage.

MULTI-STAGE TRANSMITTER KIT

Basic low power foundation unit which may be used:

- 1—Straight CW telegraph transmitter.
- 2—Can be combined with separate modulator unit for telephone purposes.
- 3—Can be used in conjunction with additional higher power linear amplifiers.

The modern radio amateur, whether he be an oldtimer or a beginner, realizes that an efficient, up-to-date transmitter must be of the oscillator amplifier or multi-stage type and not of the self-excited single tube type. The narrowed amateur wave channels which are now congested with more transmitters than ever before require the use of absolute frequency precision and frequency stability. The multi-stage transmitter, which may be either of the master oscillator or Piezo crystal excited type, fulfills the requirements for modern times.

Radio Engineering Laboratories have developed a low power basic unit known as their Cat. No. 215. The very reasonable price places this transmitter kit at the doorsteps of every amateur. The tubes employed and the power supply required are practically the same as that used in modern broadcast receivers, thereby thus meaning that the cost for accessories is reduced to a minimum. This is a very essential thought, because in most cases the actual transmitter is cheap when compared with the cost of the tubes and power supply required. Furthermore, the REL Cat. No. 215 kit is simple to operate. The amateur who has been used to a one tube set need not despair of tuning a three tube multi-stage transmitter. The procedure is definite and positive and the instructions furnished are clear and distinct. No unnecessary experimentation is required. This means that the inductances, condensers and the choke coils have the correct values. The Radio Engineering Laboratories has taken care of

this for you. All that is required of the purchaser is to assemble and wire the kit as per instructions. The tuning and placing of the transmitter in operation is actually simpler than tuning some of the modern custom built broadcast receivers. The beginner who is bubbling over with enthusiasm to join the amateur ranks will find this Cat. No. 215 kit the ideal apparatus with which to initiate himself into the fraternity of midnight brass pounders. The clear steady note and the absolute stable signal will immediately gain for him the respect and applause of the older "dyed in wool" "hams."

The present-day amateurs who are continually handling traffic or those who are interested in telephone transmission will immediately appreciate the design features incorporated in the REL Cat. No. 215 kit. This apparatus can be employed as a basic telegraph transmitter the output of which can be fed directly into any standard type of antenna system. The standard No. 215 unit is equipped and designed to employ a master oscillator type of frequency control stage. This allows for quick shifting of frequency in any of the regular assigned amateur channels. At slightly additional cost the

purchaser may secure a Piezo crystal control oscillator stage. However, this will limit the transmitter to one definite frequency and will not allow shifting in the band.

It is, therefore, suggested that you determine this fact before deciding upon the building of your new station. Do you want crystal control and one definite frequency only or do you want master oscillator type of control with flexible means for shifting frequency in each band? The Radio Engineering Laboratories have determined that for general amateur purposes the master oscillator type of control stage should be superior, due to its flexibility and also due to its lower cost in price.

The oscillator stage employs RCA UY-227 or equal. The filament power may be derived either from AC or DC. 2½ volts at 1.75 amperes are necessary. The 180 volt plate supply may be obtained from a rectifier unit,

a "B" eliminator, or, best of all, from four medium size or heavy duty 45 volt B batteries connected in series to give a total of 180 volts. When using a pure DC plate supply such as is obtained from batteries, the tone will in all respects resemble a crystal controlled transmitter.

The next stage is the buffer "Class B" type amplifier, which employs a RCA UY-224 or equal tube. The filament has the same specifications as that for the tube employed in the oscillator stage. Plate supply likewise is 180 volts and may be obtained from the same source as that which furnishes the oscillator tube. The 75 volts

necessary for the screen grid may be tapped off from the B supply. The C battery bias may be secured from small size B batteries. One large C battery bank is sufficient to operate all three tubes in the Cat. No. 215 unit. The various required C voltages can be tapped off from this bank.

The power amplifier stages employ a RCA UY-245 or equal. The filament supply necessary is 2½ volts at 1.5 amperes. As the filament in this tube is not of the separately heated type such as employed in the other two tubes, it will be necessary to employ a filament heating transformer which has an accurate center tap. Incidentally, the same filament transformer may also be used to heat the filaments of the oscillator and buffer tubes. This, therefore, means that the filament heating transformer, if alternating current is employed, or the battery if direct current is employed must be capable of delivering 2½ volts at 5 amperes. As previously mentioned, if an AC transformer is used it should be center tapped so that the return of the power amplifier tube will go to this connection. Such a center tap transformer is very advantageous when the Cat. No. 215



The illustration shows the front assembly view of the Cat. No. 215 unit. A neat metal case provides an enclosure for the apparatus. The overall dimensions of the Cat. No. 215 unit are 19 in. x 9 in. front x 16 in. deep. The approximate weight is 18 pounds.

of your transmitter and slowly rotate the oscillator tuning condenser until the carrier is picked up in your receiver. This then indicates that your transmitter is operating on a frequency somewhere in the band. The actual frequency cannot be ascertained, but you can determine whether you are in the upper part, in the lower part or in the middle.

3—Use a broad range wavemeter for approximately locating the transmitter within the band. A broad range wavemeter may be defined as that type of indicator which covers wavelengths from 15 to 200 meters, such as the REL Cat. No. 125 type A.

You may next monitor or listen to the note of the oscillator. Use your present receiver or if a small monitor is on hand use this. The note heard will be exactly the same as that which eventually travels out over your antenna system to other receivers. The stability of the signal may be checked by letting the oscillator run for a considerable time and listen in continuously on your receiver or monitor. The tone should not vary. Thus, you will have checked both the character of your emitted signal and also the frequency.

If you are desirous of calibrating your transmitter, you may do this by taking several readings at various settings of the oscillator condenser. An accurate frequency meter is practically the only means against which you may obtain precision calibration. It is a novel feature to be able to shift your frequency up or down within a certain band and it is still more novel to be able to tell the other fellow exactly where you are shifting to. This is a feature which will sooner or later be highly appreciated by all amateurs.

As previously mentioned, a Neon glow lamp is an essential item for checking of radio frequency circuits.

The Radio Engineering Laboratories, Inc., offers a very rugged and practically everlasting Neon tube for this purpose. This tube is sold for \$1.50. When ordering simply specify: one test type Neon tube.

With such a Neon tube you may test the effectiveness of the various radio frequency choke coils employed in the transmitter. For instance, the plate choke "RFC-1" should indicate radio frequency at its plate end and at the other end of the choke it should indicate nothing. In like manner, the end of coil "L1" which is connected to the coil base prong "1" should also be alive. The grid end of the inductance "L1" which connects to the base prong "4" must indicate some RF. Of course, the amount of RF indicated at the grid end is slightly less than that at the plate end. Continuing along these lines the radio frequency is traced through the grid coupling condenser "GCI," and further on up to the top grid connection of the UY-224 Buffer Amplifier Tube.

The oscillator circuit has now been checked and tuned to the desired frequency. The next step is to tune the Buffer Amplifier. Connect another wire from the same 180 volt battery supply to the post marked "+180" at the rear of the Buffer Amplifier compartment. Also connect the plus 75 volts to the post marked "+75." This may be obtained by tapping the 180 volt battery. In most cases 75 volts is difficult to obtain because standard 45 volt batteries are usually furnished with a mid tap at 22½ volts. The nearest screen grid voltage thus obtainable, would be either at 67½ or at 90. The 67 volt tap will be found satisfactory for most purposes. Therefore, connect plus 67 volts to the "+75" volt terminal, which appears at the rear of the Buffer Amplifier compartment.

The UY-224 Amplifier tube when employed with 180 volts plate and 67 volts screen grid requires approximately 67½ volts negative C biasing battery for correct operation. This 67½ volts may be obtained from the "C" battery bank. This bank may comprise of two 45 volt small size batteries connected in series. The amateur need not be alarmed at the cost of these batteries, because their life is exceptionally long and they should stand-up for practically a whole year's operation.

The Buffer Amplifier is now ready for operation. Plug in the inductor "L2." Remove the plate milliammeter plug from the oscillator jack "J1" and insert it in the Buffer Amplifier jack "J2." In this position the plate meter will read the amount of current drawn by the UY-224 tube. Turn on the power and then slowly rotate the buffer amplifier tuning condenser "C2." A definite place will be reached where the milliammeter needle shows a sharp dip downward towards the low end of the scale. Set the condenser at that position where the milliammeter needle gives the lowest reading. This indicates that the Buffer Amplifier is in exact resonance with

the master oscillator circuit and therefore operating at the same frequency. A test for radio frequency may be now made. Touch the Neon tube to the stator plates of the buffer tuning condenser "C2." It should glow very brightly. In like manner, you may check the grid radio frequency choke coil "RFC3" and the plate radio frequency choke coil "RFC2." One end of each of these chokes must be alive and the other end must be dead. That is, of course meaning radio frequency.

It is now essential to check whether or not the master oscillator circuit is really controlling or driving the UY-224 tube. By inserting a dummy plug or a small piece of wood into the master oscillator plate jack "J1," you will stop this oscillator circuit from functioning. Immediately, when the oscillator plate circuit is open, you will notice that the Buffer plate current as indicated on meter "M" will fall to zero. Furthermore, if you take the Neon tube and touch it to the stator plates of condenser "C2," you will notice that there is no radio frequency flowing. This means that the oscillator is really controlling the Buffer stage. With the oscillator jack "J1" open, the buffer plate current should fall to zero. If it does not you will have to increase the C voltage which is connected to the minus "C1" terminal. There must be sufficient C bias on the buffer tube so that it will cut the plate current to zero when excitation from the oscillator stage is cut off.

The actual correct amount of C voltage required for the Buffer tube is realized when the Buffer plate meter falls to zero. Do not use more C battery than necessary and likewise, do not use too little. Experiments with several models of the Cat. No. 215 units have definitely proven that 67½ volts are correct.

With the Buffer stage correctly tuned, you should again check the tone by listening in on your receiver or monitor. It should be exactly the same as that which you heard when the master oscillator was functioning independently. You should also note a slight increase in the intensity or volume of the signal. If the Buffer is not in absolute resonance with the master oscillator circuit, you will notice a broad tone not sharp and distinct. Should this be the case a very slight adjustment of condenser "C2" will synchronize both circuits.

The final stage is to place in operation the power amplifier or output circuit. This circuit employs a UX-245 tube which requires approximately 250 to 300 volts plate supply. This may be obtained from any source as previously outlined. The negative biasing battery used may be the same as that employed for the buffer tube, except that 90 volts are necessary. The minus 90 volts is connected to the minus "C2" post. The positive connection of the C battery has previously been connected to the "plus C" or ground post.

The milliammeter plug is now taken out of jack "J2" and inserted in the Power Amplifier jack "J3." In this position the plate meter will indicate the amount of current drawn by the UX-245 tube. Incidentally, this plate circuit must be closed. That is, connect the "plus 300" volt power supply. The open jack "J3" naturally was closed when the meter "M" was inserted.

The next and final step is to rotate the amplifier tuning condenser "C3" until the plate meter needle dips to a minimum position. This now indicates that the power amplifier is in resonance with the Buffer amplifier, which, of course, in turn is being controlled by the master oscillator circuit. The Neon tube may be used to check the radio frequency. Touch the stator plates of condenser "C3." Be careful when doing this because the amount of radio frequency developed in the power amplifier stage is considerably more than that had in the previous stages. The operator should always be careful to hold the glass portion of the tube and not touch any of the metallic base portion. The neon tube may also be used to check the radio frequency choke coils "RFC4" and "RFC5." "RFC4" should indicate very brightly at the plate end and nothing at all at the jack end. Likewise "RFC5" should indicate at the grid end and show no indication at the "minus C2" end.

The Power Amplifier Tube UX-245 will require about 90 volts negative C battery when the Cat. No. 215 set is used for telegraph transmission. Ninety (90) volts will be sufficient to operate this tube at the cut off point. This circuit is then functioning as a class "B" amplifier. Incidentally, the Buffer stage is also functioning as this type of amplifier. It is essential that the operator experiment with the negative C voltage so as to make sure that just sufficient is applied to reduce the plate current

mils to zero, when excitation from a previous stage is cut off. Experiments with various models have proven that with 300 volts plate supply, 90 volts negative C will be sufficient to accomplish this.

The Cat. No. 215 Multi-Stage Transmitter can now be considered completely tuned and ready for feeding the available antenna.

For information regarding various types of antenna, refer to the diagrams and tables furnished elsewhere in this booklet.

Outside of the inductor "L4" there is no other additional antenna equipment. As previously stated, this is so that the amateur may connect the set to any type of antenna system or if so desired he may feed the output into another larger amplifier. If the output of the inductor "L4" is to be fed directly into an antenna the operator can very easily assemble the necessary antenna variable condensers and meters. These may be advantageously mounted directly above the transmitter.

The following summary of plate current readings may be more or less closely followed:

Oscillator Plate	10 milliamperes
Buffer Amp. Plate Current.....	12 milliamperes
Power Amplifier Plate Current.....	32 milliamperes

L2—3500 KC band (80 meters) buffer amplifier inductance.

L3, L4—3500 KC band (80 meters) power amplifier inductance with independent antenna winding.

Three standard plug-in coil bases are furnished for the above coils.

C1—REL Cat. No. 181-B, oscillator tuning condenser 115 mmfd. capacity.

C2—REL Cat. No. 181-B, buffer amplifier tuning condenser 115 mmfd. capacity.

C3—REL Cat. No. 181-B, power amplifier tuning condenser 115 mmfd. capacity.

NOTE: Three large type pointer knobs are supplied for the above condensers.

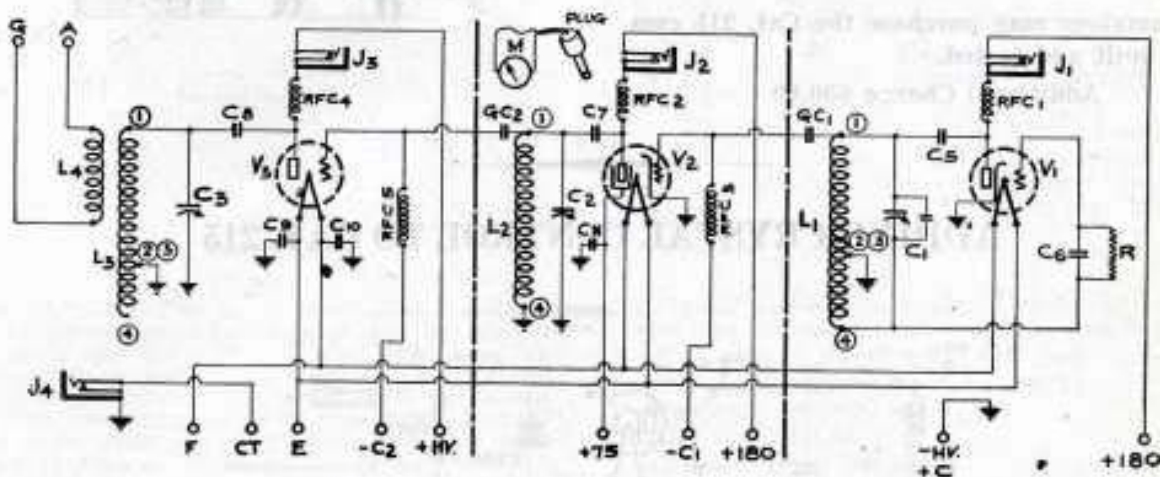
C5—REL Cat. No. 150 type "K" oscillator plate blocking condensers, 2000 mmfda.

C6—REL Cat. No. 150 type "K" oscillator grid condenser, 2000 mmfda.

C7—REL Cat. No. 150 type "K" buffer amplifier plate blocking condenser, 2000 mmfda.

C8—REL Cat. No. 150 type "K" power amplifier plate blocking condenser, 2000 mmfda.

C9, C10—REL Cat. No. 150 type "K" power amplifier filament bypass condensers, 2000 mmfda. each.



Schematic Wiring Diagram, Cat. No. 215
Multi-Stage Transmitter

The plate current drawn by the power amplifier tube will increase to the above mentioned normal rating when the set has been tuned to resonance with the antenna system or tuned to feed another larger amplifier. When using alternating current to heat the filaments you may insert the key so that it will open and close the center tap connection of the filament transformer. This is accomplished by inserting the key plug into the jack "J4." If direct current is used for heating the filaments the key should be inserted into the amplifier plate jack "J3." Bear in mind that if this last method of keying is employed you will have to take special precaution not to touch any of the metallic portion of the key because this will be carrying 300 volts.

The output characteristic of the transmitter may again be listened to. However, this time you may find that the receiver will not do because of the increased power now available. Under these conditions you will be obliged to use a regular monitor placed at a distance to the transmitter. The character of the note should resemble that which you originally heard while testing the master oscillator circuit. A very good check for frequency stability is to plug the milliammeter into jack "J1" and while keying the set carefully note that this meter needle shows hardly any deflections. This is a positive proof that the master oscillator circuit is driving consistently and is not being subjected to any feed back from the power amplifier circuit. This is also proof that the Buffer stage is functioning correctly and doing what its name implies.

The following parts are supplied with each Cat. No. 215 kit:

L1—3500 KC band (80 meters) oscillator inductance with internal high C fixed condenser.

C11—Buffer amplifier screen grid bypass condenser 1 mfd. 250 volt type.

GC1—REL Cat. No. 150 type "K" buffer amplifier grid coupling condenser, 2000 mmfda.

GC2—REL Cat. No. 150 type "K" power amplifier grid coupling condenser, 2000 mmfda.

NOTE: The fixed condensers with the exception of C9, C10 and C11 are supplied with bakelite strips and bushings for mounting as shown in the photograph.

RFC1—REL Cat. No. 132 oscillator plate RF choke coil.

RFC2—REL Cat. No. 132 buffer amplifier plate choke coil.

RFC3—REL Cat. No. 132 buffer amplifier grid choke coil.

RFC4—REL Cat. No. 132 power amplifier plate choke coil.

RFC5—REL Cat. No. 132 power amplifier grid choke coil.

J1—Oscillator plate meter jack single circuit closed type.

J2—Buffer amplifier plate meter jack single circuit closed type.

J3—Power amplifier plate meter jack single circuit closed type.

J4—Key jack single circuit closed type. 2A.

M—Plate milliammeter Jewell model No. 135, 0-100 mls.

P—Meter plug with 2 foot extension cord.

V1—Oscillator tube socket, Buffalo UY type.

V2—Power amplifier tube socket, Buffalo UY type.

V3—Power amplifier tube socket, Buffalo UX type.

R—Oscillator grid resistance, 5000 ohms.

ADDITIONAL INSTRUCTIONS FOR THE OPERATION OF REL CAT. NO. 215 TRANSMITTER.

REVISING ONLY OSCILLATOR CIRCUIT

Continued experiments on the Cat. No. 215 transmitter have shown that improvements of a beneficial nature can be made. A study of the new wiring diagram will show that a grid coil, L5, has been added to the oscillator circuit. This addition results in a more efficient combination, that is, greater output for the same input. The legend below the circuit diagram gives the new parts list, which differs but very little from the older list.

ASSEMBLY

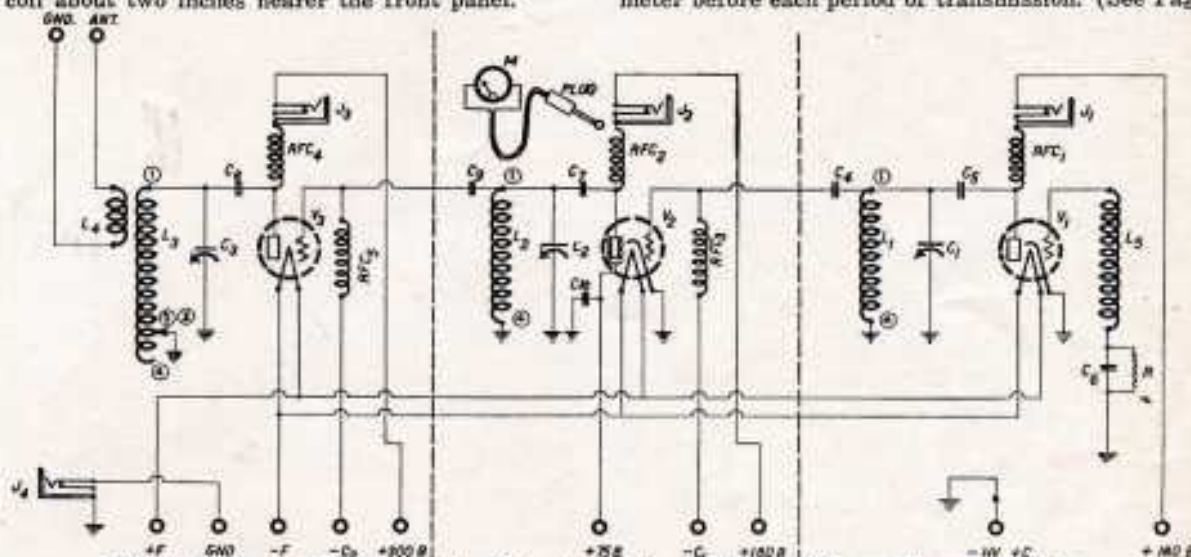
The circuit changes that have been made do not affect the assembly instructions given elsewhere. The grid coil base is mounted in the oscillator compartment in the space formerly occupied by the grid leak and grid condenser, R and C6. These are now mounted next to the grid coil about two inches nearer the front panel.

OPERATION

The operation remains unchanged and the instructions given on Pages 3, 4 and 5 should be carefully followed if the best results are to be obtained. The following table gives the approximate setting of the oscillator dial for the various bands. It is understood that the proper plate coil and corresponding grid coil must be used.

BAND	DIAL DIVISIONS
80	65 - 95
40	35 - 45
20	25 - 30

These readings are only approximations and vary widely with different tubes and sets. The frequency should always be checked with an accurate frequency meter before each period of transmission. (See Page 16.)



List of Parts Used in the Construction of the Above Transmitter.

- L1—Oscillator plate inductance.
- L2—Buffer amplifier inductance.
- L3, L4—Power amplifier inductance with independent antenna winding.

Three standard plug-in coil bases are furnished for the above coils.

- L5—Grid coil. A plug-in base is also furnished with this coil.

- C1—REL Cat. No. 181-B oscillator tuning condenser, 115 mmfds.

- C2—REL Cat. No. 181-B, buffer amplifier tuning condenser, 115 mmfds.

- C3—REL Cat. No. 181-B, power amplifier tuning condenser, 115 mmfds.

NOTE: Three large type pointer knobs are supplied for the above condensers.

- C4—REL Cat. No. 150 type "K" buffer grid coupling condenser, 2000 mmfds.

- C5—REL Cat. No. 150 type "K" oscillator plate blocking condenser, 2000 mmfds.

- C6—REL Cat. No. 150 type "K" oscillator grid condenser, 2000 mmfds.

- C7—REL Cat. No. 150 type "K" buffer amplifier plate blocking condenser, 2000 mmfds.

- C8—REL Cat. No. 150 type "K" power amplifier plate blocking condenser, 2000 mmfds.

- C9—REL Cat. No. 150 type "K" power amplifier grid coupling condenser, 2000 mmfds.

- C10—Buffer amplifier screen grid bypass condenser, 1 mfd. 250 volt type.

NOTE: The fixed condensers with the exception of C11 are supplied with bakelite strips and bushings for mounting as shown in the photograph.

- RFC1—REL Cat. No. 132 oscillator plate RF choke coil.

- RFC2—REL Cat. No. 132 buffer amplifier plate choke coil.

- RFC3—REL Cat. No. 132 buffer amplifier grid choke coil.

- RFC4—REL Cat. No. 132 power amplifier plate choke coil.

- RFC5—REL Cat. No. 132 power amplifier grid choke coil.

- J1—Oscillator plate meter jack single circuit closed type.

- J2—Buffer amplifier plate meter jack single circuit closed type.

- J3—Power amplifier plate meter jack single circuit closed type.

- J4—Key jack single circuit closed type.

- M—Plate milliammeter Jewell Model No. 135, 0-100 mls.

- P—Meter plug with 2 foot extension cord.

- V1—Oscillator tube socket, Buffalo UY type.

- V2—Power amplifier tube socket, Buffalo UY type.

- V3—Power amplifier tube socket, Buffalo UX type.

- R—Oscillator grid resistance, 5000 ohms.

- F—Drilled and engraved aluminum front panel finished in black crystalline lacquer.

- A—Antenna and ground binding post strip.

- B—5 ply veneer baseboard finished in black lacquer. Size 18 3/4" x 9 3/4" x 1/2" thick.

- S—Two aluminum partition shields with necessary 1/2" angle strips for mounting.

- SS—Copper sheet for covering baseboard. REL kits are supplied with baseboard fitted and covered with copper sheet.

- N—Brackets for supporting rear binding post strip.

- T—Bakelite rear terminal strip drilled and engraved. This strip is fitted with all necessary terminal screws. The four jacks are to be mounted in this strip.

A neat pressed steel cabinet is supplied with each Cat. No. 215 kit. This has a removable top. The finish matches the front panel.

Necessary mounting screws and wire are supplied with each Cat. No. 215 kit.

F—Drilled and engraved aluminum front panel finished in black crystalline lacquer.

A—Antenna and ground binding post strip.

B—5 ply veneer baseboard finished in black lacquer. Size 18 3/4" x 9 3/4" deep x 1/4" thick.

S—Two aluminum partition shields with necessary 1/2" angle strips for mounting.

SS—Copper sheet for covering baseboard.

REL kits are supplied with baseboard fitted and covered with copper sheet.

N—Brackets for supporting rear binding post strip.

T—Bakelite rear terminal strip drilled and engraved. This strip is fitted with all necessary terminal screws. The four jacks are to be mounted in this strip.

A neat pressed steel cabinet is supplied with each Cat. No. 215 kit. This has a removable top. The finish matches the front panel.

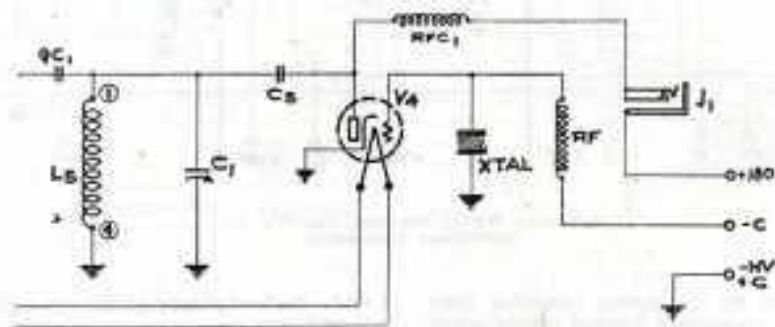
Necessary mounting screws and rolls of wire are supplied with each Cat. No. 215 kit.

The amateur may purchase the Cat. 215 completely built and tested.

Additional Charge \$30.00



ADDING CRYSTAL CONTROL TO CAT. 215



Schematic Wiring, Cat. 215,
Oscillator Stage Fitted for
Piezo Crystal Control

If the amateur so desires, he may use crystal control with the Cat. No. 215 unit. The above wiring diagram shows the crystal control oscillator circuit of the Cat. No. 215 unit. A direct comparison between this oscillator circuit and the master oscillator circuit in the Cat. No. 215 will readily show that only a very small change is necessary.

When considering crystal control the amateur must decide whether he will operate with a 160 meter crystal or with an 80 meter crystal. If a 160 meter crystal is used it will be necessary to double frequency into the buffer stage. If an 80 meter crystal is used the same frequency will be had in all three stages.

The Cat. No. 215 unit when crystal controlled can be operated on 40 and 20 meters. It simply becomes necessary to double frequency in succeeding stages so as to arrive at the desired output frequency.

When ordering the Cat. No. 215 unit for crystal control operation the amateur must specify the frequency of the crystal that he will employ and also the output frequency at which the power amplifier tube is to operate. By doing this he will be furnished with correct crystal oscillator inductance "L5" and the correct crystal oscillator grid choke "RF."

The crystal will require C battery. This is connected to the post "-C." The same C battery bank which supplies the buffer and power amplifier may be used for

this purpose. Therefore, the connection for the "-C" post should go to -22 1/2 volts on this battery bank.

Crystals and crystal holders are not included or furnished with this unit. The amateur may purchase these separately. Prices will be given pending application.

There are no additional charges for supplying the Cat. No. 215 unit for crystal control. If the 215 is desired for crystal control specify so when ordering, otherwise the standard 215 M. O. type oscillator is furnished.

A few brief hints will be given on how to obtain successful operation with a crystal.

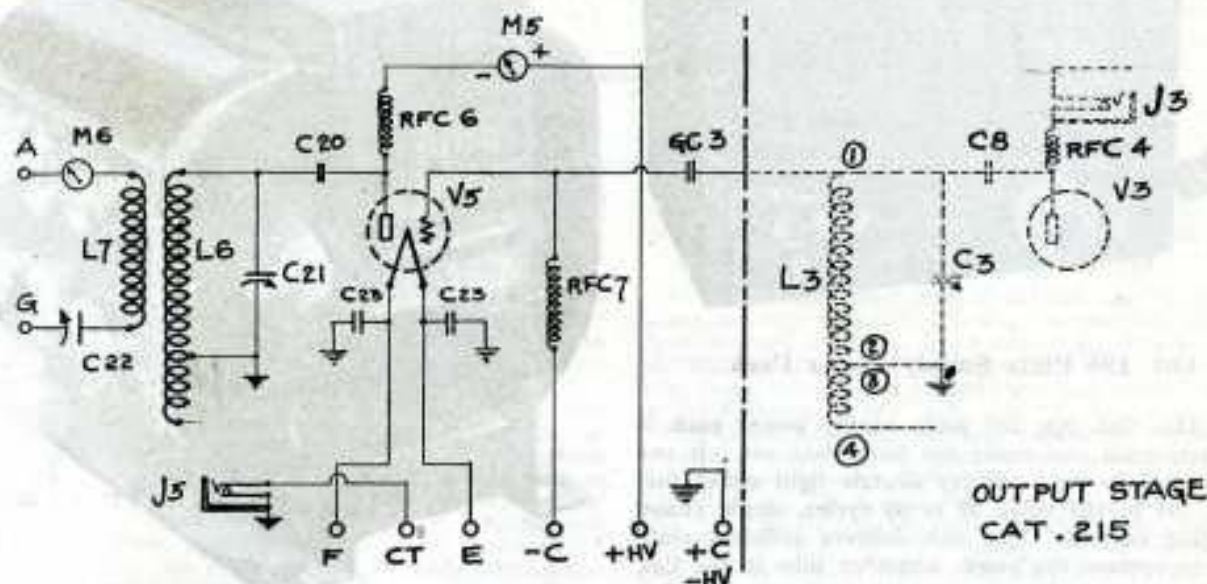
Before inserting the crystal wash it with a carbons solution. Likewise wash the upper and lower crystal holder plates. When the crystal is thus cleaned the surface should not again be touched with the fingers. After it is inserted in the holder and all the necessary power supply connected, rotate the crystal tuning condenser "C1" until a minimum dip is indicated on the plate meter "M." It is, of course, necessary to insert the plate meter plug into jack "J1." The neon tube may be used as an additional check to see that radio frequency is being generated by the crystal oscillator stage. A good point to determine this is directly at the stator plates of the crystal oscillator tuning condenser "C1."

The tuning of the remaining stages remains the same as previously outlined.

ADDING LINEAR AMPLIFIER TO CAT. 215

REL CAT. 206 AMPLIFIER

50 OR 75 WATT TYPES



Wiring Diagram, Cat. 206,
50 or 75 Watt Linear Amplifier

If the amateur desires higher power than that developed in the power amplifier stage of the Cat. No. 215 basic unit he may add a 50 or 75 watt linear amplifier. A very adaptable unit is the standard Cat. No. 206. This may be purchased either for 50 or 75 watt operation. When purchasing specify the type of tube that will be used in the linear amplifier; that is, it will be either a RCA type 203A or RCA type 211, 50 watt tube or a RCA type 852, 75 watt tube. Another very effective tube to use would be the RCA type 860, which is equivalent to the 852, but is of the screen grid type. The diagram above, however, is shown for use with tubes not of the screen grid type.

This additional linear amplifier can be tuned to operate either at the same frequency as the power amplifier in the Cat. No. 215 unit or at double the frequency of this power amplifier.

The following is a part list of the REL Cat. No. 206 amplifier:

- M5—Plate milliammeter 0-300 mils.
- GC3—Linear amplifier grid coupling condenser 2000 mmfd. 5000 volt type.
- C20—Linear amplifier plate blocking condenser 2000 mmfd. 5000 volt type.
- C21—Linear amplifier tuning condenser, REL Cat. No. 149 type "K" 200 mmfd. 3000 volt type.
- J5—Key jack, single circuit closed type.
- L6—Linear amplifier tank inductance. May be REL type "L" or type "S" units. For 80 meter operation use "L;" for 40 and 20 meter use type "S." When ordering be sure to specify which type is desired.
- L7—Antenna coupling coil. Use REL type "L" or "S," depending upon the antenna constants and the output operating frequency.
- M6—Antenna meter 0-3 thermo coupled RF.
- C22—Antenna series variable condenser, REL Cat. No. 149 type "K" 200 mmfd. 3000 volt type.
- RFC6—Linear amplifier plate choke. Use REL power type.
- RFC7—Linear amplifier grid choke. Use standard REL Cat. No. 132.
- C23—Filament bypass condensers 2000 mmfd. 1000 volt type.

V5—Linear amplifier tube socket, either 50 watt or 75 watt type, depending upon customer's specifications.

- 1—Metal cabinet, size 9" x 19" x 16" deep.
- 1—Drilled and engraved panel.
- 1—Baseboard fit with copper foil.
- 1—Rear binding post strip.
- 1—Complete set of hardware.

Cat. No. 206 amplifier kit.....Price \$94.00

Cat. 206 Amplifier, completely built and tested—additional charge\$38.00

The power supply necessary for operating the linear amplifier will have to be independent from any of the power supply used for the Cat. No. 215 unit or the Cat. No. 225 modulator unit. Filaments may be operated either from AC or DC. The supply necessary must furnish 10 volts at 3.25 amperes. If AC is used for filament supply the transformer must be accurately center tapped. The filaments must then be bypassed with two 2000 mmfd. 1000 volt type condensers. These bypass condensers should be located directly at the filament tube socket. The plate supply required for the 50 watt tubes is 1000 volts DC at 150 watts. The plate supply required for the 75 watt tubes is 2000 volts DC at 150 watts. Prices and description of rectifier units and motor generators will be furnished upon request.

A few operating hints for using the linear amplifier will be given.

The "C" battery voltage may be obtained from the same "C" batteries which supply the Cat. No. 215 unit. The correct amount will be determined by the type of tube used. For telegraphic purposes the linear amplifier is operated as a type "B" and as such sufficient "C" battery must be applied to reduce the plate current mills to "0" when excitation from a previous stage is removed.

Procedure for tuning and adjusting the amplifier is the same as that previously outlined for the power amplifier stage in the No. 215 unit. The user has an option to either key the power amplifier tube in the Cat. No. 215 unit or else to key the center tap connection in the Cat. No. 206 linear amplifier. If DC is used for heating the filament this last method cannot be employed.

The output of the Cat. No. 206 linear amplifier is fed to any of the antenna systems illustrated in this booklet.



Cat. 185 Plate Supply Power Pack

The REL Cat. No. 185 plate supply power pack is completely built and ready for immediate use. It can be connected to any ordinary electric light outlet furnishing 105 to 125 volts, 50 to 60 cycles, single phase, alternating current. This unit delivers sufficient plate supply to operate the power amplifier tube in the Cat. No. 215 unit, and also the modulator tubes in the Cat. No. 225 modulator unit.

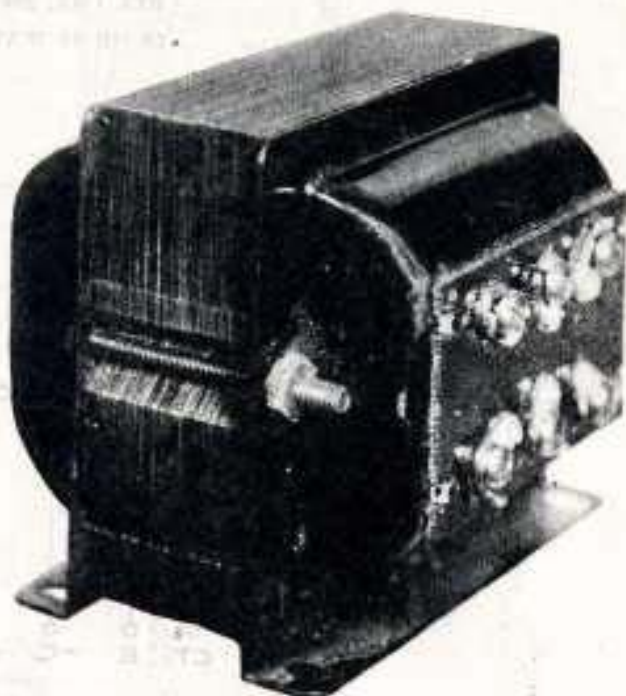
One standard RCA type 281 tube is employed in a half wave rectifier circuit. Parts of the highest quality together with skilled workmanship make this power unit a welcome necessity in every station.

This unit delivers 600 volts at 40 watts. It is housed in a metal case measuring 12 1/2" x 8" front x 9" deep. Weight 20 pounds. Necessary insulated terminals are furnished. The unit is also supplied with a snap switch and an 8 foot connecting cord.

Besides the plate supply that this unit is capable of furnishing, it has also a connection for obtaining 7 1/2 volts at 2 1/2 amperes. This is an additional supply which may at some time be found useful for heating filaments.

This Cat. No. 185 unit is supplied without meters. Their use is optional. The purchaser may make external connections to a DC plate voltmeter. Two posts are also supplied for external primary voltage regulating resistance. This may be of the standard variable resistance type which is connected in the primary supply.

Cat. No. 185 power pack complete less tube...Price \$38.00



Cat. 215 Filament Heating Transformer

The Cat. No. 215 filament heating transformer is small and compact. It will deliver sufficient power to heat the filaments of all tubes in the Cat. No. 215 and No. 225 units. It is designed to operate from 110 to 120 volts, 50 to 60 cycles, single phase, alternating current.

The secondary output characteristics are as follows:

- 1—Center tapped winding delivering 7 1/2 volts at 1.5 amperes.
- 1—Center tapped winding delivery 2 1/2 volts* at 7 amperes.

Size 3 1/4" x 3 1/2" base x 3 1/4" high. Weight 3 pounds.

Cat. No. 215 Transformer.....Price \$6.00



Cat. 215 Plate Voltage Reducing Resistor

The REL Cat. No. 215 plate voltage reducing resistor is designed to operate in conjunction with the Cat. No. 185 power pack and the Cat. No. 215 basic CW telegraphic unit. When the Cat. No. 215 unit is operated without the Cat. No. 225 modulator it requires 300 volts plate supply for the power amplifier tube. This is obtained by inserting the Cat. No. 215 plate voltage reducing resistor in series with the output of the No. 185 power supply. It will then reduce this voltage to 300, which is the required voltage for the type 245 power amplifier tube.

This resistor is 5,000 ohms, 44 watts and measures 4" long, 3/4" diameter.

Cat. No. 215 resistor.....Price \$1.75

CATALOGUE NO. 225
100% MODULATOR KIT

THE PERFECT MODULATOR AND SPEECH
AMPLIFIER UNIT FOR AMATEUR USES

The modern amateur radio telephone transmitter is radically different than the sets and systems employed several years ago. Those who desire efficient radio telephone communication appreciate that as much as possible of the continuous wave carrier should be modulated. This may be more readily explained as follows:

When listening in for a radio telephone station the amateur has often noticed that the carrier is sufficiently strong, but the voice is weak. The system employed in the REL Cat. No. 225 amateur modulator unit is designed to give practically 100% modulation of the carrier output of the Cat. No. 215 basic unit. Therefore when using the Cat. No. 225 unit in conjunction with the Cat. No. 215 unit the operator will be able to receive reports which indicate that his modulated voice is just as strong as his CW carrier wave. It has often been reported that low powered CW telegraph transmitters have covered great distances. It can now well be said that when using the 100% system of modulation these same low powered telegraph sets can be made into telephone transmitters having the same great DX range.

The REL Cat. No. 225 amateur modulator unit, although expressly designed for use with the Cat. No. 215 basic unit, can be made adaptable to any other present oscillator system which employs a power amplifier tube of the RCA UX-245 type or equal. The main requisite is that the tube which is to be modulated must use approximately one-half of the plate voltage that is required for the modulator tube. In the case of the 225 unit a RCA UX-250 type tube is used with 550 to 600 volts plate and in conjunction with this the modulated amplifier tube employs 300 volts plate. Furthermore, the modulator watts output of the 250 tube are sufficient to operate the 245 tube.

The Cat. No. 225 unit is designed to use a single button carbon microphone. This is sufficient to obtain good reproduction over the average voice frequencies employed. If the user so desires, he may very easily employ a two-button carbon microphone. It will simply be necessary to replace the microphone transformer "T1" with any transformer designed for use with the two-button microphone. The amateur will really find no great advantage in using the two-button microphone because for ordinary speech transmission the single-button is sufficiently practical. For the transmission of music and other sounds which have a greater variation of voice frequencies the two-button microphone will be necessary.

The Cat. No. 225 unit should be a welcome addition in any station which desires to employ a radio telephone whose signals will be clearly understood. Reports obtained will be very gratifying. It sure is a great thrill to receive QSL cards which say that the phone signals

compare favorably with those of any good present-day broadcast station. Therefore for a very reasonable price the amateur can equip himself with this unit, thereby placing on the air a real honest to goodness phone set.

BUILDING THE CAT. NO. 225

All necessary parts, panels, cabinet and hardware is furnished with each No. 225 kit. A complete listing of these is given under the schematic wiring diagram shown elsewhere in this booklet. When unpacking one of these kits, check over all the parts to see that they correspond to those shown on the parts list.

The front panel is supplied completely drilled and engraved. It is finished in crystalline black lacquer. On the front panel are mounted the microphone jack "J7." The resistor "R2" is mounted on a small strip of bakelite, thus insulating the movable arm from the metal panel. The jack "J7" is mounted directly on the front panel. One arm of this is automatically grounded.

The baseboard is supplied already covered with copper sheet "S." This is of thin gauge and will readily allow

punching and insertion of wood screws. These wood screws are used to mount the various parts. The rear view assembly shown on the next page is sufficiently clear to show the exact placement of all parts. Therefore further details regarding the mounting of these parts will not be given.

The rear terminal strip "BPS" is fastened to the baseboard by means of two angle brackets "BR." This "BPS" strip must be so mounted that when the complete unit is slid into the cabinet it will project through the opening provided in the back of the cabinet. All mounting terminals are already fastened to the terminal

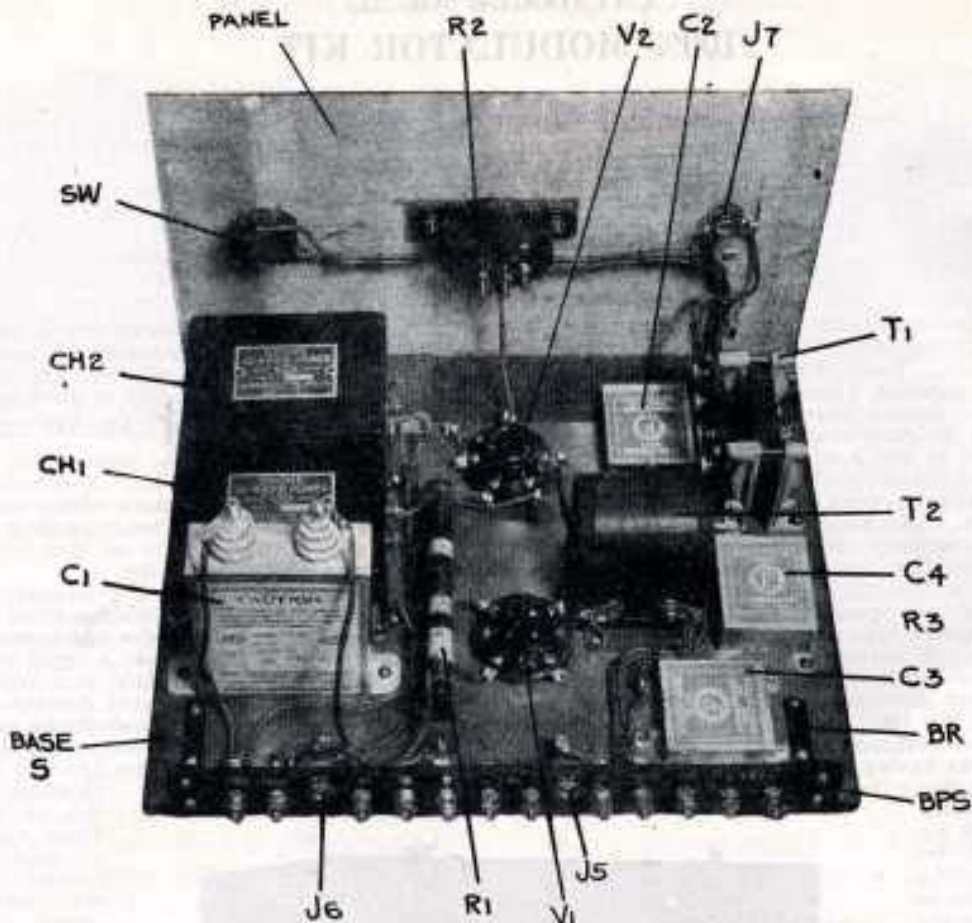
strip. To complete the assembly of this strip it is simply necessary to mount the two jacks "J5" and "J6." These jacks are provided in the plate circuits of each of the two tubes employed. The same plate milliammeter employed in the Cat. No. 215 is also used to measure the plate current drawn by two tubes in the Cat. No. 225 unit. When the meter is inserted in jack "J5" it will read the plate current consumed by the speech amplifier tube. When the meter is inserted in jack "J6" it will read the plate current consumed by the modulator tube.

The voltage reducing resistor "R1" is used to reduce the plate voltage to the power amplifier tube. It is therefore simply necessary to connect 550 to 600 volts DC plate supply to the Cat. No. 225 unit. The resistor R1 automatically reduces this voltage so that 300 volts are fed to the 245 amplifier tube.

The Cat. No. 225 unit is located on the operating table alongside of the Cat. No. 215 unit. Connections between the two units are made at the rear.



This illustrates the complete Cat. No. 225 kit. It has an attractive and businesslike appearance and will enhance any amateur station. In reality it's a little set which looks and works like a regular commercial unit.



This is the rear view of the Cat. No. 225 unit. It clearly illustrates the position of the various parts. Mount them exactly as shown.

The complete station is always ready for either telephone or telegraph transmission. The only adjustments necessary is to turn on the microphone switch SW when using telephone, and turn this off when using telegraph. All tubes in the modulator and in the Cat. No. 215 unit are always lit. This is a very good feature because it allows instant shifting from telephone to telegraph.

OPERATING THE CAT. NO. 225 UNIT

After the unit has been assembled and all the wiring carefully checked it is ready for operation. The power supply employed can be the same as that used for the No. 215 telegraph set. The REL Cat. No. 215 filament heating transformer is of sufficient size to supply the RCA type 250 modulator tube with 7½ volts at 1.25 amperes and to also supply the RCA type 227 Speech Amplifier Tube with 2½ volts at 1.75 amperes. If alternating current is not available the filaments of these tubes may be heated from an 8-volt storage battery. Necessary filament reducing resistor must be employed in the circuit of the 227 speech amplifier tube so that it will only receive 2.5 volts.

The plate supply to the modulator tube must be between 550 and 600 volts DC. This can be secured from the REL Cat. No. 185 power unit, from a motor generator or from a B battery bank. The plate supply to the speech amplifier tube is secured from B batteries. The same heavy duty B batteries which are used to supply the oscillator and buffer tubes in the 215 will suffice for this purpose. One hundred and thirty-five volts are necessary. These may be secured by tapping the battery, or in other words using three of the 45-volt batteries. The C battery voltages required for the speech amplifier and modulator tubes may be obtained from the C battery bank, which feeds the Cat. No. 215 unit. The six-volt supply necessary for the microphone may be obtained from any 6-volt battery. The best method is to employ the 6-volt storage battery which is used to heat the filaments in the receiver. The polarity connections are not critical. The wiring diagram for the 225 shows that the positive side is grounded. If the posi-

tive side of the receiver battery is also grounded this connection will be satisfactory. If, however, the negative side of the receiver battery is grounded then it will be necessary to reverse the battery connections to the microphone so that the negative side will run to ground. In any case the same side must be grounded, as that which is grounded in the receiver, otherwise the receiver storage battery will be short circuited.

The following gives correct plate meter readings and "C" battery voltages for the Cat. No. 225 unit:

Modulator—Plate Mils 55—C voltage minus 135.

Speech Amplifier—Plate Mils 9—C Voltage minus 9.

When making adjustments it is essential to adhere to the above plate current readings and C battery voltages.

The microphone input is controlled by the resistor "R2." A combination will be found so that the operator will readily know the distance from the microphone mouth-piece to his mouth and the intensity at which the microphone is being actuated. This will vary with various types of microphones employed and also will vary with the voice of the person using the microphone. The correct combination of R2 and voice input to the microphone should be sufficiently strong to just about show the movement on the plate meter and the speech amplifier tube. If too much gain is used this plate meter needle will fluctuate in synchronism with the input and when thus fluctuating it is a safe indication that distortion is being had.

In like manner, the plate meter when inserted into the modulator tube circuit should remain practically constant and should not fluctuate with the input.

In the instructions given for the Cat. No. 215 CW unit no mention was made on the changes necessary to adapt this unit for telephone purposes. Therefore, when using the Cat. No. 225 modulator in conjunction with the 215 the following adjustments will have to be made in the 215 power amplifier stage:

The ordinary C voltage employed on the 245 amplifier tube was 90 volts. Therefore, change the C battery from 90 to 157 or 180 volts. By doing this the plate current

of the power amplifier tube will be reduced, thus placing the tube in a condition where it will not be overloaded when the highest peaks of modulation are delivered from the modulated tube.

The meter which is used to indicate resonance in the antenna circuit will approximately show 70% of the reading ordinarily had before the C bias was doubled. That is, this reading will be had when the microphone is not spoken into. As the microphone is actuated this antenna meter needle will rise approximately 30% from its low idling position. The best way to test this upward swing is to actuate the microphone with a steady constant tone like that obtained from a Buzzer or from the head phones of the receiver, when this receiver is in an oscillating condition and howling at an audio frequency. Another simple method is to whistle into the microphone and thereby note the upward swinging of the antenna meter needle. At all times while telephoning it will be noted that the antenna meter will swing upwards in direct proportion with the amount of input to the microphone.

It is of course essential to monitor or check the output when using the telephone transmitter. This may be accomplished by listening in at the receiver when this receiver is in a non-oscillating condition, or better yet, by using the method which employs a crystal detector connected in series with a coil and a pair of phones. This coil can be coupled to the antenna lead going to

T1—Modulation transformer for use with single button carbon microphones. Acme type A-3.

T2—Audio frequency transformer, ratio 3 to 1, Dongan type "S."

R1—Amplifier plate voltage reducing resistor H. & H. 5000 ohm 44 watt type. Supply with end mountings and Y type terminals.

R2—Gain control variable resistor Centralab 500,000 ohm.

NOTE: This resistor is supplied with bakelite strip and mounting screws for insulating purposes.

R3—Audio transformer shunt resistor Daven 100,000 ohm supplied with 2 grid leak mounting clips.

J5—Speech amplifier meter jack, Carter single circuit closed jack, type 2A.

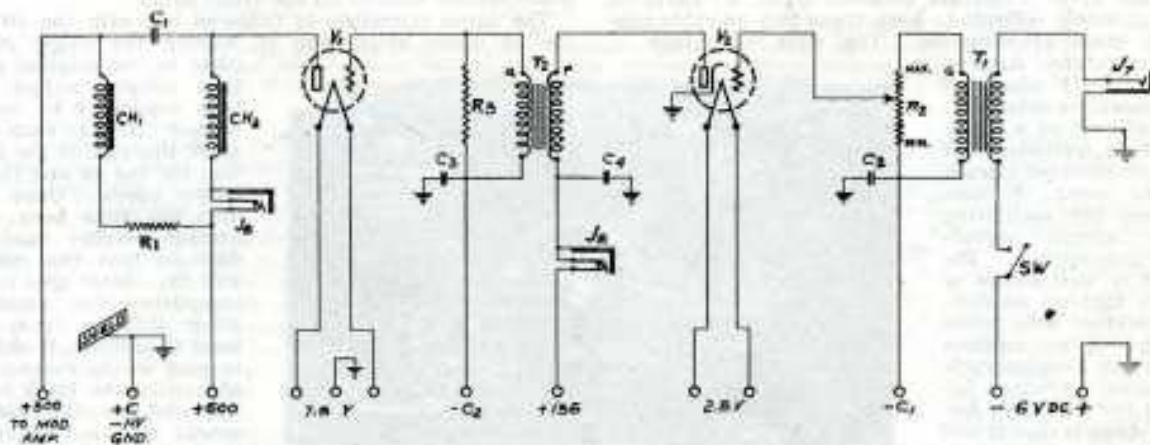
J7—Microphone plate, Carter single circuit open jack, type 1.

NOTE: This jack is mounted directly on metal panel, thus grounding one of the prongs.

V1—Modulator tube socket, Buffalo UX type.

V2—Speech amplifier tube socket, Buffalo UY type.

SW—Microphone battery switch, Hubbell.



the transmitter. There is no reason why the amateur should not be able to know exactly what his phone sounds like. It is not necessary to ask for reports on your phone, when you can easily and quickly check yourself directly at the station. A good monitor is the best indicator.

Schematic Wiring Diagram shown above shows exactly how the Cat. No. 225 Modulator unit is connected. Follow this out exactly, run all plate and grid leads short and direct. All other wiring may be cabled as illustrated in the rear view.

The following is a description of the parts furnished with each 225 kit:

C1—REL Cat. No. 123 by-pass condenser 2 mfd. 1000 volt type.

C2—REL Cat. No. 123 speech amplifier grid by-pass condenser .5 mfd. 450 volt type.

C3—REL Cat. No. 123 modulator grid by-pass condenser .5 mfd. 450 volt type.

C4—REL Cat. No. 123 speech amplifier plate by-pass condenser .5 mfd. 450 volt type.

CH1—Constant current choke special Dongan type No. 1591.

CH2—Constant current choke special Dongan type No. 1591.

S—Five-ply veneer baseboard finished black lacquer and covered with copper sheet. Baseboard dimensions 13" long, 9 3/4" deep, 1/2" thick.

BPS—Rear binding post terminal strip completely fitted with 12 8-32 binding post screws, nuts and washers.

BR—Two angle brackets for supporting rear terminal strip.

P—Front panel aluminum completely drilled and engraved—front side finished black crystalline lacquer. Rear side satin finished aluminum.

C—Pressed steel cabinet—inside finished dull black lacquer—outside finished black crystalline lacquer. Equipped with removable top. Size 13" x 9" front x 10" deep.

In addition to the above equipment, each Cat. No. 225 kit is furnished with a complete set of hardware, comprising mounting screws, nuts, washers, bushings, solder lugs, lock washers and flexible rubber-covered wire.

Cat. 225—can be purchased completely built and tested, additional charge.....\$24.00

AMATEUR BAND RECEIVER KIT

A typical receiver for the amateur station employing untuned stage of screen grid RF detector and one audio—wide spread tuning on each amateur band.

The average amateur station has employed many different types of receivers during the past several years. Some of these have been "hay-wire" arrangements, others may have been built along commercial lines. However, in each case the main purpose was to obtain maximum efficiency with the simplest combination. Gathering the experience had with all these receivers, the Radio Engineering Laboratories, Inc., have especially designed for the amateur the Cat. No. 231 set. This set will accomplish everything necessary for an amateur station receiver. The various features of the Cat. No. 231 receiver will be taken up and discussed individually.

An untuned stage of radio frequency employing a screen grid tube of the RCA UX-222 type was found to be practical and necessary. The untuned stage was selected in preference to a tuned stage because the addition of a tuned stage would have required an extra tuning condenser control. This would mean that the amateur would be obliged to adjust both tuning condensers at the same time. Furthermore, when desiring to quickly cover a certain amateur band, it would be found extremely difficult to keep these two movable controls in exact synchronism. The main advantage of using the untuned stage of screen grid RF ahead of the regenerative detector is that it will act as a blocking tube to oscillation set up in the detector circuit. In other words, it does not allow the oscillating detector circuit signals to be transmitted. The amateur is well aware of the fact that an oscillating receiving tube when connected to an antenna will create considerable disturbance. Another advantage for the radio frequency stage is that it will allow the detector regeneration control to be smooth and not erratic; thus it will block the antenna harmonic effect, thus providing smooth control of regeneration. The screen grid RF stage will also help to amplify weak signals to some extent, although screen grid tubes cannot be used to their utmost advantage on short waves—they will furnish some radio frequency gain.

The detector circuit employs a tube of the RCA or equal 201-A type. Regeneration is controlled by means of a variable resistor. This resistor is of the drum type, making perfect noiseless contact at all times. The tickler coil combinations employed are of such ratio that the regeneration control resistor will at all times give absolute positive and smooth control of oscillations.

Three correctly designed plug-in coils are supplied with each Cat. No. 231 receiver. These are designed to cover with maximum efficiency the 20, 40 and 80 meter amateur bands. By means of the special combined tank and vernier tuning condenser full spread coverage of each amateur band is obtained. A brief description of how this is accomplished follows. The single rotor and the single stator main tuning condenser "C2" is controlled from the front panel. The stator plate is movable; that is, its position to and from the rotor plate may be varied, thus allowing the maximum capacity of this vernier control condenser to be set at any desired capacity. This single stator plate is therefore set at an arbitrary position and the rotor plate is set at mini-

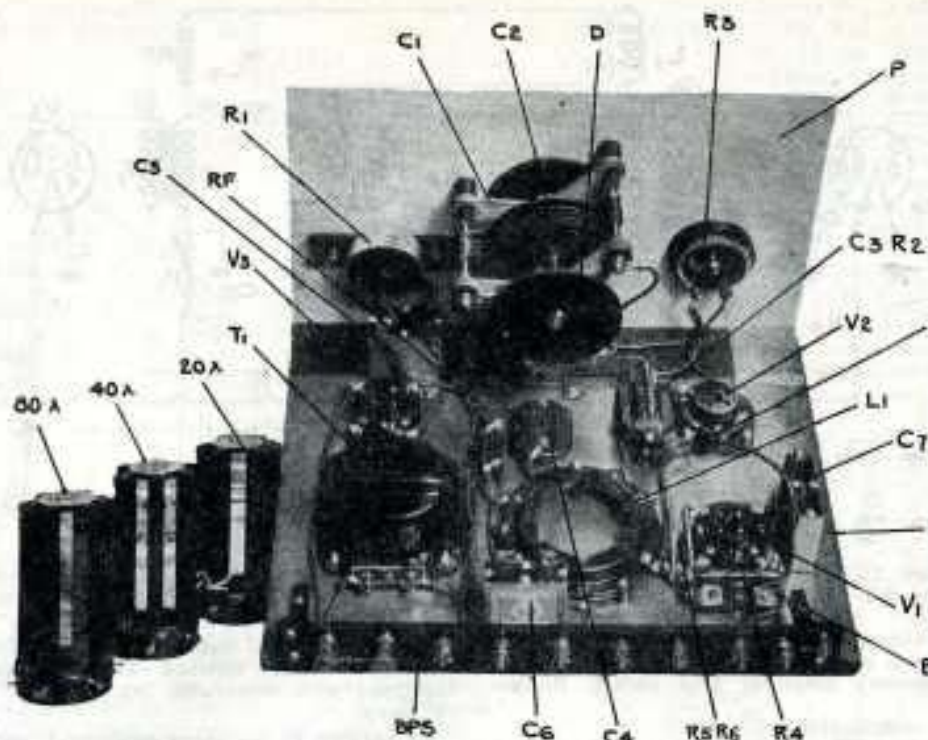
mum capacity or in the "all out" position. This will then indicate as zero on the dial located on the front of the panel. The 80 meter coil is plugged into the coil socket and the large tank condenser "C1" is set to a certain definite position which will tune the bottommost end of the 80 meter band. This large semi-variable tank capacity condenser is controlled by means of the 3" bakelite disc "D." The ratchet makes friction contact to this bakelite disc. At the exact point where the bottom of the 80 meter band is received scratch a line onto the bakelite disc where the ratchet makes contact. The variable control of the vernier condenser is then set to maximum capacity or in the "all in" position; that is, where the front dial indicates at "100." By moving the single stator plate closer to the single rotor plate of the vernier control a point will be had where the uppermost point of the 80 meter band is received. The user will now note that without any further adjustment of the large tank condenser "C1" it will be possible to cover the complete 80 meter band by simply using a single plate vernier control on the front panel.

The same procedure is followed out with the 40 and the 20 meter coils; that is, leaving the single stator plate in the original position simply adjust the tank condenser by means of disc "D." In each case mark this disc at the position for the 40 and the 20 meter bands. Once this disc has thus been calibrated, notches may be filed so that the ratchet will fit. After this is accomplished the amateur, when shifting from one band to another, is obliged to plug in the correct coil and swing the black bakelite disc to the correct notch; that is, if the 40 meter coil is plugged in set the tank condenser with its bakelite disc so that the 40 meter notch will coincide with the ratchet. Full spread coverage is then obtained by means of the vernier control on the front panel. This feature for obtaining full spread tuning of each amateur band is simple and positive. It has been developed at the Radio Engineering Laboratories, Inc. The amateur who has had previous experience and knows how bad the congestion and Q R M is on the various bands should immediately appreciate such wide spread tuning.

Without the use of any additional coils the amateur may employ this same receiver for 10 meter reception, only when doing so he will not obtain full wide spread coverage. The procedure is to plug in the 20 meter coil and reduce the capacity of the large tank condenser until a position is had where 10 meter signals are heard. The tank condenser may then be left in that position and further tuning in the 10 meter band is accomplished with the vernier control condenser.

The audio frequency circuit employs a tube of the RCA or equal 112-A type. Only one stage of audio has been incorporated in this receiver because this is sufficient for headphone reception. It has been found through experience that the average amateur uses only headphones and not loud speaker. Should anyone desire to use loud speaker it is a simple matter to add an additional power amplifier to the output of the No. 231 receiver.





Rear view of the Cat. No. 231. The placement of the various individual parts should be exactly as shown here. Note the well-designed plug-in coils and the specially constructed combined tank and variable tuning condenser. Features such as these are offered to the amateur in this very compact, efficient and simple set.

SIGNAL STRENGTH GOES UP
THE CAT. NO. 231 RECEIVER IS NOW
DESIGNED FOR USE WITH THE NEW
2 VOLT TUBES. INSTRUCTIONS
SHOWING SLIGHT REVISIONS SUP-
PLIED WITH EACH KIT

The receiver is supplied in kit form. A neatly drilled and engraved aluminum front panel makes the appearance and building of the set a simple matter.

ASSEMBLING AND BUILDING

Various parts supplied with the Cat. No. 231 receiver should be mounted in the approximate positions shown in the rear view layout. As this illustration is clear and distinct, it is needless to go into further details regarding the mounting of the equipment. The schematic wiring diagram given should be used when connecting the receiver. All grid and plate leads should be run short and as direct as possible. All other wires may be bunched in cable fashion.

OPERATION

Sufficient data has already been given regarding the tuning of this receiver. The only other points to remember are as follows:

The filament rheostat "R3" should be set so that when using a 6-volt storage battery the tubes will receive 5 volts. Further adjustment to this control is not necessary.

The regeneration control resistor "R1" is set at a position just beyond the oscillating point when receiving CW signals and when receiving telephone signals this resistor is set in a position just before the oscillating point. When tuning a signal the operator will easily and quickly obtain the knack for the correct combination of this variable regenerating control.

The power supply necessary for the Cat. No. 231 receiver is as follows: A standard 6-volt storage battery is used for filament heating purposes.

Three heavy duty 45-volt B batteries supply all plate voltages. Plate voltage on the screen grid RF amplifier and on the audio amplifier is 135 volts. Screen grid voltage on the radio frequency tube is 67 and the plate voltage on the detector tube is 45. A small 9-volt C battery is used to supply the grid of the audio amplifier tube. (In the general station assembly layout given in the beginning of this booklet it will be noted that four 45 volt batteries are shown as "6." The fourth battery is not employed in the receiver circuit, but is only added that 180 volts total can be obtained for supplying the plates of the first two tubes in the Cat. No. 215 unit. Therefore, if the amateur desires to use the Cat. No. 231 receiver independent of the transmitter it will only be necessary to employ three batteries.)

The general station layout further shows a separate antenna "14" to be used with the receiver. This is an advantage in so far as it eliminates the necessity for switching the antenna from transmitter to receiver. However, if it is impossible to erect a separate receiving antenna use the transmitter antenna with a single pole double throw switch. By the use of two separate antennae, that is, one for the transmitter and one for the receiver, the amateur will be able to operate duplex. This is quite an improvement over the single antenna system.

The following is an explanation of the Cat. No. 231 schematic wiring diagram and also a complete list of parts which is furnished with each Cat. No. 231 receiver kit:

C1-C2—REL Cat. No. 187-E tuning condenser supplied with 4" type KK vernier control knob.

C3—REL Cat. No. 150 type "K" .0001 condenser fitted with 1 pair grid leak mountings.

C4—REL Cat. No. 150 type "K" .002 condenser.

C5—REL Cat. No. 123, 1 mfd. 250 volt condenser.

C6, C7—REL Cat. No. 123, .5 mfd. 250 volt condensers.

L1—One set (3) REL Cat. No. 182-S coil kit with one coil base.

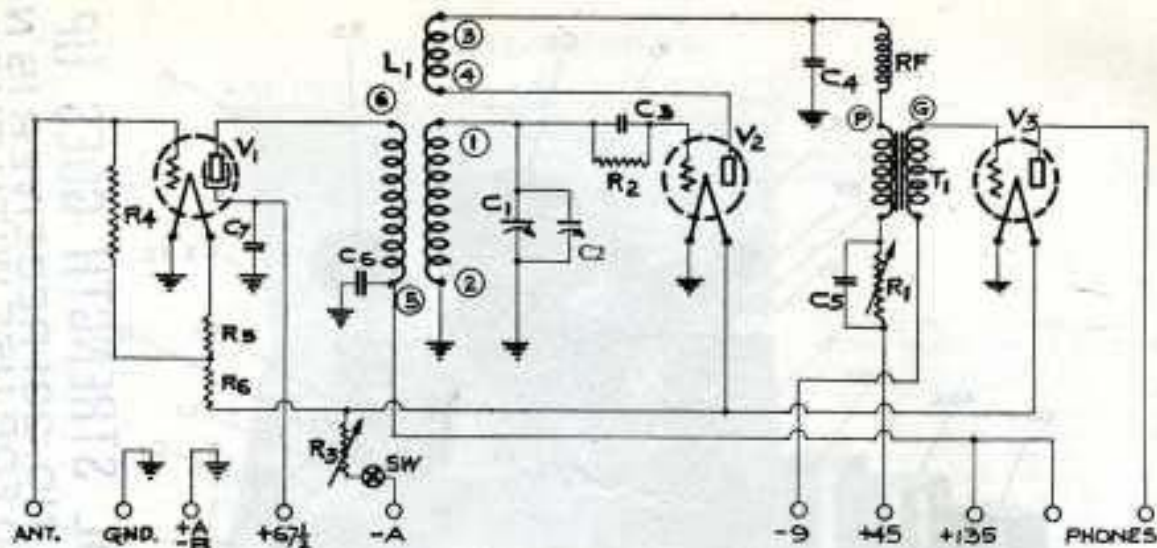
T1—Audio frequency transformer, 5 to 1 ratio.

R1—Regeneration control resistor, Frost 100,000 ohms, complete with small bakelite mounting strip and KK pointer knob.

R2—Grid leak, Daven 10 megohm.

R3—Rheostat 10 ohm, De Jur, fitted with KK pointer knob.

R4—Antenna resistor, Daven .01 megohm, supplied with small bakelite mounting strip fitted with 1 pair grid leak mountings.



R5-R6—Combined 15 ohm tapped resistor, H. & H. type. (Note: The R5 section is 10 ohms and the R6 section is 5 ohms.)

V1—Radio frequency tube socket, Buffalo UX type.

V2—Detector tube socket, Buffalo UX type.

V3—Audio frequency amplifier tube socket, Buffalo UX type.

SW—Filament switch, Hubbell.

RF—REL Cat. No. 182 radio frequency choke coil, 5 slot type.

BPS—Rear binding post terminal strip completely fitted with eight 8-32 binding post screws, nuts and washers and also two binding posts for phone connection.

B—5-ply veneer baseboard, finished black lacquer and covered with copper sheet. Baseboard dimensions 13" long, 9 1/4" deep, 1/2" thick.

BR—2 angle brackets for supporting rear terminal strip.

P—Front panel aluminum completely drilled and engraved. Front side finished black crystalline lacquer. Rear side satin finish aluminum.

C—Pressed steel cabinet. Inside finished dull black lacquer; outside finished black crystalline lacquer. Equipped with removable top. Size 13" x 9" front x 10" deep.

In addition to the above equipment, each Cat. No. 231 kit is furnished with a complete set of hardware, comprising mounting screws, nuts, washers, bushings, solder lugs, lock washers, flexible rubber covered wire, and one "KK" 4" vernier dial.

Cat. 231 Receiver, completely built and tested—additional charges \$17.00

ANTENNAE SYSTEMS FOR AMATEUR WAVE BANDS.

GENERAL

The antenna or at least the effective radiating portion of an antenna system should be located in an unob-

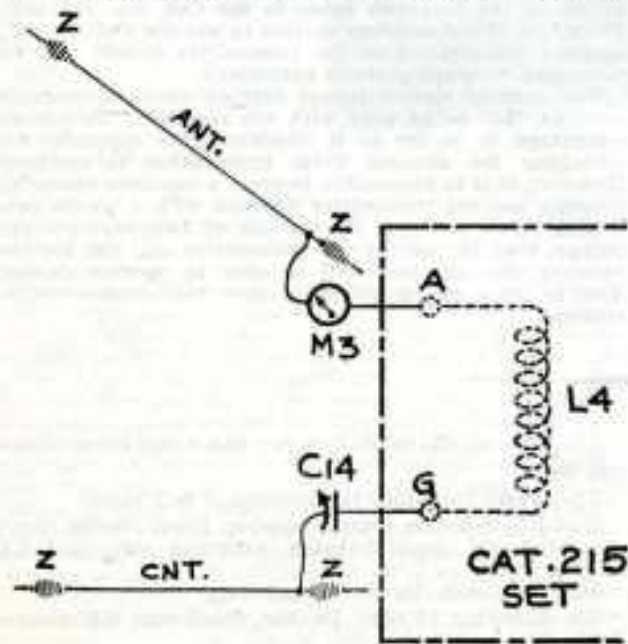


FIG. 1

structed area, free from trees, metallic structures or other foreign bodies. In each particular locality certain types of antennae will lend themselves more readily while others will never prove satisfactory. The tuning equipment, such as variable condensers, meters or switches, should be mounted in an appropriate place above the transmitter unit. The antenna leads may be wired from the transmitter posts to these pieces of apparatus and then to the antenna lead out insulators. All points of an antenna system should be equally well insulated by use of pyrex or other suitable material. One poorly insulated portion of an antenna may be the weak link in the whole system.

Fig. 1—Antenna Counterpoise System

This type of antenna may be used very well by a beginner. It is simple in adjustment and in most cases is a very good radiator. It may be used wherever one is not compelled to run long leads in order to get to a clear unobstructed area. The antenna and counterpoise should be separated by as great a distance as is possible. The following lengths given will be suitable when the antenna and counterpoise are separated by distances varying between 10 and 50 feet:

20 Meter Band	17 ft.
40 " "	32 ft.
80 " "	64 ft.
160 " "	130 ft.

When measuring the length of the antenna or counterpoise, include the total length of the wire from its extreme end through the lead-in and antenna tuning apparatus to the antenna post on the Cat. No. 215 transmitter. For example, if an antenna counterpoise system were to be erected for operation in the 80 meter band the antenna wire would be 64 feet long from its extreme insulator "Z" to the antenna binding post on the transmitter "A." Likewise, the counterpoise wire would be

64 feet long from its extreme insulator "Z" to the antenna post on the transmitter "G."

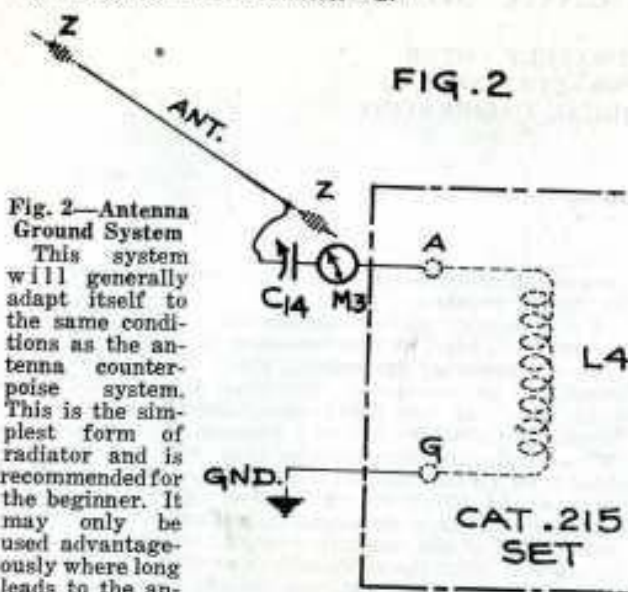


Fig. 2—Antenna Ground System

This system will generally adapt itself to the same conditions as the antenna counterpoise system. This is the simplest form of radiator and is recommended for the beginner. It may only be used advantageously where long leads to the antenna are not necessitated. It may be used very well on a small boat or in aircraft. With this system the ground must be made positive and good. The length of the antenna wire will be equal to those shown on the table for Fig. 1. The ground being untuned or aperiodic will function with any length of antenna. However, as it is more than likely that several feet of wire will be used in the lead that connects the ground to the transmitter, it may be necessary to vary from the antenna lengths specified slightly. This arrangement should only be used when a good ground is available.

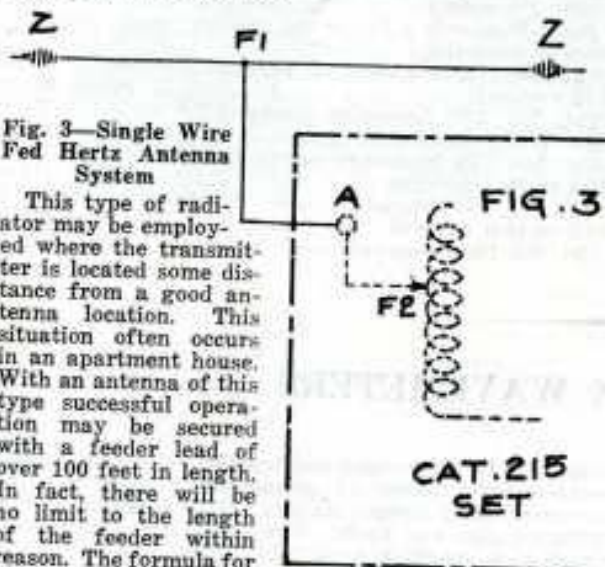


Fig. 3—Single Wire Fed Hertz Antenna System

This type of radiator may be employed where the transmitter is located some distance from a good antenna location. This situation often occurs in an apartment house. With an antenna of this type successful operation may be secured with a feeder lead of over 100 feet in length. In fact, there will be no limit to the length of the feeder within reason. The formula for the correct length of the actual antenna between points "Z" and "Z" is as follows: This dimension is to be calculated in meters. One meter = 39.37 inches.

The wavelength upon which operation is desired equals the length in meters times 2.07.

$$\text{i. e.} - \text{Length of antenna (ft.)} \times 2.07 = \text{Wavelength (ft.)}$$

The feeder "F1" must now be connected to the proper position on the antenna wire. The following formula shows where "F1" should be connected.

The distance (measured in feet) of the feeder from the center equals the antenna length times 25 and the product divided by 180. That is:

$$\text{Feeder distance from center} = \frac{\text{Length of antenna (ft.)} \times 25}{180}$$

The length of the feeder from "F1" to "R2" may be anything within reason and no specific length is required. The following is a table which will give the exact data for the various amateur bands.

20 Meter Band. 14,000 Kcs. Antenna length 33 ft. 11 in. Distance from the

40 Meter Band.

center for feeder tap 4 ft. 9 in. 7,000 Kcs. Antenna length 67 ft. 10 in. Distance from the center for feeding tap 9 ft. 6 in.

80 Meter Band.

3500 Kcs. Antenna length 135 ft. 6 in. Distance from the center for feeder tap 18 ft. 11 in.

An antenna of this type may be operated very well at its harmonics. If a 3500 Kc. antenna were erected operation on both the 7000 and 14,000 Kilocycle bands will be satisfactory.

For further information on single wire feed Hertz Antenna, we refer you to page 19 of the September 1929 issue of Q. S. T.

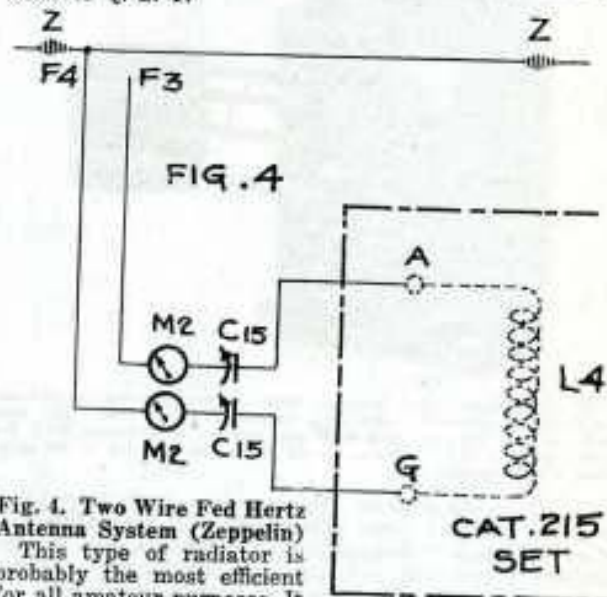


Fig. 4. Two Wire Fed Hertz Antenna System (Zeppelin)

This type of radiator is probably the most efficient for all amateur purposes. It may be used to extreme advantage where the transmitter is located some distance from the position of a good radiating system. It is possible to slightly wander off the fundamental frequency of a two wire feed system and still secure good efficiency. The following are the requirements in the dimensions of a successful two wire or better known Zeppelin type antenna.

1—The feeder system must be such that each wire is equivalent in length to an odd multiple of one quarter of the wavelength being used.

2—Antenna must have a length equivalent to an even multiple of one quarter wavelength.

3—The feeder system must be electrically symmetrical.

An antenna that will operate on the four amateur bands 3500, 7000, 14,000 and 28,000 Kc. (80, 40, 20 and 10 meters) would be calculated as follows: We would employ a half wave 80 meter system. One meter is 3.28 ft. and the length of a half wave 80 meter antenna is therefore one-half times 3.28 times 80 or 131.2 ft. This would be the length of the radiator suspended in a clear space, as shown in Fig. 4, designated by the wire spread between insulators "Z" and "Z." Feeders may vary in length to suit each particular location. Therefore the wires "F4" and "F3" should be run from one end of the antenna to the transmitting inductances. By use of two condensers "C15" connected in series or by one condenser connected in parallel across inductor "L4" the feeder system may be tuned over a considerable band of frequencies. In this manner "F3" and "F4" may be tuned to the fundamental or an odd multiple of the fundamental of the wavelength being used. The feeder construction must be symmetrical. Each wire must be exactly the same length as the other. This is particularly important when the system is being operated on the higher frequencies. The distance between the wires F3 and F4 may be anywhere from 6 inches to 18 inches.

When adjusting this antenna it must be so tuned that the currents in both the ammeters "M2" are of equal value. When this has been attained the antenna is operating as a real two wire Hertzian voltage feed radiator.

For further information on two wire feed Hertz Antennae, we refer you to page 33 of the September 1928 issue of Q. S. T.

PRECISION FREQUENCY METERS

DESIGNED TO ACCURATELY COVER
EACH AMATEUR BAND—FULL SPREAD
DIAL READING—INDIVIDUAL CALIBRATION



The above illustration shows an REL frequency meter coupled and mechanically fastened to an REL frequency meter unit. The same indicator unit may be used with any number of different REL frequency meters. The indicator should always be fastened to the meter when taking readings.

The Radio Engineering Laboratories, Inc., offers to the amateur the best constructed and most accurately calibrated frequency measuring instrument on the market. Extremely sensitive, permitting a very loose coupling to your transmitter. These meters should be the most important piece of equipment in every ham station.

The time has come when the amateur transmitter must be accurately held within the definitely assigned channels. He is required by law to stay within these frequency bands. These bands are of different widths and their outer edges are not in harmonic relation. His greatest problem will be to know exactly where his transmitter frequency is located in the spectrum. The station whose frequency does not fall within one of these assigned bands may possibly interfere with commercial

stations in other bands and in all probability will have its license revoked.

For frequency meters such as these which only cover a very small band, it was necessary to design a different type of frequency indicator. Flash light lamps, neon tubes and galvanometers, the usual type of indicators, were tried out but found unsatisfactory. They were found unsatisfactory not only because they did not indicate sharply but also because they were in the actual measuring circuit and the slightest variation of any of these would affect the calibration. It was, therefore, necessary to use a resonance-indicating device that was independent of the measuring circuit; one that would not in any way alter the calibration; one that would indicate sharply and precisely at one definite point only. The REL frequency meter indicators used in conjunction with the frequency meters employ a DC milliammeter rectifying crystal and pick-up coil.

For more detailed information on REL amateur frequency meters refer to the REL Catalogue, page 21-A.

The frequency meters are mounted in neat metal cases measuring 5 1/2" x 5 1/2" x 4" high. The outer edge of the coil projects 6" beyond the case. Net weight 2 pounds. The frequency meter indicators are mounted in metal cases measuring 5 1/2" x 3" x 4" high. The outer edge of the coil projects 6" beyond the case. Net weight 1 1/2 pounds.

The following is a list of the standard meters built for amateur operation:

Cat. No. 173 frequency meter, 3,500 to 4,000 K. C. (85 to 75 meters).....	Price \$15.00
Cat. No. 177 frequency meter, 7,800 to 7,300 K. C. (42.8 to 41.0 meters).....	Price \$15.00
Cat. No. 178 frequency meter, 14,000 to 14,400 K. C. (21.4 to 20.8 meters).....	Price \$15.00
Cat. No. 179 frequency meter, 28,000 to 30,000 K. C. (10.7 to 10.0 meters).....	Price \$15.00
Cat. No. 180 frequency meter indicator....	Price \$16.00

GENERAL PURPOSE WAVEMETERS



The REL Cat. No. 125 type "A" wavemeter will be found satisfactory for all general purposes. It is essential in every radio station. It is particularly adapted to short wave receiving, transmitting and laboratory uses. These type A wavemeters can be used in conjunction with the above illustrated amateur frequency meters. They will serve to ascertain the approximate settings. When these have been determined the frequency meters should be used for precision measurements.

The type A wavemeters are supplied with grooved

bakelite coils of rugged construction, insuring constant characteristics under all atmospheric conditions. The condenser is of rugged design. It is supplied with an engraved dial and knob. The resonance indicator employed is a sensitive neon tube.

The type A wavemeter is also very adaptable to the following uses: Tuning the transmitter; checking the transmitter; locating antenna and counterpoise nodes; locating coil fields; calibrating an oscillator wave trap—absorption or induction method; calibrating the receiver; measuring capacity; measuring inductance.

Each type A wavemeter is individually calibrated and guaranteed to be accurate. Easy reading chart showing color calibration curves covers the following wavelength ranges:

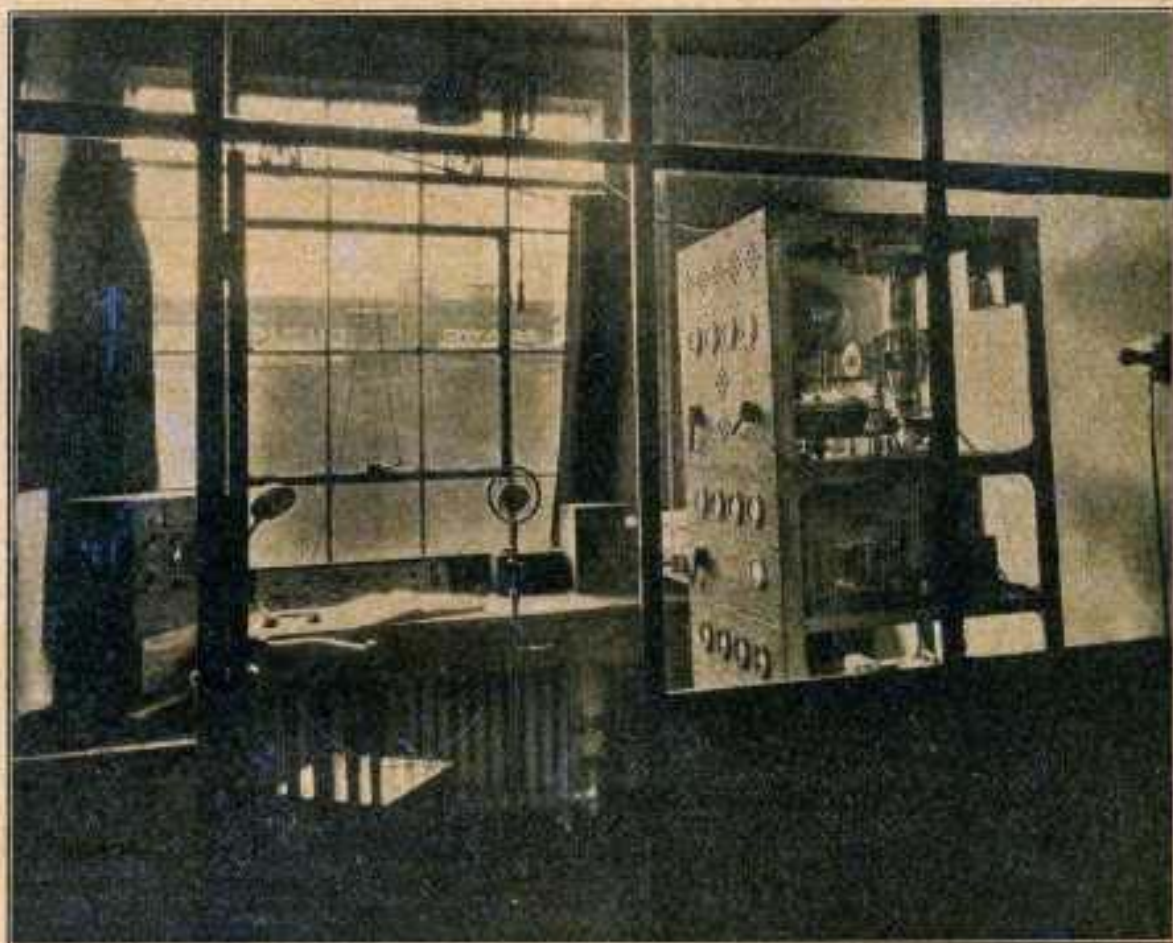
- Coil No. 1—Black curve 17 to 60 meters.
- Coil No. 2—Red curve 50 to 160 meters.
- Coil No. 3—Green curve 160 to 560 meters.

The complete type A wavemeter is housed in a metal case supplied with a removable cover. Sufficient space is allowed for spreading the three coils. The calibration chart which is covered with a transparent soil proof material fits directly into the cover. The case measures 9 1/2" x 7" x 7 1/2" high. Net weight 4 1/2 pounds.

Cat. No. 125 wavemeters..... Price \$22.00

RADIO STATION W2XV

EXPERIMENTAL STATION OWNED
AND OPERATED BY THE
RADIO ENGINEERING LAB., INC., L. I. CITY, N. Y.



The above illustrates the main operating room of short wave experimental station W2XV. The Radio Engineering Laboratories, Inc., maintains this station to conduct various experiments for the benefit of the radio fraternity and also for testing and checking the quality of REL apparatus.

W2XV cannot very readily be classed as a station comprised of amateur parts. It has been designed and built along commercial lines and may be considered a very modern complete station. Brief details on this station are given so that the amateur and other interested parties may have an opportunity to visualize the engineering capabilities of this concern.

The transmitter unit which is shown on the right has a CW output of 750 watts and a peaked modulation telephone output of 750 watts. It is of the multi-stage type (similar to Cat. No. 215), employing crystal control. The crystal is kept at a constant temperature. It is mounted in a standard REL Cat. No. 211 temperature control compartment. This compartment is shown mounted on the center left portion of the transmitter frame. The circuit arrangement is as follows: A 210 tube is employed in the crystal oscillator stage. This feeds a 7½ watt screen grid buffer which in turn operates a 210 intermediate modulated amplifier stage. This then feeds the 75 watt first linear amplifier which in turn excites the 750 watt screen grid output power amplifier. The modulator is comprised of two 250 type tubes connected in parallel, which feeds the 210 intermediate modulated amplifier. Another 250 tube is used as a speech amplifier. The set is housed in an aluminum case having each independent circuit freely shielded in its own compartment. (The sides of the transmitter have been removed in the above photograph so that an internal view of the parts may be had.) The plate supply for the 75 watt and 750 watt tubes is derived from a 4,000 volt motor generator unit mounted elsewhere in the building. The plate supply for all other tubes is derived from a half wave rectifier mounted in

the lower portion of the transmitter unit. Negative biasing for all tubes is obtained from a half wave rectifier unit also mounted in the transmitter.

The antenna system employed is of the antenna counterpoise type with the transmitter operating on the third harmonic.

Directly behind the transmitter and located on the table is the station amplifier and control unit used for broadcasting purposes. (A modern sound proof studio located elsewhere in the building is used for broadcasting weekly programs.) If you are interested in receiving a schedule of the transmitting hours and the frequencies employed write the Radio Engineering Laboratories, Inc.

The finger tip automatic apparatus control panel is mounted to the left of the amplifier. All of the circuits are controlled from this panel. The receiver employed is shown in the extreme left portion. This receiver employs the most modern short wave super-heterodyne circuit known. Each individual circuit is completely shielded and enclosed in its own compartment. This receiver employs AC tubes throughout and is operated direct from the 110 volt lighting system available.

W2XV has consistently and successfully broadcast programs up to 2,000 miles. There are, of course, numerous cases where the station has been heard at much greater distances, reports having been received from practically all points within a radius of 6,000 miles of New York City.

The receiver employed is capable of picking up signals from unlimited distances.

The Radio Engineering Laboratories, Inc., is very proud to give this brief description of its experimental station.

OTHER REL APPARATUS

Besides the apparatus illustrated in this booklet the Radio Engineering Laboratories, Inc., manufactures a complete line of all necessary parts employed in amateur transmitters and receivers. For information on any of this equipment refer to the standard loose leaf pages which are enclosed in the large REL catalog.

Several of the standard REL parts are as follows: Transmitter inductors; transmitter variable condensers; transmitter fixed condensers; RF choke coils; transmitter resistances; metal cases and panels; various types and sizes of complete transmitter kits ranging from 7 watts to 250 watts; various receiver kits ranging from standard 2 tube sets to large 7 tube units; etc.

Besides the standard line of apparatus for amateur purposes, Radio Engineering Laboratories, Inc., are equipped to design and build special equipment. Your problems will be solved by a competent engineering staff.