CBY-38039 tubes CONNECTED TO 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.

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 46 to the cathodes, 47 and 56 to the screen grids, and 56 to the plates. If an ohmmeter is available check the values of these resistors. Check all by-pass condensers 1, 2, 3, 4, 5, 6, 7, 8, and 9 for internal short circuits. Check resistors 66, 62, 67, 68, 70, and 72 for short circuits. Check the neon tube 87 for a short circuit. Under normal service conditions this tube will last for the life of the receiver without replacement.

57. MODEL RU-3 RECEIVING EQUIPMENT

GENERAL

Model RU-3 receiving equipment is a complete radio receiving set designed for use on aircraft. It is adapted for installation and operation in airplanes of all types. It may be used to receive modulated, unmodulated, and damped-wave signals in the frequency range 224 - 13,575 Kc.

Model RU-3 receiving equipment consists of a Type CBY-46036 receiver, Type CBY-46011 receiver mounting base, Type CBY-62003 junction box, Type CBY-21108 dynamotor unit, Type CBY-23046 receiver switch box, Type CBY-23012 remote tuner, Type CBY-23021 remote tuner mechanical linkage, and 15 sets of coils covering the frequency range.

These units are also parts of Model GF and Model RU-2 equipments and may be used interchangeably in Models RU-2, RU-3, GF, and GF-1. No other items listed herein may be used in Model RU-2 or Model GF equipment. Fig. 58 shows cabling diagram while Fig. 59 and Fig. 60 shows schematic circuit.

RECEIVER.

Type CBY-46036 receiver consists of a set-box including the supply and coupling terminals, tube sockets, power terminals and plug-in coil terminals.

Electrically the receiver comprises three stages of radio frequency amplification, a detector and one audio amplifier, an A.G.C. stage , and a heterodyne oscillator. The radio amplifier tubes are Type CRP-38078; the detector and

A.G.C. tubes are Type CRP-38077; the combined oscillator and audio amplifier tube is a Type CRP-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.

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, 58, of the variable gang tuning condenser. The fifth consists of a fixed band-pass coupling circuit which is made up of a coil assembly 93, shunted by resistor 37, a grid condenser 34 shunted by a resistor 29, and a coupling condenser 13. These five elements are all included in the band-pass stage of CBY-47077, but is omitted from all other Coil Sets. Condenser 34 is included in the band-pass stages of CBY-47066 and 47067, in the low frequency band-pass stages of CBY-47076 and 47077, resistor 29 is included in the band-pass stages of all Coil Sets except the high frequency range of CBY-47077. 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 roatation of the gang tuning condenser through 180 degrees. All tubes coupled by the tuned transformer 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, 58, of the gang tuning condenser, which tunes the coils 89 and 90 to resonance with each other and with the incoming radio signal, are augmented by the aligning condensers 59A. The aligning condensers are built into the respective sections of the gang condenser, and are separately adjustable, but not as a receiver operating adjustment. The function of condensers 59A is two-fold: First to compensate in all frequency bands for slight inequalities in the residual capacity of each stage: Second to provide a relatively high capacity in each tuned stage following the antenna stage.

The first stage is coupled to the collecting structure through a two-position "antenna-loop switch" 45. With switch 45 in the "A" position (open) the antenna, connected to terminal 46, is coupled to the input coil assembly 89 through a variable series condenser 98, adjustable by knob 244. Condenser 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 condenser 59A. When this is done the input circuit 89 is in resonance with the remaining tuned circuits at all

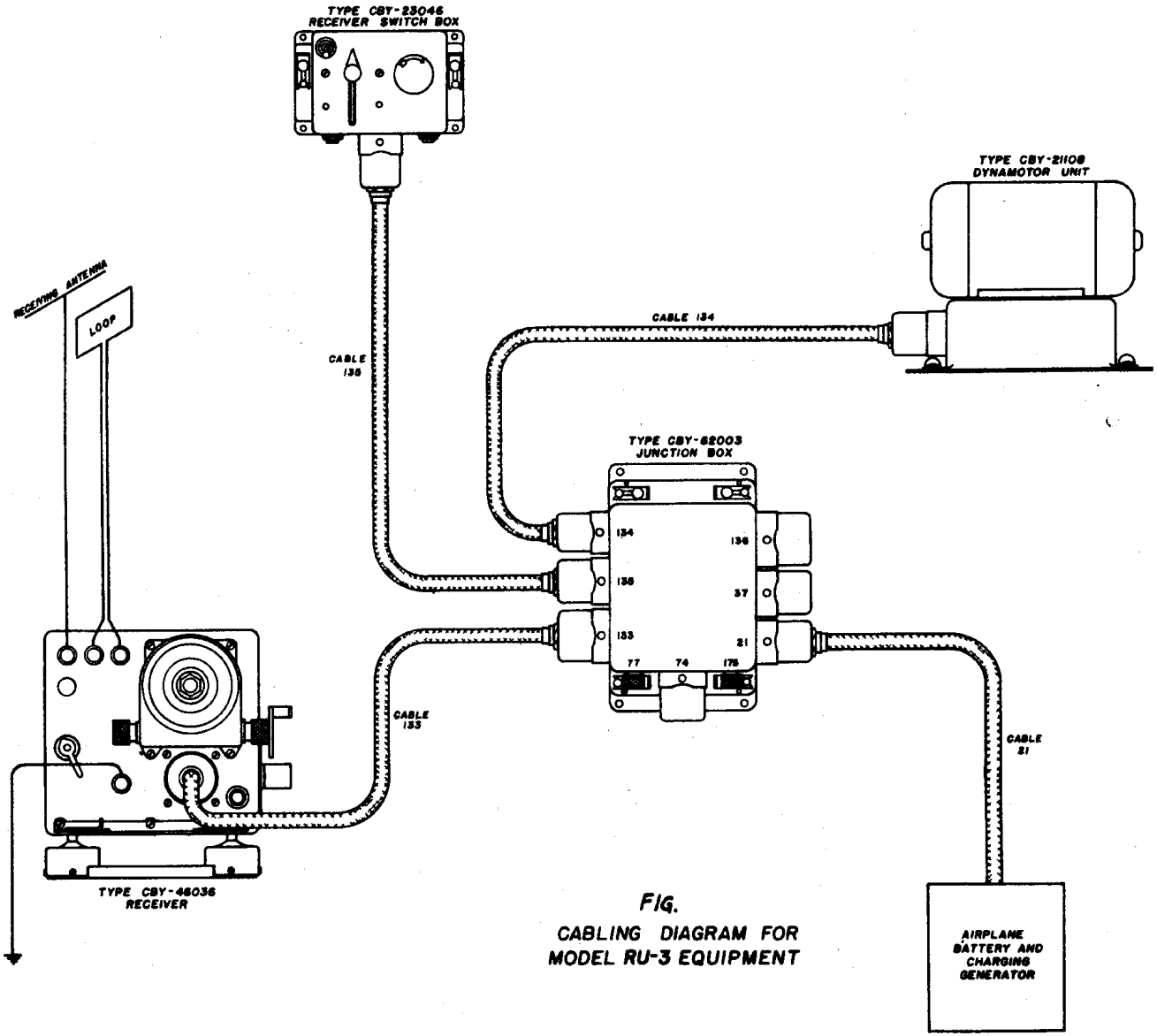


FIG.
CABLING DIAGRAM FOR
MODEL RU-3 EQUIPMENT

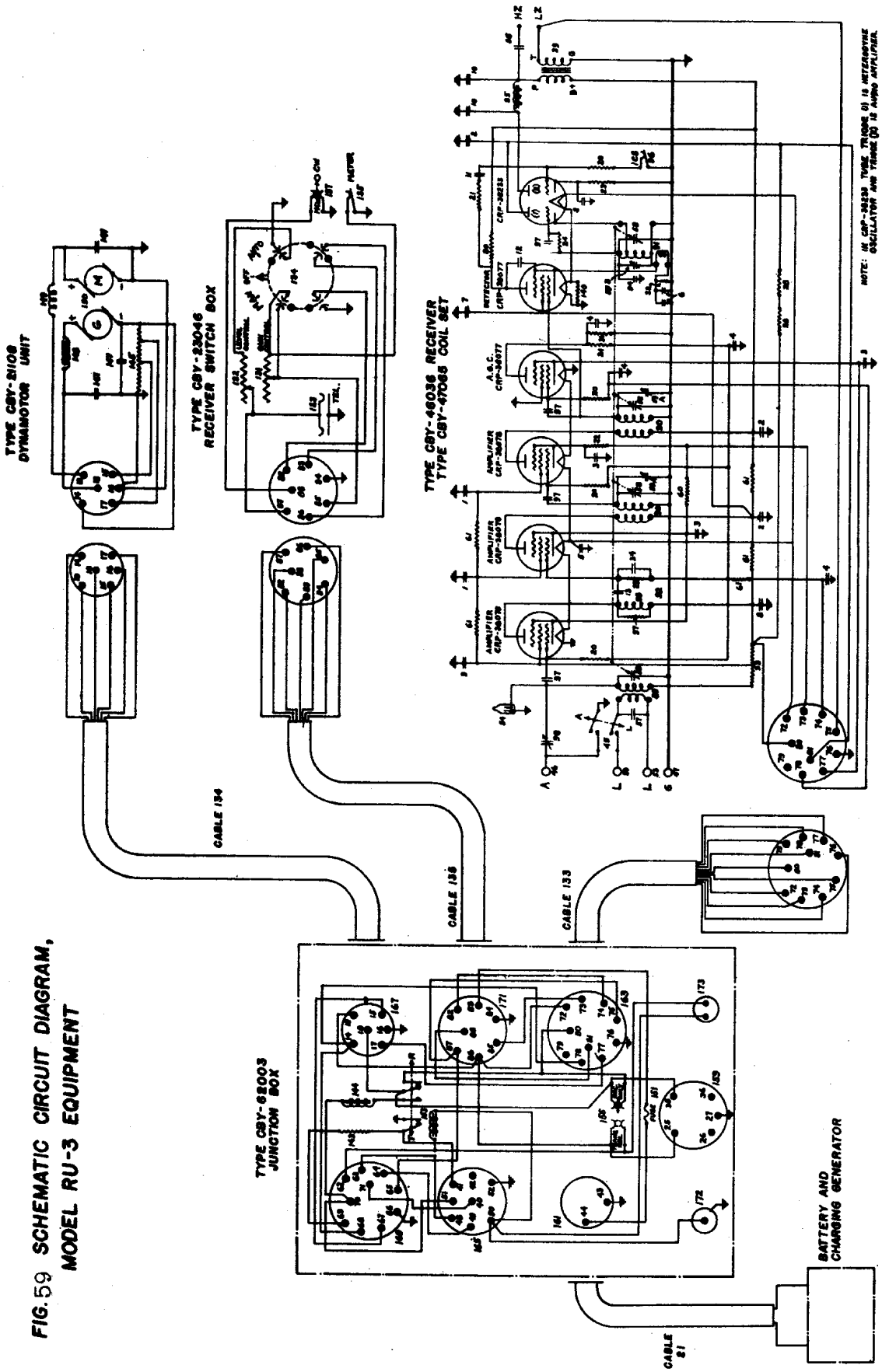
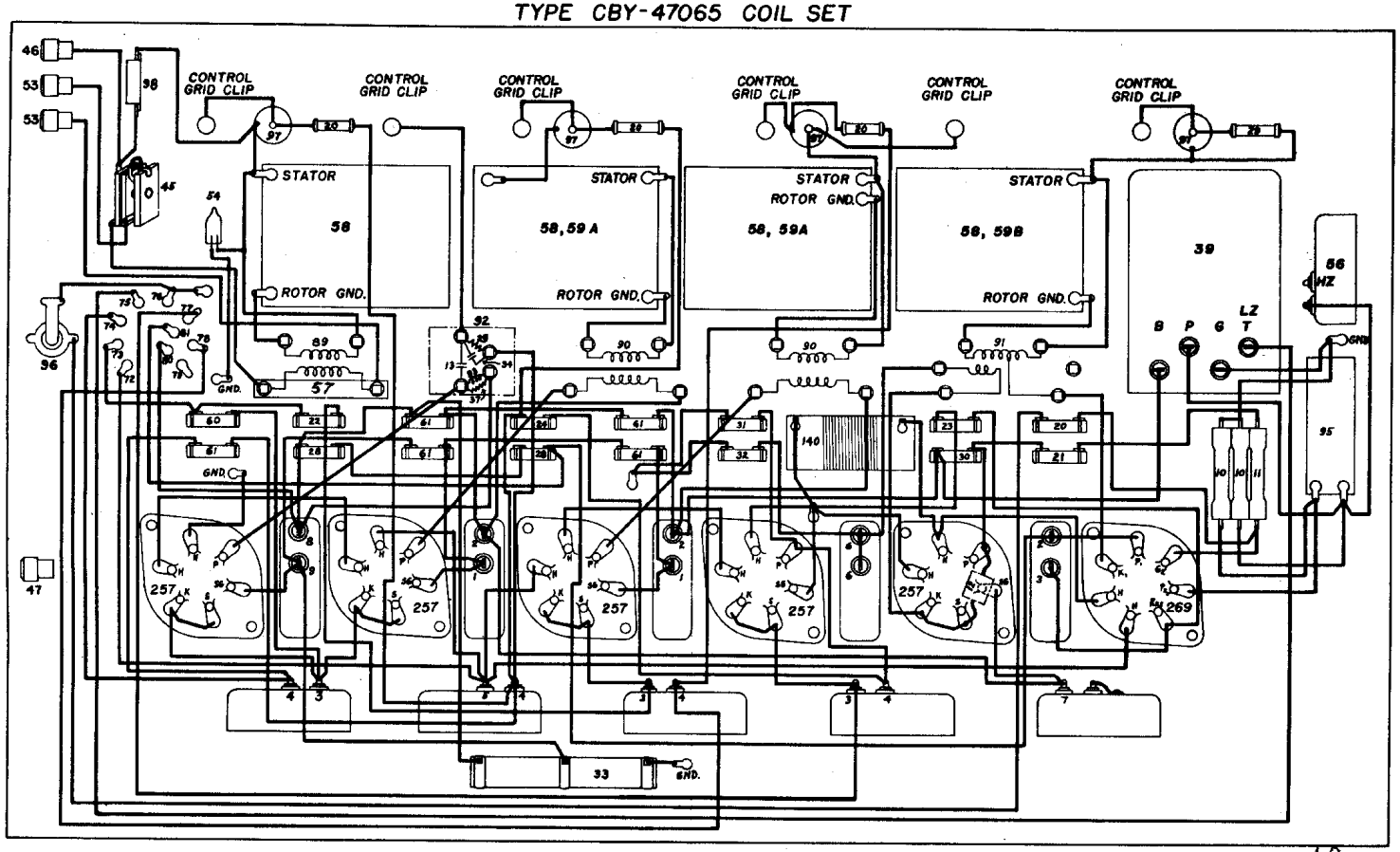


FIG. 59 SCHEMATIC CIRCUIT DIAGRAM, MODEL RU-3 EQUIPMENT

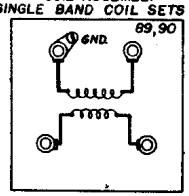
TYPE CBY-46036 RECEIVER
TYPE CBY-47065 COIL SET



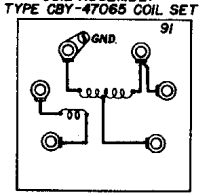
RU-3

FIG. 10

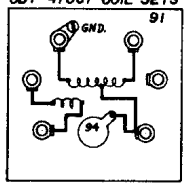
INPUT AND AMPLIFIER COIL ASSEMBLY ALL SINGLE BAND COIL SETS



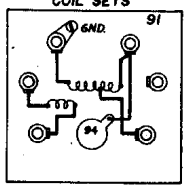
OSCILLATOR COIL ASSEMBLY TYPE CBY-47065 COIL SET



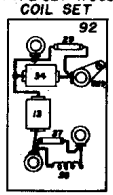
OSCILLATOR COIL ASSEMBLY TYPES CBY-47066 AND CBY-47067 COIL SETS



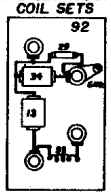
OSCILLATOR COIL ASSEMBLY TYPES CBY-47068, CBY-47069 CBY-47070, CBY-47071, CBY-47072, CBY-47073, CBY-47074, CBY-47075 COIL SETS



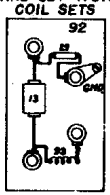
BAND PASS COIL ASSEMBLY TYPE CBY-47065 COIL SET



BAND PASS COIL ASSEMBLY TYPES CBY-47066 AND CBY-47067 COIL SETS



BAND PASS COIL ASSEMBLY TYPES CBY-47068 CBY-47069, CBY-47070 CBY-47071, CBY-47072 CBY-47073, CBY-47074 AND CBY-47075 COIL SETS



settings of the gang tuning condenser. Switch 45 is set at the "L" position when it is desired to use an inductive loop or coil aerial as a collecting structure, connected between the two terminals 53. In this position the antenna binding post is grounded by the upper contacts of switch 45 and the input alignment condenser 98 is connected in parallel with the first 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 of Types CBY-47065, CBY-47066, CBY-47067, CBY-47068, CBY-47069, and the low-frequency range of CBY-47076 and CBY-47077 are designed to operate in this fashion with the loop having an inductance of APPROXIMATELY 110 microhenries and a distributed capacity of APPROXIMATELY 100 microfarads. 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 condenser 98 which resonates the input circuit for any frequency within the band defined by the rotation of the gang tuning condenser. It should be borne in mind, when receiving from a loop, that the input section 58 of the gang condenser is the main variable tuning element of the loop circuit, and condenser 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 condenser 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 CONDENSER 98 IS NECESSARY OR DESIRABLE IF IT IS PROPERLY SET ON INSTALLATION. The shaft of the gang condenser 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 58 of the gang tuning condenser. This coil assembly consists of a tuned coil which is connected between the grid and plate of the oscillator triode (1) of the CRP-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 CRP-38077 detector tube and the by-pass condenser 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 except CBY-47065 is a small additional condenser 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 condensers 59A and 59B because these condensers 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 it stops 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 CRP-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 condenser. Coil 9i 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 58 of the gang condenser. 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 condenser shaft. No means are provided for controlling externally the strength of oscillation of the heterodyne oscillator, the amplitude of oscillation is maintained automatically at a level suitable for the detector, as the Receiver is tuned through any frequency band covered by rotation of the gang condenser.

After successive amplification through the three CRP-38078 tubes the amplified radio signal is impressed upon the control grids of the two CRP-38077 tubes. It is impressed on the A.G.C. tube through fixed condenser 97 and through a direct connection to the detector tube. Considering first the CRP-38077 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 CRP-38233, through a resistor 21 and condenser 11. This audio amplifier triode (2) amplifies the audio signal, which

TYPICAL PLATE, SCREEN, AND BIAS VOLTAGES IN RU-2A RECEIVER
SWITCH AT CW
(Control grids short circuited to ground, Volume Control at maximum).

	Heater.		Screen Grid.		Plate.		Cathode to ground. (Control Grid Bias).	
	12 V.	14 V.	12 V.	14 V.	12 V.	14 V.	12 V.	14 V.
First RF (CBY-38039)....	6v.	7v.	95v.	110v.	184v.	213v.	3.2v.	4v.
Second RF (CBY-38039)...	12	14	95	110	183	212	3.2	4
Third RF (CBY-38039)....	12	14	95	110	182	211	3.2	4
Detector (CBY-38036)....	6	7	95	110	98	112	5.7	6.8
Oscillator (CBY-38036)..	6	7	35	40	35	40	8	9.5
Audio (CBY-38038)....	12	14	130	145	138	156	12	14

IMPORTANT NOTE: 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 (control grid) 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.

TABLE No.1

passes from its plate through a low-pass filter section comprising choke coil 95 and condensers 10, to the output transformer 39. The low-pass filter attenuates all audio frequencies above about 2500 cycles per second; it is included in the circuit to reduce "noise" occurring at the higher frequencies. Resistor 21 operates in conjunction with condenser 11 to keep radio-frequency currents out of the audio output stage. Resistor 20 is a grid return for the output tube. Two terminals are provided for the telephone receiver circuit from plug terminal 75, identified by the letters LZ and HZ. The HZ terminal is connected through condenser 56 to the primary winding of transformer 39. When output line 75 is wired to the HZ terminal the Receiver is adapted for use only with high-impedance load. Transformer 39 is a step-down transformer. When the output line to 75 is connected, as shown in Fig. 59 to the secondary terminal LZ of this transformer, the Receiver is adapted for use with low-impedance load. These high and low-impedance output terminals are accessible at the rear end of the Coil Set compartment and the soldered connection between line 75 and one output terminal may be changed to the other output terminal without removing the Receiver chassis from its case. 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.

The sensitivity of the Receiver is controlled by varying the control grid bias and hence the R.F. amplification of the three '78 R.F. amplifier tubes. This is done either externally, by a manually operated variable resistor, or internally by the A.G.C. circuit.

On "AUTO", terminal 73 is grounded, bringing cathodes of the R.F. amplifiers to ground. Control grids of the three R.F. amplifiers are opened through terminal 74. A DC voltage between the control grids of the three R.F.s and ground will determine the grid bias and hence the amplification of the three R.F. stages. Such a voltage is developed automatically, by rectification of the incoming carrier wave by the A.G.C. tube.

The A.G.C. tube is biased at "cutoff" so that no plate current flows unless a signal is impressed upon the grid of the A.G.C. and is rectified in the plate circuit. The rectified signal appears as an audio and D.C. voltage across 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 are by-passed to ground through condenser 4, and are further suppressed from the line returning to the grids of the R.F. amplifiers, by 24 which forms, in cooperation with condenser 4, a low-pass filter section.

As the amplified carrier of the incoming radio signal increases, the plate of the A.G.C. draws current and the D.C. drop appears across 31 which causes the plate to become more negative with respect to ground.

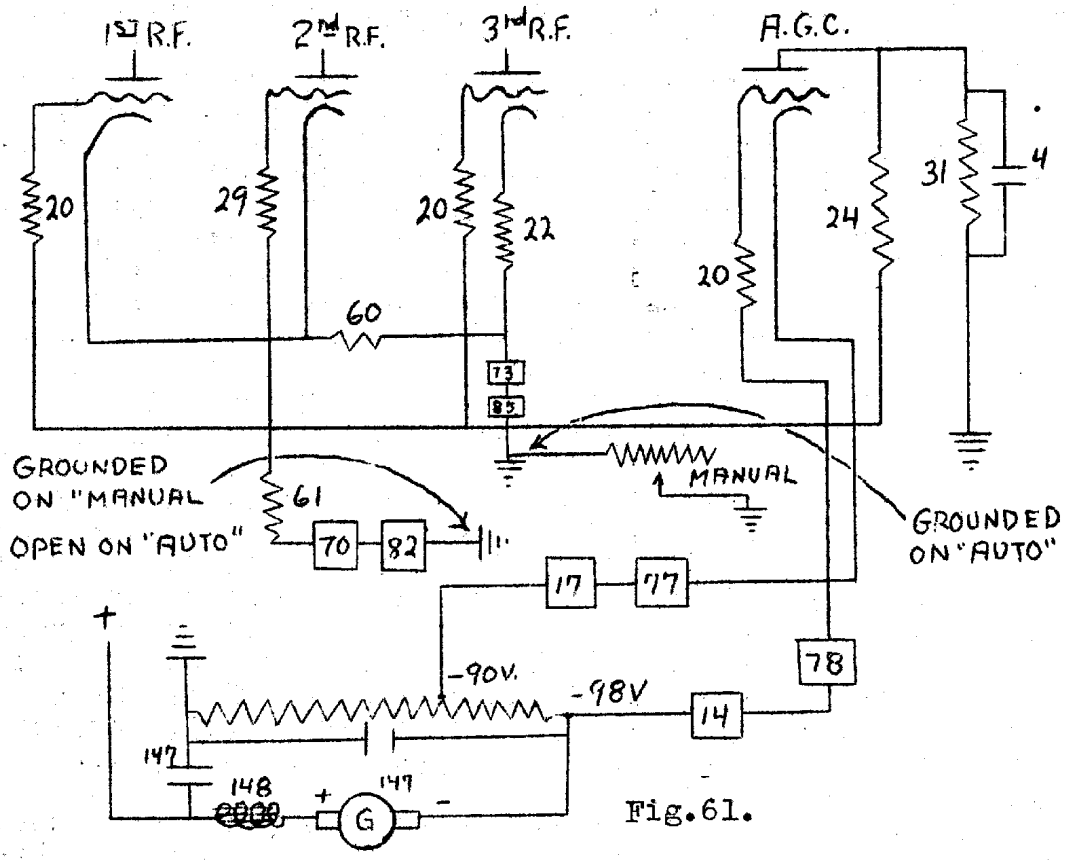


Fig.61.

FUNDAMENTAL A.G.C. CIRCUIT OF RU-3 RECEIVER.

This negative voltage is impressed through 29 and 20 upon the grids of the three amplifiers, 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 strength.

On "AUTO" the level control 132 is shunted around the phones to determine the sensitivity desired.

The operation of the A.G.C. tube is independent of the operation of the heterodyne oscillator. It is fed by the incoming signal and varies the gain of the R.F. amplifiers ahead of the detector. The heterodyne oscillator affects the detector only. Thus A.G.C may be used in the reception of either CW or modulated signals.

If the voltages on the cathode and the grid of the A.G.C. tube are varied so that the bias is less than 8 volts, the A.G.C. action will occur at much weaker signal levels and therefore cut down or block the weak incoming signals out altogether. It is the eight volt drop that gives the delayed action, so that weak signals will not be affected. If the bias exceeds eight volts the signal level will be too high and the A.G.C. action will be delayed too much. It is important then, that the difference

in cathode and grid voltage of the A.G.C. tube be substantially eight volts.

When using the manual control the grids of the three RF amplifiers are biased through resistor 61 to ground. This bias is maintained constant, at the same time the manual control switch when in the "ON" position grounds 61 through 74 and 82, the ground is removed from 73 and 85 and is maintained through a variable resistor (manual volume control) to ground. With the resistor in series to ground the potential difference can be varied between grid and cathode of all three RF amplifiers and will give a biasing action to control the gain of the receiver.

The heavy line in Fig. 59 represents the grounded frame of the receiver. The cathodes of the three amplifier tubes are connected for direct current to terminal 73 of the power plug. The control grids of these amplifier tubes are connected for direct current 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, CRP-38077. If terminal 74 is grounded externally, thus connecting all grid circuits directly to ground, an external resistance between the cathode (terminal 73) and ground will limit or control the amplification of the CRP-38078 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 DC 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 condenser 97 and is rectified in the plate circuit of the tube. The rectified signal appears as an audio and DC voltage across the plate resistor 31. Only the DC component, which varies approximately in proportion to the strength of the incoming radio carrier voltage, is used. The audio components of the A.G.C. tube are by-passed to ground through condensers 4, and are further suppressed from the line returning to the grids of the amplifier tube, by resistor 24 which forms, in cooperation with condensers 4, 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 DC drop in resistor 31, this negative voltage impressed through resistors 29 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, permitting external adjustment of the radio-frequency amplification by the DC 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. The 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 CRP-38233 tube. A residual negative bias is imparted to the grids of the CRP-38078 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 CRP-38078 tubes, the plate voltage for both triodes of the CRP-38233 tube, and the plate and screen voltage for the CRP-38077 detector tube. Resistor 33 is connected between terminal 80 and ground as a voltage divider. A center tap on 33 provides screen grid voltage for the CRP- 38078 tubes. Terminal 77 is maintained at a relatively large negative voltage with respect to ground and to this terminal is connected the cathode of the CRP-38077 A.G.C. tube. The plate and screen grid of the tube are both returned to ground. Thus the plate and screen grid are positive with respect to the cathode by approximately the amount of the negative voltage on terminal 77. Terminal 78 is maintained at a slightly greater negative voltage with respect to ground than terminal 77. The control grid of the A.G.C. tube is returned to 78, and this grid is thus biased negatively with respect to the cathode by the difference between the voltages on 77 and 78. It is necessary to return the plate circuit of the A.G.C. tube to ground because the control grids of the CRP-38078 tubes are returned by a D.C. connection to the plate of the A.G.C. tube, and the only permissable 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. Two series resistors, 28, are thrown between the high-voltage positive terminal 80 and ground, in place of the heterodyne oscillator tube, which terminal 81 is grounded externally. Terminal 76 is grounded at the power plug receptacle and terminal 79 is a spare. Terminal 75 is connected externally to the telephone receivers.

Resistor 32, by-passed by two condensers 6, is a bias resistor in the cathode circuit of the CRP-38077 detector tube. Resistors 61 and condensers 1 are decoupling filter elements

Unfortunately, pages 187-202 are missing from the original document. If I can locate them, I'll add them to this pdf.