SERIAL NO.
14255

FINAL INSTRUCTION BOOK

for

Navy Model RU-18 and Navy Model RU-19 Aircraft Radio Telegraph and Telephone Receiving Equipments

Manufactured for

U. S. NAVY DEPARTMENT BUREAU OF SHIPS

by

WESTERN ELECTRIC COMPANY, INC.

CHICAGO, ILLINOIS

CONTRACT NOs 84530, DATED APRIL 21, 1941

RESTRICTED SERIAL NO. 14255

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Navy Model RU-18 and Navy Model RU-19 Aircraft Radio Telegraph and Telephone Receiving Equipments

FREQUENCY RANGE: 195—13,575 KILOCYCLES

This instruction book is furnished for the information of commissioned, warranted, enlisted and civilian personnel of the Navy whose duties involve design, instruction, operation, and installation of radio and sound equipment. The word RESTRICTED as applied to this instruction book signifies that this instruction book is to be read only by the above personnel, and that the contents of it should not be made known to persons not connected with the Navy.

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ELECTRIC SHOCK FIRST-AID TREATMENT

SAFETY FIRST

Regard electrical apparatus generally, and especially all current-carrying parts, as dangerous, irrespective of voltage. Exercise great care in handling, and avoid broad contacts such as are made by standing on a metal deck or in water.

Dangerous contact may result through lessened resistance when the skin and clothing are wet with perspiration. Contact with damp metal surfaces—decks, bulkheads, guns, machinery—may allow the current to ground through the moist skin and body.

Electric shock is due to current passing through the body—current actually passing—irrespective of the voltage. A pressure as low as 110 volts has caused death. Current passing through the body in the region of the heart is especially dangerous. In using electric breast drills avoid the possibility of a ground. Usually electric shock does not kill instantly. Life can often be saved even though breathing has stopped.

1. Free the Victim from the Circuit Immediately

Use a dry nonconductor (rubber gloves, clothing, rope, board) to move either the victim or the wire.

Beware of using metal or moist material.

Shut off the current.

If necessary to cut a live wire, use an ax or hatchet with a dry wooden handle; turn your face away from the electrical flash.

2. Attend Instantly to the Victim's Breathing

Begin resuscitation at once on the spot. Do not stop to loosen clothing; every moment counts.

Resuscitation by the Prone Pressure Method of Artificial Respiration
Gas Asphyxiation ELECTRIC SHOCK Drowning

Waste no time. When the patient is removed from the water, gas, smoke, or electric contact, get to work at once with your own hands. Send for the medical officer or nearest physician.

No reliance should be placed upon any special mechanical apparatus, as it is frequently out of order and often is not available when most needed. The patient's mouth should be cleared of any obstruction such as chewing gum or tobacco, false teeth, or mucus, so that there is no interference with the entrance and escape of air.

FIG. A

POSITION

1. Lay the patient on his belly, one arm extended directly overhead, the other arm bent at elbow and with the face turned outward and resting on hand or forearm, so that the nose and mouth are free for breathing. (See Inset Fig. A.)
2. Kneel straddling the patient's thighs with your knees placed at such a distance from the hip bones as will allow you to assume the position shown in Fig. A.

Place the palms of the hands on the small of the back with fingers resting on the ribs, the little finger just touching the lowest rib, with the thumb and fingers in a natural position, and the tips of the fingers just out of sight. (See Fig. A.)

(over)

Fig. B

FIRST MOVEMENT

3. With arms held straight, swing forward slowly, so that the weight of your body is gradually brought to bear upon the patient. The shoulder should be directly over the heel of the hand at the end of the forward swing. (See Fig. B.) Do not bend your elbows. This operation should take about two seconds.

Fig. C

SECOND MOVEMENT

4. Now immediately swing backward, so as to remove the pressure completely. (See Fig. C.)

5. After two seconds, swing forward again. Thus repeat deliberately twelve to fifteen times a minute the double movement of compression and release, a complete respiration in four or five seconds.

6. Continue artificial respiration without interruption until natural breathing is restored. Do not get discouraged at the slow results that sometimes happen when resuscitating the apparently drowned. Efforts often have to be continued a long time before signs of life are apparent. Do not discontinue the efforts until certain that all chance is lost. Sometimes, even after several hours' work, recovery takes place.

7. As soon as this artificial respiration has been started and while it is being continued, an assistant should loosen any tight clothing about the patient's neck, chest, or waist. TO KEEP THE PATIENT WARM DURING ARTIFICIAL RESPIRATION IS MOST IMPORTANT AND IT MAY BE NECESSARY TO COVER HIM WITH BLANKETS AND WORK THROUGH THEM, AS WELL AS TO APPLY HOT-WATER BOTTLES, HOT BRICKS, ETC. Do not give any liquids whatever by mouth until the patient is fully conscious.

8. To avoid strain on the heart when the patient revives, he should be kept lying down and not allowed to stand or sit up. If the doctor has not arrived by the time the patient has revived, he should be given some stimulant, such as one teaspoonful of aromatic spirits of ammonia in a small glass of water or a hot drink of coffee or tea, etc. Continue to keep the patient warm and at rest.

9. Resuscitation should be carried on at the nearest possible point to where the patient received his injuries. As a general rule he should not be moved from this point until he is breathing normally of his own volition and then moved only in a lying position. Should it be necessary, due to extreme weather conditions, etc., to move the patient before he is breathing normally, resuscitation should be carried on during the time that he is being moved.

10. A brief return of natural respiration is not a certain indication for stopping the resuscitation. Not infrequently the patient, after a temporary recovery of respiration, stops breathing again. The patient must be watched, and if natural breathing stops, artificial respiration should be resumed at once.

11. In carrying out resuscitation it may be necessary to change the operator. This change must be made without losing the rhythm of respiration. The relief operator should kneel behind the one giving the artificial respiration and at the end of the movement, the operator crawls forward while the relief takes his place. By this procedure no confusion results at the time of change of operator, and a regular rhythm is kept up.

Practice in the Performance of Artificial Respiration on a Volunteer Subject should be obtained by everyone

ADDENDUM SHEET

The following design change in GF/RU and RU Radio Equipments was applied to a limited number of units due to its introduction after large quantities of equipments had been manufactured and delivered by the contractor.

Design Change

To improve the audio coupling factor of RU Receivers, the telephone jacks 133A in the Type CW-23096-A or CW-23087 Receiver Switch Box have been shunted with a .003 microfarad (plus or minus 20%, 500V. D.C.) capacitor. The application of this capacitor improves the coupling factor about .005 to .0005 (20 D.B.) at dial 100 range K. Capacitor is in accordance with requirements of the American Standards Association Specification C-75.3 and is identified by code CM40A332M.

Serial Numbers of Equipments Affected

Receiver Switch Box

	Serial No. Regular Eqpt.		*Serial No. Bulk Spares*	
	Start	*End*	*Start*	*End*
RU-16	9973	10948	987-S	1095-S
RU-17	4444	4987	454-S	493-S
RU-18	—	—	—	—
RU-19	11095	11531	—	—

NOTICE TO
OPERATING AND MAINTENANCE PERSONNEL

Operation of this equipment involves the use of high voltages which are dangerous to life. Operating personnel must at all times observe all safety regulations. Do not change tubes or make adjustments inside equipment with high voltage supply on. Do not depend upon door switches or interlocks for protection but always shut down motor generators or other power equipment. Under certain conditions dangerous potentials may exist in circuits with power controls in the off position due to charges retained by capacitors, etc. To avoid casualties always discharge and ground circuits prior to touching them.

The attention of officers and operating personnel is directed to Bureau of Engineering Circular Letter No. 5a of 3 October, 1934, or subsequent revisions thereof on the subject of "Radio—Safety Precautions To Be Observed."

GUARANTEE

The contractor guarantees all parts and spare parts, including vacuum tubes, of this equipment for a service period of one year, with the understanding that, as a condition of the contract, all items found to be defective as to design, material, workmanship, or manufacture shall be replaced without delay at no expense to the Government, provided: that such guarantee and agreement shall not obligate the contractor to make replacement of defective material unless failure occurs within a period of two years from the date of delivery of the equipment to and acceptance by the Government, and provided further that; if any part or parts (except vacuum tubes) fail in service or are found defective in ten per cent (10%) or more of the equipment furnished under contract such part or parts shall be conclusively presumed to be of defective design and as a condition of contract subject to one hundred per cent (100%) replacement. Redesigned replacements which will assure proper operation of the equipment will be supplied promptly, transportation paid, to the naval activities using such equipment upon receipt of proper notice and without cost to the Government.

REPORT OF FAILURE

Report of failure of any part of this equipment, during its guaranteed life shall be made on form N. Aer. 4112 "Report of Unsatisfactory or Defective Material" in accordance with the latest instruction received by the Inspector of Naval Material (location to be supplied upon request) and the Bureau of Ships, before any action can be taken for replacement of the unsatisfactory part. Copies of this report shall be forwarded in accordance with existing instructions from the Bureau of Aeronautics. Such reports of failure shall include—

1—Reporting activity..

2—Nameplate data ....

3—Date placed in service, if known..

4—Part which failed..

5—Nature and cause of failure..

6—Replacement needed (yes—no)..

7—Remedy used or proposed to prevent recurrence..

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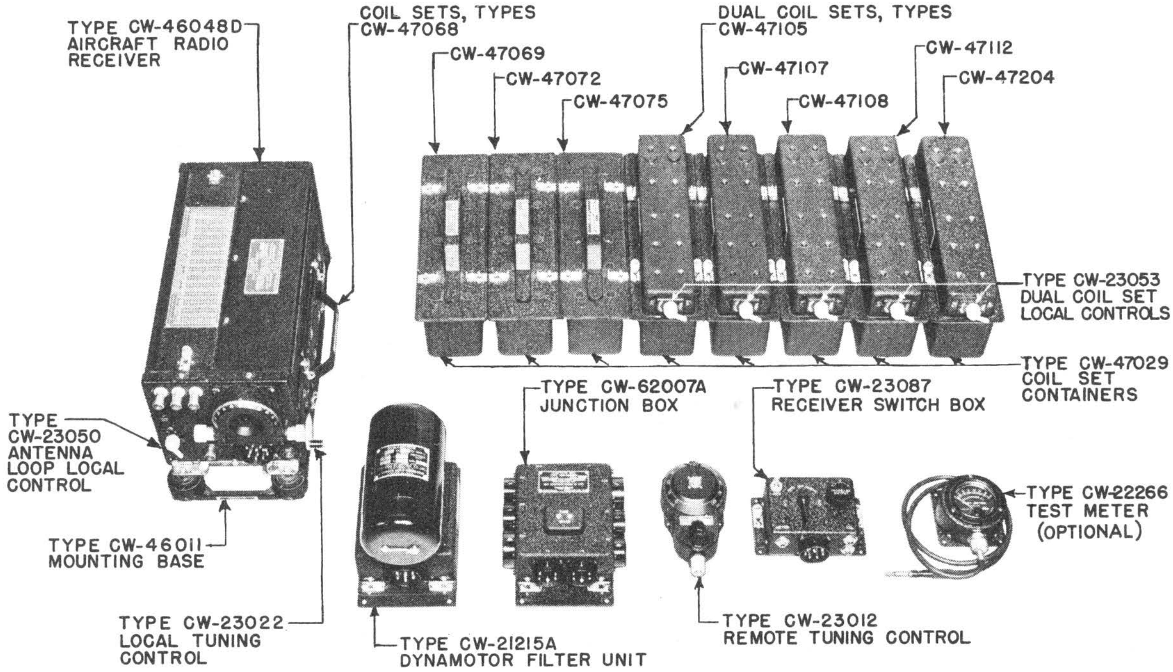


FIG. 1A—PRINCIPAL UNITS, MODEL RU-18 (12-VOLT) RECEIVING EQUIPMENT

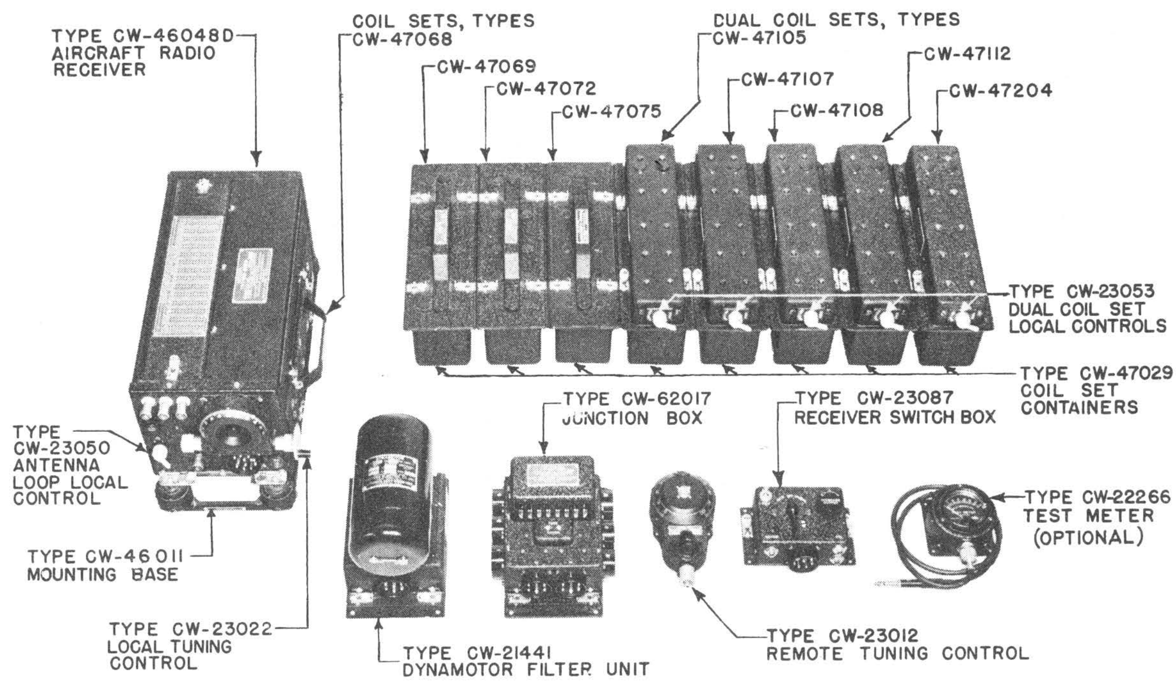


FIG. 1B—PRINCIPAL UNITS, MODEL RU-19 (24-VOLT) RECEIVING EQUIPMENT

Navy Model RU-18 and Navy Model RU-19 Aircraft Radio Equipments

SECTION I. DESCRIPTION

1. General

Model RU-18 is a complete aircraft radio receiving equipment capable of reception of MCW or CW signals in the frequency range of 195-13,575 kilocycles. It is designed for use on airplanes equipped with a 12-15 volt d-c source. Model RU-19 Equipment is similar to Model RU-18 except that it is designed for use on airplanes having a 24-30 volt d-c source. *The junction boxes and the dynamotor-filter units of the two equipments are the only corresponding items which are not interchangeable.*

All major units of Model RU-18 are completely interchangeable with the corresponding major units of Models RU-4, RU-5, RU-6, RU-10 and RU-11. Receiver coil sets of Models RU-18 and RU-19 are interchangeable with corresponding ranges of Models RU-3, RU-3A, RU-4, RU-4A, RU-5, RU-5A, RU-6, RU-7, RU-10, RU-11, RU-12, RU-13, RU-14, RU-16 and RU-17.

2. Nameplate Colors

All nameplates on major units of Model RU-18 (12-volt equipment) have a black background, and all nameplates on major units of Model RU-19 (24-volt equipment) have a blue background. However, all such units are interchangeable except the junction boxes and dynamotor-filter units.

3. Symbol Numbers

The symbol numbers used in the following discussion refer to parts shown and similarly numbered in photographs and drawings, and in the Parts Reference Lists, Table I and Table II at the end of the text.

The following table, arranged numerically according to Navy Type Numbers, shows items which may be used as components of Model RU-18 and Model RU-19 Radio Equipments. Not all items listed are supplied in each lot of equipment purchased on Contract NOs 84530.

Items Which May Be Used as Components of the Model RU-18 and Model RU-19 Equipments on Contract NOs 84530

(Certain lots of equipments do not include all of the apparatus listed below)

Navy Type Designation	*Name of Major Unit or Accessory*	*Supplied with Model RU-*	*Quantity per Equipment*	*Mfr's Designation*
CW-21215A	Dynamotor-Filter Unit with Base No. 2955	18	1	2921
CW-21441	Dynamotor-Filter Unit with Base No. 2955	19	1	6697
*CW-22266	Test Meter	18, 19	1	3140
CW-23012	Receiver Remote Tuning Control with 0-100 Dial No. 3055 and 100-0 Dial No. 3595	18, 19	1	3042
CW-23021	Remote Tuning Control Mechanical Linkage (bulk)	18, 19	1	1607
CW-23052	Remote Switching Mechanical Linkage (bulk)	18, 19	2	1246
CW-23053	Dual coil set Local Control (On receiver dual coil set)	18, 19	1 per dual coil set	1001
CW-23054	Dual coil set Remote Control	18, 19	1	1645
CW-23087	Receiver Switch Box with Base No. 1448	18, 19	1	3147
CW-46048D	Aircraft Radio Receiver with Type CW-46011 Mounting Base, Type CW-23022 Local Tuning Control, Type CW-23050 antenna-loop Local Control, and one set vacuum tubes	18, 19	1	3749

*Optional, not furnished with all lots of equipments.

Navy Type Designation	*Name of Major Unit or Accessory*	*Supplied with Model RU-*	*Quantity per Equipment*	*Mfr's Designation*
⊖CW-47029	Receiver Coil Set Containers	18, 19	1 per coil set	2203
∅ -47067	Receiver Coil Set, Range C, 545-850 kc			1774
CW-47068	Receiver Coil Set, Range D, 850-1330 kc	18, 19	1	1775
CW-47069	Receiver Coil Set, Range E, 1330-2040 kc	18, 19	1	1776
Ω CW-47070	Receiver Coil Set, Range F, 2040-3000 kc	18, 19	1	2818
∅ -47071	Receiver Coil Set, Range G, 3000-4525 kc			1778
CW-47072	Receiver Coil Set, Range H, 4000-6000 kc	18, 19	1	2819
CW-47075	Receiver Coil Set, Range K, 9050-13575 kc	18, 19	1	1782
∅ -47088	Receiver Coil Set, Range N, 6000-9050 kc			2845
∅ -47099	Receiver Coil Set, Range M, 5200-7700 kc			2820
CW-47105	Receiver Dual Coil Set, Range O, 195-290 kc, and Range P, 290-435 kc	18, 19	1	3283
∅ -47106	Receiver Coil Set, Range L, 400-600 kc			3325
CW-47107	Receiver Dual Coil Set, Range Q, 540-830 kc, and Range G, 3000-4525 kc	18, 19	1	2853
CW-47108	Receiver Dual Coil Set, Range Q, 540-830 kc, and Range M, 5200-7700 kc	18, 19	1	2854
CW-47112	Receiver Dual Coil Set, Range L, 400-600 kc, and Range N, 6000-9050 kc	18, 19	1	3549
∅ CW-47202	Receiver Dual Coil Set, Range F, 2040-3000 kc, and Range N, 6000-9050 kc			ES-691307
∅ CW-47203	Receiver Dual Coil Set, Range F, 2040-3000 kc, and Range G, 3000-4525 kc			ES-691310
CW-47204	Receiver Dual Coil Set, Range Q, 540-830 kc, and Range F, 2040-3000 kc	18, 19	1	7971
CW-62007A	Junction Box with Base No. 2955, 3 Protective Caps No. 1943 and 1 Protective Cap No. 1942	18	1	2938
CW-62017	Junction Box with Base No. 2955, 3 Protective Caps No. 1943 and 1 Protective Cap No. 1942	19	1	6560
	Bulk Parts for Cable Assemblies 1610, 1611, 1613, 3084 and *3141	18, 19	1 set	
	*Receiver Slip Cover	18, 19	1	P280
	*Rubber Sleeves for Plugs. One set consists of:	18, 19	1 set	
	3 Receiver plug size			P337
	5 Switch box plug size			P336
	3 Dynamotor unit plug size			P335
	1 Test meter plug size			3475
	Aligning Wrench	18, 19	1	FR235
	Instruction Book	18, 19	1	
	Receiver tuning chart (In addition to one on receiver tube cover)	18, 19	1	
	Set of Operating Spare Parts in Spare Part Box (See Table 3 and list on box cover)	18, 19	1 set	

* Optional, not furnished with all lots of equipments.
⊖ Each receiver is shipped with one coil set in place. One coil set container is provided for each additional coil set furnished.
Ω Supplied with certain equipments when Type CW-47204 was not supplied.
∅ Not supplied by the Western Electric Company as a part of the RU-18 or RU-19 equipment.

SEE FIG. 15 FOR DIMENSIONS AND WEIGHTS OF MAJOR UNITS

4. Vacuum Tubes

Three Navy Type -78 Vacuum Tubes are used in the Type CW-46048D Aircraft Radio Receiver as radio frequency amplifiers. This tube is a pentode comprising an indirectly heated cathode, a control grid, a screen grid, a suppressor grid, and a plate. The oxide-coated cathode is heated by a two-terminal *heater* filament. The tube is designed primarily as a radio-frequency *variable-mu* amplifier. In operation, the control grid is biased negatively by an amount depending upon the amount of amplification desired and the screen grid is maintained at a positive potential of approximately one-half the plate voltage. The control grid terminal is brought out at the top of the glass envelope of the tube. The heater, screen grid, cathode, suppressor grid and plate terminals are brought out through six prongs in the tube base. (See Fig. 14 for terminal arrangement.) Functionally the tube is characterized by (a) high-amplification factor; (b) small variation in plate current with control grid voltage at high values of negative bias *(variable mu)*; (c) high internal plate resistance and (d) low power output.

One Navy Type -77 vacuum tube is used in each receiver as a detector, and one as an automatic-gain-control (A.G.C.) tube. This tube is a pentode comprising an indirectly-heated cathode, a control grid, a screen grid, a suppressor grid and a plate. The cathode and heater are the same as those used in the Navy Type -78 tube. The tube is designed primarily for use as a detector. In operation as a detector the control grid is biased negatively by an amount suitable for plate-circuit rectification and the screen grid is maintained at a positive potential. The control grid is brought out at the top of the glass envelope of the tube. The heater, screen grid,

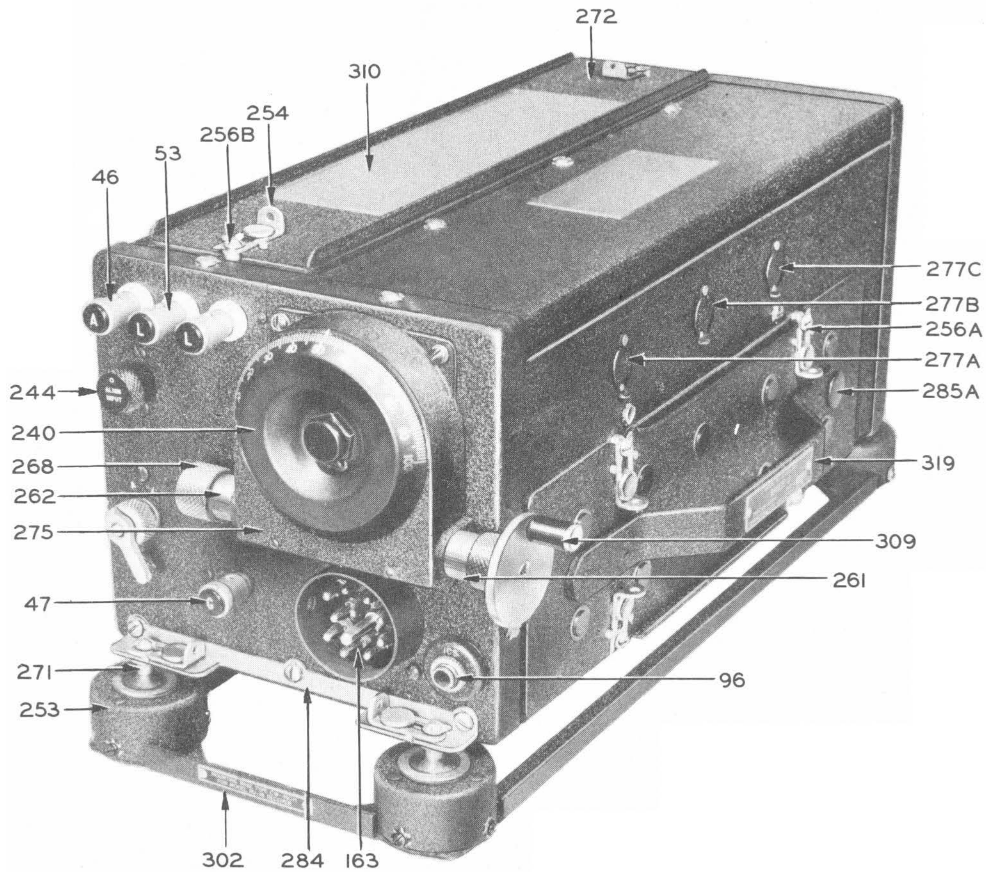


FIG. 2—TYPE CW-46048D AIRCRAFT RADIO RECEIVER, TYPE CW-46011 MOUNTING BASE, TYPICAL SINGLE COIL SET, TYPE CW-23022 LOCAL TUNING CONTROL, TYPE CW-23050 ANTENNA-LOOP LOCAL CONTROL

cathode, suppressor grid and plate are brought out through six prongs in the tube base (see Fig. 14 for terminal arrangement). Functionally the tube is characterized by (a) high amplification factor; (b) high detection coefficient; (c) high internal plate resistance and (d) low power output.

One Type -38233 vacuum tube is used in the receiver as a combined heterodyne oscillator and audio frequency amplifier. It comprises two independent triodes enclosed in one glass envelope, each consisting of an indirectly heated cathode, a grid, and a plate. The two oxide-coated cathodes are heated by two heater filaments which are connected in parallel internally in the tube. The grid of one triode is brought out through the top of the glass envelope of the tube. The plate and cathode of this triode and the plate, grid and cathode of the second triode, and two heater terminals, are brought out through seven prongs in the tube base (see Fig. 14 for terminal arrangement). Both triodes of the tube have the same characteristics and are characterized functionally by (a) medium amplification factor; (b) medium plate resistance and (c) moderate power output.

The following table gives the significant constants of all tubes at the operating voltages specified therein:

	Navy Type -78	*Navy Type* -77	*Type* -38233
Heater Voltage	6.3 v.	6.3 v.	6.3v.
Heater Current	0.3 a.	0.3 a.	0.6 a.
Control Grid Voltage	—3 v.	—3 v.	—16.5 v
Screen Grid Voltage	125 v.	100 v.	——
Plate Voltage	250 v.	250 v.	250 v.
Plate Current	0.0105 a.	0.0023 a.	0.008 a.
Amplification Factor	990	1500	10.5
Plate Resistance	0.6 megohm	1.5 megohms	8,000 ohms

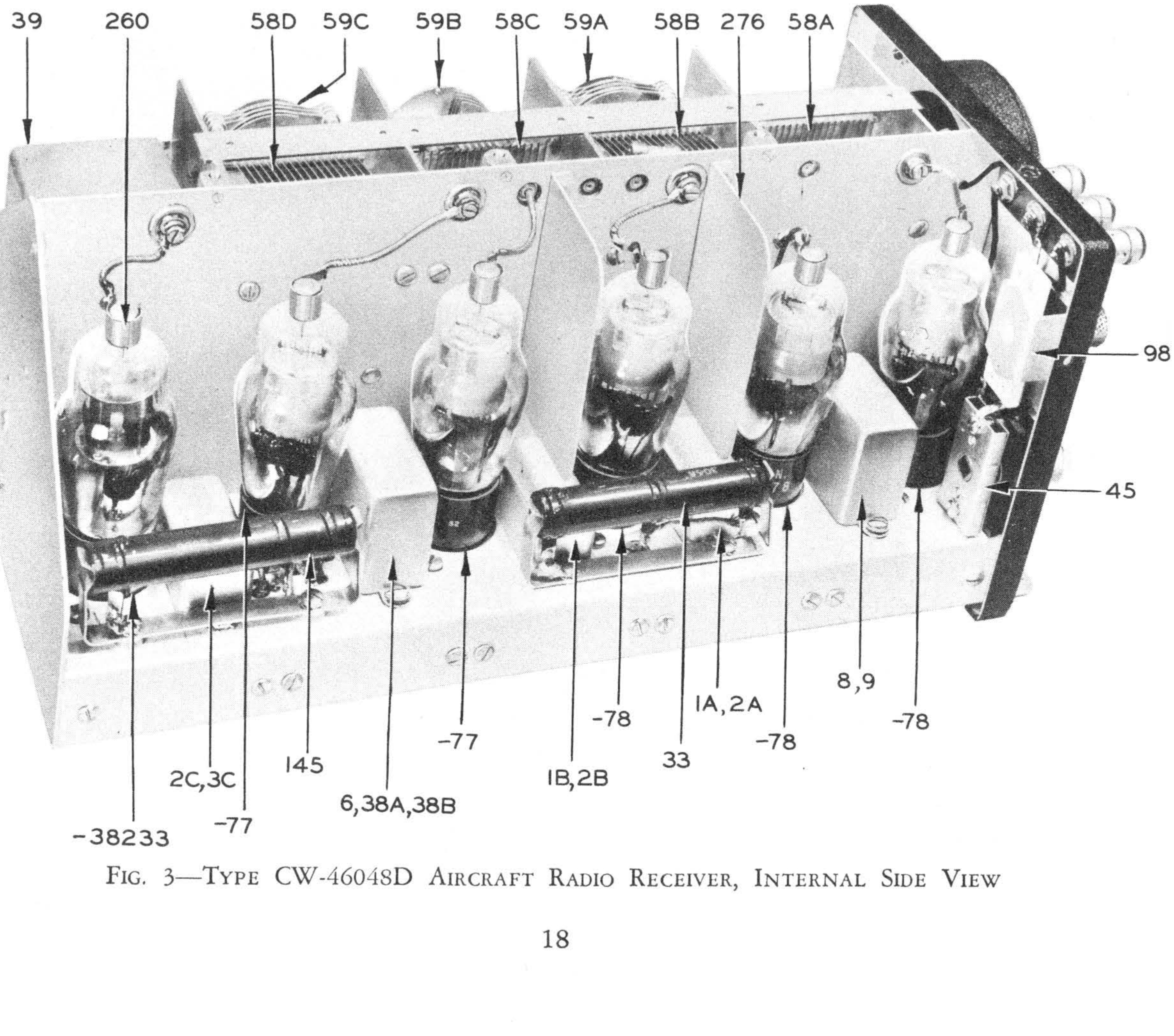


FIG. 3—TYPE CW-46048D AIRCRAFT RADIO RECEIVER, INTERNAL SIDE VIEW

5. Type CW-46048D AIRCRAFT RADIO RECEIVER (Including Type CW-46011 Mounting Base), COIL SETS

Type CW-46048D Aircraft Radio Receiver consists of a setbox including the supply and coupling terminals, power terminals and plug-in coil terminals. It is shown in Figs. 1A, 1B, 2, 3, 4, 15 and 16. Views of typical coil sets are shown in Figs. 6 and 7. A functional circuit diagram is shown in Fig. 5A, a schematic in Fig. 13A and actual wiring in Fig. 14.

The receiver case is of aluminum, having one end blank and the other end open. It has an opening in the top closed by tube cover 272 which allows access to the tubes. The open end of the case is closed by a metal panel on which are mounted the antenna binding post 46, two loop binding posts 53, ground binding post 47, the input alignment condenser 98 with its adjusting knob 244, the antenna-loop switch 45, with outlet for either local or remote control, an input jack 96 for use in the airplane interior communication system if desired, together with the tuning gear unit 275 carrying dial 240, and the power plug receptacle 163. The internal frame or chassis of the receiver is permanently attached to the front panel. The case is attached by screws to the front panel and various other points of the receiver and forms, together with the front panel, a complete shielding closure for the receiver. Tube cover 272 is secured to the case by two snapslides 254. The tube compartment is divided into cells by the tube shields 276 which serve to reduce the capacity coupling between the tuned stages of the radio frequency amplifier.

Electrically the receiver comprises three stages of radio-frequency amplification, a detector and one audio amplifier, an A.G.C. stage, and heterodyne oscillator. The radio amplifier tubes are Navy Type -78; the detector and A.G.C. tubes are Navy Type -77; the combined oscillator and audio amplifier tube is a Type -38233. Each of the coil sets includes the same essential parts of the radio-frequency circuit, and except where otherwise noted, the following discussion applies to the receiver when using any one of the coil sets.

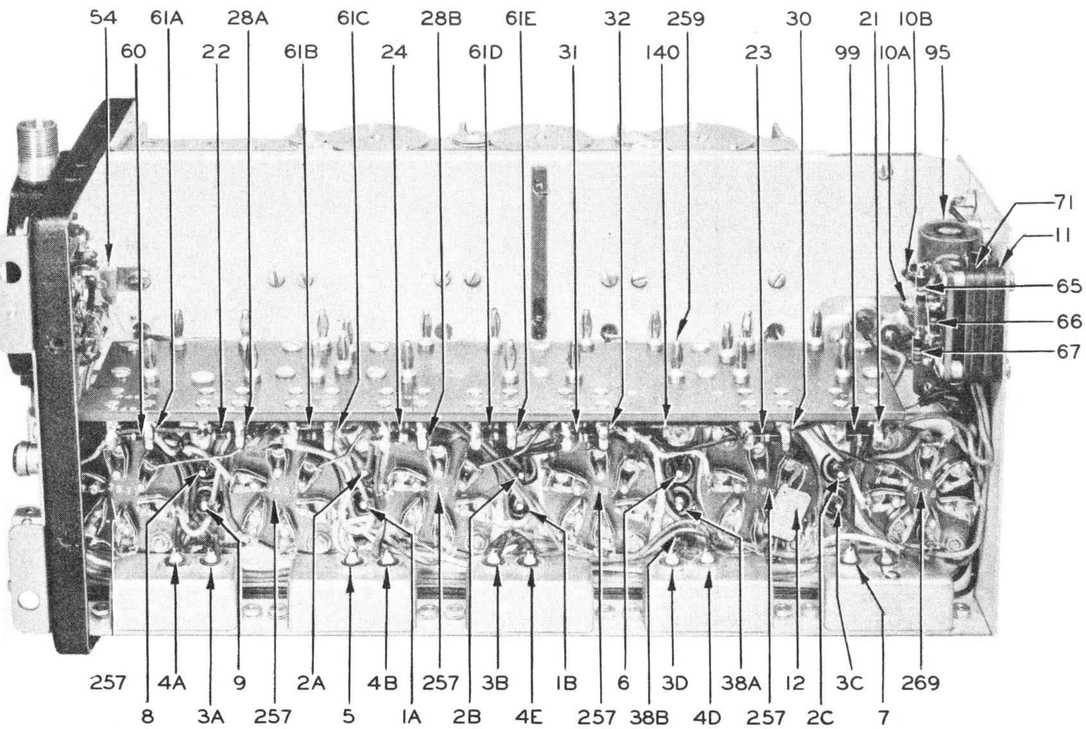
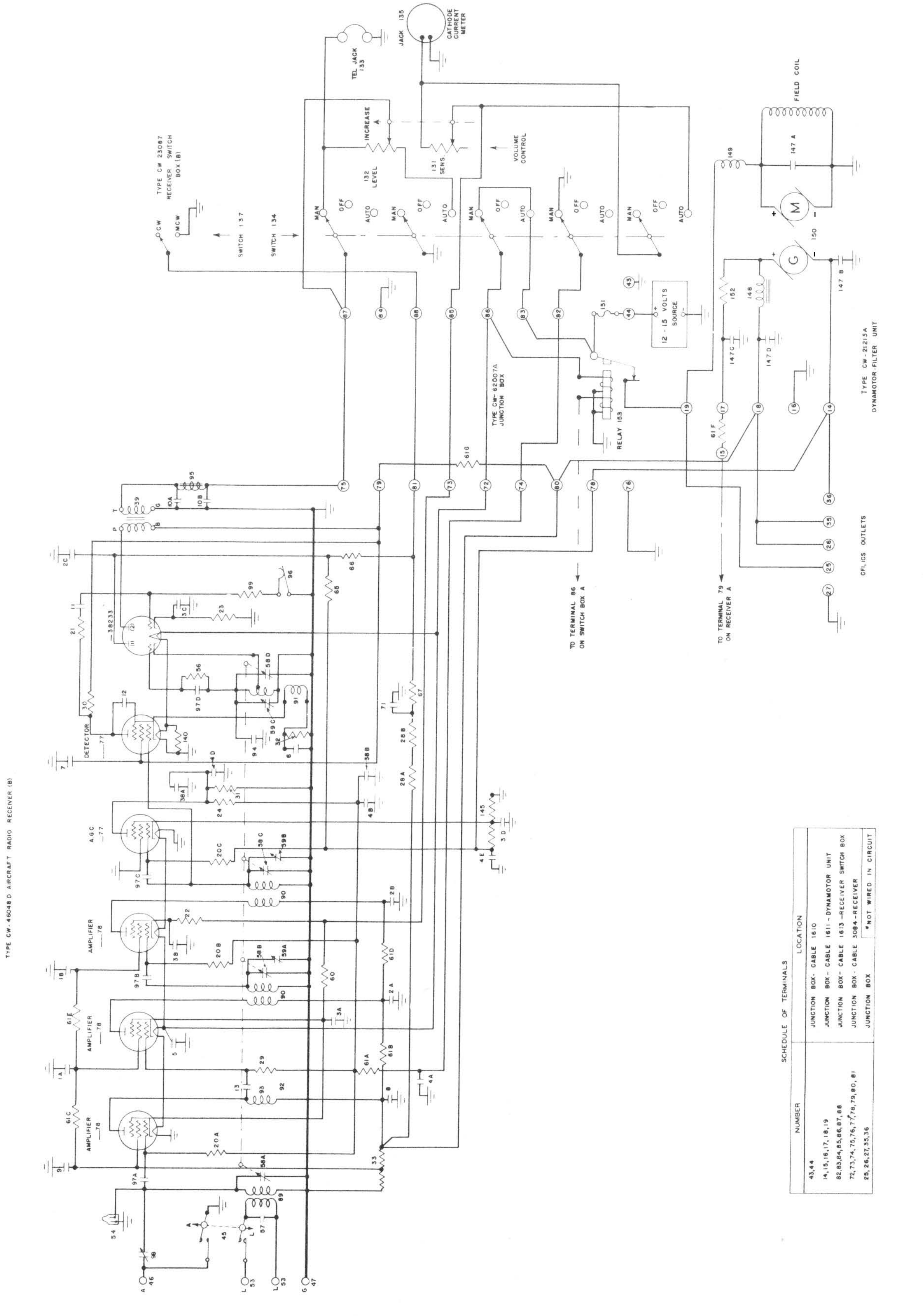


FIG. 4—TYPE CW-46048D AIRCRAFT RADIO RECEIVER, INTERNAL BOTTOM VIEW

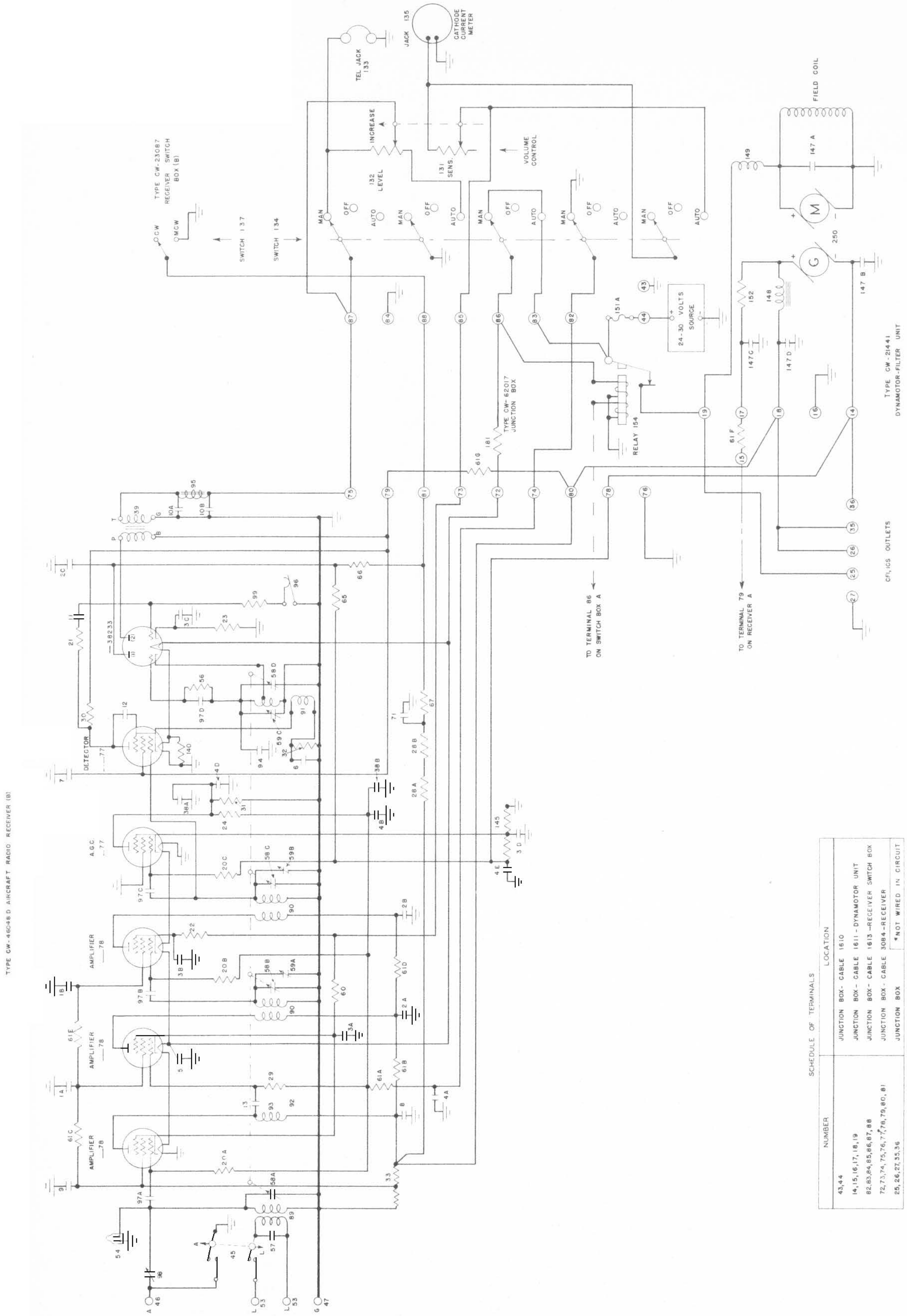


SCHEDULE OF TERMINALS

NUMBER	LOCATION
43,44	JUNCTION BOX - CABLE 1610
14,15,16,17,18,19	JUNCTION BOX - CABLE 1611 - DYNAMOTOR UNIT
82,83,84,85,86,87,88	JUNCTION BOX - CABLE 1613 - RECEIVER SWITCH BOX
72,73,74,75,76,77*,78,79,80,81	JUNCTION BOX - CABLE 3084 - RECEIVER
25,26,27,35,36	JUNCTION BOX

*NOT WIRED IN CIRCUIT

FIG. 5A—FUNCTIONAL CIRCUIT DIAGRAM, MODEL RU-18 (12-VOLT) EQUIPMENT



SCHEDULE OF TERMINALS

NUMBER	LOCATION
43,44	JUNCTION BOX- CABLE 1610
14,15,16,17,18,19	JUNCTION BOX- CABLE 1611-DYNAMOTOR UNIT
82,83,84,85,86,87,88	JUNCTION BOX- CABLE 1613-RECEIVER SWITCH BOX
72,73,74,75,76,77*,78,79,80,81	JUNCTION BOX- CABLE 3084-RECEIVER
25,26,27,35,36	JUNCTION BOX
	*NOT WIRED IN CIRCUIT

FIG. 5B—FUNCTIONAL CIRCUIT DIAGRAM, MODEL RU-19 (24-VOLT) EQUIPMENT

The following paragraphs, describing principles of operation, are best illustrated by the functional circuit diagram, Fig. 5A, on page 20, which is a simplified diagram showing all essential circuits for the operation and control of one receiver. The consolidated schematic diagram, Fig. 13A, in the back of the book, shows all the circuit elements, similarly numbered, with two receivers and two switch boxes.

The three radio-frequency stages are coupled by four coupling circuits, three of which consist of radio-frequency transformer coils 89, 90, tuned by equal sections of the variable gang tuning capacitor. The fourth consists of a fixed band-pass coupling circuit which is made up of a coil assembly 93, a resistor 29, and a coupling capacitor 13. These three elements are all included in the band-pass stage of all coil sets. All coil sets except CW-47204 having a frequency range below 850 kc also include a capacitor 34 in the band-pass stage. A fifth element, resistor 37 (see Fig. 13A) is connected across a portion of coil 93 in the band-pass stage of some dual coil sets. The function of the fixed band-pass coupling between the first and second tubes of the amplifier is to equalize the amplification over any frequency band which is covered by rotation of the gang-tuning capacitor. All tubes coupled by the tuned transformers 90 amplify considerably more at small values of tuning capacity than at large values of tuning capacity. The band-pass coupling unit is designed, for each coil set, so that the amplification of the vacuum tube nearest the antenna is greatest at the low-frequency end of each frequency band.

The capacities of the equal sections of the gang-tuning capacitor, which tune the coils 89 and 90 to resonance with each other and with the incoming radio signal, are augmented by the aligning capacitors. These aligning capacitors are built into the respective sections of the gang capacitor, and are separately adjustable, but not as a receiver-operating adjustment. Their function is two-fold. They compensate in all frequency bands for slight inequalities in the residual capacity of each stage; and they provide a relatively high capacity in each tuned stage following the antenna stage.

The first stage is coupled to the antenna through a two-position antenna-loop switch 45. With switch 45 in the A position (open), the regular antenna, connected to terminal 46, is coupled to the input coil assembly 89 through a variable series capacitor 98, adjustable by knob 244. Capacitor 98 is adjusted, for any given receiving antenna, until the series combination of its capacity with the antenna capacity is equal to the residual or minimum capacity introduced into the remaining tuned stages by capacitors 59A, 59B. When this is done the input circuit 89 is in resonance with the remaining tuned circuits at all settings of the gang-tuning capacitor. Switch 45 is set at the L position when it is desired to use an inductive loop or coil aerial as an antenna, connected between the two terminals 53. In this position the antenna binding post is grounded by the upper contacts (Fig. 5A) of switch 45 and the input alignment capacitor 98 is connected in parallel with the first tuned radio coil assembly 89. The loop terminals 53 are connected in parallel with the ungrounded primary of coil assembly 89, which serves to couple the loop to the tuned input circuit. The input coil assemblies are designed to operate in this fashion with a loop having an inductance of *approximately* 200 microhenries and a distributed capacity of *approximately* 50 micromicrofarads. With a loop having approximately these constants connected to terminals 53, and the switch in the L position, it is possible to find a setting of the input alignment capacitor 98 which resonates the input circuit for any frequency within the band defined by the rotation of the gang-tuning capacitor. It should be borne in mind, when receiving from a loop, that the input section 58A of the gang capacitor is the main variable-tuning element of the loop circuit, and capacitor 98 is merely a supplemental control. Resonance in the input circuit is not critical when a loop is used, but it will be found that slight readjustments of capacitor 98, as the receiver is tuned through a frequency band, may produce slightly stronger received signals. But when using antenna reception, with switch 45 in its A position, *no readjustment of capacitor 98 is necessary or desirable if it is properly set on installation.* The shaft of the gang capacitor is brought out the front of the receiver and terminates in dial 240. It is rotated, for tuning to resonance with the incoming signal, by a worm-gear drive, to which coupling is made through outlets 261 and 262.

The last element of each coil set is an oscillator coil assembly 91 which is tuned by the last section 58D of the gang-tuning capacitor. This coil assembly consists of a tuned coil which is effectively connected between the grid and plate of the oscillator triode (1) of the -38233 vacuum tube. The cathode of this tube is connected to an intermediate tap on this tuned coil. A second coil of assembly 91 is coupled to the tuned coil and is connected between the cathode of the Navy Type -77 detector tube and the by-pass capacitor 6, thus impressing a radio-frequency heterodyne voltage from the oscillator between the detector cathode and detector control grid. Included inside the shield of the oscillator coil assembly on all coil sets is a small additional capacitor 94 whose function is to provide a compensating element, in each of the coil sets, for unavoidable differences in distributed capacity between the oscillator coil of the coil set, and the other tuned coils of the same set. The slight differences in distributed capacity herein referred to cannot be compensated by adjusting the aligning capacitors 59A and 59B because these capacitors are an integral part of the receiver and can have only one setting for all the coil sets.

For convenience in wiring and control of the oscillator, the cathode and grid terminals of the oscillator coil are made to have different radio-frequency potentials, both above ground, and the plate of the tube is kept at ground potential for radio frequencies. If terminal 81 is grounded externally the plate voltage is removed from the oscillator and a small negative voltage is impressed upon the plate of the oscillator in virtue of its connection through the 500,000 ohm resistor 65 to the negative terminal 78 of the power plug, to prevent the triode, section (1), from oscillating. In this condition the receiver is adapted to receive modulated signals. When terminal 81 is left open with respect to ground, triode (1) of the -38233 tube oscillates and induces through the coupling coil of assembly 91 a radio voltage between the cathode and control grid of the detector.

The frequency of this oscillation is determined by the setting of the variable gang capacitor. Coil 91 is so designed, for each coil set, that this frequency is equal to one-half the frequency of the received signal, to which the amplifier stages are tuned by the preceding sections of the gang capacitor. When this half-frequency voltage is impressed on the control grid of the detector, the second harmonic of the frequency of this voltage beats with the incoming signal voltage, also impressed between cathode and grid from the last tuned amplifier coil 90. Thus when receiving a CW signal, the operations of tuning the amplifier stages to resonance with the incoming signal and tuning the heterodyne oscillator so that its harmonic beats at an audio frequency with the incoming signal, are both carried out simultaneously by rotating the gang capacitor shaft. No means is provided for controlling externally the strength of oscillation of the heterodyne oscillator; the design is such that the amplitude of oscillation is maintained at a level suitable for the detector, as the receiver is tuned through any frequency band.

After successive amplification through the three Navy Type -78 tubes, the amplified radio signal is impressed upon the control grids of the two Navy Type -77 tubes. It is impressed on the A.G.C. tube through fixed capacitor 97C and on the detector tube through a direct connection. Considering first the Navy Type -77 detector tube, its control grid has impressed upon it either a modulated incoming signal alone, or in the case of CW reception, for which the heterodyne oscillator tube is turned on, an incoming signal plus the heterodyne voltage from the coils 91 as previously explained, which effectively modulates it in the plate circuit.

A corresponding audio-frequency voltage is developed in the plate circuit of the detector tube by plate rectification. This audio voltage appears across the detector plate resistor 30, and is impressed upon the grid of the audio amplifier tube, triode (2) of the -38233, through resistor 21 and capacitor 11. This audio amplifier triode (2), amplifies the audio signal, which passes from its plate through primary winding PB of the output transformer 39. From the secondary TG of this transformer the audio signal passes through a low-pass filter section comprising choke coil 95 and capacitors 10A and 10B. This filter attenuates audio frequencies above about 3500 cycles per second; it is included in the circuit to reduce noise occurring at the higher audio frequencies. Resistor 21 operates in conjunction with capacitor 11 to keep radio-frequency currents out of the audio output stage. Resistor 99 is a grid return for the output tube. The telephone receiver circuit, from plug terminal 75, is connected to terminal T of the output transformer through the filter section. Transformer 39 is a step-down transformer and the *receiver is adapted for use only with low-impedance phones (approximately 600 ohms)*. A closed-circuit jack 96 is provided on the front panel of the receiver for connecting into the grid circuit of the audio amplifier triode (2) the transmission system of the airplane interior communication system if desired.

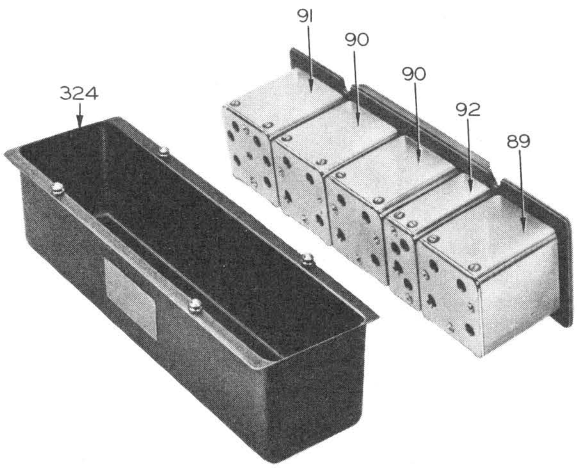


Fig. 6—Typical Coil Set, Type CW-47029 Coil Set Container

The sensitivity of the receiver is controlled by varying the control grid bias and hence the radio-frequency amplification of the three Navy Type -78 amplifier tubes. This is done either externally, by a manually operated variable resistor, or internally by the A.G.C. (automatic gain control) circuit. The heavy line in Fig. 5A represents the grounded frame of the receiver. The cathodes of the three amplifier tubes are connected for direct-current purposes to terminal 73 of the power plug. The control grids of these amplifier tubes are connected for direct-current purposes to terminal 74 of the power plug, as well as to a line running through resistor 24, to the plate of the A.G.C. tube, Navy Type -77. If terminal 74 is grounded externally, thus connecting all grid circuits directly to ground, a variable external resistance between the cathodes (terminal 73) and ground will limit or control the amplification of the Navy Type -78 tubes by making their grids more negative with respect to their cathodes. If terminal 73 is grounded externally, bringing all cathode circuits to ground, a d-c voltage between terminal 74 and ground will determine the grid bias and hence the amplification of the three amplifier tubes. Such a voltage is developed automatically, when terminal 73 is grounded and 74 is opened externally, by rectification of the incoming carrier wave by the A.G.C. tube. The amplified incoming signal is impressed upon the control grid of this A.G.C. tube through capacitor 97C and is rectified in the plate circuit of this tube. The rectified signal appears as an audio and d-c voltage across the plate resistor 31. Only the d-c component, which varies approximately in proportion to the strength of the incoming radio carrier voltage, is used.

The audio components in the plate circuit of the A.G.C. tube are by-passed to ground through capacitors 4D and 38, and are further suppressed from the line returning to the grids of the amplifier tubes, by resistor 24 which forms, in co-operation with capacitors 4B and 38B, a low-pass filter section. As the amplified carrier of the incoming radio signal increases, the plate of the A.G.C. tube becomes more and more negative with respect to ground, owing to the d-c drop in resistor 31; this negative voltage is impressed through resistors 24 and 20 upon the grids of the three amplifier tubes, and the amplification of these tubes is correspondingly reduced as the radio-frequency signal increases. Thus the output of the receiver is held substantially constant over a wide range of incoming signal strengths. The connections of the external circuits to the power plug are such that terminals 73 and 74 cannot be grounded simultaneously. Either terminal 74 is grounded, permitting external adjustment of the radio-frequency amplification, or terminal 73 is grounded, permitting internal control of the amplification by the d-c voltage from the plate circuit of the A.G.C. tube. The operation of the A.G.C. tube is independent of the operation of the heterodyne oscillator. The A.G.C. tube is fed by the incoming signal and varies the gain of the radio amplifier ahead of the detector. The heterodyne oscillator affects the detector only. Thus automatic gain control may be used in the reception of either CW or modulated signals.

Terminal 72 of the power plug is a positive 12-14 volt terminal and is connected within the receiver to each of the three series-connected pairs of heaters of the six vacuum tubes. Resistor 140 shunted across the heater of the detector tube serves to equalize the resistance of this branch with the resistance of the two parallel-connected heaters of the -38233 tube. A residual negative bias is imparted to the grids of the Navy Type -78 tubes by including between ground and their cathodes two resistors, 22 and 60. Terminal 80 is maintained at high positive potential with respect to ground. From this terminal is obtained the plate voltage for the Navy Type -78 tubes, the plate voltage for triode (1) of the -38233 tube, and the plate and screen-grid voltage for the Navy Type -77 detector tube (See page 37, Operation With Two Receivers.) Resistor 33 is connected between terminal 80 and ground as a voltage divider. A center tap on 33 provides screen-grid voltage for the Navy Type -78 tubes.

Terminal 78 is maintained at a relatively large *negative* voltage with respect to ground and to this terminal is connected the control grid of the Navy Type -77 A.G.C. tube. The plate and screen grid of this tube are both returned to ground. A voltage divider resistor 145 is connected between terminal 78 and ground, and the cathode of the A.G.C. tube is connected to an intermediate tap on this resistor. Thus the plate and screen of the A.G.C. tube are positive with respect to the cathode by the amount of the voltage drop between the tap on 145 and ground, and positive with respect to the control grid by the greater voltage between terminal 78 and ground. It is necessary to return the plate circuit of the A.G.C. tube to ground because the control grids of the Navy Type -78 tubes are returned by a d-c connection to the plate of the A.G.C. tube, and the only permissible d-c voltage between these control-grid circuits and ground is that developed by the rectification of incoming signals in the A.G.C. tube. Thus the plate and grid voltages necessary to operate the A.G.C. tube must be obtained by polarizing the cathode and control grid of this tube negatively with respect to ground. Terminal 81 is the ON-OFF control terminal for the heterodyne oscillator triode, as has been explained. Three series resistors, 28A, 28B, and 67, by-passed by capacitor 71, are placed between the high-voltage positive terminal 80 and ground, in place of the heterodyne oscillator tube, when terminal 81 is grounded externally. Resistors 65 and 66 form a voltage divider to impress a slight negative voltage on the oscillator plate when 81 is grounded. Terminal 76 is grounded at the power plug receptacle and terminal 77 is a spare. Terminal 75 is connected externally to the telephone receivers. Terminal 79 may be used as a separate plate supply connection for supplying plate voltage to the plate of the audio output triode (2). See page 37, Operation With Two Receivers.)

Resistor 32, by-passed by capacitor 6, is a bias resistor in the cathode circuit of the Navy Type -77 detector tube. Capacitor 6 is one section of a sealed paper capacitor having three sections of 0.5 microfarad each. The remaining two sections, 38A and 38B, are by-pass and filter capacitors on the A.G.C. line as previously explained. Resistors 61 and capacitors 1 are decoupling filter elements for the screen grid circuits of the Navy Type -78 tubes. Resistors 61 and capacitors 2 in the plate supply lines of these tubes are also decoupling filter elements; capacitor 8 is an additional by-pass capacitor on this plate supply line. Capacitors 3 are cathode by-pass capacitors and capacitors 4A, 4B are low-pass filter capacitors in the line from the plate of the A.G.C. tube to the control grids of the amplifier tubes. Capacitor 7 is an additional screen by-pass capacitor and 5 is a heater by-pass capacitor. Resistors 20 are grid resistors on the amplifier tubes and 56 is a grid resistor on the heterodyne oscillator. Capacitors 97 are grid capacitors. Capacitor 12 is a radio-frequency by-pass in the plate circuit of the detector tube. Resistor 23 is a bias resistor for the audio amplifier tube.

A two-element gaseous (neon) tube 54 is

connected in parallel with the secondary winding of the first radio-frequency transformer 89 in the input stage. This tube is a voltage limiting device designed to protect the receiver from damage if it is accidentally tuned to the frequency of a nearby transmitter. The tube 54 ionizes at a voltage of about 80 volts, and a gaseous discharge occurs which effectively short-circuits the input stage of the first amplifier, but only so long as the high incoming voltage is present.

Capacitor 57 is a small fixed capacitor permanently connected across the primary terminals of the first tuned radio-frequency transformer to compensate, in tuning alignment, for the inter-electrode tube capacities across the primaries of all the other radio-frequency transformers.

The single-band coil sets (Figs. 6 and 13A) consist each of an assembly of shielded plug-in radio-frequency transformers (one transformer 89, two transformers 90) a band-pass assembly 92, and an oscillator coil assembly 91. Each coil set is identified by a certain frequency range, which is the range throughout which the receiver can be continuously tuned when that coil set is mounted in the receiver. The receiver dial 240 is graduated in equal divisions from 0 to 100, increasing numbers corresponding to increasing frequency on any coil set. Increments in frequency in any band are proportional to increments in dial setting (straight line frequency tuning). Coil sets of all types are plugged into the receiver at the side, as indicated in Fig. 2, and secured by snapslides 254 at four points.

The dual coil sets consist of two single-band coil sets all mounted in a plug-in assembly like the single coil sets, together with a gang switch for switching the terminals, which make contact with the receiver circuits, from one group of coils to the other. A circuit diagram of Dual Coil Set Type CW-47105 is shown in Fig. 13A and wiring diagrams of all dual coil sets are given in Fig. 14. Each coil assembly consists of two separate shielded enclosures attached together and including one section 55 of the gang switch. Referring to Figs. 13A and 14 it will be seen that all sections of this gang switch are alike, and consist each of two single-pole double-throw switches. The coil assemblies 89, 90, of the tuned amplifier stages each consist of one high-frequency and one low-frequency radio coupling transformer. The low-voltage terminals of these transformers are connected to the terminals which connect respectively to the positive plate voltage line and the ground line in the receiver. The high-voltage RF terminals are so connected to the switch points that in the HIGH-FREQUENCY position of the switches the plate of one tube and the grid of the next are connected to the high-frequency coils, and in the LOW-FREQUENCY position of the switches these respective terminals are connected to the low-frequency coils. The elements of the high- and low-frequency sections of the band-pass stage 92 are similarly connected. In the HIGH position of the switch the plate circuit of the first amplifier tube includes a section of coil 93 which is coupled by capacitor 13 to the next grid circuit. The grid circuit of the second amplifier tube includes a grid resistor 29 which is shunted in some ranges by a fixed capacitor 34. In the LOW position of the switch the plate circuit of the first amplifier tube includes the entire coil 93 and the grid circuit of the second amplifier includes resistor 29, shunted in some ranges by a capacitor 34 (see Table 1). The oscillator stage 91 of the dual coil set consists of a high-frequency tapped tuned coil with a suitable coupling coil, and a low-frequency tapped tuned coil with a suitable coupling coil. The section of the gang switch in this stage serves to switch the grid and the cathode of the oscillator tube respectively between the high-voltage terminals of the high- and low-frequency coils, and the tap terminals of the high- and low-frequency coils. The coupling coils for the high- and low-frequency bands are connected between the cathode of the detector tube and the detector bias resistor. The coil capacitors 94 of the dual oscillator stage are connected between grid and ground in the high-frequency band, and between cathode and ground in the low-frequency band.

The photograph, Fig. 7, shows the outlet of the switch shaft 341. The dual coil set is plugged into the receiver and secured by snapslides, as are the single-band coil sets. Switching between the high and low-frequency bands of a dual coil set may then be done locally by attaching the CW-23053 Local Control to the outlet of the switch shaft 341.

The frequency bands of the Coil Sets which may be used are as follows:

Type	*Range*	*Frequency Band*
Ø -47067	C	545 — 850 Kc
CW-47068	D	850 — 1330 Kc
CW-47069	E	1330 — 2040 Kc
♌CW-47070	F	2040 — 3000 Kc
Ø -47071	G	3000 — 4525 Kc
CW-47072	H	4000 — 6000 Kc
CW-47075	K	9050 — 13575 Kc
Ø -47088	N	6000 — 9050 Kc
Ø -47099	M	5200 — 7700 Kc
CW-47105	O	195 — 290 Kc
	P	290 — 435 Kc
Ø -47106	L	400 — 600 Kc
CW-47107	Q	540 — 830 Kc
	G	3000 — 4525 Kc
CW-47108	Q	540 — 830 Kc
	M	5200 — 7700 Kc
CW-47112	L	400 — 600 Kc
	N	6000 — 9050 Kc
*CW-47202	F	2040 — 3000 Kc
	N	6000 — 9050 Kc
*CW-47203	F	2040 — 3000 Kc
	G	3000 — 4525 Kc
CW-47204	Q	540 — 830 Kc
	F	2040 — 3000 Kc

Two metal calibration charts are furnished with each receiver. One is mounted on the receiver tube cover and the other is left unmounted. These charts cannot be used for tuning the receiver to an exact predetermined frequency, but are intended merely as a general guide in locating stations on the receiver dial. Calibration data for an average receiver are shown on page 47.

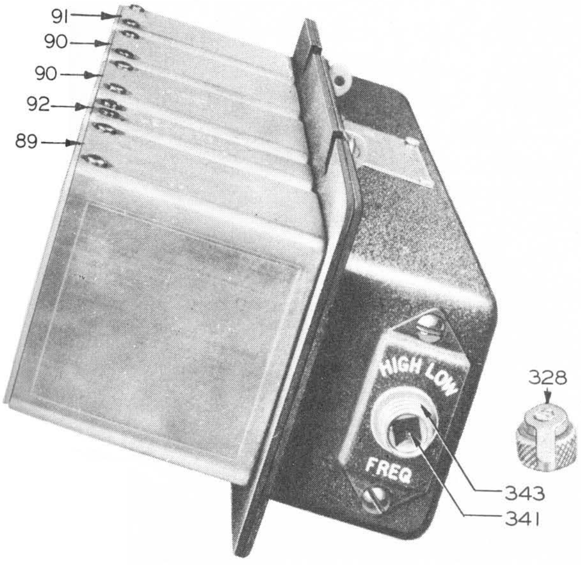


Fig. 7—Typical Dual Coil Set, Type CW-23053 Dual Coil Set Local Control

The Type CW-46011 Mounting Base 302 consists of a metal frame with a shockproof cup assembly 253 at each corner. Four snapslides on mounting brackets 284 on the receiver engage the four studs 271 which are moulded in the soft rubber of the shockproof cup assemblies.

6. Type CW-23087 Receiver Switch Box

The Type CW-23087 Receiver Switch Box is a small unit carrying two switches, control resistors, telephone receiver jacks and a jack for a cathode current meter. It is designed for remote control of the electrical power and amplification circuits of the receiver. It is shown in Figs. 1A, 1B, 5A, 5B, 8, 13A, 13B, 14 and 15. The switch box carries three manually operated controls as follows: (1) rotary switch 134 operated by handle 263; (2) the volume control 131, 132, operated by knob 265; (3) a two-position toggle switch 137. The rotary switch 134 has a center position OFF, a side position MANUAL, and a second side position, AUTO. Both the side positions are operating positions. The contact portion of switch 134 consists of a group of spring contacts arranged in pairs, associated with a group of short-circuiting studs. The various pairs of spring contacts are mounted about the circumference of a circle and are fixed with respect to the frame of the switch box. The studs are mounted in a similar circle upon the rotable member of the switch, and short-circuit the respective pairs of spring contacts as they rest between them. The switch member upon which the studs are mounted is rotated by the handle 263.

In the schematic circuit and wiring diagrams the rotable member of the switch is shown as a circle, and the studs, indicated by black dots, are to be considered as rotating with the switch rotor between each of the three positions, and the contact springs are fixed with respect to the remainder of the diagram. In the functional

*Optional, not furnished with all lots of equipments.
♌ Supplied with certain equipments when Type CW-47204 was not supplied.
ØNot supplied by the Western Electric Company.

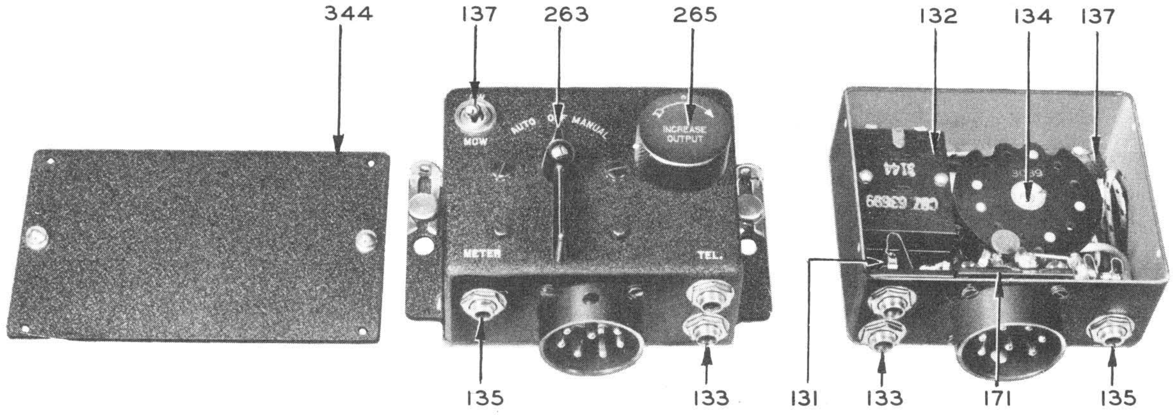


FIG. 8—TYPE CW-23087 RECEIVER SWITCH BOX

diagrams, Figs. 5A and 5B, the switch elements are shown conventionally as a gang switch. Switch 137 is a single-circuit, one-way switch connected between terminal 88 of the plug receptacle and ground. In its open position terminal 88 is ungrounded and the heterodyne oscillator of the receiver operates; this is the position appropriate for CW reception. In its closed position terminal 88 is grounded and the plate voltage is removed from the heterodyne oscillator tube; this is the position for reception of modulated signals.

The connections to the remaining controls can be considered independently of switch 137 since this switch affects the oscillator only. Terminal 83 of the plug receptacle is connected to switch 134 and is closed on terminal 86 in each of the operating positions, but is open in the center OFF position. These two terminals are in the main low-voltage supply to the entire equipment. Terminal 85 is connected to the switch 134 and to the manual sensitivity control resistor. Terminal 87 is connected to the switch and to the audio level control resistor 132. The telephone receiver jacks 133 are connected between ground and the high side of resistor 132. These are two-contact jacks adapted to receive a telephone plug, Type-49006 or equivalent. Terminal 82 is connected to switch 134 and terminal 84 is grounded.

The audio level control resistor 132 and manual gain control resistor are both varied simultaneously by a single shaft which is rotated by knob 265. This knob is, in both operating positions, a volume control knob controlling the receiver output. In the MANUAL position it controls the sensitivity by varying the resistance in series between ground (through the cathode current meter) and terminal 85 which leads through the junction box to the cathodes of the three Navy Type -78 radio amplifier tubes. In the AUTO position, resistor 132 is shunted across the telephone receivers and the output line from the receiver through terminal 87 is shifted up and down on resistance 132, varying the voltage fed by the receiver to the telephones. Resistor 131 is short-circuited by switch 134 in the AUTO position and resistor 132 is open-circuited by switch 134 in the MANUAL position. Jack 135 is connected in series with terminal 85, the manual gain control resistor, and ground. A suitable milliammeter plugged into this jack will indicate the plate and screen currents of the three radio amplifier tubes (i. e., cathode currents).

7. Type CW-21215A (RU-18, 12-Volt) Dynamotor-Filter Unit

The Type CW-21215A Dynamotor-Filter Unit consists of a dynamotor mounted on a box containing an audio filter, a radio filter, a filter resistor, and a receptacle assembly. It is shown in Figs. 1A, 5A, 9, 13A, 14, 15 and 16. A photograph of the various parts of the dynamotor, disassembled, is shown in Fig. 12. A sectional diagram of the dynamotor is shown in Fig. 17. Fig. 9 shows the Type CW-21215A Dynamotor-Filter Unit with base and sub-base removed for identification of parts.

The dynamotor 150 is manufactured by Continental Electric Company. Its rating may be seen on the table, page 30. For convenience in ordering spare parts for the dynamotor alone, the part numbers listed in Table 1, page 74 are Continental Electric Company part numbers, and should be specified.

Dynamotor 150 is of the totally-enclosed type having a low-voltage commutator and brushes at one end and a high-voltage commutator and brushes at the other end. Current is fed to the low-voltage commutator and to the common field winding from the 12-14 volt d-c source. Current is drawn from the high-voltage commutator at 300-345 volts, depending upon the value of the applied low voltage and the load. Four color coded leads pass from the machine into the box, two serving as low-voltage input leads and two as high-voltage output leads from the machine. Terminal 16 of the power plug receptacle is grounded in the dynamotor-filter unit and connected to the negative side of the low-voltage supply line which feeds the motor winding M of the dynamotor (Fig. 13A). *The negative terminal of the high-voltage generator winding G is not grounded* but is by-passed by capacitor 147B and connected to terminal 14. The positive 12-14 volt supply terminal 19 is connected through a radio filter coil 149 to the positive terminal of the motor winding. One positive high-voltage terminal 18 is connected to the positive terminal of the generator winding G through the audio filter section comprising choke 148 and capacitor 147D. A second high-voltage terminal 17 is fed through resistor 152, by-passed by capacitor 147C. Capacitor 147 is a four-section paper capacitor. The remaining section 147A, is connected across the motor winding M of the dynamotor.

The dynamotor-filter unit base 156 is a base plate having studs 256C to which the remainder of the unit is attached by means of snapslides. The interior of the unit is protected, when it is not attached to the base plate, by a sub-base 245 which is screwed to the filter box at three points.

The Type CW-21215A and the Type CW-21441 Dynamotor-Filter Units are identical in

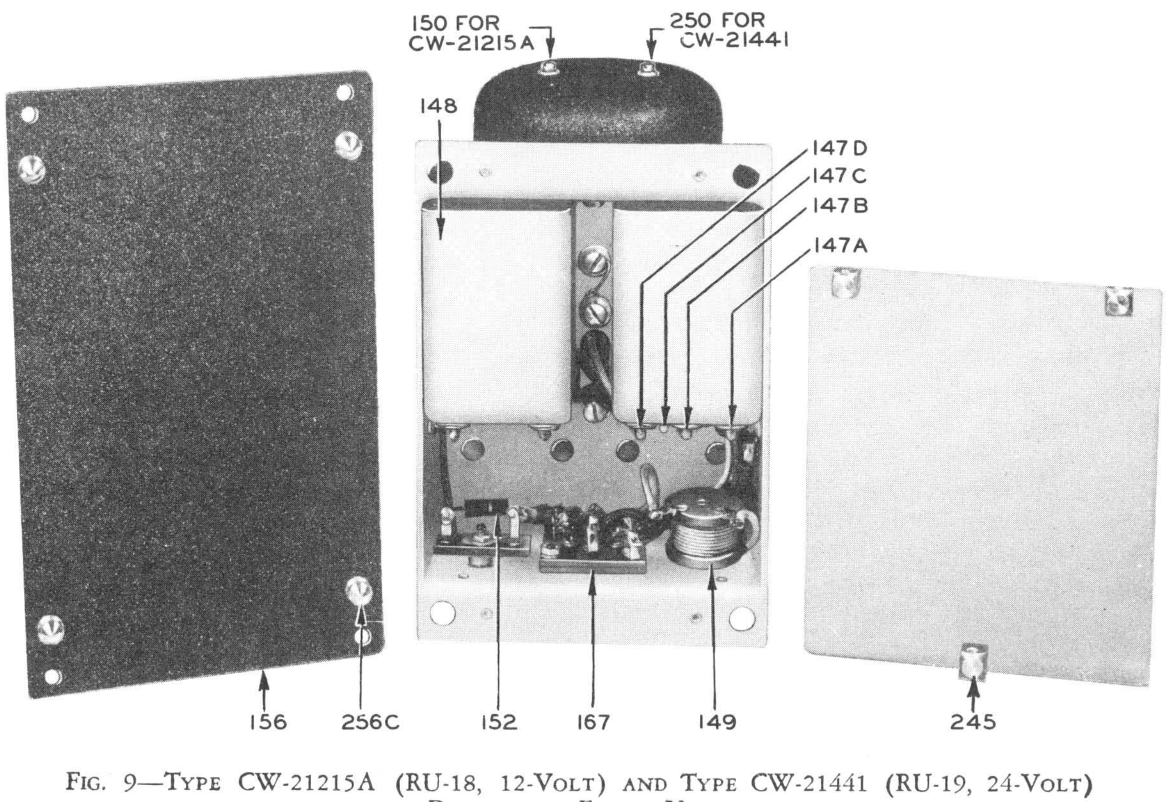


Fig. 9—Type CW-21215A (RU-18, 12-Volt) and Type CW-21441 (RU-19, 24-Volt) Dynamotor-Filter Units

every respect except that the dynamotor of the Type CW-21215A operates on 12-14 volts and the dynamotor of the Type CW-21441 operates on 24-28 volts, both producing the same output voltage and power. The Type CW-21215A Dynamotor-Filter Unit is operatively interchangeable with the Type CBY-21215 Dynamotor Unit of the Model RU-4, RU-5, RU-6 and RU-10 equipments. It is also interchangeable with the Type CBY-21215A Dynamotor-Filter Unit in the RU-11 equipment.

8. Type CW-21441 (RU-19, 24-Volt) Dynamotor-Filter Unit

The Type CW-21441 Dynamotor-Filter Unit consists of a dynamotor mounted on a box containing an audio filter, a radio filter, a filter resistor, and a receptacle assembly. It is shown on Figs. 1B, 5B, 9, 13B, 14, 15 and 16. A photograph of the various parts of the dynamotor, disassembled, is shown in Fig. 12. A sectional diagram of the dynamotor is shown in Fig. 17. Fig. 9 shows the Type CW-21441 Dynamotor-Filter Unit with base and sub-base removed for identification of parts.

The dynamotor 250 is manufactured by Continental Electric Company. Its rating may be seen on the table, page 30. For convenience in ordering spare parts for the dynamotor alone, the part numbers listed in Table I, page 76 are Continental Electric Company part numbers.

Dynamotor 250 is of the totally-enclosed type having a low-voltage commutator and brushes at one end and a high-voltage commutator and brushes at the other end. Current is fed to the low-voltage commutator and to the common field winding from the 24-28 volt d-c source. Current is drawn from the high-voltage commutator at 300-345 volts, depending upon the value of the applied low voltage and the load. Four color-coded leads pass from the machine into the box, two serving as low-voltage input leads to the machine and two as high-voltage output leads from the machine. Terminal 16 of the power plug receptacle is grounded in the dynamotor-filter unit and connected to the negative side of the low-voltage supply line which feeds the motor winding M of the dynamotor (Fig. 13B). *The negative terminal of the high-voltage generator winding G is not grounded* but is by-passed by capacitor 147B and connected to terminal 14. The positive 24-28 volt supply terminal 19 is connected through a radio filter coil 149 to the positive terminal of the motor winding. One positive high-voltage terminal 18 is connected to the positive terminal of the generator winding G through the audio filter section comprising choke 148 and capacitor 147D. A second high-voltage terminal 17 is fed through resistor 152, by-passed by capacitor 147C. Capacitor 147 is a four-section paper capacitor. The remaining section, 147A, is connected across the motor winding M of the dynamotor.

The dynamotor-filter unit base 156 is a base plate having studs 256C to which the remainder of the unit is attached by means of snapslides. The interior of the unit is protected, when it is not attached to the base plate, by a sub-base 245 which is screwed to the filter box at three points.

The Type CW-21215A and the Type CW-21441 Dynamotor-Filter Units are identical in every respect except that the dynamotor of the type CW-21215A operates on 12-14 volts and the dynamotor of the Type CW-21441 operates on 24-28 volts, both producing the same output voltage and power. The Type CBY-21441 Dynamotor-Filter Unit supplied with the RU-12 equipment is interchangeable with the Type CW-21441 Dynamotor-Filter Unit.

DYNAMOTOR RATINGS

	Dynamotor 150 *Part of Type* CW-21215A *Dynamotor-Filter Unit* (RU-18)	*Dynamotor* 250 *Part of Type* CW-21441 *Dynamotor-Filter Unit* (RU-19)
Input Voltage	14.0 v. (at brushes)	28.0 v. (at brushes)
Output Voltage	330. v. (at brushes)	330. v. (at brushes)
Input Current	6.2 a.	3.1 a.
Output Current	.170 a.	.170 a.

Voltage drop across the RF filter choke 149, and across the AF filter choke 148 should be taken into consideration when measurements are made at points other than at the brushes.

9. Type CW-62007A (RU-18, 12-Volt) Junction Box

This unit is the central inter-connecting element for all circuits of Model RU-18 equipment.

It consists of an assembly of receptacles for the plugs of all cables, with two additional receptacles 163B and 171B for a second receiver and receiver switch box, as well as two similar outlets, 159A and 159B, for supplying power to a crystal frequency indicator, interior communication system, or direction finders not supplied with this equipment. Included also in the junction box are a fuse block, two decoupling resistors, 61G, 61F, and a two-winding relay, 153. The contacting members of all receptacles are pin plugs 259. The various receptacles and terminals are wired together inside the junction box as indicated on the circuit diagram, Fig. 13A, and the wiring diagram, Fig. 14. The fuse 151 is a 50-ampere cartridge fuse. It is connected between terminals 44 and 83 in series with the positive 12-14 volt supply line. One spare fuse is mounted, together with the active fuse, in clips under the fuse cover which is accessible from the front of the junction box.

The important difference between this junction box and earlier models, such as Type CBY-62003, is that this junction box has no outlets for a transmitter. It is designed for inter-connecting the control and power circuits of two receivers operating from one dynamotor-filter unit. Relay 153 serves only one function, that of connecting the dynamotor supply terminal 19 with the positive battery terminal 44. This relay has two independent windings. Both are grounded on one side; the other end of one winding goes out to one terminal 86 and the other end of the second winding goes out to the other terminal 86. Either winding, when energized, will close the single pair of contacts. Thus the external connection of either terminal 86 to a twelve-volt battery terminal will connect the battery terminal 44 to the dynamotor supply terminal 19. The two receiver cable receptacles are marked 163A and 163B on the various diagrams and illustrations hereof and are similarly wired inside the junction box with the following exceptions: (1) 79 on receptacle 163A is wired through resistor 61F to 17, but 79 on receptacle 163B is wired through 61G to 18; (2) 86 on receptacle 171A is wired to one winding of the relay, but 86 on receptacle 171B is wired to the other winding of the relay. In the functional circuit diagram, Fig. 5A, the terminals of receptacles 163A, 163B, and 171A, 171B as well as receptacles 159A and 159B, which are correspondingly numbered and connected together, are not shown in duplicate. On the schematic diagram, Fig. 13A, all terminals are shown. The two outlets for external equipment, 159A and 159B, are connected in parallel and on each there are four circuit terminals: 35 and 26 connected to the positive high-voltage 18; 25 connected to the positive low-voltage 19; 36 connected to the ungrounded negative terminals 78; and 27 grounded.

The outlets are all identified on the front of the junction box by engraved numbers corre-

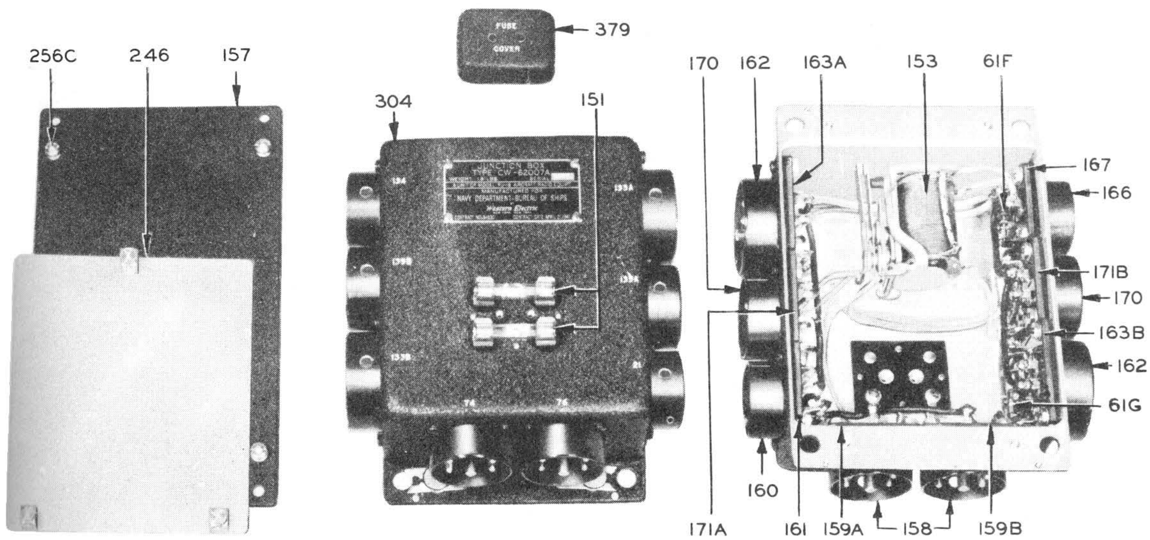


FIG. 10A—TYPE CW-62007A JUNCTION BOX (RU-18, 12-VOLT) sponding to the plug numbers, as follows: receivers, 133; receiver switch boxes, 135; dynamotor-filter unit, 134; battery, 21; spares 74 and 76.

The junction box base 157 is identical and interchangeable with the dynamotor-filter unit base 156, and performs a similar function for the junction box. The junction box sub-base 246 is a metal plate which is attached to the junction box by means of three screws to form a protecting closure for the wiring when the junction box is not attached to its base. It is interchangeable with the dynamotor-filter unit sub-base 245.

Junction Box Type CW-62007A (RU-18, 12-volt) is not interchangeable with Junction Box Type CW-62017 (RU-19, 24-volt) but *is* interchangeable with the Type CBY-62007A Junction Box supplied with Model RU-10 and RU-11 equipments, and interchangeable, except in certain connections to auxiliary outlets 74 and 76, to the junction boxes supplied with Models RU-4, RU-5 and RU-6 equipments.

10. Type CW-62017 (RU-19, 24-Volt) Junction Box

This unit performs the same inter-connecting function for the components of the Model RU-19 equipment that the Type CW-62007A Junction Box described above does for the Model RU-18 equipment. It differs in two important respects from the Type CW-62007A Junction Box in that the two independent windings of the relay 154 are designed for 24-volt operation instead of 12 volts and two large wire-wound 10.8 ohm resistors, 180 and 181, are mounted under a cover 182 on the face of the junction box. One of these resistors is in series with the 24-volt source and the heater line of receiver (A) by way of terminal 72, and the other is similarly connected to receiver (B).

The Type CW-62017 Junction Box consists of an assembly of receptacles for the plugs of all cables, with two additional receptacles 163B and 171B for a second receiver and receiver switch box, as well as two similar outlets, 159A and 159B, for supplying power to a crystal frequency indicator, interior communication system, or direction finders not supplied with this equipment. Included also in the junction box are a fuse block, two decoupling resistors, 61F and 61G, and a two-winding relay, 154. The contacting members of all receptacles are pin plugs 259. The various receptacles and terminals are wired together inside the junction box as indicated on the circuit diagram, Fig. 13B, and the wiring diagram, Fig. 14. The fuse

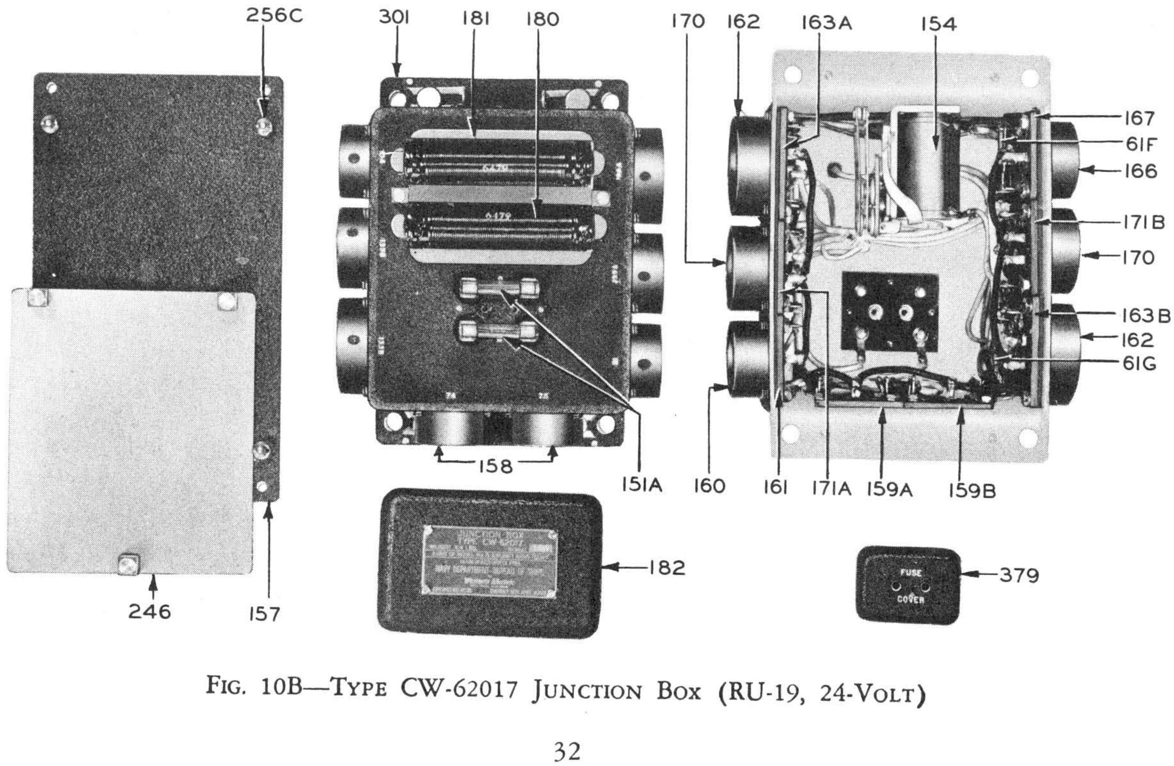


FIG. 10B—TYPE CW-62017 JUNCTION BOX (RU-19, 24-VOLT)

151A is a 20-ampere cartridge fuse. It is connected between terminals 44 and 83 in series with the positive 24-28 volt supply line. One spare fuse is mounted, together with the active fuse, in clips under the fuse cover which is accessible from the front of the junction box.

The important difference between this junction box and earlier models, such as Type CBY-62003, is that this junction box has no outlets for a transmitter. It is designed for inter-connecting the control and power circuits of two receivers operating from one dynamotor-filter unit. Relay 154 connects the dynamotor supply terminal 19, with the positive battery terminal 44. This relay has two independent windings. Both are grounded on one side; the other end of one winding goes out to one terminal 86 and the other end of the second winding goes out to the other terminal 86. Either winding, when energized, will close the single pair of contacts. Thus the external connection of either terminal 86 to a 24-volt battery terminal will connect the battery terminal 44 to the dynamotor supply terminal 19. The two receiver cable receptacles are marked 163A and 163B on the various diagrams and illustrations hereof and are similarly wired inside the junction box with the following exceptions: (1) 79 on receptacle 163A is wired through resistor 61F to 17, but 79 on receptacle 163B is wired through 61G to 18; (2) 86 on receptacle 171A is wired to one winding of the relay but 86 on receptacle 171B is wired to the other winding of the relay. In the functional circuit diagram, Fig. 5B, the terminals of receptacles 163A, 163B and 171A, 171B as well as receptacles 159A and 159B, which are correspondingly numbered and connected together, are not shown in duplicate. On the schematic diagram, Fig. 13B, all terminals are shown. The two outlets for external equipment, 159A and 159B, are connected in parallel and on each there are four circuit terminals: 35 and 26 connected to the positive high-voltage 18; 25 connected to the positive low-voltage 19; 36 connected to the ungrounded negative terminal 14; and 27 grounded.

The outlets are all identified on the front of the junction box by engraved numbers corresponding to the plug numbers, as follows: receivers, 133; receiver switch boxes, 135; dynamotor-filter unit, 134; battery, 21; spares, 74 and 76.

The junction box base 157 is identical and interchangeable with the dynamotor-filter unit base 156, and performs a similar function for the junction box. The junction box sub-base 246 is a metal plate which is attached to the junction box by means of three screws to form a protecting closure for the wiring when the junction box is not attached to its base. It is interchangeable with the dynamotor-filter unit sub-base 245.

Junction Box Type CW-62017 (RU-19, 24-volt) is interchangeable with Junction Box Type CBY-62017 supplied with the RU-12 equipment.

11. Cables

The following cables (supplied in bulk on Contract NOs 84530) are included in Model RU-18 and Model RU-19 equipments.

Cable	*Plug (Qnty. per Cable in Parenthesis)*	*No. of Conductors*	*Use*	*Bulk Length Supplied*
1610	21 (1)	2	Junction box to battery	4 feet
1611	134 (2)	6	Junction box to dynamotor-filter unit . . .	3 1/2 feet
1613	135 (2)	8 (7 in use)	Junction box to receiver switch box	4 2/3 feet
3084	133 (2)	10	Junction box to receiver	9 feet
*3141	3145 (1) 3146 (1)	2	Test meter	3 feet

*Optional, not furnished with all lots of equipments.

Each cable is shielded with tinned copper braid and all but the battery cable terminate at each end in a suitable plug. The arrangement of the cables is shown in Fig. 16. The battery cable is terminated at one end in a plug which fits into a junction box receptacle, and at the other end in a ferrule designed to be clamped to a suitable threaded outlet by means of a nut which is supplied on the cable. This nut has an 11/16 inch-24 thread in accordance with Drawing No. 213017 of the Naval Aircraft Factory, Philadelphia, or Army-Navy Aeronautical Standard AN-3054.

If it should become necessary to alter the length of any cable or to assemble replacement cables, these should be assembled as indicated in Fig. 18. This drawing is for cable 3084, but data indicated thereon are applicable to all other power cables. Each of the power plugs consists of a shell 352, insulation 347, spring 348, sleeve 355, washer 353, nut 354 and screw 364. The shielding braid 356, rubber belt 351 and individual conductor insulations 350 should be cleaned back from the end of the cable by the respective distances AD, AC and AB indicated on the drawing. Pass nut 354, washer 353 and shell 352 over the cleaned end of the cable, in the order named. Having threaded the cable through these parts, "tin" the end of the braid 356 with hot solder, fit the sleeve 355 over the end of the cable and braid, so that the braid is covered to a distance DE, and sweat the braid into the sleeve so that a secure soldered contact is made between the sleeve and the braid. Tin each individual contact insert 349, and solder the cleaned ends AB of the conductors into these inserts. Both the inserts and the conductors must be thoroughly tinned before this operation. Do not allow surplus lumps of solder to remain on these inserts or on any part of the bakelite insulation.

When all conductors are securely soldered, bunch the insulated portions together so that they will not rub on the shell 352 when plug is reassembled. Draw the shell up to the shoulder on sleeve 355 and fasten it securely by tightening nut 354. As this operation is performed, the hairpin spring 348 must be held in close contact with the inner surface of the shell, with the two studs protruding through the holes in the top of the shell. As the shell is drawn up to the shoulder of sleeve 355, the insulation 347, now attached to the cable, should be drawn into this shell so that the spring 348 passes into, and is held in, the square groove in the top of the insulation. Line up the screw hole in the shell with the threaded hole in the bottom of the insulation and complete the assembly by tightening screw 364 in this hole. *Do not use acid flux or paste in soldering; use only resin flux.* If acid flux is used in soldering the conductors, the plug will ultimately break down in service.

12. Type CW-23012 Remote Tuning Control — Type CW-23021 Mechanical Linkage — Type CW-23022 Local Tuning Control

The Type CW-23012 Remote Tuning Control is designed for remote tuning of the receiver. It is shown in Figs. 1A, 1B and 11, also in Figs. 15 and 16. It comprises a housing inclosing a gear train, an exposed crank 249, a dial 327 graduated 0 to 100 divisions, and an adjustable pointer 248. Rotation of the crank rotates the dial under the fiducial mark of the pointer and also rotates the coupling spline 266. The internal spline of the mechanical linkage engages the external spline 266 inside the threaded outlet 267 of the remote tuning control when the coupling nut on the end of the linkage housing is screwed on to this outlet. A similar spline in the opposite end of the linkage shaft engages a spline shaft which is geared to the capacitor tuning shaft and dial of the receiver, when the coupling nut on this end of the linkage housing is screwed on to the outlet 261 of the receiver. A second outlet 262 provides access to the opposite end of this spline shaft for use in case it is desired to couple the receiver tuning mechanism to other equipment. The motion of the crank on the remote tuning control is transmitted to the gang capacitor shaft of the receiver successively through the step-up gear train of the remote tuning control, the mechanical linkage, and the gear train between the receiver spline shaft and the capacitor shaft. The several gears are so related that dial 327 on the remote tuning control makes one complete excursion between 0 and

100 divisions as dial 240 on the receiver rotates between 0 and 100 divisions. In Fig. 2 outlet 262 of the receiver is shown closed by a cap nut 268 and the other outlet 261 is shown closed by a Type CW-23022 Local Tuning Control.

The mechanical linkage is supplied in bulk on this contract. No attempt should be made to assemble a linkage unless proper tools are available for attaching the splines to the shaft. Referring to Fig. 19, each linkage consists of a casing 335 terminating in a ferrule 338 and a coupling nut 345; this houses shaft 336 terminating in an assembly 337 of a spline in a spline-ferrule. The shaft 336 is made up of tightly wrapped steel wires which *will not hold their shape unless they are soldered or swaged together at the ends.* To assemble a shaft the casing 335 should be spread out flat and the shafting 336 cut to a length somewhat greater (1/4 to 1/2 inch) than the length of casing between the faces of ferrules 338, which are spot-swaged on the trimmed edges of the casing. The shafting 336 must be filled with solder at the point where it is cut *before cutting.* After cutting the shafting it should be fed through the casing and the spline-ferrule assemblies 337 may then be sweated on to the shaft ends, since the excess length of the shaft allows its ends to be drawn beyond the finished ends of the casing.

The Type CW-23022 Local Tuning Control (see Fig. 11) is intended solely for local tuning of the receiver. It consists of an internal spline 270 housed in a threaded bearing support which may be screwed on to the receiver tuning outlet 261. The spline is rotated manually by a small disc and crank which form a part of the unit.

13. Cooperation of Units

In an operating installation where the various units are connected through the cables to the junction box and the battery, the circuits of the whole system are interconnected as in Figs. 5A and 13A. Each terminal in the junction box is connected through a cable to the terminal bearing the same number on one of the operating units. Each of the numbered circles, except 43 and 44, refers to two correspondingly numbered terminals, one on the junction box and one in an operating unit.

The operation of a connected receiving system can best be described in connection with Fig. 5A, which shows the completed circuits for one receiver connected to receptacle 133B, one receiver switch box connected to receptacle 135B, together with a dynamotor-filter unit and a battery source. Current is drawn from the source through the positive supply line from terminal 44, fuse 151, and terminal 83 on the receiver

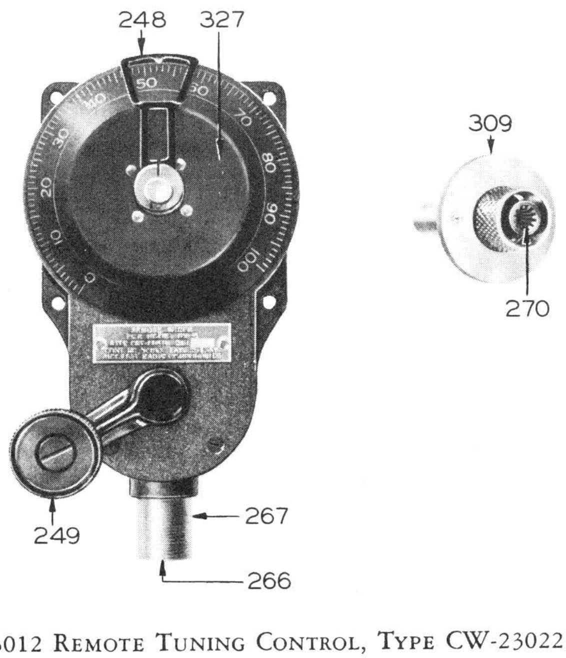


FIG. 11—TYPE CW-23012 REMOTE TUNING CONTROL, TYPE CW-23022 LOCAL TUNING CONTROL

switch box. When the switch box switch 134 is in the OFF position this line through 83 is open and there is no voltage on the dynamotor unit or receiver for any position of the other controls. In the MANUAL and AUTO positions of this switch, terminal 83 is connected to 86 and the supply voltage is impressed upon the dynamotor through the relay contacts to terminal 19 and the receiver through 72.

The circuits of the receiver are energized as follows, for the various operating positions of the control switches. In the MANUAL position the voltage divider 33, energized from terminal 18 of the dynamotor unit, supplies high positive potential to the plates of the amplifier and oscillator tubes; it also supplies from the center tap a lower positive voltage to the screen grids of the radio amplifiers. The plate and screen of the detector tube are also energized from high-voltage terminal 18 or 17 of the dynamotor unit. Negative terminal 14 of the dynamotor unit is connected through 78 to the second voltage divider 145 in the receiver. The control grid of the A.G.C. tube is the most negative point in the circuit and is returned to 78. The A.G.C. cathode is connected to the tap on resistor 145 and is thus slightly more positive than the control grid. The plate and screen-grid of the A.G.C. tube, returned to ground, are considerably positive with respect to the cathode. Telephone receivers at jacks 133 are connected through switch 134, terminals 87 and 75, to the output circuit of triode (2) of the -38233 tube. Variable resistor 132 in the switch box is open-circuited and variable resistor 131 is connected between ground and the cathodes of the three Navy Type -78 radio amplifier tubes, through terminals 85 and 73. Variation of resistor 131 by rotating the knob 265 varies the gain of the radio amplifier. The receiver sensitivity increases in the direction of the arrow engraved on this knob, which is the direction of decreasing resistance. The automatic-gain control action of the Navy Type -77 A.G.C. tube is suppressed in this position of switch 134 by grounding the grid circuits of the radio amplifier tubes through 74 and 82.

With the switch box switch at AUTO the dynamotor and receiver power circuits are energized as in the MANUAL position. But in the AUTO position the manual gain control resistor 131 is short-circuited to ground thus grounding the *cathode* circuits of the three radio amplifier tubes. The grid circuits of these tubes, connected to terminal 74, are now disconnected from ground, and the gain-control voltage developed by the A.G.C. tube across resistor 31 controls the bias, and hence the amplification of these tubes. If the radio signal voltage impressed upon the control grid of the A.G.C. tube increases in amplitude, the plate of this tube becomes more negative with respect to ground, owing to the increased flow of rectified current (d-c) through resistor 31, and the control grids of the three amplifier tubes become more negative with respect to ground. If the radio signal voltage decreases, the negative bias on the amplifier control grids is correspondingly *reduced*.

The fixed element of the level-adjusting resistor 132 is shunted across the telephone receivers, and the output line from the receiver, through 75 and 87, is connected to the sliding contact on this resistor. Resistor 132 thus acts as an audio-frequency voltage divider; rotation of knob 265 in the INCREASE direction moves the contact up (see Fig. 5A) and increases the fraction of the receiver output which is impressed upon the phones. The phones are not shunted out of the circuit leading to the junction box when the level adjuster is retarded, since the resistance across the phones is still that of the entire resistor 132, or approximately 5,000 ohms. The control knob now has no effect upon the *sensitivity* of the receiver, which automatically decreases and increases as the incoming signal increases and decreases. Resistor 132 is placed in the circuit in the AUTO position of the switch because a suitable level of audio signal output cannot be permanently predetermined, but depends upon the external noise and the aural acuteness of the operator. The automatic gain-control circuit of the receiver is so designed that the controlled signal output, with knob 265 in its maximum INCREASE position, is too great for suitable reception except under the most unfavorable conditions.

It should be noted that if a suitable milliammeter, preferably one having a 0-35 milliampere range is connected in series with the cathodes of the radio amplifier tubes by plugging it into jack 135, the cathode current indicated by this meter will vary as the sensitivity of the amplifier is varied, either manually or automatically. In particular, when switch 134 is in its AUTO position this current (which increases with increasing *sensitivity*) thus *increases* as the incoming radio signal becomes *weaker* and *decreases* as the incoming radio signal becomes *stronger*. Thus the reading on this meter may be used as a rough indication of radio field intensity. One practical application of this function is to radio direction-finding or homing with the receiver. If a loop is used for reception, the test meter gives a visual indication of the bearing of the transmitting station by reading a *maximum* of current when the loop is set in its position of minimum received signal.

The CW-MCW switch 137 on the receiver switch box turns the heterodyne oscillator tube, -38233 triode (1), ON and OFF by opening and closing the connection through 81 and 88 between the plate of this oscillator tube and ground.

14. Use of Test Meter*

Some Model RU-18 and Model RU-19 equipments include a test meter (CW-22266) and cable. The meter is a d-c milliammeter, scale 0-35 milliamperes, in a suitable carrying case. The cable is a two-wire cord having a screw plug on the end attached to the meter and a Navy Type-49007 plug on the other end, which may be plugged into the jack 135 on the receiver switch box. When the meter is plugged into this jack it is connected in series with the cathodes of the radio amplifier tubes, and the current indicated by the meter will vary as the sensitivity of the receiver is varied, either manually or automatically. The meter may be used to check the cathode currents of the tubes at full sensitivity. Or, in the AUTO position of the switch box switch the meter reading gives a rough measure of radio field intensity, since this current (which increases with increasing *sensitivity*) will *increase* as the incoming radio signal becomes *weaker* and *decrease* as the radio signal becomes *stronger*. Thus when receiving on a loop the test meter will give a visual indication of bearings by indicating a current maximum when the loop is set in its position of minimum received signal.

*Optional, not furnished with all lots of equipments.

15. Operation With Two Receivers

This equipment is similar to Models RU-4, RU-5, RU-6, RU-10, RU-11 and RU-12 in that provision is made for operating two receivers from one dynamotor-filter unit. Assume that two receivers and receiver switch boxes are connected to the junction box through their respective cables. Fig. 13A is a complete schematic circuit diagram. Receiver (B), controlled by switch box (B), is shown in Fig. 5A. All terminals of receiver (A) are energized in parallel with the corresponding terminals of receiver (B) except the high-voltage supply line on terminal 79, for the plate-screen detector circuit and the plate circuit of the audio output triode (2). Terminal 79 of receiver (A) is supplied from 17 of the dynamotor-filter unit, instead of 18 which feeds the corresponding circuits of the other receiver. The purpose of this separation of the supply lines from the dynamotor-filter unit is to reduce cross-talk in the audio-frequency circuits of the two receivers. Also, in the two-receiver installation the correspondingly numbered terminals of the receiver switch boxes are similarly connected to the same respective control terminals of the two receivers. The only divergence between the circuits of the two switch boxes lies in the fact that one relay winding is connected to 86 on switch box (A) and the other relay winding is connected to 86 on switch box (B). Thus the dynamotor starts when either switch box switch is thrown to MANUAL or AUTO, and stops only when both switch boxes are set at OFF. But the vacuum tube heaters of both receivers are turned on and off independently by the switches on their respective receiver switch boxes.

NOTE: Each receiver, receiver switch box and cable is like every other unit having the same type number. The distinguishing letters (A) and (B) are engraved on the Junction Box and appear on the diagrams of this Instruction Book merely for convenience in discussing or locating the parts of a two-receiver installation. The performance of any receiver is the same regardless of whether it is connected to receptacle 133A or receptacle 133B. But a receiver switch box connected to 135A controls only the receiver connected to 133A and a switch box connected to 135B controls only the receiver connected to 133B.

SECTION II. INSTALLATION

16. General

Before installation of the radio equipment the aircraft engine, generator and accessories *must be* completely shielded and bonded if satisfactory radio results are to be obtained. It must be realized that the interference with signal reception, produced by the radiation of electrical disturbances from the engine ignition system, charging generator, unbonded contacting metal surfaces, etc., bears no direct relation to the sensitivity of the radio receiver.

The *relative* magnitude of such disturbances at the receiving antenna in comparison with the incoming radio wave field is the factor of prime importance. If the radio field intensity is equal to or greater than the local electrical noise level, reception will be possible on any radio receiver sensitive enough to operate on that radio field. The more sensitive the radio receiver, the weaker the radio signal which it will receive, but only so long as the local noise or interference level is less than the incoming radio waves can the signal be heard. Frequently a highly sensitive radio receiver is considered to be "noisy" when the airplane is in flight simply because it will receive both radio signals and local disturbances which are weaker than those receivable on a relatively insensitive receiver. The high sensitivity possessed by the receiver is no handicap to its performing as well as less sensitive types under conditions of bad static or local disturbances, since a continuous control of the sensitivity is provided by the volume control knob on the receiver switch box. The proper criterion of a complete job of bonding and shielding is that with the airplane in flight (or with the engine running on the ground) in clear cold weather when static is negligible, no sound will be audible in the telephone receivers except radio signals, when the receiver volume control is set at maximum. If the airplane is maintained in this condition, extremely long distance ranges of reception will be obtained with this equipment.

17. Receiver and Receiving Antenna

The choice of location for the receiver and mounting base in an airplane is governed by several factors: (1) accessibility for coil set and tube replacements; (2) proximity to a suitable location for the receiving antenna lead-in; (3) avoidance of sharp bends in the mechanical linkages and cables; (4) weight distribution.

Item one is of vital importance if coil sets are to be changed in flight. When the equipment is to be confined to missions involving communications within one frequency band or the two bands of a dual coil set this is of less consequence.

Item two is particularly important when the equipment is to be used in a high-frequency band. The best results cannot be obtained at any frequency if the lead to the receiving antenna is run around the interior of the fuselage for several feet before connecting to the antenna binding post, and this is particularly harmful at high frequencies where dielectric losses are greater.

A receiving antenna suitable for the entire frequency range of the receiver will not have a large capacity, and additional capacity to the fuselage between the lead-in insulator and the antenna binding posts shunts the receiver and may seriously reduce the signal energy reaching it. If for physical reasons it is impossible to position the *receiver binding post closer than about one foot away from the lead-in insulator,* the harmful shunting effect of this lead may be reduced by: (a) making it as small a copper wire as consistent with mechanical strength; (b) choosing a bare or thinly-insulated conductor. Heavy rubber insulation on this lead increases its capacity. There is no justification from a radio standpoint for the practice of using rubber-covered ignition cable for this lead. Furthermore, this lead should not be taped to metal longerons or ribs if this can be avoided.

The ideal installation would have the receiver connected to the antenna lead-in by means of a single conductor not larger than No. 18 B. and S. gauge, this conductor being insulated with thin rubber or a wax-impregnated fabric wrap, and suspended in air throughout its length. Conductors of B. and S. gauge sizes 16 and 18 are suitable for radio receiving antenna connections inside the airplane; the capacity of such a conductor is relatively small, and this lead should not be located so that it is likely to be struck or subjected to stresses involving the tensile strength of the wire. If it is necessary that this lead be longer, and supported along its length, every effort should be made to space it away from metal structural members by at least one-half inch. Glass or porcelain stand-off insulators or cleats are ideal for this purpose, but if they are not available, it is preferable to use dry wooden blocks impregnated with paraffine wax as spacers, rather than to lash this conductor direct to metal members.

To item three must be added the caution to provide sufficient slack in every cable, shaft and conductor attached to the receiver so that the receiver is free to move in every direction with respect to its mounting base. If even a single taut wire is attached to the receiver case the airplane vibration will be transmitted direct to the receiver and the effect of the shockproofing will be lost. The ground binding post should be connected by a slack wire to the nearest metal member of the fuselage, using a firm clean joint, preferably soldered. *This ground lead must be short, not more than one foot in length.* Locations for the receiver which meet all the above-mentioned requirements can usually be found back of the pilot's seat in single-seat airplanes, and either back of the observer's seat or on a shelf in front of *it*, in two-seat airplanes.

The location and external length of the receiving antenna are usually dictated by considerations of safety and convenience, but a few general principles can be followed. Length of the antenna wire in feet is of no value in itself, nor is electrostatic capacity to the fuselage of any value unless this capacity is obtained in a certain way. An insulated antenna wire lashed along the outside of a metal monococque fuselage possesses large capacity, but it would not pick up radio signals effectively.

The radio antenna is essentially a capacity structure, operating against the bonded airplane frame as a counterpoise. Its effectiveness as a collector of radio waves increases as the length is increased, but only provided that this increase in length is in a direction *away* from the metal of the airplane. Increasing its capacity by bringing any part of the antenna *closer* to the airplane usually does more harm than good. Increasing its capacity by increasing the amount of conducting surface of the portions separated from the airplane, *without decreasing that separation*, tends to improve the antenna as a radio collector.

A five-foot vertical mast antenna mounted in the fuselage of the airplane forms a suitable receiving antenna for this equipment if the lead to the receiver inside the fuselage is not too long. Also, this type of antenna should be located not less than two feet away from the base of the vertical fin, if installed back of the cockpit. On high-speed airplanes a single wire slanting from a lead-in insulator in the headrest fairing up to a stub mast on top of the rudder is sometimes used. This antenna is fairly effective if broken by a strain insulator from six to ten inches ahead of the stub mast, but is not a particularly good radio antenna unless this stub mast extends at least twelve inches above the top of the rudder.

A flat-top antenna consisting of a top section strung between the wing tip and rudder, with a down-lead connected to this top section at a point well ahead of the rudder, is an effective receiving antenna for all biplanes and high-wing monoplanes. It is a good general rule that the remote ends of any wire antenna should not be in close proximity with metal end supports. If they are attached to these supports by stays, the strain insulators separating the stays from the antenna wires should be spaced by one foot or more from the metal supports if possible. Down leads from flat-top antennas supported by a high wing should be brought into the fuselage as near the *bottom* of the fuselage as possible, since this increases effective spacing of the top section from the fuselage.

An additional consideration enters into the arrangement of the receiving antenna if the airplane is to be flown on directively-transmitted signals from radio range beacons. These beacons are of two types designated as RL (range loop) and RA (range antenna) beacons by the publication "Civil Aeronautics Authority Tabulation of Air Navigation Radio Aids," wherein are listed all radio range beacon stations and their characteristics. All receiving antennas may be roughly classified for purposes of this discussion as follows:

1. Principally vertical (mast or short trailing wire with heavy weight).

2. Vertical with symmetrical horizontal portion (fixed T-type).

3. Vertical with unsymmetrical horizontal portion (fixed L-type or long trailing wire).

Type one and type two antennas are best for radio range beacon reception. They are subject to no course errors by day with either type of beacon, no errors at night with RA beacons, and reduced errors at night with RL beacons. In general they yield a sharp localizing indication of the type known as the "cone of silence" directly over any beacon.

Type three antennas, when receiving from RL beacons, are subject to course errors both day and night and a diminution or actual reversal of the cone of silence. They produce negligible course errors when receiving from RA beacons by day, but may produce errors at night, even from RA beacons. The daytime course errors to which type three antennas are subject increase with decreasing distance from the beacon, and with increasing divergence of the angle which the horizontal section makes with a straight line to the beacon. In other words, the daytime course error with a trailing wire will be negligible only when flying directly towards or away from the beacon, and at a considerable distance. The daytime course error with a fixed antenna having an unbalanced athwartships component will be negligible only when flying directly across the course to the beacon and at a considerable distance. If it is necessary to use a trailing wire for beacon reception, *the use of unnecessarily long lengths should be avoided.* If a fixed antenna is to be used for beacon reception, *keep the downlead as nearly vertical as possible and the flat top as nearly symmetrical and as nearly fore and aft as possible.*

The receiver will frequently be used with a rotatable radio compass loop for precision radio bearings. The technique of radio compass-loop design and calibration is an extensive subject and has no place in this instruction book. It may be stated that as a general principle, however, that a *loop which is effectively shielded must be used with this receiver for best results.* By "effectively shielded" is meant a loop either having its conductor enclosed in a metal housing, or positioned in close proximity to metal members of the airplane. If the loop is enclosed in a metal housing, the metallic circuit around the loop *must be broken at one point in the circumference.* A Bellini-Tosi system may be used with fair results at frequencies below about 1000 kilocycles, provided that the goniometer search coil (connected to the loop terminals of the receiver) has a center-tap ground. There is no ground on the circuit inside the receiver between its loop binding posts.

The loop or equivalent inductive circuit connected between the loop terminals should have an inductance of approximately 200 microhenries and a capacity of approximately 50 micromicrofarads, *if the receiver is to be operated throughout the radio-compass frequency bands with a minimum of adjustment of the input alignment capacitor 98 (knob 244 on receiver front panel).* If the equipment is locally operated this is not such an important consideration, and variations from the above ideal values may be tolerated. For example, the distributed capacity of a typical shielded loop with shielded downleads may be as high as 200 to 300 micromicrofarads. When such a loop is connected to the receiver loop terminals 53, the receiver input circuit can be tuned to resonance at any frequency on any coil set up to about 1500 kilocycles, by adjusting capacitor 98, but the required range of adjustment on this capacitor may be considerable in any one frequency band, covered by a given coil set.

Another peculiarity of all loops which must be considered in connection with this receiver is the rapid change, with frequency, in the constants of the loop as the receiver is tuned through the natural frequency of the loop. In general, good bearings can be obtained in daylight at frequencies as high as 2000 kilocycles and higher, particularly if the aircraft is at a high altitude. If the natural frequency of the loop is above 2000 kilocycles the system can be tuned throughout the range below 2000 kilocycles with uniformly good sensitivity. But if the natural frequency of the loop is in the operating band, unsatisfactory results will be obtained at this frequency. In the immediate vicinity of this natural frequency the resistance of the loop is high, its reactance changes abruptly with frequency from inductive to capacitive, and the effect upon the receiver is to "broaden" the tuning and render it impossible to obtain perfect resonance. The result is an abrupt reduction in the overall sensitivity of the whole system for a limited region of the frequency spectrum. At frequencies above this critical region the loop behaves as a capacity connected between the receiver loop terminals, and direction finding with satisfactory sensitivity is again possible provided that the altitude, terrain, and time of day is such that the transmitted wave has a significant direction of propagation. It is usually desirable to keep the natural frequency of the loop as high as possible, other things being equal, since in general the lower frequencies are more useful for navigational purposes. Consequently a given loop should be installed with leads to the receiver loop terminals as short as is consistent with convenient operation. The loop terminals are located at the top of the front panel to facilitate the connection of leads from a compass loop mounted above the receiver. In general it is *not advisable* to shield the leads from the loop to the receiver, particularly if the equipment is installed inside the hull of a flying boat. If these leads consist merely of a twisted pair, the signal currents picked up by the leads will be negligible, and it is desirable to avoid the extra capacity which will be introduced by shielding these leads. In a land plane having a metal monococque fuselage the considerations are the same. Even in a fabric-covered fuselage the pickup on unshielded loop leads due to "antenna effect" will be negligibly small if these leads are run parallel to a metal longeron or cross member throughout most of their length. In designing or arranging a shielded loop for use with this receiver the following should always be borne in mind:

Increasing the number of turns in the loop does not necessarily increase the overall sensitivity of the system. Unless the self-capacity of the loop is less than about 50 micromicrofarads the inductance of the loop, installed, must not exceed about 0.2 millihenry for proper tuning and acceptable sensitivity of the combination of loop and receiver. (See page 46 for further instructions on loop tuning.)

Using coil sets covering frequencies up to 2000 kilocycles, good bearings on the *direction of propagation of the transmitted wave* may be expected if reasonable precautions are taken with the installation. The direction of propagation may vary rapidly with time, by an amount which increases with increasing frequency but decreases with increasing altitude, and the utility of such bearings as an indication of the bearing of the transmitting station is outside the control of the operator. It is possible to obtain bearings at frequencies as high as 4000 kilocycles but such operations should be regarded as experimental. Not only are such bearings difficult to obtain, but they are apt to be an erratic and unreliable indication of the true direction of the transmitting station.

If direction finding is attempted at frequencies above 2000 kilocycles it is recommended that the loop be used as a directive capacity antenna. In order to accomplish this: (a) leave one side of the loop unconnected; (b) *connect the other side to the antenna binding post 46;* (c) place the switch 45 in its A position so that capacitor 98 is in series with the open-ended loop. If a non-directive antenna is also used in conjunction with this loop, the throwover between loop and antenna must be done by a single-pole double-throw switch external to the receiver, leaving switch 45 in its A position.

18. Receiver Switch Box Remote Tuning Control

The receiver switch box must be accessible to the operator whether the receiver is remotely controlled or locally controlled. In many installations for operation by an observer or navigator, the receiver may be tuned directly by means of the local tuning control and the remote tuning control is not needed. Dismissing this case from consideration, both the switch box and the remote tuning control should be mounted within easy reach of the operator. They have no shock-proofing and may be screwed directly to the cowling or to a panel inside the cockpit (see Fig. 15 for spacing of mounting holes).

The switch box is provided with a separate base-plate to which the unit is attached by means of snapslides. If it is necessary to make a choice, the switch box should be mounted in the most accessible location, since in the course of a series of communications the operator must reach this switch and volume control more often than the tuning control. The pointer 248 of the tuning control is adjustable to any one of seven positions around the housing of the unit, so that this unit may be mounted in practically any position with respect to the operator, and the pointer located to make its fiducial mark clearly visible. The pointer is secured to the dial shaft by spring action between the jaws of the pointer hub. It may be forced off this shaft, in order to change its position, by pushing on the pointer near the fiducial mark.

The remote tuning control mechanical linkage may be bent more than once throughout its length, but no bends should be permitted of radius less than 6 inches. The linkage must be firmly secured to a rigid support at frequent intervals along its length, except at points close to its attachment to the receiver. If both these precautions are not observed, it will be difficult to tune the receiver accurately. When properly installed, even with lengths of twenty feet or more of linkage, both dials will rotate smoothly without appreciable backlash as the remote tuning control crank is turned, and the receiver dial may be set to coincide with the tuning unit dial. When the mechanical linkage is attached to the outlet 261 on the radio receiver and the tuning control, the reading of dial 327 on the tuning control must be made to coincide with the reading on the dial 240 on the receiver. This is done by rotating either one of the dials separately before the final coupling is made.

The foregoing considerations apply without modification to two-receiver installations in which two receivers with their accompanying switch boxes are all operated from the same junction box. There is one additional point, characteristic of two-receiver installations, which should always be borne in mind, as follows:

Although interaction (producing cross-talk) is suppressed by special filters from the *audio* circuits, *no amount of filtering can prevent interaction between the radio input circuits of the receivers if appreciable coupling exists between two antennas tuned to, and operating on the same frequency.* In other words, the antenna and/or loop used to feed one receiver should be decoupled as much as possible by spacing of receiver and lead-ins, right-angling the lead-ins and antennas themselves, etc., from the collecting structures used to feed the other receiver. Complete isolation of the collecting structure of one receiver from the collecting structure of the other is obviously impossible. Therefore, even after all feasible precautions have been taken simultaneous two-channel operations should be organized wherever possible to provide a large frequency separation between the two channels. Cross-talk transmitted between the antennas and input circuits will always be obtained if one receiver is operated at substantially the same frequency as the other.

19. Dynamotor-Filter Unit

The location of the dynamotor-filter unit is a matter of comparative indifference so far as the operation of the unit itself is concerned, but it is *inadvisable to mount it close to the receiving antenna lead-in.* The unit should be so located that cable 1611 is no longer than necessary, since this cable carries a relatively heavy supply current. The dynamotor base is permanently fixed in the airplane (see Fig. 15) and the unit may be removed for inspection or replacement by releasing the snapslides. As in the receiver mounting base, the snapslides of the dynamotor-filter unit should each be safety-wired to their respective studs after they are closed.

20. Junction Box

As in the case of the dynamotor-filter unit, the junction box mounting is permanently mounted in the airplane and the junction box is attached to it by snapslides. While the junction box can be removed from the airplane by detaching all the cables which go into it, it is desirable that it be sufficiently accessible, and that enough slack be left in the cables adjacent to it so that it may be unsnapped from its base and inverted while the radio set is operating in order to check the voltages on the various circuits.

21. Cables

The cables which interconnect the various units will normally be lashed or clamped to structural members of the airplane along their length. There is one important point to be observed in the installation of these cables. They are armored with metal braid and their outer surfaces may produce an electrical noise in the receiver unless they are carefully bonded to metal airplane members wherever they are likely to touch or rub thereon. In the best installations these cables are bonded at intervals of approximately eighteen inches and the intervening lengths, between bonds, are wrapped with friction tape or similar insulation, to eliminate all possibility of receiver "noise" arising from this source. The battery cable 1610 terminates at its battery end in a pair of open terminals. If a conductor of any length whatever carrying current from the charging generator to the battery, is included in the circuit between the positive conductor of cable 1610 and the battery terminal, this may produce electrical noise in the receiver which will come from the generator circuit. Consequently it is desirable to carry direct to the battery independently of any other circuit in the airplane.

U. S. Navy airplanes are now being fitted with a junction box (in accordance with Naval Aircraft Factory, Philadelphia, Drawing No. 39923) which is located in close proximity to the battery. This junction box is also available as a standard stock item for issue to older aircraft not so equipped. The battery cable may be connected to this junction box directly or via radio power junction box, (Naval Aircraft Factory, Philadelphia, Drawing No. 38742) or the distribution panel in single seaters, to which separate radio power leads from junction box 39923 have been installed, and not directly to the battery, so that provision of additional outlets from the battery box for cable 1610 is unnecessary. The junction box of either type may be fitted easily with one of the 11/16 inch -24 threaded hub fittings shown on Naval Aircraft Factory, Philadelphia, Drawing No. 39921, Fig. 3, also a standard stock item. Experience has shown that when cable 1610 is thus connected and the junction box 39923 is located in close proximity to the battery the resulting interference is nearly negligible.

22. Adjustment of Input Alignment

The final installation operation of the receiver is the alignment of the antenna circuit of the receiver by means of the input capacitor 98, adjusted by knob 244. Set the switch 45 on its A position. If the antenna used is so large that its characteristics vary widely with frequency over the operating range, this adjustment must be made for each coil set. If the antenna is small or consists of a rigid mast, one adjustment may give satisfactory results for all coil sets.

The Receiver is operated with the switch at MANUAL. A signal is tuned in at the high-frequency end of one of the bands, preferably on the HIGH range of the Type CW-47108 Coil Set. The volume control *must* be progressively retarded during the adjustment to keep the signal at the lowest audible level. Knob 244 is turned until the signal is a maximum. Then the receiver tuning must be readjusted for maximum, and knob 244 adjusted again for resonance. If the receiver is to be operated for a considerable period in the low-frequency bands only, this antenna alignment may be performed near the maximum dial (frequency) setting on a low-frequency coil set. But for use throughout the range, the antenna alignment must be performed on one of the high-frequency bands. An alternative method of alignment, when no incoming signals are available, is to switch to CW, MANUAL, and adjust knob 244 for maximum noise in the telephone receivers.

Do not operate the receiver with any coil set, if it is impossible, owing to the size or arrangement of the antenna and lead-in, to adjust knob 244 for resonance, as indicated by maximum signal. The overall sensitivity will be low and the results will be unsatisfactory unless capaci-

tor 98, controlled by knob 244, is accurately adjusted.

If a receiver is to be used with a loop, the switch 45 on the front of the receiver must be operated to change between antenna and loop. For homing operations on a fixed frequency it is possible to eliminate the necessity of also readjusting the input alignment capacitor 98, when the receiver input is thrown from antenna to loop, by making the loop capacity and inductance on installation of such value that the receiver is resonant at the setting of capacitor 98 which is correct for the receiving antenna installed on the airplane. *This adjustment of the loop capacity and inductance must be done at the particular frequency on which direction finding will be performed. The alignment of the input circuit will then be satisfactory over a narrow band of frequencies in this region but it will not be satisfactory over the entire range 195-1500 kc.*

No general design rules can be given for the matching of the antenna and loop for two positions of the switch 45, since the inductance and capacity of the loop will depend upon its size, number of turns, mounting and length of leads to the receiver. This matching process can, however, be carried out experimentally with very little trouble in practical installations if the loop is operated only at a low or medium frequency *and the number of turns are so determined as to make the loop inductance approximately 0.2 millihenry.*

If, after the capacitor 98 is properly set to align the receiver for the chosen fixed antenna, it is necessary to turn knob 244 of capacitor 98 to the *right* (increasing capacity) to obtain maximum signal when the switch 45 is set on the LOOP position, a fixed capacitor of physically small size should be connected in parallel with the loop leads to the receiver. If, after capacitor 98 is properly set for the antenna, it is necessary to turn knob 244 to the *left* (decreasing capacity) to obtain a maximum signal on loop, either the capacity or the inductance of the loop is too large; turns should be removed from the loop until, on switching to the fixed frequency in the loop band, the sensitivity cannot be improved by readjusting knob 244. If no change whatever in the strength of the signal received from the loop is observed when adjusting knob 244, the chances are that the loop is either open-circuited, short-circuited, or has too many turns.

WEIGHT OF OPERATIVE INSTALLATION OF MODEL RU-18 OR MODEL RU-19 EQUIPMENT
(See also Fig. 15)

No. Required	*Unit*	*Used with RU-18 Weight (pounds)*	*Used with RU-19 Weight (pounds)*
1	Type CW-46048D Aircraft Radio Receiver with tubes and single coil set	13.9	13.9
1	Type CW-46011 Mounting Base	0.6	0.6
1	Type CW-62007A Junction Box	1.9	
1	Type CW-62017 Junction Box		2.4
1	Type CW-21215A Dynamotor-Filter Unit	9.0	
1	Type CW-21441 Dynamotor-Filter Unit		9.0
1	Type CW-23087 Receiver Switch Box	0.9	0.9
1	Type CW-23012 Remote Tuning Control	0.9	0.9
1	Type CW-23021 Remote Tuning Control Mechanical Linkage (0.14 pound per foot)	1.4	1.4
1	Set of four power cables	4.3	4.3
	Total Weight, pounds	32.9	33.4

SECTION III. OPERATION

Operation of this equipment involves the use of high voltages which are dangerous to life. Operating personnel must at all times observe all safety regulations. Do not change tubes or make adjustments inside the equipment with high voltage supply on.

23. General

Switch 134 in the Type CW-23087 Receiver Switch Box turns off all power to the equipment. When this switch is in its OFF position the dynamotor unit is disconnected and power is thrown off the filaments of the associated receiver for all positions of the other controls. With the switch box switch in either of the two positions at which the dynamotor turns (AUTO and MANUAL) the rotary switch 134 determines the *type* of volume or sensitivity control under which the receiver is operated, and the toggle switch 137 turns on and off the heterodyne oscillator for CW and MCW reception respectively. The connections of the various power and operating circuits have been described in connection with the circuit diagrams.

24. Operating Test

After installation a receiver operating test must be made before flying with the equipment, for which detailed instructions follow:

1. Plug a coil set into the receiver corresponding to a frequency band in which signals will be available for test purposes. See that the full frequency range on the remote tuning control dial can be swept through for the chosen position of the pointer without encountering the stops on the remote tuning control. The tuning control should turn smoothly and easily.

2. If the coil set to be used is a dual coil set, remotely controlled, attach the dual coil set mechanical linkage according to the instructions given under "Installation" and switch the dual coil set remote control lever between HIGH and LOW. The dual coil set switch will throw back and forth as the remote control lever is thrown back and forth. If the installation has been correctly made, the positive action of this switch between its HIGH and LOW positions will be indicated: (a) to the operator's hand by a positive snapping action as the switch assumes its operating position; (b) to the operator's ears by a change in the residual noise in the telephone receivers as the frequency band is changed.

3. If the antenna-loop switch is remotely controlled by mechanical linkage and a Type CW-23051 Remote Control, check the operation of this control by a process exactly similar to that described in the preceding paragraph for the dual coil remote control.

4. With telephone receivers plugged into the receiver switch box, turn the rotary switch to MANUAL with the toggle switch at MCW. The dynamotor should start and as soon as the receiving tubes are warm a slight hum will be heard in the telephones, indicating that the receiver is operating. Atmospherics and electrical "noise" are usually heard at the maximum "increase" position of the volume control, particularly on the lower-frequency coil sets. Switch to CW. The noise in the telephones should increase in the CW position. Advance the volume control to its maximum "increase" position and tune in a signal, if possible, which is very loud on the MANUAL position of switch 134. Switch to AUTO. The signal should decrease. The receiver output on weak signals will remain substantially unchanged, at the maximum "increase" position of the volume control when switching from MANUAL to AUTO and weak signals therefore do not give a positive test of the operation of the automatic gain control.

It should be noted in connection with operation of this receiver that at the AUTO position of the switch box switch, the A.G.C. tube of the receiver holds the level of the audio output in the telephone receivers at a substantially constant level for *all values of incoming radio signal strength above a certain minimum.* This constant audio output level may be varied, if desired, by the use of the volume-control knob in the AUTO position, but it cannot be increased thereby above the level to which it is set by maximum rotation of the knob. For a given setting of this knob it increases with increasing percentage modulation of the radio wave. The design of the A.G.C. circuit is such that at the maximum "increase" position of the volume-control knob, the AUTO output level is approximately 100 milliwatts for Type CW-46048D Aircraft Radio Receivers into "600-ohm" telephone receivers, for an incoming radio wave modulated 30 per cent. *If the percentage modulation is reduced to a low value, say 10 per cent, the audio power output in the* AUTO *position will be only about 5 or 10 milliwatts, which in general is unsatisfactory under flight conditions.* Thus it is necessary for satisfactory reception of modulated signals in the AUTO position that the average modulation of the transmitted wave be at least 25 per cent.

A weak audio output in the telephone receivers, when receiving strong radio signals in the AUTO position may indicate insufficient modulation in the transmitted wave. But in making tests by comparing the audio output of the receiver on AUTO with the output on MANUAL it should be borne in mind that for strong incoming radio signals the audio output which represents the AUTO control level may sound considerably weaker than the output which is heard on MANUAL. For example, if the incoming radio wave is of sufficient magnitude to give the maximum receiver output on MANUAL, which is 300-500 milliwatts, the power output in the telephones may drop by a factor of 5 or 10 to 1 when the switch is thrown to AUTO. This in itself is an indication that the receiver automatic gain control is operating normally. Then if the distance from the transmitting station is steadily increased, the output level on MANUAL will gradually decrease (remaining constant on AUTO) until it reaches the level which characterizes the output on AUTO. If the incoming radio wave becomes still weaker, from this point on, the audio output on AUTO will decrease, together with the output on MANUAL. *In general, for weak incoming signals only,* the audio output of the receiver is equal on AUTO and MANUAL.

5. Before flying with the receiver the installation should be further checked with the airplane engine running. If, with the volume control set at maximum in any position of the tuning dial, the electrical noise in the telephones is increased on starting the airplane engine, this indicates imperfect shielding of the ignition or generator system, or difficulty with the voltage regulator on the charging generator. If circumstances render necessary the operation of the receiver under these conditions only those radio signals can be received which are of a strength comparable to the local disturbance.

6. If the receiver is installed for use on a radio compass loop in addition to the antenna, turn the switch 45 to its L position and repeat the tests on signal reception, with the switch box at both CW and MCW. Check the operation of capacitor 98, controlled by knob 244, at a number of frequencies on the different coil sets below 1500 kilocycles. It should be possible to resonate the input circuit at any position of the tuning control on each of these coil sets. (See discussion of loop constants on page 40.)

NOTE: For satisfactory direction finding or homing operations on any loop the signal should be received in the CW *position of the switch regardless of whether the transmission is modulated or not. If the test meter is used as a visual indicator for direction finding or homing, the switch box switch 134 must be on* AUTO, *since the current indicated by this meter is varied by the amplitude of the incoming carrier only in virtue of the action of the A.G.C. tube.*

RECEIVER TUNING TABLE

The following data give the approximate frequencies for each ten divisions of the receiver dial for coil sets furnished by the Western Electric Company on Contract NOs 84530.

	CW-47105		CW-47112		CW-47107		CW-47108		CW-47204		CW-47202		CW-47203	
Rec. Dial	*Range O*	*Range P*	*Range L*	*Range N*	*Range Q*	*Range G*	*Range Q*	*Range M*	*Range Q*	*Range F*	*Range F*	*Range N*	*Range F*	*Range G*
0	186	280	389	5915	526	2960	529	5075	531	1975	1970	5920	1970	2955
10	197	296	410	6225	555	3115	558	5340	560	2080	2075	6240	2075	3115
20	208	312	433	6550	585	3270	588	5620	592	2190	2185	6560	2185	3280
30	219	329	456	6880	616	3435	620	5890	624	2300	2295	6880	2295	3440
40	231	346	480	7215	649	3600	652	6175	657	2410	2410	7210	2410	3610
50	242	364	505	7550	682	3770	685	6455	691	2525	2525	7540	2525	3780
60	254	381	529	7875	714	3930	718	6725	725	2640	2640	7860	2640	3945
70	266	398	553	8190	746	4090	750	6990	758	2750	2750	8180	2750	4100
80	278	416	577	8505	778	4250	783	7260	792	2860	2865	8490	2865	4275
90	290	434	602	8820	811	4410	817	7530	827	2975	2985	8800	2985	4445
100	302	451	626	9120	844	4570	850	7780	860	3085	3095	9100	3095	4605

	CW-47068	CW-47069	CW-47070	CW-47072	CW-47075
Rec. Dial	*Range D*	*Range E*	*Range F*	*Range H*	*Range K*
0	828	1285	1975	3865	8750
10	877	1360	2095	4080	9240
20	929	1440	2220	4315	9760
30	983	1525	2350	4550	10280
40	1040	1610	2480	4785	10810
50	1098	1700	2620	5030	11340
60	1155	1785	2750	5270	11860
70	1211	1875	2890	5515	12380
80	1271	1965	3035	5760	12910
90	1334	2060	3180	6015	13430
100	1396	2155	3320	6265	13950

SECTION IV. MAINTENANCE

25. Inspection

The radio equipment should be given an operating inspection before each flight. The following routine is suggested:

a. Flight Inspection

1. Turn the power on and tune the receiver over the band. The gain control should be at maximum. Note the general signal and noise level. On certain planes, coil sets covering a wide range of frequencies may be carried and switched in flight, but on others, this may not be possible or desirable. It is therefore essential that the proper single or dual coil set be installed for the performance of that particular mission.

2. If there are signs of undue noise, tap the tubes sharply with the fingers while listening for microphonic response. If such occurs, replace the defective tube or tubes. It is good practice to check occasionally whether or not the proper types of tubes are in their sockets. Grid clips should be securely attached. Tubes should be inserted all the way into their sockets.

3. Snapslides should be carefully closed to prevent any possibility of a unit loosening during certain maneuvers. Plugs should be fully inserted and snap-locked.

4. Check all operating controls including antenna-loop switch and dual coil set switch, if installed. All of these test operations require but a few seconds unless trouble is found.

5. It is desirable to check the antenna alignment, particularly if the listening test indicates that the signals are not quite as strong as they should be.

6. Unless the airplane has just returned from a flight in which the radio was reported as satisfactory, it is good practice to turn up the engine past the speed at which the generator cuts in, and to observe the noise and the charging voltage. In a completely shielded installation there should be negligible increase in the noise level as the generator "cuts in."

7. If there are intermittent noises not due to static or other determinable outside sources, check the telephone cords for open or intermittent contacts.

8. Poor bonding of cables, or broken shielding is a cause of noise and should not be tolerated.

9. Do not allow the model RU-18 equipment to be operated outside the primary voltage limits of 11-15 volts nor the Model RU-19 outside the limits of 22-30 volts.

NOTE: Always turn the switch box switch to OFF *before leaving the airplane.*

The following Service Inspection should be made approximately once a month:

b. Service Inspection

1. The first check should follow closely the tests outlined above for Flight Inspection. The result of that check will indicate any necessity for further tests on receiver, junction box, switch box, cables, or switches.

2. The battery, generator, and voltage regulator, should be checked by one with the proper authority to do this. It is essential that the battery be in condition to operate the radio equipment *before* as well as *after* the engine has been started.

3. A careful inspection of all bonding, cable shielding, plug locking, snapslide locking, and antenna structures should be made. Broken shielding and poor bonding of the shielding to the metallic structure of the airplane should not be tolerated. Clean all insulators.

4. Detailed instructions regarding dynamotor maintenance follows:

c. Maintenance of Dynamotors

If the radio equipment is operating satisfactorily with the dynamotor noise at a suitably low level, the dynamotor should rarely be touched. Constant sanding of commutators, manipulating of brushes, or excessive greasing, is likely to do more harm than good. The dynamotors supplied with this equipment are provided with grease-sealed ball bearings containing sufficient lubricant for 1000 hours of operation. The life of the brushes should exceed 1000 hours. Hence the routine inspection should consist of a check on the "radio" and "audio noise" attributable to the dynamotor, and a cleaning of carbon or copper dust, which may have accumulated in the vicinity of the commutators, by means of an air hose or a soft cloth saturated with carbon tetrachloride.

The check on the "radio noise" may be made by operating the receiver at maximum gain and comparing the noise output with that from a machine known to be satisfactory. After a little experience it will be possible to distinguish dynamotor noise from other types, and a comparison machine will not be necessary. Use the receiver coil set for this test that will normally be employed in flight. "Dynamotor noise" is sometimes due to a break in the shielding of one of the cables, usually cable 133 or 134. If the shielding braid is broken or if it is not properly bonded to the metal fuselage, noise may be experienced even when the dynamotor is operating satisfactorily.

The check on "audio noise" may be made by operating the receiver at minimum gain. If a loud low-pitch tone is heard, it is indicative of commutator or armature trouble. In a normal dynamotor, the "ripple" will be so low that in the presence of a small amount of external radio noise it can barely be distinguished. If the "audio noise" is loud, make certain that all brushes make good contacts with the commutators and that the brushes slide easily in their slots. If the noise still persists, disconnect the brushes and field coils and check each coil winding of the armature for an open circuit. This is accomplished by placing the terminals of an ohmmeter on adjacent commutator bars and continuing the test around the commutator. Each test around the commutator should indicate the same resistance—approximately 19 ohms for the high-voltage side of the 12-volt (RU-18) machines and 16 ohms for the 24-volt (RU-19) machines. Any appreciable variation from this indicates an open circuit, a short circuit, or a partial short circuit, in which case the armature must be replaced.

When it becomes necessary to replace the brushes, make certain that each new brush slides smoothly in its slot, that the pigtail connector inside the spring has no broken strands, and that the brush is the one indicated in the Parts List Table I. Each brush is stamped + or — and the bearing brackets are likewise marked + or — adjacent to the respective brush holders. The brushes should always be inserted in their respective holders with the polarity mark upward in order to insure correct replacement at all times. Low-voltage brushes should have a useful life of at least 1000 hours and high-voltage brushes 1200 hours. The end of the useful life of a low-voltage brush comes when it has worn down to one-quarter inch; that of the high-voltage brush when it has worn down to five-sixteenths inch. Whenever new brushes are installed, the commutators should be carefully sanded with very fine No. 000 sandpaper. Machines should be "run in" on the bench for a period of eight hours (or until at least 80 per cent. of the surface of all brushes are in contact with the commutator) under normal load before being replaced in service.

If it becomes necessary to remove the armature, or to replace bearings, the following notes may be of assistance. To remove the armature, proceed as follows:

Remove the end covers followed by all four brushes, then the tie rods by unscrewing the acorn nuts. The high-voltage bracket should then be pulled out of the frame. This bracket fits snugly and if difficulty is encountered in removing it, tap it lightly. Withdraw the armature. A bearing puller should then be used to remove the bearings from the shaft, as any other method is likely to damage the shaft or commutator. In an emergency, however, grip the outer bearing race in a vise and tap lightly, with a hammer, on a nail set or similar tool held against the shaft. Be sure to straighten the grease slinger, if damaged, and replace it before attaching new bearings.

New bearings should never be removed from their cartons until ready for use in order that they be kept free of foreign matter. Prior to installation they should be removed from their carton and thoroughly washed in clean carbon tetrachloride, using a small stiff brush. Be certain that the bearings run smoothly before placing them on the shaft. The shielded side of the bearings should be towards the commutator. The inner race should have a light press fit on the shaft. It should be driven on by means of a piece of pipe or tubing having a hole slightly larger than the shaft so that the driving pressure is applied to the inner race only. Reverse the removal procedure in replacing the armature and bearings assembly. Grease the new dry bearings as indicated above before starting the eight-hour "run in" with Master Lubricant Co.'s "Lubriko M-6", or equal.

26. Slip Covers*

The receivers in some Model RU-18 and RU-19 equipments are provided with waterproof slip covers. When provided, the slip cover should be firmly tied in place over the receiver while the equipment is *not* in use.

27. Operating Difficulties and Possible Causes

The following general principle should be remembered and constantly followed in connection with this equipment.

When looking for trouble in a radio set always examine all the simple causes of failure first. Try vacuum tubes first, unless some other fault appears obvious.

This equipment is divided into a number of easily removable and replaceable units in order to facilitate the location of faults. Whenever the equipment fails to work properly, first determine in what unit the trouble lies by replacing the units *one at a time* by similar units known to be in good operating condition. This method of analysis, applied down to the individual cables, will always locate the defective unit without ambiguity. The remedies suggested below should be applied to a unit only after this unit has been definitely shown to be defective by the method outlined above.

* Optional, not furnished with all lots of equipments.

a. Receiver Operative but Noisy

Probably the most common cause of poor radio reception in all airplane installations of high-sensitivity receivers is electrical "noise" of both local and atmospheric origin. Operators of the receiver should learn by experience to identify those noises in the telephone receivers which indicate faults in the apparatus or installation. Such identification by ear will greatly facilitate the correction of the fault. The following tabulation may be used as a guide.

1. Atmospherics (static), external man-made interference. Should be identified on the ground, engine not running. Static will be heard with low-frequency coil sets at all seasons of the year and most times of day. The general static level grows progressively lower with increasing frequency. The receiver cannot be adequately tested or inspected in ground locations where power-line interference, motor interference and the like are excessive. Disconnecting the antenna at the receiver binding post will generally give a satisfactory test, since if the noise encountered is static or power-line interference it will greatly diminish or disappear when the antenna is disconnected.

2. Dynamotor noise. Should be identified on the ground, engine not running; usually related to the speed of the machine and can be identified by switching the power on and off at the switch box.

3. Intermittent contact in phone cord, plug, or contacts to telephone receivers. Should be identified on ground, engine not running.

4. Loose bond or terminal plug on any receiver cable. Should be identified on ground, engine not running.

5. Ignition noise. Should be identified on ground, engine running, by varying the speed of the engine and by switching from one magneto to the other.

6. Generator noise. Should be identified on ground, engine running, by advancing the throttle to the point at which generator cuts in. If it originates in the generator itself, it will be characteristic "machine noise"; if in the voltage regulator it will probably be intermittent and appear only above a certain critical engine speed (usually 800 to 1000 rpm). Noise originating in the generator or voltage regulator can be dis-

tinguished from ignition noise by the fact that generator and voltage regulator noise is usually suppressed by opening the airplane main line switch.

7. Vacuum tube noise. Should be identified on ground, engine running; usually a crackling or ringing sound. It will sometimes appear under sustained vibration and never be heard at all when the receiver setbox is jarred intermittently by hand.

8. Intermittent contact in an internal circuit of the receiver. May be identified with the engine running or by jarring the receiver by hand. Disconnecting the antenna and vibrating the receiver is not necessarily a test because noises of this character may be increased to audibility by a strong incoming signal.

With regard to (1) it should be noted that it is no uncommon occurrence for man-made interference to be received with destructive force when flying over certain areas, and to be of such nature that it is easily confused with generator or dynamotor noise on the airplane itself. If "machine" noises are suddenly heard in flight they may possibly be identified solely with a particular ground area. Also it should be remembered that when flying through mist, rain or snow, a noise is sometimes heard which sounds like a machine noise.

With regard to (2), the interruption of current in the commutators of the dynamotor machine sets up radio-frequency oscillations in the connecting cables, which oscillations enter the receiver by way of the antenna (never through the conductors of the cables themselves; this fact may be verified by disconnecting the antenna at the receiver binding post). The transmission of dynamotor noise to the receiver is related to the condition of bonding of the cables, particularly at high frequencies. A dirty commutator will produce more noise than a clean one, but complete suppression can never be obtained if the shielded cables are not thoroughly bonded and grounded. This fact should be remembered when making bench installations of the equipment for test purposes. When this noise occurs in an airplane installation the bonding of all cables to the airplane should be checked for poor contacts.

If the noise persists, the commutators of the machine may be cleaned with a clean dry cloth while the machine is turning over. *Never use emery on a commutator.* A trace of oil or grease on a commutator may cause more trouble than a dirt deposit. The low-voltage commutator is more apt to produce noise than the high-voltage commutator. Under normal operating conditions the commutators of these enclosed machines should not require cleaning oftener than about 300 hours. But if the dynamotor is noisy or inefficient, and the cause of the trouble cannot be located elsewhere, the commutator may be cleaned with a dry cloth as described above.

Intermittent contact is a very common, but easily remedied cause of complete interruption of service, because of the severe wear to which these items are subjected.

With regard to (6), generator and voltage regulator noise is frequently a more elusive fault than ignition interference. A temporary remedy, if the generator becomes noisy in the air, is to open its field while receiving, but this is not a cure, and should not be permanently tolerated. Complete shielding will not always cure voltage-regulator interference. For best results the voltage-regulator output should be electrically filtered. A method of doing this, which is effective in many installations, is to connect a capacitor of ½ microfarad capacity between the positive generator field terminal and ground, and a second capacitor of ½ microfarad between the positive output terminal and ground. To be effective this must be done *at the generator* using the shortest possible leads.

If the voltage regulator is adjusted so that its armature vibrates continuously no amount of filtering will completely eliminate the resultant noise. The spring tension on the voltage regulator relay contacts should be so adjusted that they open and close without vibration as the generator passes through its operating speed range. Adjustments to the voltage regulator should not be attempted without proper equipment and authority.

With regard to (7), an intermittent contact inside a tube is sometimes the first indication that its useful life is over. Noises originating in the tubes are *greatly accentuated by the presence of a strong incoming radio signal,* particularly an unmodulated signal, and this may be used as a means of identifying such a noise. The faulty tube must be isolated by replacing the tubes one by one with new ones and observing when the disturbance vanishes.

If the trouble is due to (8), the receiver must be dismounted and inspected internally for loose connections. To remove the receiver chassis from its case, first take out the coil set, then remove from the setbox all bright-finished screws. Do not lose the lock-washers from these screws; these washers must all be replaced when the screws are replaced. The front panel may then be separated from the case, which slides backward off the frame. Black-headed screws and rivets must not be removed from any part of the receiver. Do not disarrange the internal wiring of the receiver during this inspection.

Operating the receiver at excessively high voltage tends to make it noisy during operation and to increase the residual causes of noise. *Never allow the radio set to be operated at a supply voltage greater than 15 volts for Model RU-18 nor 30 volts for Model RU-19.* Operation at less than normal voltage will not damage the equipment, but the radio reception will be unsatisfactory.

b. Receiver Dead. No Sounds

Having checked all plug and cable connections, dismount the junction box with cables attached and check all voltages with reference to the table, page 58. Inspect junction box wiring for open circuits. Try another coil set. Be sure that coil sets are securely seated. If dynamotor does not run: (a) check fuse 151 and renew it if it is open; (b) substitute another dynamotor-filter unit and if it runs, look for an open circuit at the low-voltage brushes of the first machine; (c) check circuit through switch box switch in MANUAL or AUTO position, starting at 44 and ending at 86 in junction box. If dynamotor runs, but voltage on terminal 18 or 19 is low, check the continuity of high voltage circuits through choke 148 and resistor 152 in dynamotor-filter unit base. Check capacitors 147 for short circuit. If all voltages on receptacle 167 of the junction box are normal, check volume control circuit with switch at MANUAL, through terminal 85 to ground. The resistance of this circuit should vary from 0 to about 30,000 ohms as the volume control knob is rotated. Plug a test meter into jack 135 and compare the reading with those given in the table on page 58. The reading of this meter should be reduced almost to zero (on MANUAL) by rotating the volume control knob back from its maximum "increase" position. If this circuit is normal and receiver is still inoperative it should be dismounted for a bench test.

Remove the receiver case and inspect the wiring for short circuits. Check transformer 39 and coil 95 for open circuits between their respective terminals. Check the coil set for open circuits between the respective pairs of terminals which are closed by windings. Inspect contacts of all tube sockets. Mount coil set and plug receiver into a complete radio set; throw the power on and with switch at MANUAL, check the voltage on each electrode of each tube by connecting a high-resistance voltmeter between the different electrodes and ground. Compare the readings with those of the tables on page 57. Check capacitor 11 for open circuit and capacitors 10 for short circuits.

IMPORTANT NOTE—All readings of electrode bias voltages and supply voltages in the receiver should be made with the switch on MANUAL. Unless the Weston Model OE Receiver Analyzer is used for these tests the control grid of each of the three Navy Type -78 tubes must be *connected to the ground,* and with the control grid clips in place on their respective tubes. If this condition is not fulfilled the receiver will oscillate, since it is out of its shielding case, and the voltage readings will be abnormal. *Be careful not to ground the control grid of the A.G.C. tube.* (See page 55 for directions for using the Weston Receiver Analyzer without removing receiver case.)

Check resistor 33 for open circuits. This resistor should show about 7,000 ohms between its end terminals. Heating of resistor 33 is not necessarily an indication of a fault, as it runs warm at normal operating voltages.

Check resistor 145 for open circuits.

If there is no plate voltage on one tube, check the contacts made between the various pin plugs and their respective receptacles on the coil set. These pin plugs may become distorted after long use; their ability to make contact can be restored, unless the springs are fractured, by tapping each plug on the end to spread the contact springs. If the cathodes or screen grids do not show approximately the same voltages as those in the table, check the circuits through the various decoupling resistors in supply lines from 73 to the cathodes and 80 to the screen grids and the plates. If an ohmmeter is available, check the values of these resistors. Check all by-pass capacitors 1, 2, 3, 4, 5, 6, 7, 8, 9 and 38, for internal short circuits. Check resistors 29, 60, 22, 20, 30 and 21 for open circuits. Check the continuity of the line starting at the grids of the Navy Type -78 tubes on one side and passing through terminal 74 and through terminal 82 of the junction box and switch box. Check the neon tube 54 for a short circuit. Under normal service conditions this tube will last for the life of the receiver, without replacement. Replace each vacuum tube with a new one of the same type. A tube may lose its emission without becoming noisy.

c. Receiver Normal on MANUAL but Abnormal on AUTO

Replace the A.G.C. tube *only* with a new tube. Check the value of resistor 31 (500,000 ohms) and resistor 24 (100,000 ohms). Measure the voltage between the cathode of the A.G.C. tube (tap on resistor 145) and terminal 78. *Do not make connection direct to the control grid. In the case of the A.G.C. tube this bias is the voltage between terminal 78 and the cathode.* If this voltage is abnormally low the A.G.C. tube will control the incoming radio signal at too low a level. If this voltage is too large the A.G.C. tube will control at too high a level. Check the continuity of the line from the A.G.C. tube control grid through its grid resistor 20 (2 megohms) to terminal 78. If this line is open the A.G.C. tube may block the receiver (but only in the AUTO position of switch 134). Check the 97C capacitor, which is connected to the control grid of the A.G.C. tube, for short circuit. If this capacitor is shorted or leaky the receiver will not operate in the AUTO position.

d. Receiver Operative but Insensitive on MANUAL

Check alignment of input circuit. Check junction box voltages with the radio set turned on. Dead batteries are the reason for a large number of communication failures. If voltages are normal, check the tubes by replacing them with new ones, one at a time.

Try another coil set.

As a last resort check the alignment of each tuned amplifying stage. *This operation should not be done in the airplane, but must be done on the bench, since it is an operation requiring considerable care.* Access to the two amplifier aligning capacitors 59A, 59B is obtained through the two rotatable snap covers 277A, 277B on the side of the receiver setbox. Connect the receiver to an antenna (or to a dummy antenna if a local signal source is available) and tune in a signal on any coil set at the *high-frequency end* of the scale (75 to 100 scale divisions). Retard the volume control until the signal is just audible. This operation should be performed on a steady tone-modulated signal, not on a radiophone signal or a signal that is fading. Align the input circuit carefully with knob 244. Insert the screwdriver into the two slotted adjusting screws that control the capacitors 59A, 59B and adjust them successively for maximum signal.

NOTE: If it is impossible to find a maximum or if the maximum signal is not located very close to the original positions of these screws, the fault is in the circuit or the gang capacitors and not in the settings of these capacitors, and they should be restored as closely as possible to their former positions.

If the tuned stages are in proper alignment, or if it is impossible to tune to maximum signal on the aligning capacitors, the fault must be in the circuits of the receiver or in the gang-tuning capacitor.

Do not touch the aligning capacitor 59C of the oscillator stage (snap cover 277C).

e. Receiver Normal on MCW but Insensitive on CW

This condition will occur if the tuned circuit of the heterodyne oscillator tube, -38233-1 gets out of tuning alignment with the RF amplifier stages. Care must be taken to make sure that the receiver *has its normal sensitivity* on MCW before attempting to adjust the oscillator. If the receiver is also insensitive on MCW the oscillator should be left alone until the adjustments described in the foregoing paragraphs have been made. This particular symptom—insensitivity on CW *only*—is most likely to be identified with a high-frequency band (Coil Sets Types CW-47070 and higher). *Consequently the capacitor 59C of the oscillator (snap cover 277C) should be left alone, since an alteration in the setting of this capacitor will change the heterodyne oscillator alignment for all coil sets.*

Mount the coil set, for which the receiver is insensitive on CW only, in the receiver and tune in a weak *modulated signal* with the switch at MCW. A signal should be chosen at about the middle of the frequency band (40 to 60 on the dial) and the volume control retarded until the modulated signal is barely audible. Tune the receiver with all possible care to exact resonance with this weak MCW signal. Then switch to CW. The heterodyne beat note will probably be inaudible. (If it is audible, the trouble has been incorrectly diagnosed and the oscillator coil should be left alone.)

Remove the black snap cap 285A which is on the coil set handle just under the oscillator capacitor snap cover 277C. This exposes the inside of the oscillator coil assembly 91, and a small cone nut will be visible over the blade of the leaf capacitor 94 which is mounted in the middle of the coil assembly (see Fig. 14). Use a small socket wrench, and adjust this cone nut by rotating it slightly until an audible heterodyne beat note is heard in the telephones. A socket wrench having an insulated handle must be used, because the insertion of a metal shaft along the axis of the coil assembly will itself detune the circuit. Only a *slight* rotation of the cone nut will be necessary. Adjust this nut so that the heterodyne beat note is audible *after the wrench is withdrawn*. This adjustment is very critical, particularly on the high-frequency coil sets, and must be performed with great care. The cone nut must be rotated *very slowly*, or the position of audible beat note will be passed through accidentally. *Be sure that the cone nut is left in such position that the heterodyne oscillator beats with the signal to which the RF amplifier is tuned, and not some other signal.* This should be checked after the adjusting wrench is removed, by switching to MCW without altering the position of the main tuning control. Replace the black snap cover cap over the aperture in the oscillator coil assembly.

NOTE: *The coil capacitors 94 of the dual coil sets are, of course, two in number, mounted under two snap caps. When a dual coil set is mounted in the receiver the upper one of these snap caps 285B exposes the coil capacitor of the high-frequency range and the lower snap cap exposes the capacitor of the low-frequency range.*

When it becomes necessary to change the setting of the low-frequency range capacitor in the CW-47107, CW-47202 or CW-47204 Coil Set, a readjustment of the high-frequency range capacitor will be required and it must be made after the low-frequency capacitor adjustment has been accomplished. Slight changes in the setting of the high-frequency capacitor in each of these dual coil sets can be made without affecting the operation of the low-frequency circuit. The adjustments of capacitors 94 in the other dual coil sets are independent of each other.

f. Receiver Fails to Oscillate on CW

Check the circuit through receiver terminal 80 and resistors 28, 66 and 67 to the plate terminal of the oscillator tube. Resistors 28 should test 30,000 ohms each. Try another coil set, of adjacent frequency band. If the receiver oscillates properly, check the continuity of the oscillator coil windings in the first coil set (see Fig. 14). Check contacts between the pin plugs on the receiver coil panel and the six sockets on the oscillator coil assembly. Check the supply voltage.

g. Receiver Oscillates or "Motorboats"

A high-quality light clock oil should be applied to the bearings and fan-shaped contactors of the gang capacitor assembly about once in six months. Turn the capacitor rotor through 180 degrees several times to work in the lubricant. If dust and dirt have collected around the contacting springs, they should be cleaned thoroughly with carbon tetrachloride before applying new oil. Most cases of oscillation or motorboating can be cured in the above manner, but if the condition persists it may be found due to Navy Type -78 tubes having high grid current. Evidence of this is a change of cathode current exceeding 2 ma on switching from MANUAL to AUTO. Tubes which do not show this effect should be used. A coil set which behaves normally over the entire band in a stable receiver should be used for the above tests. The battery voltage should be normal, that is 11-15 volts for RU-18 and 22-30 volts for RU-19. If the instability still persists, carry out the following tests:

1. See that cable shielding is not broken and that it is properly bonded to the metal fuselage (or grounded metal plate if set up on a test bench).

2. See that snapslides on tube cover and coil set are tightly closed and make good electrical contact to the cabinet.

3. See that screws holding chassis and cabinet together are tight.

If the condition of oscillation is permanent and violent, an internal inspection should be carried out. Open circuits in the supply lines will not cause oscillation. The various grid and plate voltages should be measured as outlined above. Abnormally *high* screen and plate voltage or abnormally *low* control grid bias may be sufficient cause for oscillation.

A sufficient cause for oscillation in the receiver is an open circuit in one of the various by-pass capacitors 1, 2, 3, 4, 5, 6, 7, 8, 9 and 38. Since the terminals of these capacitors are connected together through other capacitors or through resistors of various sizes it is necessary first to disconnect all leads from the ungrounded terminal of each capacitor under test. A rough test for capacity between the capacitor terminals can then be made, if a capacity meter is not available, by charging the capacitor with a 45- or 90-volt B-battery. Ground one side of the battery on the receiver frame and touch the other side of the battery to the open capacitor terminal. Remove the battery connection and touch this terminal with a grounded wire. If the capacitor is in good condition it will discharge with a visible flash or spark. A by-pass capacitor which is not open or leaky will retain for at least ten seconds enough charge to spark visibly when discharged to ground. When leads to capacitors 1, 2, 3, 4, 5, 6, 7, 8, 9 and 38 are unsoldered or restored, *care must be taken to do a neat and workmanlike job of resoldering on these lugs*, but these lugs must under no circumstances be heated for any length of time. If this soldering is done carelessly, the capacitors may open up or short circuit internally as a result of the soldering operation.

28. Use of Model OE Receiver Analyzer

The Weston Model OE Receiver Analyzer may be used in locating trouble in the receiver without removing the receiver chassis from its case. In order to check the voltages listed in the appended tables (page 57) the selective analyzer of this instrument will be used, together with the Model 666 Socket Selector Unit.

The selective analyzer consists of a milliampere-voltmeter-ohmmeter. The voltmeter has one common negative terminal and various positive terminals for the different voltage scales from 0-1 volt to 0-1000 volts.

The socket selector consists of a cable terminated in a seven-terminal plug at one end and a socket unit at the other end. Adapters are provided for the plug and socket unit to allow them to be fitted respectively to the sockets and to the tube bases of various types of tubes.

To measure the operating voltages on a given tube in a radio receiver, the plug end of the cable is inserted in the tube socket in the receiver and the tube which operates in that socket is inserted in the socket unit on the other end of the cable. The socket unit, in which the tube is inserted, is provided with receptacle-type terminals numbered 1 to 7 or 1 to 6 (depending upon the tube and adapter used), which terminals are connected to the various electrodes of the tube. The receiver controls are set in their operating positions, and connections are made, by means of flexible connectors supplied with the analyzer, between the appropriate voltmeter terminals on the left-hand side of the instrument case, and the electrode terminals on the socket unit.

In the table at the top of page 57 are listed the types of socket adapter required for the various tubes in the receiver and the numbers of the various electrode terminals which appear on the socket unit of the Model 666 Socket Selector when this instrument is connected as described above to any one of the six tube sockets of the receiver.

As an example, suppose the voltages on the Navy Type -78 tubes are to be measured for comparison with the table on page 57. The tube is removed from the receiver, connected to its receiver socket through the selector cable and the receiver is turned on, with normal supply voltage. The control grids of the remaining Navy Type -78 tubes *(not the Navy Type -77's)* should be grounded on the receiver case to prevent self-oscillation.

To measure the heater voltage, connect terminal 1 to the negative voltmeter terminal and terminal 6 to the scale 10 terminal on the voltmeter. To measure the screen-grid voltage, connect the negative voltmeter terminal to ground (any metal part of the receiver) and connect terminal 3 to the scale 250 terminal of the voltmeter. To measure the plate voltage, ground the negative voltmeter terminal to the receiver and connect terminal 2 to the scale 500 terminal. To measure the cathode voltage (control-grid bias), ground the negative voltmeter terminal to the receiver and connect terminal 5 to the scale 10 terminal. Similar operations are carried out for the remaining tubes of the receiver.

All electrode terminals on the socket unit of the analyzer are provided with a pair of series-connected outlets, so that the current to any electrode may be measured by connecting these respective pairs of terminals to the milliammeter terminals of the analyzer instrument. In general it will not be necessary to measure these space currents since in the receiver the cathode voltages to ground are all developed by the flow of space current through resistors, and abnormality in the value of any of these bias voltages will be a sufficient indication of abnormal space currents.

The junction box voltages listed on page 58 may be checked without the use of the socket selector, by merely connecting the appropriate voltmeter terminals of the analyzer direct to the various numbered terminals of the junction box.

The receiver analyzer is also provided with ohmmeter terminals, and resistances of from 5 to 10,000,000 ohms may be measured directly. To check the value of any resistor in the receiver and to make circuit continuity tests, as suggested in the earlier paragraphs of the section on Maintenance, merely connect the analyzer terminals marked RES, OHMS across the two points in the circuit between which the circuit resistance is to be measured (see instructions accompanying the analyzer). *Always disconnect the receiver power plug before making any measurements of circuit continuity or resistance.*

RECEIVER VACUUM TUBE ELEMENT TERMINATION

Tube	*Navy Type*	*Adapter*	*Heater Terminal Nos.*	*Screen Grid Terminal No.*	*Plate Terminal No.*	*Cathode Terminal No.*
First RF	—78	6 prongs	1 and 6	3	2	5
Second RF	—78	6 prongs	1 and 6	3	2	5
Third RF	—78	6 prongs	1 and 6	3	2	5
A.G.C.	—77	6 prongs	1 and 6	3	2	5
Detector	—77	6 prongs	1 and 6	3	2	5
Oscillator	—38233-1 . . .	None*	1 and 7	—	3	2
Output	—38233-2 . . .	None*	1 and 7	—	5	6

*Seven-prong socket, requiring no adapter on the socket selector cable.

MODEL RU-18

TYPICAL PLATE, SCREEN, AND BIAS VOLTAGES IN RECEIVER*

One Receiver Operating from the B Receptacle of the Junction Box Type CW-62007A
(Control grids of Navy Type -78 tubes in the receiver short-circuited to ground;
volume control at MAX.; switches at MANUAL, CW)

Tube	*Navy Type*	Heater *Volts*		Screen Grid to Ground *Volts*		Plate to Ground *Volts*		Cathode to Ground *Volts*	
		12	14	12	14	12	14	12	14
First RF	—78 . . .	6.0 v.	7.0 v.	108 v.	123 v.	230 v.	265 v.	3.5 v.	4.2 v.
Second RF	—78 . . .	6.0	7.0	107	122	229	264	3.5	4.2
Third RF	—78 . . .	6.0	7.0	106	121	227	263	3.5	4.2
A.G.C.	—77 . . .	6.0	7.0	0	0	0	0	—65	—76
Detector	—77 . . .	6.0	7.0	230	265	100-215	120-180	14	16
Oscillator	—38233-1 .	6.0	7.0	—	—	20-50	25-60	0	0
Output	—38233-2 .	6.0	7.0	—	—	218	255	12.5	14.5

MODEL RU-19

TYPICAL PLATE, SCREEN, AND BIAS VOLTAGES IN RECEIVER*

One Receiver Operating from the B Receptacle of the Junction Box Type CW-62017
(Control grids of Navy Type -78 tubes in the receiver short-circuited to ground;
volume control at MAX.; switches at MANUAL, CW)

Tube	*Navy Type*	Heater *Volts*		Screen Grid to Ground *Volts*		Plate to Ground *Volts*		Cathode to Ground *Volts*	
		24	28	24	28	24	28	24	28
First RF	—78 . . .	6.0 v.	7.0 v.	108 v.	123 v.	230 v.	265 v.	3.5 v.	4.2 v.
Second RF	—78 . . .	6.0	7.0	107	122	229	264	3.5	4.2
Third RF	—78 . . .	6.0	7.0	106	121	227	263	3.5	4.2
A.G.C.	—77 . . .	6.0	7.0	0	0	0	0	—65	—76
Detector	—77 . . .	6.0	7.0	230	265	100-215	120-180	14	16
Oscillator	—38233-1 .	6.0	7.0	—	—	20-50	25-60	0	0
Output	—38233-2 .	6.0	7.0	—	—	218	255	12.5	14.5

*IMPORTANT NOTICE: These voltages are all developed across high-resistance units in the receiver and must be measured with a high-resistance voltmeter or the readings will be meaningless. A voltmeter range having not less than 30,000 ohms resistance must be used for measuring cathode bias, and a voltmeter range having not less than 200,000 ohms resistance must be used for measuring plate and screen-grid voltages at these respective electrodes. The voltage between cathode and ground is the initial control-grid bias on all tubes except the A.G.C. tube. The values in each of the foregoing tables are for one receiver, only, turned on.

MODEL RU-18
TYPICAL JUNCTION BOX VOLTAGES

One Receiver Operating from the B Receptacle of the Junction Box Type CW-62007A

(Switches at MANUAL, CW. Volume Control at MAX.)

Voltage to Ground with 12 Volts Supply	*Voltage to Ground with 14 Volts Supply*	*Terminals**
+12 v.	+14 v.	19, 25, 44, 72, 83, 86
+48**	+55**	81, 88
+230	+265	18, 26, 35, 79, 80
+235	+275	15, 17
0	0	16, 27, 43, 73, 74, 75, 76, 77, 82, 84, 85, 87
—72	—86	14, 36, 78

MODEL RU-19
TYPICAL JUNCTION BOX VOLTAGES

One Receiver Operating from the B Receptacle of the Junction Box Type CW-62017

(Switches at MANUAL, CW. Volume Control at MAX.)

Voltage to Ground with 24 Volts Supply	*Voltage to Ground with 28 Volts Supply*	*Terminals**
+12 v.	+14 v.	72
+24	+28	19, 25, 44, 83, 86
+48**	+55**	81, 88
+230	+265	18, 26, 35, 79, 80
+235	+275	15, 17
0	0	16, 27, 43, 73, 74, 75, 76, 77, 82, 84, 85, 87
—72	—86	14, 36, 78

*The terminals listed in this column are those on the receptacles of the battery, dynamotor-filter unit, receiver B, and receiver switch box B, only. When a single receiver and switch box are operated in the A receptacles the normal voltage on terminal 17 of the dynamotor-filter unit is 30-35 volts lower than when these units are operated in the B receptacles. When two receivers and two switch boxes are operated simultaneously all voltages are somewhat lower than those listed in the above table.

**The indicated voltage will vary considerably with voltmeter resistance, even when using a high-resistance voltmeter.

CATHODE CURRENT

Cathode current for the first three Navy Type -78 amplifier tubes, as measured by the test meter at meter jack 135, with receiver switch box controls at MANUAL, CW, and maximum gain position. The following table is applicable to Model RU-18 and Model RU-19.

Model RU-18 Supply Voltage	*Model RU-19 Supply Voltage*	*Current, (One Receiver Operating at Outlet A)*	*Current, (Two Receivers Operating at Outlets A and B)*
12 v.	24 v.	.025 a.	.021 a.
14 v.	28 v.	.031 a.	.026 a.

TOTAL INPUT TO EQUIPMENT

Number of Receivers Connected RU-18 or RU-19	*Number of Receivers Operating RU-18 or RU-19*	*Supply Voltage*		*Dynamotor Current*		*Filament and Relay Current*		*Total*	
		RU-18	*RU-19*	*RU-18*	*RU-19*	*RU-18*	*RU-19*	*RU-18*	*RU-19*
1	1	12 v.	24 v.	3.6 a.	1.6 a.	1.2 a.	1.2 a.	4.8 a.	2.8 a.
1	1	14 v.	28 v.	4.0 a.	1.8 a.	1.4 a.	1.4 a.	5.4 a.	3.2 a.
2	1	12 v.	24 v.	4.4 a.	2.2 a.	1.2 a.	1.2 a.	5.6 a.	3.4 a.
2	1	14 v.	28 v.	4.9 a.	2.4 a.	1.4 a.	1.4 a.	6.3 a.	3.8 a.
2	2	12 v.	24 v.	4.9 a.	2.4 a.	2.4 a.	2.4 a.	7.3 a.	4.8 a.
2	2	14 v.	28 v.	5.5 a.	2.7 a.	2.8 a.	2.7 a.	8.3 a.	5.4 a.

29. Resistor Color Code

Small composition resistors are color coded by one of two methods to represent the resistance in ohms. The first method is as follows: first digit by body color, the second digit by tip color, the number of zeros after the second digit by a dot painted on the body. The second method is as follows: three narrow rings are painted around the body, starting at one end. The color of the end ring represents the first digit, the second ring the second digit, and the third ring the number of zeros after the second digit. A fourth ring represents the tolerance, ±5% by gold and ±10% by silver.

0—Black	3—Orange	7—Violet
1—Brown	4—Yellow	8—Gray
2—Red	5—Green	9—White
	6—Blue	

Example: 350,000 ohms. First method: body orange, tip green, dot yellow. Second method: orange, green and yellow rings, starting at one end. If the second method were used and the fourth ring were silver, it would indicate a ±10% tolerance from nominal.

See table in next column for nominal and acceptable operating limits for all composition resistors used in this equipment.

30. Capacitor Color Code

Fixed capacitance molded mica capacitors which are too small to be conveniently marked with capacitance values are color coded by the use of three dots. Colors represent the same numbers as listed above for resistors. Reading from left to right in the direction of the arrow the micromicrofarads capacitance is indicated by the following: first color, first digit; second color, second digit; third color the number of zeros after the second digit.

Example: 350 micromicrofarads (0.00035 mfd) would have an orange, green, and brown dot, reading from left to right.

EQUIPMENT OPERATING RESISTANCE TOLERANCE FOR COMPOSITION RESISTORS

Symbol Number	*Western Electric Drawing Number*	*Nominal Resistance*	*Equipment* Operating Resistance Tolerance*
20	3070	2.0 meg.	±40%
21, 24, 29, 56	P501	0.1 meg.	±30%
22	P498	400	±20%
23	P499	2,000	±20%
28	P504	0.03 meg.	±20%
29	4062	0.1 meg.	±30%
30	P502	0.2 meg.	±20%
31, 65	P493	0.5 meg.	±20%
32	P500	0.05 meg.	±20%
37	P505	5,000	±20%
57	P510	0.02 meg.	±20%
37	4064	0.02 meg.	±20%
60, 61	P497	200	±20%
66	P491	0.01 meg.	±20%
67	P492	0.015 meg.	±20%
99	4170	1.0 meg.	±30%
152	4182	5000	±20%

*Equipment is still satisfactorily operable if resistance is within these limits.

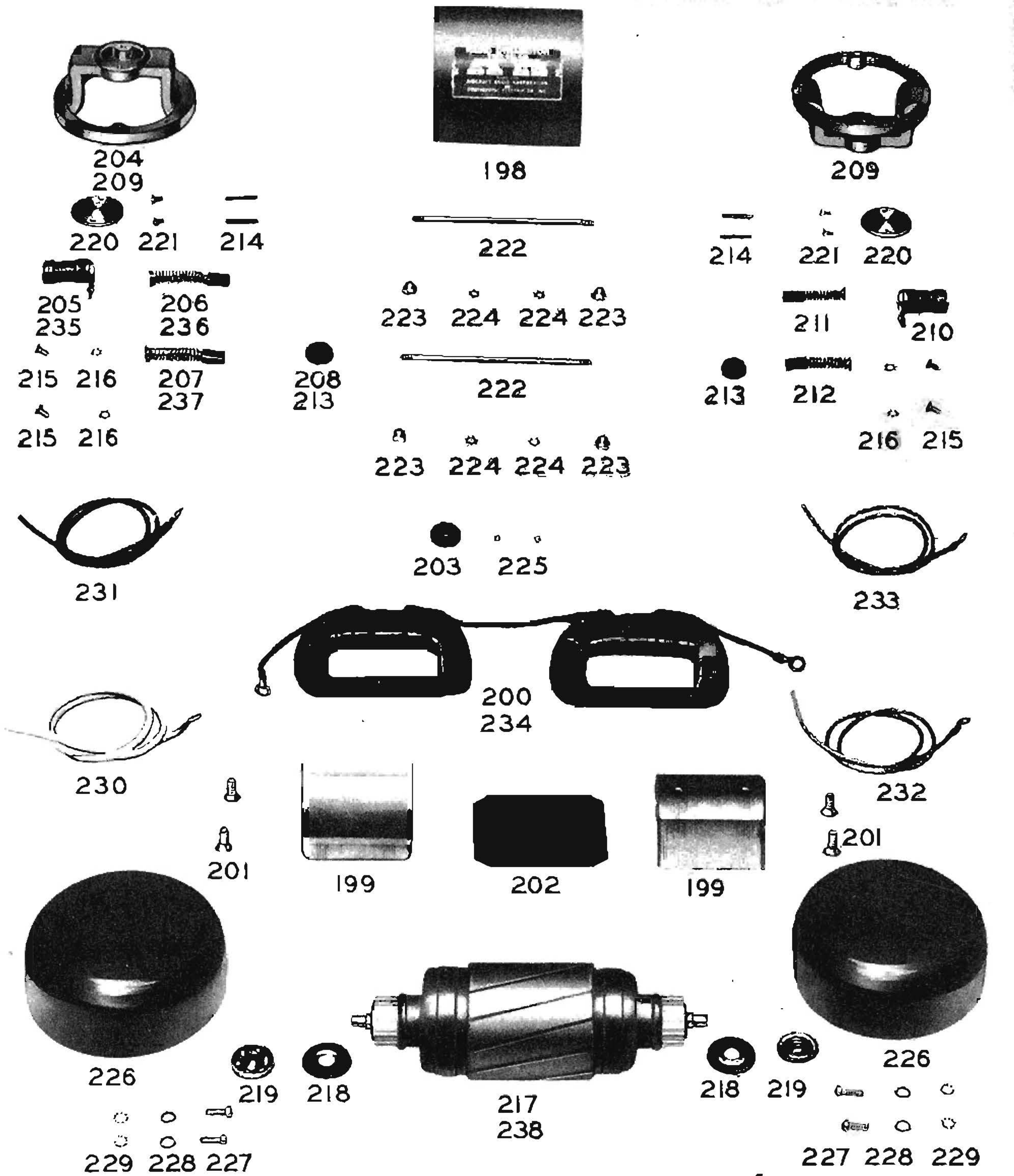


FIG. 12—PARTS OF DYNAMOTORS FOR DYNAMOTOR-FILTER UNITS, TYPES CW-21215A AND CW-21441 (WHERE TWO SYMBOL NUMBERS ARE SHOWN, THE LESSER REFERS TO THE 12-VOLT MACHINE AND THE LARGER TO THE 24-VOLT MACHINE)

SECTION V. APPARATUS LISTS

LIST OF MAJOR UNITS AND ACCESSORIES OF MODEL RU-18 AND RU-19 EQUIPMENTS

Table I Page No.	*Navy Type Designation*	*Name of Major Unit or Accessory*	*Quantity Per Equip.*	*Mfr's. Designation*	*Weight (pounds)*
74	CW-21215A	Dynamotor-Filter Unit with Base No. 2955. Used in Model RU-18	1	2921	9.0
76	CW-21441	Dynamotor-Filter Unit with Base No. 2955. Used in Model RU-19	1	6697	9.0
78	*CW-22266	Test Meter with Base No. 1950. Used in Model RU-18 and Model RU-19	1	3140	.5
78	CW-23012	Receiver Remote Tuning Control with 0-100 Dial No. 3055 and 100-0 Dial No. 3595. Used in Model RU-18 and Model RU-19	1	3042	.9
79	CW-23021	Remote Tuning Mechanical Linkage (bulk). Used in Model RU-18 and Model RU-19	1	1607	.14 per ft.
79	CW-23052	Remote Switching Mechanical Linkage (bulk)	1	1246	.14 per ft.
71	CW-23053	Dual Coil Set Local Control (On receiver dual coil set). Used in Model RU-18 and Model RU-19	1 per dual coil set	1001	.03
80	CW-23054	Dual Coil Set Remote Control. Used in Model RU-18 and Model RU-19	1	1645	.06
72	CW-23087	Receiver Switch Box with Base No. 1448. Used in Model RU-18 and Model RU-19	1	3147	.9
63	CW-46048D	Aircraft Radio Receiver with Type CW-46011 Mounting Base, Type CW-23022 Local Tuning Control, Type CW-23050 Antenna-Loop Local Control, and one set of vacuum tubes	1	3749	12.9
71	⊖CW-47029	Receiver Coil Set Container. Used in Model RU-18 and Model RU-19	1 per coil set	2203	.6
67	Ø 47067	Receiver Coil Set, Range C, 545-850 kc		1774	1.7
67	CW-47068	Receiver Coil Set, Range D, 850-1330 kc	1	1775	1.7
67	CW-47069	Receiver Coil Set, Range E, 1330-2040 kc	1	1776	1.7
67	ΩCW-47070	Receiver Coil Set, Range F, 2040-3000 kc	1	2818	1.7
67	Ø 47071	Receiver Coil Set, Range G, 3000-4525 kc		1778	1.7
67	CW-47072	Receiver Coil Set, Range H, 4000-6000 kc	1	2819	1.7
67	CW-47075	Receiver Coil Set, Range K, 9050-13,575 kc	1	1782	1.7
67	Ø 47088	Receiver Coil Set, Range N, 6000-9050 kc		2845	1.7
67	Ø 47099	Receiver Coil Set, Range M, 5200-7700 kc		2820	1.7
67	CW-47105	Receiver Dual Coil Set, Range O, 195-290 kc and Range P, 290-435 kc	1	3283	2.7
67	Ø 47106	Receiver Coil Set, Range L, 400-600 kc		3325	1.7
67	CW-47107	Receiver Dual Coil Set, Range Q, 540-830 kc, and Range G, 3000-4525 kc	1	2853	2.7

*Optional, not furnished with all lots of equipments.
⊖ Each receiver is shipped with one coil set in place. One coil set container is provided for each additional coil set furnished.
Ω Supplied with certain equipments when Type CW-47204 was not supplied.
Ø Not supplied by the Western Electric Company as a component of the Model RU-18 and RU-19 equipments.

LIST OF MAJOR UNITS AND ACCESSORIES OF
MODEL RU-18 AND RU-19 EQUIPMENTS (Continued)

Table I Page No.	*Navy Type Designation*	*Name of Major Unit or Accessory*	*Quantity Per Equip.*	*Mfr's Designation*	*Weight (pounds)*
67	CW-47108	Receiver Dual Coil Set, Range Q, 540-830 kc, and Range M, 5200-7700 kc	1	2854	2.7
67	CW-47112	Receiver Dual Coil Set, Range L, 400-600 kc, and Range N, 6000-9050 kc	1	3549	2.7
67	∅CW-47202	Receiver Dual Coil Set, Range F, 2040-3000 kc, and Range N, 6000-9050 kc		ES-691307	2.7
67	∅CW-47203	Receiver Dual Coil Set, Range F, 2040-3000 kc, and Range G, 3000-4525 kc		ES-691310	2.7
67	CW-47204	Receiver Dual Coil Set, Range Q, 540-830 kc, and Range F, 2040-3000 kc	1	7971	2.7
72	CW-62007A	Junction Box with Base No. 2955, 3 Protective Caps No. 1943, 1 Protective Cap No. 1942. Used in Model RU-18	1	2938	1.9
73	CW-62017	Junction Box with Base No. 2955, 3 Protective Caps No. 1943, 1 Protective Cap No. 1942. Used in Model RU-19	1	6560	2.4
79		Bulk Parts for Cable Assemblies 1610, 1611, 1613, 3084, *3141. Used in Model RU-18 and Model RU-19	1 set		4.3
80		*Receiver Slip Cover. Used in Model RU-18 and Model RU-19	1	P280	
80		*Rubber Sleeves for plugs. Used in Model RU-18 and Model RU-19. One set consists of:			
		Receiver plug size	3	P337	
		Switch box plug size	5	P336	
		Dynamotor unit plug size	3	P335	
		Test meter plug size	1	3475	
80		Aligning Wrench. Used in Model RU-18 and Model RU-19	1	FR235	
		Instruction Book. Used in Model RU-18 and Model RU-19	1		
66		Receiver Tuning Chart in addition to one on receiver tube cover. Used in Model RU-18 and Model RU-19	1		
		Operating Spare Parts in Spare Part Box. (See Table 3 and list on box cover.) Used in Model RU-18 and Model RU-19	1 set		

*Optional, not furnished with all lots of equipments.
∅Not supplied by The Western Electric Company as a component of the Model RU-18 and RU-19 equipments.

TABLE I—PARTS LIST BY SYMBOL DESIGNATION

Type CW-46048D Aircraft Radio Receiver with Type CW-46011 Mounting Base, Type CW-23022 Local Tuning Control, Parts of Type CW-23050 Antenna-Loop Local Control

Symbol	*Function*	*Description*	*Navy Type*	*Mfr.*	*Mfr's. Desig.*	*Dwg. and Part No.*
1A	2nd RF screen by-pass	Capacitor, 0.1 mfd ±10%, 400 volts, paper, (0.1/0.1 mfd)	48680	C		1574
1B	3rd RF screen by-pass	Same as 1A				
2A	2nd RF plate by-pass	Same as 1A				
2B	3rd RF plate by-pass	Same as 1A				
2C	Oscillator plate by-pass	Same as 1A				
3A	1st, 2nd, RF cathode by-pass	Capacitor, 0.1 mfd ±10%, 400 volts, paper, (0.1/0.1 mfd)	48678	C		1572
3B	3rd RF cathode by-pass	Same as 3A				
3C	Output tube cathode by-pass	Same as 1A				
3D	AGC cathode bias line filter	Same as 3A				
4A	AGC line filter	Same as 3A				
4B	AGC line filter	Same as 3A				
4D	AGC line filter	Same as 3A				
4E	AGC grid bias line filter	Same as 3A				
5	Heater line filter	Same as 3A				
6	Det. cathode by-pass	Capacitor, 0.5 mfd —10% +20%, 100 volts, paper (0.5/0.5/0.5 mfd)	48763	C		3562
7	Det. screen by-pass	Capacitor, 0.5 mfd —10% +20%, 300 volts, paper	48679	C		1573
8	1st RF plate by-pass	Capacitor, 0.5 mfd —10% +20%, 300 volts, paper (0.5/0.5 mfd)	48681	C		1575
9	1st RF screen by-pass	Same as 8				
10A	Audio output filter	Same as 3A				
10B	Audio output filter	Same as 3A				
11	Audio coupling	Capacitor, 0.006 mfd —10% +20%, 450 volts, mica	48672	B	1461	P91
12	Det. plate by-pass	Capacitor, 0.00025 mfd ±20%, 400 volts, mica	48673-20	B	1465	P221
20A	1st RF grid resistor	Resistor, 2 megohms ±10%, 1/3 watt	63481	K	F1/3	3070
20B	3rd RF grid resistor	Same as 20A				
20C	AGC grid resistor	Same as 20A				
21	Det. plate decoupling	Resistor, 0.1 megohm ±10%, 1/3 watt	63481	D	E	P501
22	3rd RF cathode auto bias	Resistor, 400 ohms ±10% 1/3 watt	63481	D	E	P498
23	Output tube cathode auto bias	Resistor, 2000 ohms ±10%, 1/3 watt	63481	D	E	P499

TABLE I—PARTS LIST BY SYMBOL DESIGNATION (Continued)

Type CW-46048D Aircraft Radio Receiver with Type CW-46011 Mounting Base, Type CW-23022 Local-Tuning Control, Parts of Type CW-23050 Antenna-Loop Local Control (Continued)

Symbol	*Function*	*Description*	*Navy Type*	*Mfr.*	*Mfr's. Desig.*	*Dwg. and Part No.*
24	AGC plate filter	Same as 21				
28A	RF osc. plate dropping	Resistor 0.03 megohm ±10%, 1/3 watt	63481	D	E	P504
28B	RF osc. plate dropping	Same as 28A				
30	Det. plate	Resistor, 0.2 megohm ±10%, 1/3 watt	63481	D	E	P502
31	AGC plate	Resistor, 0.5 megohm ±10%, 1/3 watt	63481	D	E	P493
32	Det. cathode auto bias	Resistor 0.05 megohm ±10%, 1/3 watt	63481	D	E	P500
33	Voltage Divider	Resistor, 7000 ohms ±2%, center tapped. 8 watts, wire wound		F		3068
38A	AGC plate by-pass	Same as 6				
38B	AGC line by-pass	Same as 6				
39	Rec. output	Transformer, 4 to 1 turns ratio. Primary resistance 1680 ohms ±15%, secondary resistance 104 ohms ±15%	30294	W		3096
45	Transfer switch	Antenna-loop switch		W		1426
46		Antenna binding post		W		2716
47		Ground binding post		W		2715
53		Loop binding post		W		2805
54	Input voltage limiter	Neon tube		I	T2 modified	FR6
56	Osc. grid resistor	Same as 21				
57	Coil Compensating	Capacitor, mica leaf, fixed, part of coil panel assembly, 9 mmfd.		W		Part of 3797
58A	Ant. input section	Capacitor, variable, air, part of gang capacitor 3239		W		Part of 3239
58B	Amp. tuning	Same as 58A				
58C	Amp. tuning	Same as 58A				
58D	Osc. tuning	Same as 58A				
59A	3rd RF amp. aligning capacitor	Capacitor, variable, air trimmer, part of 3239		W		Part of 3239
59B	Det. aligning capacitor	Same as 59A				
59C	Osc. aligning capacitor	Same as 59A				
60	1st, 2nd RF cathode auto bias	Resistor, 200 ohms ±10%, 1/3 watt	63481	D	E	P497
61A	1st, 2nd RF grid line filter	Same as 60				
61B	2nd RF plate filter	Same as 60				
61C	2nd RF screen filter	Same as 60				

TABLE I—PARTS LIST BY SYMBOL DESIGNATION (Continued)

Type CW-46048D Aircraft Radio Receiver with Type CW-46011 Mounting Base, Type CW-23022 Local Tuning Control, Parts of Type CW-23050 Antenna-Loop Local Control (Continued)

Symbol	*Function*	*Description*	*Navy Type*	*Mfr.*	*Mfr's. Desig.*	*Dwg. and Part No.*
61D	3rd RF plate filter	Same as 60				
61E	3rd RF screen filter	Same as 60				
65	RF Osc. plate voltage divider	Same as 31				
66	RF Osc. plate voltage divider	Resistor, 0.01 megohm ±10%, 1/3 watt	63481	D	E	P491
67	RF Osc. plate dropping	Resistor, 0.015 megohm ±10%, 1/3 watt	63481	D	E	P492
71	RF Osc. plate line filter	Same as 11				
95	Output filter choke	Choke, 0.035 henry ±10%, dc resistance 10.5 ohms ±10%, 1100 turns	47149	W		2998
96	ICS input jack	Jack		W		4749
97A	1st RF grid blocking	Capacitor, 0.00012 mfd —10% +30%, 400 volts, mica		W		2218
97B	3rd RF grid blocking	Same as 97A				
97C	AGC grid blocking	Same as 97A				
97D	Osc. grid blocking	Same as 97A				
98	Input alignment	Capacitor, mica leaf, adjustable, 20-150 mmfd. ±20%		W		2957
99	Output tube grid	Resistor, 1 megohm ±10%, 1/3 watt	63481	D	E	4170
140	Fil. series	Resistor, 21 ohms ±2%, 3 watts, wire wound	63505	W		2961
145	Voltage divider for AGC tube biases	Resistor, 1140 ohms ±2%, 25 watts, wire wound, with tap at 140 ohms ±2% Note: Replacements on resistor indicated by symbol 145 on any receiver of Model RU-4, RU-5, RU-6, RU-10, RU-11, or RU-12 should be made with part number 8025.		F		8025
162	Protection for receptacle plate	Receptacle ring		W		6060
163	All external connections to receiver	Receptacle plate assembly, large, 11-wire		W		3038
240		Receiver Dial, 0-100		W		2722
244	Input alignment control	Knob		W		3007
253		Shockproof cup assembly:				
		Right front or left rear		W		3835
		Left front or right rear		W		3836

TABLE I—PARTS LIST BY SYMBOL DESIGNATION (Continued)

Type CW-46048D Aircraft Radio Receiver with Type CW-46011 Mounting Base, Type CW-23022 Local Tuning Control, Parts of Type CW-23050 Antenna-Loop Local Control (Continued)

Symbol	*Function*	*Description*	*Navy Type*	*Mfr.*	*Mfr's. Desig.*	*Dwg. and Part No.*
254		Snapslide		W		2540
255		Snapslide button		W		G534
256A		Snapslide stud; short (coil set)		W		1089
256B		Snapslide stud; medium (tube cover)		W		1090
257	For -77 and -78 tubes	Six prong tube socket		W		3537
259		Pin plug		W		ARC14
260		Control grid clip		N		2313
261		Receiver tuning outlet, right		W		Part of 3036
262		Receiver tuning outlet, left		W		Part of 3036
268	Thread protector	Cap nut		W		G169
269	For 38233 tube	Seven prong tube socket		W		3538
270		Internal spline		W		G108
271		Snapslide stud, long, for receiver mounting base		W		3831
272		Receiver tube cover assembly		W		FR239
273A		Receiver cabinet engraved		W		1578
273B		Receiver cabinet, not engraved		W		1225
275		Receiver gear unit		W		3036
276		Tube Shield		W		G184
277A	3rd RF aligning capacitor cover	Cover		W		G617
277B	Det. aligning capacitor cover	Same as 277A				
277C	Osc. aligning capacitor cover	Same as 277A				
284		Mounting bracket assembly		W		F486
300		Type CW-46048D Aircraft Radio Receiver	46048D	W		3749
302		Type CW-46011 Mounting Base	46011	W		3834
309		Type CW-23022 Local Tuning Control	23022	W		FR128
310		Tuning chart,				
		CW-46048D of RU-18 Equip.		W		7555
		CW-46048D of RU-19 Equip.		W		7558
342		Antenna-loop switch outlet (Built-in)		W		

TABLE I—PARTS LIST BY SYMBOL DESIGNATION (Continued)

Parts of Receiver Coil Sets

Symbol	*Function*	*Description*	*Navy Type*	*Mfr.*	*Mfr's. Desig.*	*Dwg. and Part No.*
13	Band-pass coupling	Capacitor, 0.0001 mfd ±5%, 400 volts, mica, part of band-pass stage in all coil sets except CW-47112		W		2660, or ES-688646
		Capacitor, 0.00015 mfd ±5%, 500 volts, mica, part of assembly 92 in CW-47112	48689-5	C	5	P511
29	2nd RF grid return	Resistor, 0.1 megohm ±10%, 1/3 watt, part of band-pass stage in all coil sets except CW-47204	63481	D	E	P501
29	2nd RF grid return	Resistor, 0.1 megohm ±10%, 1/2 watt, part of CW-47204 Coil Set	63360	D	EB	4062
34	Reduction of voltage gain	Grid capacitor, band-pass stage				
		Capacitor, 0.00015 mfd ±5%, 400 volts, mica, part of -47067	48689-5	C	5	P511
		Capacitor, 0.0002 mfd ±5%, 400 volts, mica, part of -47106	48675-5	C	5	P513
		Capacitor, 0.0005 mfd ±5%, 400 volts, mica, part of CW-47105 (low)	48691-5	C	5	P515
		Capacitor, 0.00025 mfd ±5%, 400 volts, mica, part of CW-47105 (high)	48690-5	C	5	P516
		Capacitor, 0.0001 mfd ±5%, 400 volts, mica, part of CW-47107 (low) and CW-47108 (low)	48674-5	C	5	P520
		Capacitor, 0.0001 mfd ±5%, 400 volts, mica, part of CW-47112 (low)		W		2660
37	Band-pass coil shunt	Resistor, 0.02 megohm ±10%, 1/3 watt, across coil in CW-47105 (low)	63481	D	E	P510

TABLE I—PARTS LIST BY SYMBOL DESIGNATION (Continued)

Parts of Receiver Coil Sets (Continued)

Symbol	*Function*	*Description*	*Navy Type*	*Mfr.*	*Mfr's. Desig.*	*Dwg. and Part No.*
37	Band-pass coil shunt	Resistor, 5000 ohms ±10%, ⅓ watt, across part of coil (high) in CW-47108, CW-47112, CW-47202	63481	D	E	P505
37	Band-pass coil shunt	Resistor, 0.02 megohm ±10%, ½ watt, across coil (low) in CW-47204 with	63360	D	EB	4064
		50 mmfd. ±10%, 600 volts working, capacitor in parallel		X	O	ES-688847
55		Dual coil set switch, amplifier and oscillator section, part of dual coil sets		W		1850
55		Dual coil set switch, band-pass stage, part of dual coil sets		W		1851
89	RF amplifier input coupling	*Tuned input coil assembly, part of				
		47067				1869
		CW-47068		W		1873
		CW-47069		W		1877
		CW-47070		W		2821
		47071				1884
		CW-47072		W		2822
		CW-47075		W		1896
		47088				2824
		47099				2823
		CW-47105		W		3284
		47106				3326
		CW-47107		W		2858
		CW-47108		W		2861
		CW-47112		W		3550
		CW-47202		W		ES-691292
		CW-47203		W		ES-691311
		CW-47204		W		7968

*For single coil sets listed, coil assemblies include the wound coils and any other electrical parts permanently attached to the coil forms. For dual coil sets, coil assemblies listed include, in addition, the coil switches and shields. This distinction is necessary because in the single coil sets, shields are integral with the cover and shield assembly, whereas in the dual coil sets, shields and switches are unitary with the coil assemblies.

TABLE I—PARTS LIST BY SYMBOL DESIGNATION (Continued)

Parts of Receiver Coil Sets (Continued)

Symbol	*Function*	*Description*	*Navy Type*	*Mfr.*	*Mfr's. Desig.*	*Dwg. and Part No.*
90	RF interstage transformer	*Tuned coupling coil unit assembly, part of				
		47067				1870
		CW-47068		W		1874
		CW-47069		W		1878
		CW-47070		W		2821
		47071				1884
		CW-47072		W		2822
		CW-47075		W		1896
		47088				2824
		47099				2823
		CW-47105		W		3284
		47106				3326
		CW-47107		W		2858
		CW-47108		W		2861
		CW-47112		W		3550
		CW-47202		W		ES-691292
		CW-47203		W		ES-691311
		CW-47204		W		7968
91	RF osc. inductance and coupling to detector	*Tuned oscillator coil assembly, part of				
		47067				1872
		CW-47068		W		1876
		CW-47069		W		1880
		CW-47070		W		1883
		47071				1886
		CW-47072		W		1889
		CW-47075		W		1898
		47088				2843
		47099				2842
		CW-47105		W		3288
		47106				3330
		CW-47107		W		2860
		CW-47108		W		2863
		CW-47112		W		3552
		CW-47202		W		ES-691294
		CW-47203		W		ES-691313
		CW-47204		W		7962
92	Untuned RF coupling	*Band-pass coil unit assembly, part of				
		47067				1871
		CW-47068		W		1875
		CW-47069		W		1879
		CW-47070		W		1882
		47071				1885
		CW-47072		W		1888
		CW-47075		W		1897
		47088				2832
		47099				2831
		CW-47105		W		3286
		47106				3328

*For single coil sets listed, coil assemblies include the wound coils and any other electrical parts permanently attached to the coil forms. For dual coil sets, coil assemblies listed include, in addition, the coil switches and shields. This distinction is necessary because in the single coil sets, shields are integral with the cover and shield assembly, whereas in the dual coil sets, shields and switches are unitary with the coil assemblies.

TABLE I—PARTS LIST BY SYMBOL DESIGNATION (Continued)

Parts of Receiver Coil Sets (Continued)

Symbol	*Function*	*Description*	*Navy Type*	*Mfr.*	*Mfr's. Desig.*	*Dwg. and Part No.*
92	Untuned RF coupling (Continued)	CW-47107		W		2859
		CW-47108		W		2862
		CW-47112		W		3551
		CW-47202		W		ES-691293
		CW-47203		W		ES-691312
		CW-47204		W		7966
93	Band-pass inductor	Coil, band-pass coil assembly (Part of assembly 92): part of				
		47067				1718
		CW-47068		W		1720
		CW-47069		W		1722
		CW-47070		W		1702
		47071				1704
		CW-47072		W		1706
		CW-47075		W		1712
		47088				2655
		47099				2851
		CW-47105 (High)		W		3321
		CW-47105 (Low)		W		3320
		47106				1716
		CW-47107 (High)		W		2712
		CW-47107 (Low)		W		2711
		CW-47108 (High)		W		1662
		CW-47108 (Low)		W		3347
		CW-47112 (High)		W		3498
		CW-47112 (Low)		W		1860
		CW-47202 (High)		W		3498
		CW-47202 (Low)		W		ES-691297
		CW-47203 (High)		W		2712
		CW-47203 (Low)		W		ES-691314
		CW-47204 (High)		W		4792
		CW-47204 (Low)		W		2711
94	Supplemental osc. trimmer	Oscillator trimming capacitor				
		Capacitor, adjustable, mica leaf, dual, 30 mmfd. max., used in all dual coil sets except CW-47105		W		3358
		Capacitor, adjustable, mica leaf, dual, 30 mmfd. max., used in CW-47105		W		2702
		Capacitor, adjustable, mica leaf, single, 30 mmfd. max., used in -47067 and -47106		W		1659
		Capacitor, adjustable, mica leaf, single, 30 mmfd. max., for following coil sets is assembly of corresponding oscillator coil 91 with shield base 1900:				

TABLE I—PARTS LIST BY SYMBOL DESIGNATION (Continued)

Parts of Receiver Coil Sets (Continued)

Symbol	*Function*	*Description*	*Navy Type*	*Mfr.*	*Mfr's. Desig.*	*Dwg. and Part No.*
94	Supplemental osc. trimmer (Continued)	CW-47068 CW-47069 CW-47070 47071 CW-47072 CW-47075 47088 47099				
285A	Access to capacitor 94, single coil sets	Snap cover		U		P248
285B	Access to capacitor 94, dual coil set	Snap cover		U		P192
311		Dual Coil Set, Range O, 195-290 kc; P, 290-435 kc	47105	W		3283
312		Single Coil Set, Range C, 545-850 kc	47067			1774
313		Single Coil Set, Range D, 850-1330 kc	47068	W		1775
314		Single Coil Set, Range E, 1330-2040 kc	47069	W		1776
315		Single Coil Set, Range F, 2040-3000 kc	47070	W		2818
316		Single Coil Set, Range G, 3000-4525 kc	47071			1778
317		Single Coil Set, Range H, 4000-6000 kc	47072	W		2819
318		Single Coil Set, Range M, 5200-7700 kc	47099			2820
319		Single Coil Set, Range N, 6000-9050 kc	47088			2845
320		Single Coil Set, Range K, 9050-13,575 kc	47075	W		1782
321		Single Coil Set, Range L, 400-600 kc	47106			3325
324		Receiver Coil Set Container	47029	W		2203
328		Dual Coil Set Local Control	23053	W		1001
341		Dual Coil Set Switch Shaft		W		1009
343		Dual Coil Set Switch Coupling Box		W		1837
		Dual Coil Set, Range Q, 540-830 kc; G, 3000-4525 kc	47107	W		2853
		Dual Coil Set, Range Q, 540-830 kc; M, 5200-7700 kc	47108	W		2854

TABLE I—PARTS LIST BY SYMBOL DESIGNATION (Continued)

Parts of Receiver Coil Sets (Continued)

Symbol	*Function*	*Description*	*Navy Type*	*Mfr.*	*Mfr's. Desig.*	*Dwg. and Part No.*
343 (Continued)		Dual Coil Set, Range L, 400-600 kc; N, 6000-9050 kc	47112	W		3549
		Dual Coil Set, Range F, 2040-3000 kc; N, 6000-9050 kc	47202	W		ES-691307
		Dual Coil Set, Range F, 2040-3000 kc; G, 3000-4525 kc	47203	W		ES-691310
		Dual Coil Set, Range Q, 540-830 kc; F, 2040-3000 kc	47204	W		7971
438	By-pass on L.F. osc. coupling coil in dual coil sets	By-pass capacitor, oscillator stage				
		Capacitor, 0.0005 mfd ±5%, 400 volts, mica, part of CW-47108	48691-5	C	5	P515
		Capacitor, 0.00025 mfd ±5%, 400 volts, mica, part of CW-47112	48690-5	C	5	P516
		Capacitor, 30 mmfd ±1.5 mmfd, 500 volts, ceramic, part of CW-47202, with		Y	N080L	ES-696845
		Resistor, 1000 ohms ±10%, ½ watt in parallel	63360	D	EB	4081

Parts of Type CW-23087 Receiver Switch Box With Base No. 1448

131	Sensitivity control	Resistor, variable 0-30,000 ohms ±15%	63699	D	AA	Part of 3144
132	AGC level control	Resistor, variable 0-5,000 ohms ±15%	63699	D	AA	Part of 3144
133		Dual telephone jack		W		3282
134		Rotary switch assembly		W		3039
135		Meter jack		W		3010
136		Switch stop spring		W		Part of 3039
137	CW-MCW switch	Toggle switch		L		1516
171	All external connections to switch box	Receptacle plate assembly, medium, seven wire		W		2229
263		Switch handle		W		G204
265		Volume control knob		W		3047
305		Receiver switch box	23087	W		3147
344		Mounting base		W		1448

Parts of Type CW-62007A (RU-18, 12-volt) Junction Box With Base No. 2955

61F	Plate dropping resistor, receiver A	Resistor, 200 ohms ±10%, ⅓ watt	63481	D	E	P497
61G	Plate dropping resistor, receiver B	Same as 61F				

TABLE I—PARTS LIST BY SYMBOL DESIGNATION (Continued)

Parts of Type CW-62007A (RU-18, 12-volt) Junction Box With Base No. 2955 (Continued)

Symbol	*Function*	*Description*	*Navy Type*	*Mfr.*	*Mfr's. Desig.*	*Dwg. and Part No.*
151	A + line fuse	Fuse, 50 amperes, cartridge		M	3AG	P411
153	Dynamotor switching	Relay, two energizing coils, contacts for dynamotor starting		W		2940
157		Mounting base		W		2955
158	Receptacle protection	Receptacle ring for outlets 74 and 76		W		6059
159A	Connections to CFI, etc.	Receptacle plate, spare for CFI, etc.		W		2226
159B	Connections to CFI, etc.	Same as 159A				
160	Receptacle protection	Receptacle ring for outlet 21		W		6058
161	Connections to battery	Receptacle plate, small, 2-wire		W		2488
162	Receptacle protection	Receptacle ring for outlets 133A and 133B		W		6060
163A	Connections to receiver A	Receptacle plate, large, 10-wire		W		3038
163B	Connections to receiver B	Same as 163A				
166	Receptacle protection	Same as 160 for outlet 134				
167	Connections to dynamotor	Receptacle plate, small, 6-wire		W		2187
170	Receptacle protection	Receptacle ring for outlets 135A and 135B		W		6059
171A	Connections to switch box A	Receptacle plate, medium, 7-wire		W		2229
171B	Connections to switch box B	Same as 171A				
246		Junction box sub-base		W		FHJ8
256C		Snapslide stud, short, junction box base		W		2945
259		Pin plug		W		ARC14
304		Junction box	62007A	W		2938
369		Coil assembly, power relay		W		Part of 2594
370		Contact unit assembly, power relay		W		2190
377	Pin plug protection	Protective cap, medium		W		1943
378	Pin plug protection	Protective cap, large		W		1942
379	Fuse protection	Fuse cover		W		2197

Parts of Type CW-62017 (RU-19, 24-volt) Junction Box With Base No. 2955

Symbol	*Function*	*Description*	*Navy Type*	*Mfr.*	*Mfr's. Desig.*	*Dwg. and Part No.*
61F	Plate dropping resistor, receiver A	Resistor, 200 ohms ±10%, 1/3 watt	63481	D	E	P497
61G	Plate dropping resistor, receiver B	Same as 61F				
151A	A + line fuse	Fuse, 20 amperes, cartridge		M	3AG	P4

TABLE I—PARTS LIST BY SYMBOL DESIGNATION (Continued)

Parts of Type CW-62017 (RU-19, 24-volt) Junction Box With Base No. 2955 (Continued)

Symbol	*Function*	*Description*	*Navy Type*	*Mfr.*	*Mfr's. Desig.*	*Dwg. and Part No*
154	Dynamotor switching	Relay, two energizing coils, contacts for dynamotor starting		W		6383
157		Mounting base		W		2955
158	Receptacle protection	Receptacle ring for outlets 74 and 76		W		6059
159A	Connections to CFI, etc.	Receptacle plate, spare for CFI, etc.		W		2226
159B	Connections to CFI, etc.	Same as 159A				
160	Receptacle protection	Receptacle ring for outlet 21		W		6058
161	Connections to battery	Receptacle plate, small, 2-wire		W		2488
162	Receptacle protection	Receptacle ring for outlets 133A and B		W		6060
163A	Connections to receiver A	Receptacle plate, large, 10-wire		W		3038
163B	Connections to receiver B	Same as 163A				
166	Receptacle protection	Same as 160 for outlet 134				
167	Connections to dynamotor	Receptacle plate, small, 6-wire		W		2187
170	Receptacle protection	Receptacle ring for outlets 135A and 135B		W		6059
171A	Connections to switch box A	Receptacle plate, medium, 7-wire		W		2229
171B	Connections to switch box B	Same as 171A				
180	Heater line dropping	Resistor, 10.8 ohms ±3%, 35 watt, wire-wound		F		6479
181	Heater line dropping	Same as 180				
182	Resistor protection	Cover for two wire-wound resistors		W		6377
246		Junction box sub-base		W		FHJ8
256C		Snapslide stud, short, junction box base		W		2945
259		Pin plug		W		ARC14
301		Junction box	62017	W		6560
368		Coil and armature assembly		W		6387
370		Contact unit assembly, power relay		W		2190
377	Pin plug protection	Protective cap, medium		W		1943
378	Pin plug protection	Protective cap, large		W		1942
379	Fuse protection	Fuse Cover		W		2197

Parts of Type CW-21215A (RU-18, 12-volt) Dynamotor-Filter Unit With Base No. 2955

Symbol	*Function*	*Description*	*Navy Type*	*Mfr.*	*Mfr's. Desig.*	*Dwg. and Part No*
147A	Dynamotor L.V. filter	Capacitor, 0.8 mfd ±10%, 400 volts, paper, (0.8/0.8/0.8/0.8)	48682	W		2933

TABLE I—PARTS LIST BY SYMBOL DESIGNATION (Continued)

Parts of Type CW-21215A (RU-18, 12-volt) Dynamotor-Filter Unit With Base No. 2955 (Continued)

Symbol	*Function*	*Description*	*Navy Type*	*Mfr.*	*Mfr's. Desig.*	*Dwg. and Part No.*
147B	Bias supply filter	Part of 147A				
147C	H.V. supply filter	Part of 147A				
147D	H.V. supply filter	Part of 147A				
148	H.V. supply filter	Choke, 8 henries, —0, +30%, d-c resistance 180 ohms ±10%	30295	W		1584
149	RF choke	Choke, 17 microhenries, ±20%, d-c resistance less than 0.07 ohm		W		1587
150	H.V. supply	Dynamotor		O	Type DM416 Drawing 25626-WS-7439	6436
152	H.V. filter	Resistor, 5000 ohms, ±10%, 1 watt	63288	D	G	4182
156		Mounting base		W		2955
167	Control and output connections	Receptacle plate assem., small, 6-wire		W		2187
198		Frame		O		25624
199		Pole assembly, field		O		15994
200		Coil assembly, field		O		16950-WS7439
201		Screw, pole		O		25626-17
202		Guard, wire		O		12061-416
203		Grommet		O		25626-18
204		Bearing bracket, L.V.		O		23371-3
205		Brushholder, L.V. (includes No. 208)		O		23610-7
206		Brush assembly, L.V. +		O		23609-9(+)
207		Brush assembly, L.V. —		O		23609-9(—)
208		Screw cap, brushholder, L.V.		O		23607-1
209		Bearing bracket, H.V.		O		23371-1
210		Brushholder, H.V. (includes No. 213)		O		23610-4
211		Brush assembly, H.V. +		O		23609-6(+)
212		Brush assembly, H.V. —		O		23609-6(—)
213		Screw cap, brushholder, H.V.		O		23607-2
214		Lock pin, brushholder, L.V. and H.V.		O		25626-19
215		Screw, connecting L.V. and H.V		O		25626-20
216		Lock washer, connecting screw		O		25626-21

TABLE I—PARTS LIST BY SYMBOL DESIGNATION (Continued)

Parts of Type CW-21215A (RU-18, 12-volt) Dynamotor-Filter Unit With Base No. 2955 (Continued)

Symbol	Function	Description	Navy Type	Mfr.	Mfr's. Desig.	Dwg. and Part No.
217		Armature		O		24709-WS7439
218		Grease slinger		O		25230
219		Ball bearing		O		25626-10
220		Cover plate, bearing		O		23100
221		Screw, bearing cover		O		25626-23
222		Tie rod		O		17042-416
223		Nut, tie rod		O		25626-24
224		Lockwasher, tie rod		O		25626-25
225		Dowel, bracket locking		O		25626-26
226		Cover, enclosing		O		16576-1
227		Screw, cover holding		O		17043
228		Plain washer, cover screw		O		25626-27
229		Lock washer, cover screw		O		25626-34
230		Connecting lead and terminal, L.V.+ (No. 18 Ga. White)		O		25626-28
231		Connecting lead and terminal, L.V.— (No. 18 Ga. Black)		O		25626-29
232		Connecting lead and terminal, H.V.+ (No. 22 Ga. Red)		O		25626-30
233		Connecting lead and terminal, H.V.— (No. 22 Ga. Black and White)		O		25626-31
245		Dynamotor-filter unit subbase		W		FHJ8
256C		Snapslide stud, short		W		2945

Parts of Type CW-21441 (RU-19, 24-volt) Dynamotor-Filter Unit With Base No. 2955

Symbol	Function	Description	Navy Type	Mfr.	Mfr's. Desig.	Dwg. and Part No.
147A	Dynamotor L.V. filter	Capacitor, 0.8 mfd ±10%, 400 volts, paper (0.8/0.8/0.8/0.8)	48682	W		2933
147B	Bias supply filter	Part of 147A				
147C	H.V. supply filter	Part of 147A				
147D	H.V. supply filter	Part of 147A				
148	H.V. supply filter	Choke, 8 henries, —0, +30%, d-c resistance 180 ohms ±10%	30295	W		1584
149	RF choke	Choke, 17 microhenries, ±20%, d-c resistance less than 0.07 ohm		W		1587
152	H.V. filter	Resistor, 5000 ohms, ±10%, 1 watt	63288	D	G	4182
156		Mounting base		W		2955

TABLE I—PARTS LIST BY SYMBOL DESIGNATION (Continued)

Parts of Type CW-21441 (RU-19, 24-volt) Dynamotor-Filter Unit With Base No. 2955 (Continued)

Symbol	*Function*	*Description*	*Navy Type*	*Mfr.*	*Mfr's. Desig.*	*Dwg. and Part No.*
167	Control and output connections	Receptacle plate assem., small, 6-wire		W		2187
198		Frame		O		25624
199		Pole assembly, field		O		15994
201		Screw, pole		O		25626-17
202		Guard, wire		O		12061-416
203		Grommet		O		25626-18
209		Bearing bracket, L.V. and H.V.		O		23371-1
210		Brushholder, H.V. (includes No. 213)		O		23610-4
211		Brush assembly, H.V.+		O		23609-6(+)
212		Brush assembly, H.V.—		O		23609-6(—)
213		Screw cap, brushholder, H.V.		O		23607-2
214		Lock pin, brushholder, L.V. and H.V.		O		25626-19
215		Screw, connecting, L.V. and H.V.		O		25626-20
216		Lock washer, connecting screw		O		25626-21
218		Grease slinger		O		25230
219		Ball bearing		O		25626-10
220		Cover plate, bearing		O		23100
221		Screw, bearing cover		O		25626-23
222		Tie rod		O		17042-416
223		Nut, tie rod		O		25626-24
224		Lock washer, tie rod		O		25626-25
225		Dowel, bracket locking		O		25626-26
226		Cover, enclosing		O		16576-1
227		Screw, cover holding		O		17043
228		Plain washer, cover screw		O		25626-27
229		Lock washer, cover screw		O		25626-34
230		Connecting lead and terminal, L.V.+ (No. 18 Ga. White)		O		25626-28
231		Connecting lead and terminal, L.V.— (No. 18 Ga. Black)		O		25626-29
232		Connecting lead and terminal, H.V.+ (No. 22 Ga. Red)		O		25626-30
233		Connecting lead and terminal, H.V.— (No. 22 Ga. Black and White)		O		25626-31

TABLE I—PARTS LIST BY SYMBOL DESIGNATION (Continued)

Parts of Type CW-21441 (RU-19, 24-volt) Dynamotor-Filter Unit With Base No. 2955 (Continued)

Symbol	Function	Description	Navy Type	Mfr.	Mfr's. Desig.	Dwg. and Part No.
234		Coil assembly, field		O		16950-WS7440
235		Brushholder, L.V. (includes No. 213)		O		23610-3
236		Brush assembly, L.V.+		O		23609-5(+)
237		Brush assembly, L.V.—		O		23609-5(—)
238		Armature		O		24709-WS7440
245		Dynamotor-filter unit sub-base		W		FHJ8
250	H.V. supply	Dynamotor		O	Type DM416, Drawing 25629-WS7440	6438
256C		Snapslide stud; short		W		2945

Parts of Type CW-22266 Test Meter

Symbol	Function	Description	Navy Type	Mfr.	Mfr's. Desig.	Dwg. and Part No.
371		Mounting case		W		3279
372		Mounting base		W		1950
373	To measure receiver cathode current	Weston 0-35 ma Model 506 with bakelite case, or	22202	Q	506	3199
		Triplett 0-35 ma Model 0221-T with bakelite case	22202	R	0221-T	3199
374		Receptacle, small, two-wire		W		2674
376		Cable assembly 3141 consisting of 3 feet of 3251 cable with plugs 3145 and 3146 and rubber sleeve 3475				3141

Parts of Type CW-23012 Receiver Remote Tuning Control With 0-100 Dial No. 3055 and 100-0 Dial No. 3595

Symbol	Function	Description	Navy Type	Mfr.	Mfr's. Desig.	Dwg. and Part No.
248		Pointer		W		G73
249		Crank assembly		W		3078
266		Male spline		W		3014
267		Remote tuning control outlet		W		Part of 3042
307		Receiver remote tuning control	23012	W		3042
327		Remote tuning control dial assembly 0-100		W		3055
375		Remote tuning control dial assembly 100-0		W		3595

TABLE I—PARTS LIST BY SYMBOL DESIGNATION (Continued)

Parts of Type CW-23021 and CW-23052 Mechanical Linkages

Symbol	*Function*	*Description*	*Navy Type*	*Mfr.*	*Mfr's. Desig.*	*Dwg. and Part No.*
308		Remote tuning mechanical linkage assembly				
		23021		W		1607
		23052		W		1246
335		Casing, 23021 and 23052		W		3406
336		Shaft				
		23021		W		1174
		23052		W		1247
337		Spline Assembly				
		23021		W		FR-237
		23052		W		1245
338		Ferrule				
		23021		W		1533
		23052		W		1236
345		Coupling nut				
		23021		W		1534
		23052		W		1167

Miscellaneous

174	Battery connections	2 terminal plug No. 21		W		1606
175	Receiver connections	10 terminal plug No. 133		W		1619
177	Dynamotor connections	6 terminal plug No. 134		W		1618
179	Switch box connections	7 terminal plug No. 135		W		1621
185	Dynamotor cable	6 conductor, shielded (bulk)		P		FHC-56
186	Switch box cable	8 conductor, shielded (bulk)		P		FHC-74
187	Receiver cable	10 conductor, shielded (bulk)		P		1455
188	Battery cable	2 conductor, shielded (bulk)		P		FHC-67
190	Junction box to battery	Cable assembly 1610 consisting of 4 feet of FHC-67 cable with No. 1606 plug at one end only				1610
191	Junction box to dynamotor	Cable assembly 1611 consisting of 3 feet 6 inches of FHC-56 cable with No. 1618 plug at each end				1611
192	Junction box to switch box A or B	Cable assembly 1613 consisting of 4 feet 8 inches of FHC-74 cable with No. 1621 plug at each end				1613

TABLE I—PARTS LIST BY SYMBOL DESIGNATION (Continued)

Miscellaneous (Continued)

Symbol	*Function*	*Description*	*Navy Type*	*Mfr.*	*Mfr's. Desig.*	*Dwg. and Part No.*
193	Junction box to receiver A or B	Cable assembly 3084 consisting of 9 feet of 1455 cable with No. 1619 plug at each end				3084
347		Plug insulation for 133		W		1215
348		Spring assembly		W		1130
349		Plug contact insert		W		2007
350		Conductor insulation		P		
351		Insulating belt		P		
352		Plug shell for 133		W		1530
353		Washer		W		FHC-60
354		Nut		W		1094
355		Sleeve		W		1452
356		Shielding braid		P		
364		Screw		W		P-293
381	Receiver protection	Receiver slip cover		W		P-280
382	Plug 133 protection	Rubber sleeve (large)		W		P-337
383	Plug 135 protection	Rubber sleeve (medium)		W		P-336
384	Plugs 21 and 134 protection	Rubber sleeve (small)		W		P-335
385	Test meter plug protection	Rubber sleeve		W		3475
386	To adjust capacitor 94 on oscillator coils	Aligning wrench		W		FR-235
	Det. and AGC	Vacuum tube, pentode	-77	E		
	RF amplifier	Vacuum tube, pentode	-78	E		
	Output tube and RF oscillator	Vacuum tube, duo triode	-38233	E		
		Dual coil set remote control	23054	W		1645

TABLE II—PARTS LIST BY NAVY TYPE NUMBER

TRANSFORMERS AND REACTORS, AF (CLASS 30)

Quantity per Equipment	*Navy Type Numbers*	*Symbol Designations Involved*
1	30294	39 (4 to 1 Receiver output transformer)
1	30295	148 (8 henry Dynamotor-filter choke)

INDUCTORS, RF (CLASS 47)

1	47149	95 (0.035 henry receiver output choke)

CAPACITORS (CLASS 48)

2	48672	11, 71 (0.006 mfd)
1	48673	12 (0.00025 mfd)
2	48674-5	34 (0.0001 mfd)
1	48675-5	34 (0.0002 mfd)
5	48678	3A, 4A; 3B, 4E; 3D, 4D; 4B, 5; 10A, 10B (2 x 0.1 mfd)
1	48679	7 (0.5 mfd)
3	48680	1A, 2A; 1, 2B; 2C, 3C (2 x 0.1 mfd)
1	48681	8, 9 (2 x 0.5 mfd)
1	48682	147A, B, C, D (4 x 0.8 mfd)
1	48689-5	13, 34 (0.00015 mfd)
2	48690-5	34, 438 (0.00025 mfd)
2	48691-5	34, 438 (0.0005 mfd)
1	48763	6, 38A, 38B (3 x 0.5 mfd)

RESISTORS (CLASS 63)

1	63288	152 (5,000 ohms)
1	63360	37 (0.02 megohm)
1	63360	29 (CW-47204) (0.1 megohm)
8	63481	60, 61A, B, C, D, E, F, G (200 ohms)
1	63481	22 (400 ohms)
1	63481	23 (2,000 ohms)
1	63481	37 (5,000 ohms)
1	63481	66 (0.01 megohm)
1	63481	67 (0.015 megohm)
1	63481	37 (0.02 megohm)
2	63481	28A, B (0.03 megohm)
1	63481	32 (0.05 megohm)
1*	63481	21, 24, 29 (one for each coil set except CW-47204)
1	63481	56, (0.1 megohm)
1	63481	30 (0.2 megohm)
2	63481	31, 65 (0.5 megohm)
1	63481	99 (1.0 megohm)
3	63481	20A, B, C (2.0 megohms)
1	63482	33 (7,000 ohms)
1	63505	140 (21 ohms)
1		145 (1140 ohms)
1	63699	131, 132 forming one assembly (0-30,000 and 0-5,000 ohms)
2		180, 181 (10.8 ohms)

*One per each Coil Set.

TABLE III

Operating Spare Parts for Model RU-18 and Model RU-19 Equipments

Certain lots of the Model RU-18 and RU-19 equipments included spare parts boxes containing the following operating spare parts:

Dwg. No.	*Navy Type Designation*	*Description*	*Quantity per Equipment*
**P4	—	Fuse, 20 Amp.	8
*P411	—	Fuse, 50 Amp.	8
—	78	Vacuum Tube	1
—	77	Vacuum Tube	1
—	38233	Vacuum Tube	1
*23609-9(+) ∅	—	Dynamotor Brush Assembly	1
*23609-9(−) ∅	—	Dynamotor Brush Assembly	1
**23609-5(+) ∅	—	Dynamotor Brush Assembly	1
**23609-5(−) ∅	—	Dynamotor Brush Assembly	1
23609-6(+) ∅	—	Dynamotor Brush Assembly	1
23609-6(−) ∅	—	Dynamotor Brush Assembly	1
ESO-696841	—	Spare Parts Box	1

Early production Model RU-18 and RU-19 equipments included spare parts boxes containing the following operating spare parts:

Dwg. No.	*Navy Type Designation*	*Description*	*Quantity per Equipment*
1572	48678	Capacitor, 2×0.1 Mfd	1
1573	48679	Capacitor, 0.5 Mfd	1
1574	48680	Capacitor, 2×0.1 Mfd	1
1575	48681	Capacitor, 2×0.5 Mfd	1
2933	48682	Capacitor, 4×0.8 Mfd	1
3562	48763	Capacitor, 3×0.5 Mfd	1
P91	48672	Capacitor, 0.006 Mfd	1
P221	48673-20	Capacitor, 0.00025 Mfd	1
P511	48689-5	Capacitor, 0.00015 Mfd	1
P520	48674-5	Capacitor, 0.0001 Mfd	1
P515	48691-5	Capacitor, 0.0005 Mfd	1
P516	48690-5	Capacitor, 0.00025 Mfd	1
2218	—	Capacitor, 0.00012 Mfd	1
2660	—	Capacitor, 0.0001 Mfd	1
ES-688847	—	Capacitor, 50 mmf	1
3070	63481	Resistor, 2 Megohms	1
P491	63481	Resistor, 10,000 Ohms	1
P492	63481	Resistor, 15,000 Ohms	1
P493	63481	Resistor, 0.5 Megohm	1
P497	63481	Resistor, 200 Ohms	1
P498	63481	Resistor, 400 Ohms	1
P499	63481	Resistor,2000 Ohms	1
P500	63481	Resistor, 50,000 Ohms	1
P501	63481	Resistor, 0.1 Megohm	1

TABLE III *(Continued)*

Operating Spare Parts for Model RU-18 and Model RU-19 Equipments

Dwg. No.	*Navy Type Designation*	*Description*	*Quantity per Equipment*
P502	63481	Resistor, 0.2 Megohm	1
P504	63481	Resistor, 30,000 Ohms	1
P505	63481	Resistor, 5,000 Ohms	1
P510	63481	Resistor, 20,000 Ohms	1
2961	63505	Resistor, 21 Ohms	1
4170	63481	Resistor, 1 Megohm	1
4182	63288	Resistor, 5000 Ohms	1
3068	—	Resistor, 7000 Ohms	1
8025	—	Resistor, 1140 Ohms	1
**6479	—	Resistor, 10.8 Ohms	1
1587	—	Radio Choke	1
2190	—	Relay Contacts	1
2998	47149	Audio Choke	1
3144	63699	Variable Resistor	1
1584	30295	Filter Choke	1
3096	30294	Audio Transformer	1
G73	—	Tuner Pointer	1
3835	—	Shockproof Cup	1
ARC-14	—	Plug	1
2313	—	Grid Clips	6
**P4	—	Fuse, 20 Amp.	5
*P411	—	Fuse,50 Amp.	5
—	-78	Vacuum Tube	3
—	-77	Vacuum Tube	2
—	38233	Vacuum Tube	1
*23609-9(+) ∅	—	Dynamotor Brush Assembly	1
*23609-9(−) ∅	—	Dynamotor Brush Assembly	1
**23609-5(+) ∅	—	Dynamotor Brush Assembly	1
**23609-5(−) ∅	—	Dynamotor Brush Assembly	1
23609-6(+) ∅	—	Dynamotor Brush Assembly	1
23609-6(−) ∅	—	Dynamotor Brush Assembly	1
ESO-681927	—	Spare Parts Box	1

*Used in Model RU-18 equipment only.
**Used in Model RU-19 equipment only.
∅ Denotes Continental Electric Company part number.

TABLE IV

Bulk Spare Parts for Model RU-18 and Model RU-19 Equipments

Dwg. No.	*Navy Type Designation*	*Description*
1572	48678	Capacitor, 2×0.1 Mfd
1573	48679	Capacitor, 0.5 Mfd
1574	48680	Capacitor, 2×0.1 Mfd
1575	48681	Capacitor, 2×0.5 Mfd
2933	48682	Capacitor, 4×0.8 Mfd
3562	48763	Capacitor, 3×0.5 Mfd
P91	48672	Capacitor, 0.006 Mfd
P221	48673-20	Capacitor, 0.00025 Mfd
P511	48689-5	Capacitor, 0.00015 Mfd
P520	48674-5	Capacitor, 0.0001 Mfd
P515	48691-5	Capacitor, 0.0005 Mfd
P516	48690-5	Capacitor, 0.00025 Mfd
2218	—	Capacitor, 0.00012 Mfd
2660	—	Capacitor,0.0001 Mfd
ES-688847	—	Capacitor, 50 mmf
3070	63481	Resistor, 2 Megohms
P491	63481	Resistor, 10,000 Ohms
P492	63481	Resistor, 15,000 Ohms
P493	63481	Resistor, 0.5 Megohm
P497	63481	Resistor, 200 Ohms
P498	63481	Resistor, 400 Ohms
P499	63481	Resistor, 2000 Ohms
P500	63481	Resistor, 50,000 Ohms
P501	63481	Resistor, 0.1 Megohm
P502	63481	Resistor, 0.2 Megohm
P504	63481	Resistor, 30,000 Ohms
P505	63481	Resistor, 5,000 Ohms
P510	63481	Resistor, 20,000 Ohms
2961	63505	Resistor, 21 Ohms
4170	63481	Resistor, 1 Megohm
4182	63288	Resistor, 5,000 Ohms
3068	—	Resistor, 7,000 Ohms
8025	—	Resistor, 1140 Ohms
**6479	—	Resistor, 10.8 Ohms
1587	—	Radio Choke
2998	47149	Audio Choke
3144	63699	Variable Resistor
1584	30295	Filter Choke
3096	30294	Audio Transformer
*23609-9(+)ø	—	Dynamotor Brush Assembly
*23609-9(−)ø	—	Dynamotor Brush Assembly
**23609-5(+)ø	—	Dynamotor Brush Assembly
**23609-5(−)ø	—	Dynamotor Brush Assembly
23609-6(+)ø	—	Dynamotor Brush Assembly
23609-6(−)ø	—	Dynamotor Brush Assembly

TABLE IV *(Continued)*

Bulk Spare Parts for Model RU-18 and Model RU-19 Equipments

Dwg. No.	*Navy Type Designation*	*Description*
1606	—	Plug 21
1618	—	Plug 134
1621	—	Plug 135
1619	—	Plug 133
⊖3145	—	Test Meter Plug
⊖3146	—	Test Meter Plug
FHC-67	—	Cable
FHC-56	—	Cable
FHC-74	—	Cable
1455	—	Cable
⊖3251	—	Cable
1607	CW-23021	Mechanical Linkage
1246	CW-23052	Mechanical Linkage
1516	—	CW-MCW Switch
F486	—	Receiver Mounting Bracket
2716	—	Ant. Binding Post
2805	—	Loop Binding Post
2715	—	Ground Binding Post
2955	—	Dynamotor Base Assembly
2955	—	Junction Box Base Assembly
1448	—	Rec. Switch Box Base Assembly
*P411†	—	Fuse, 50 Amp.
**P4†	—	Fuse, 20 Amp.
†	78	Vacuum Tube
†	77	Vacuum Tube
†	38233	Vacuum Tube
*2938	CW-62007A	Junction Box
**6560	CW-62017	Junction Box
*2921	CW-21215A	Dynamotor Filter Unit
**6697	CW-21441	Dynamotor Filter Unit
3147	CW-23087	Receiver Switch Box
1001	CW-23050	Ant. Loop Switch Local Control
1001	CW-23053	Dual Coil Switch Local Control
FR-128	CW-23022	Receiver Local Tuning Control
3042	CW-23012	Receiver Remote Tuning Control
⊖*24709-WS7439∅	—	Dynamotor Armature
⊖**24709-WS7440∅	—	Dynamotor Armature

*Used in Model RU-18 equipment only.
**Used in Model RU-19 equipment only.
∅Denotes Continental Electric Company part number.
⊖Supplied only with early production lots of equipments.
†Supplied as a bulk spare part for late production equipments only.

IDENTIFICATION OF MANUFACTURERS

Code Letter in Parts List	*Name*
B	Aerovox Corporation, New Bedford, Mass.
C	Cornell-Dubilier Corporation, South Plainfield, N. J.
D	Allen-Bradley Company, Milwaukee, Wis.
E	R.C.A. Manufacturing Co., Inc., Harrison, N. J.
F	Ward-Leonard Electric Company, Mount Vernon, N. Y.
G	General Radio Company, Cambridge, Mass.
I	General Electric Vapor Lamp Company, Hoboken, N. J.
K	International Resistance Company, Philadelphia, Pa.
L	Cutler-Hammer, Inc., 8 West 40th Street, New York, N. Y.
M	Littelfuse Laboratories, 4238 Lincoln Avenue, Chicago, Illinois.
N	National Company, 61 Sherman Street, Malden, Mass.
O	Continental Electric Co., 323 Ferry Street, Newark, N. J.
P	General Cable Corporation, 205 East 42nd Street, New York, N. Y.
Q	Weston Electrical Instrument Corporation, Newark, N. J.
R	Triplett Electric Instrument Company, Bluffton, Ohio.
U	United-Carr Fastener Corporation, 31 Ames Street, Cambridge, Mass.
W	Western Electric Company, Inc., New York, N. Y.
X	Micamold Radio Corporation, 1085 Flushing Avenue, Brooklyn, N. Y.
Y	Erie Resistor Corporation, Erie, Pa.

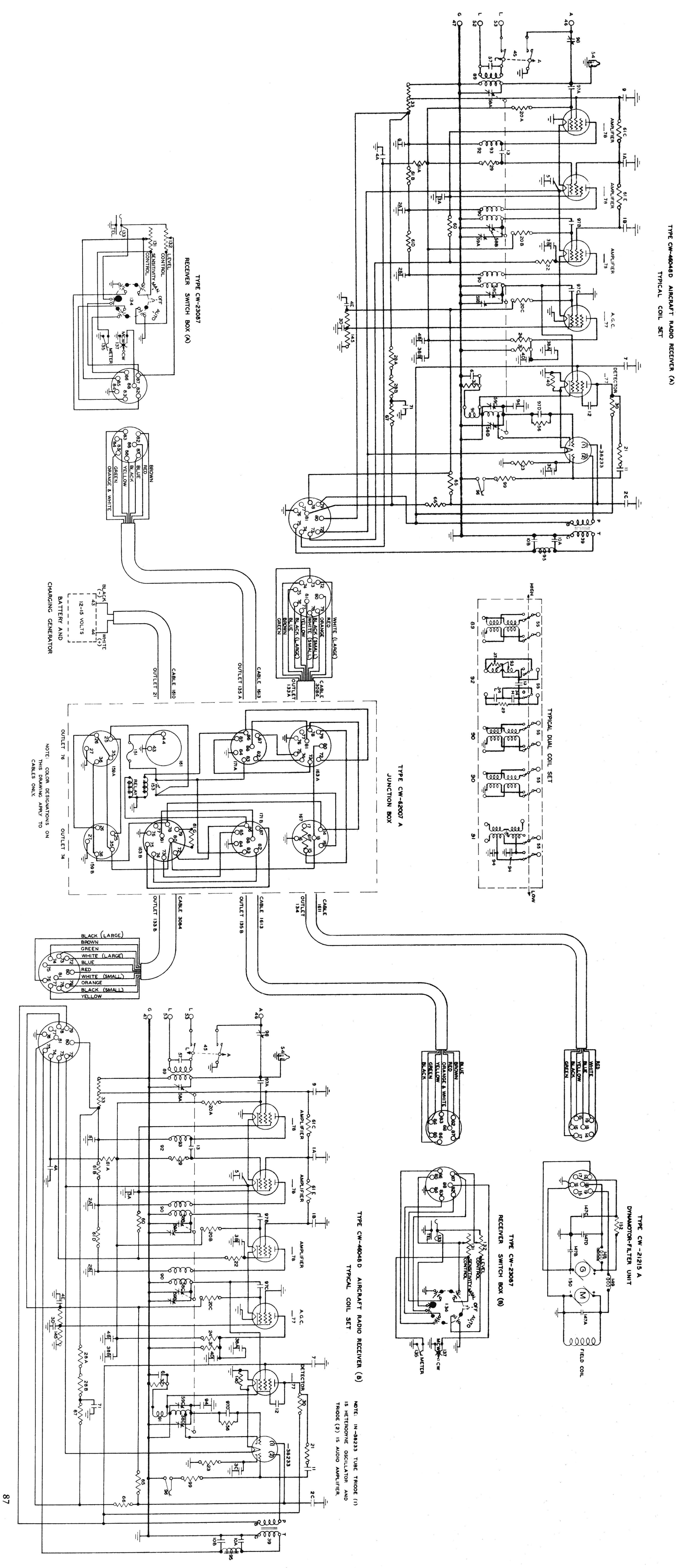


Fig. 13A—Schematic Circuit Diagram, Model RU-18 Equipment

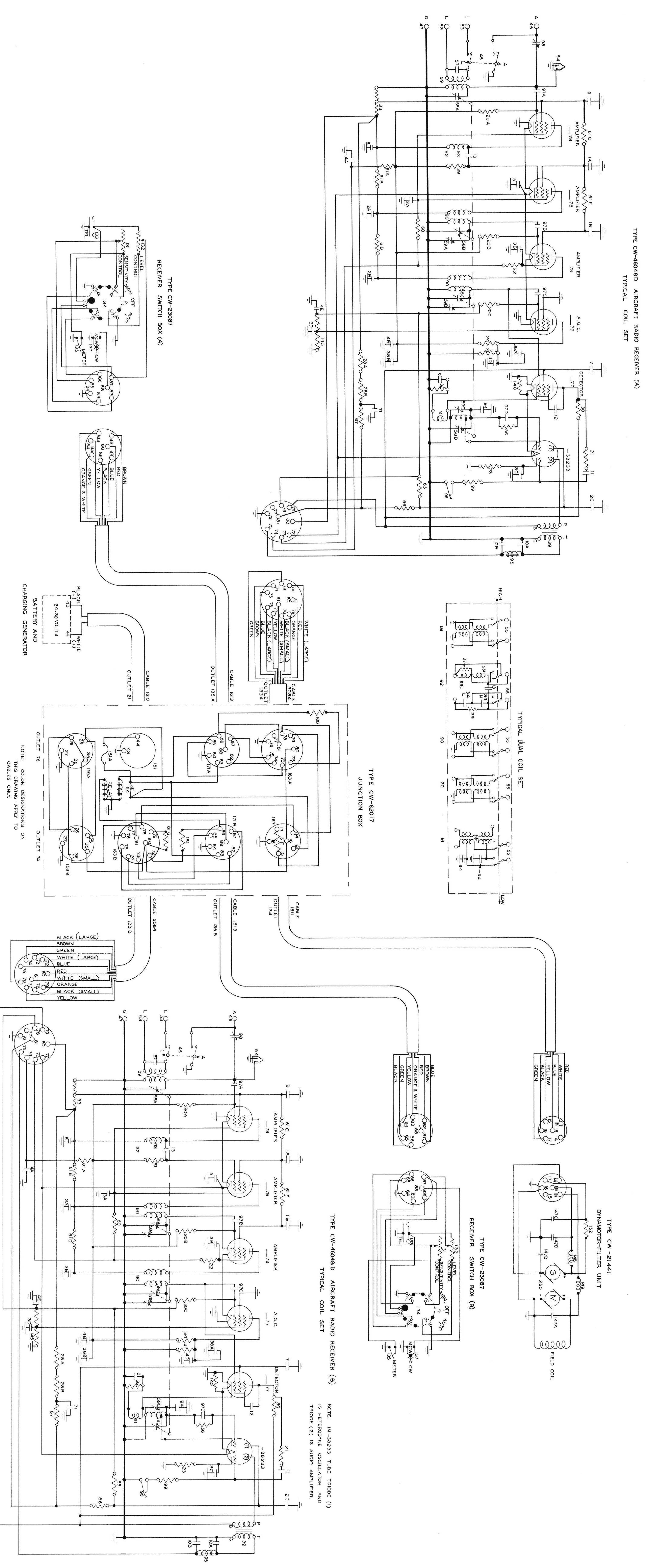


Fig. 13B—Schematic Circuit Diagram, Model RU-19 Equipment

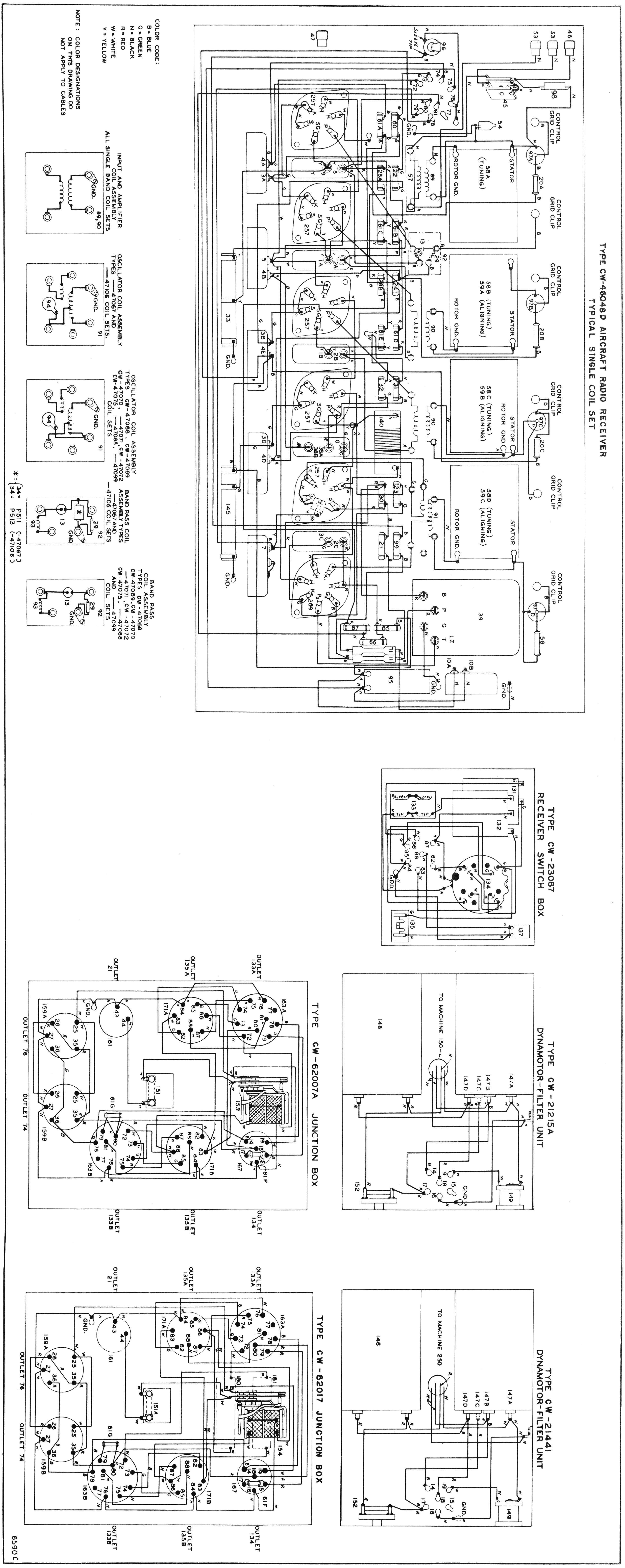


Fig. 14A—Wiring Diagram, Units of Model RU-18 and Model RU-19 Equipments

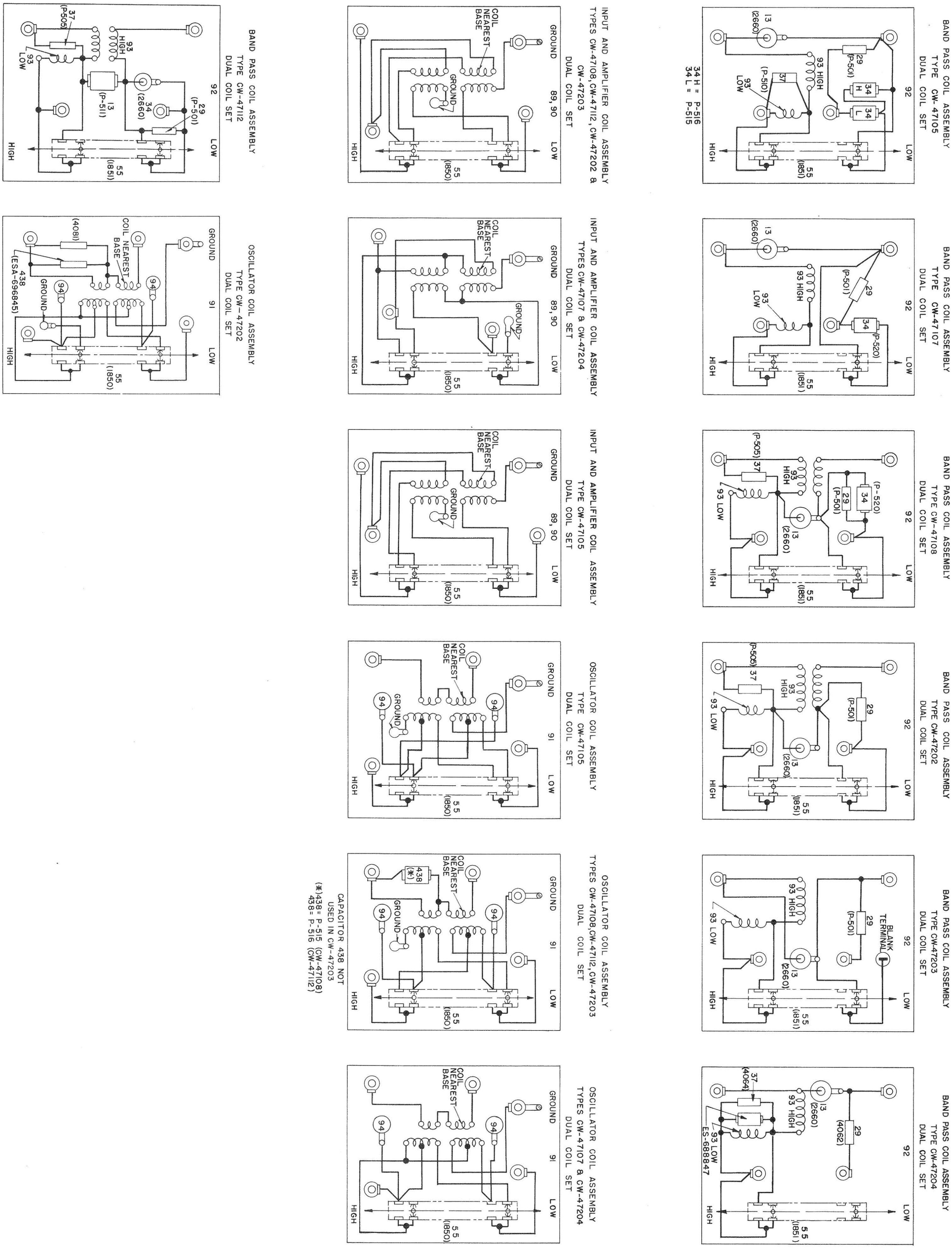


Fig. 14B—Wiring Diagram of Dual Coil Sets

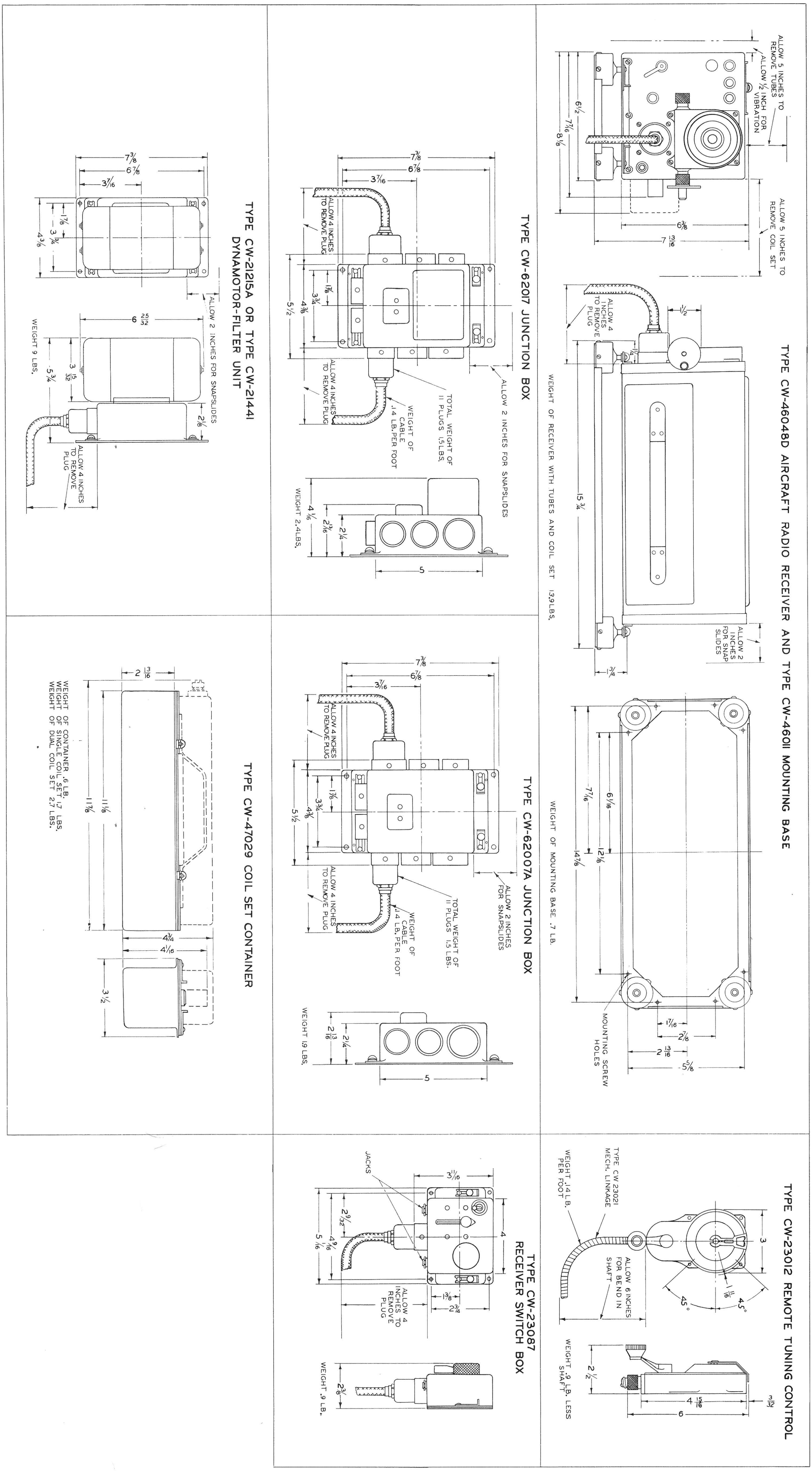


Fig. 15—Installation Dimensions and Weights, Model RU-18 and Model RU-19 Equipments

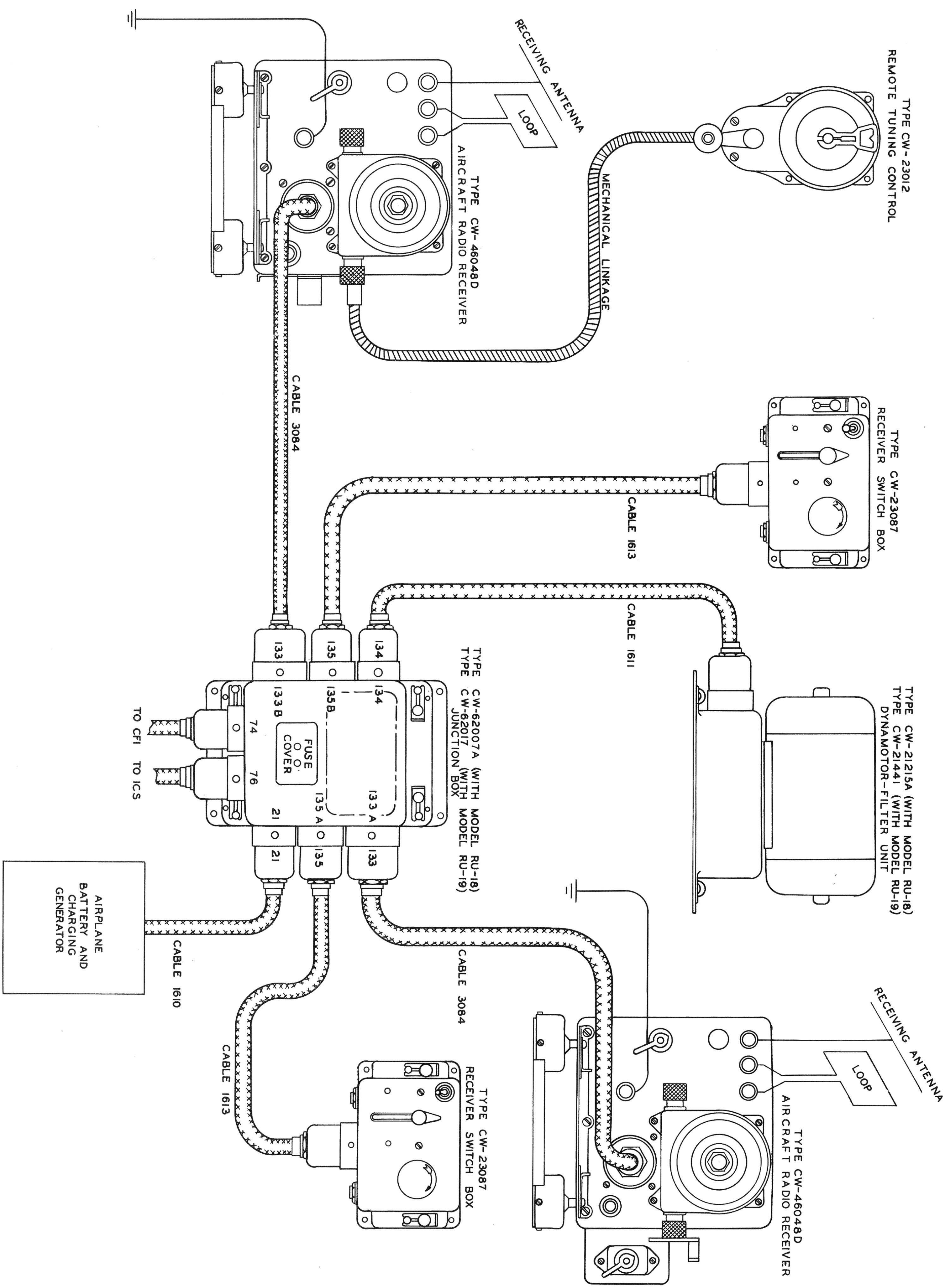
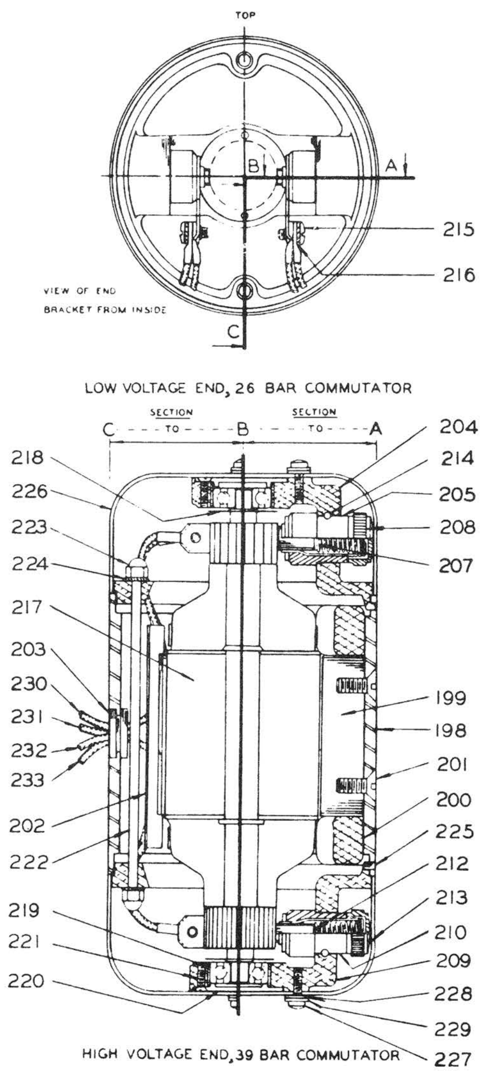
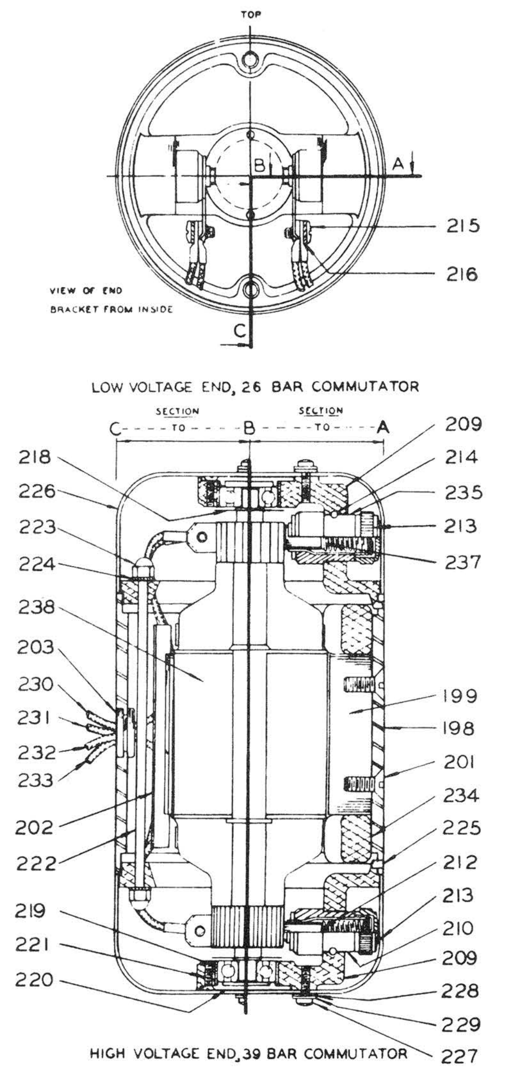


Fig. 16—Cabling Diagram, Model RU-18 and Model RU-19 Equipments



150
DYNAMOTOR FOR
TYPE CW-21215A DYNAMOTOR-FILTER UNIT



250
DYNAMOTOR FOR
TYPE CW-21441 DYNAMOTOR-FILTER UNIT

Fig. 17—Dynamotors

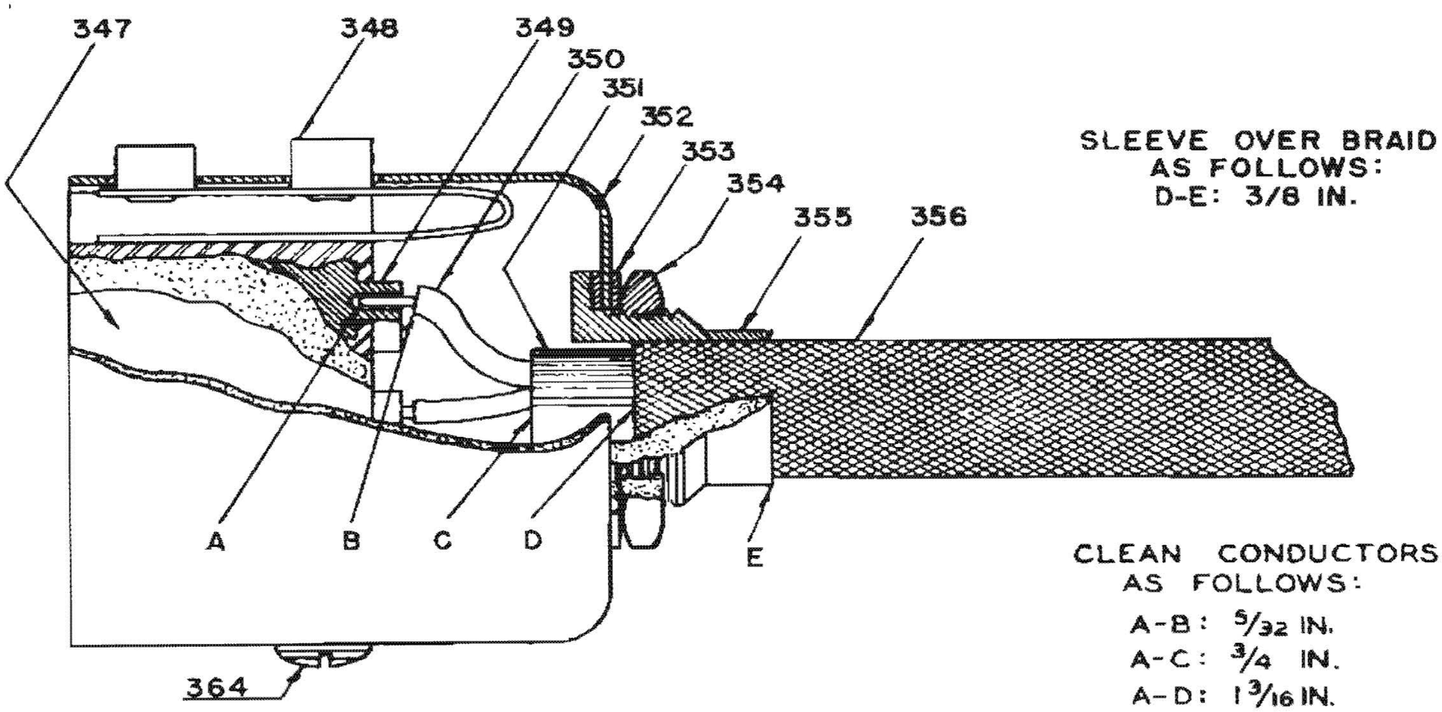


Fig. 18—Typical Cable Assembly

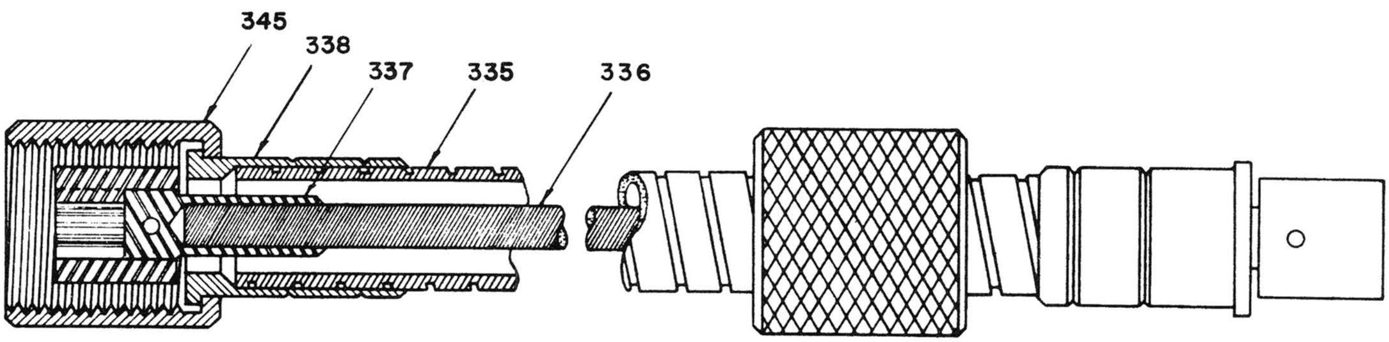


Fig. 19—Typical Mechanical Linkage Assembly