OVER-THE-HORIZON RADIO SYSTEMS

ITTL 12A-1 OVER-THE-HORIZON RADIO SYSTEM

NUS 3298 RECEIVER

DESCRIPTION

CONTENTS PAGE

1. GENERAL

1.01 This section describes the NUS 3298 diversity receiver. Detailed circuit information and equipment features are dealt with and transmission characteristics are outlined. Related photographs, simplified drawings, and reference lists are included.

1.02 The NUS 3298 diversity receiver, in combination with antennas and transmission lines and Western Electric Company TD-2 Microwave Radio System FM terminal receiver equipment, forms the receiving portion of the ITTL 12A-1 over-the-horizon radio system. The NUS 3298 receiver is used to translate a received frequency-modulated radio signal in the 692-to 880-MHz range to 70 MHz for application to the FM terminal receiver equipment.

1.03 Each NUS 3298 diversity receiver is arranged to accept, amplify, convert, modify, and combine the two received signals generated by a single distant transmitter but travelling different paths to two separated antennas. A single stabilized dual-diversity 70-MHz FM output signal is produced from two received signals which fade and undergo phase alterations independently.

1.04 The outputs of two NUS 3298 diversity receivers, arranged to receive the signals generated by two distant transmitters operating at different frequencies, can be combined to provide a single 70-MHz quadruple-diversity output. A simplified block diagram illustrating the diversity arrangements is shown in Fig. 1.

1.05 The electrical and mechanical specifications are listed in Table A.

1.06 The receiver is shown in Fig. 2. Two diplexer-preselector assemblies are mounted in the top compartments, common to two adjacent receivers.

1.07 The components of the NUS 3298 receiver, the designations assigned by the manufacturers, and the applicable schematic drawing numbers are listed in Table B.

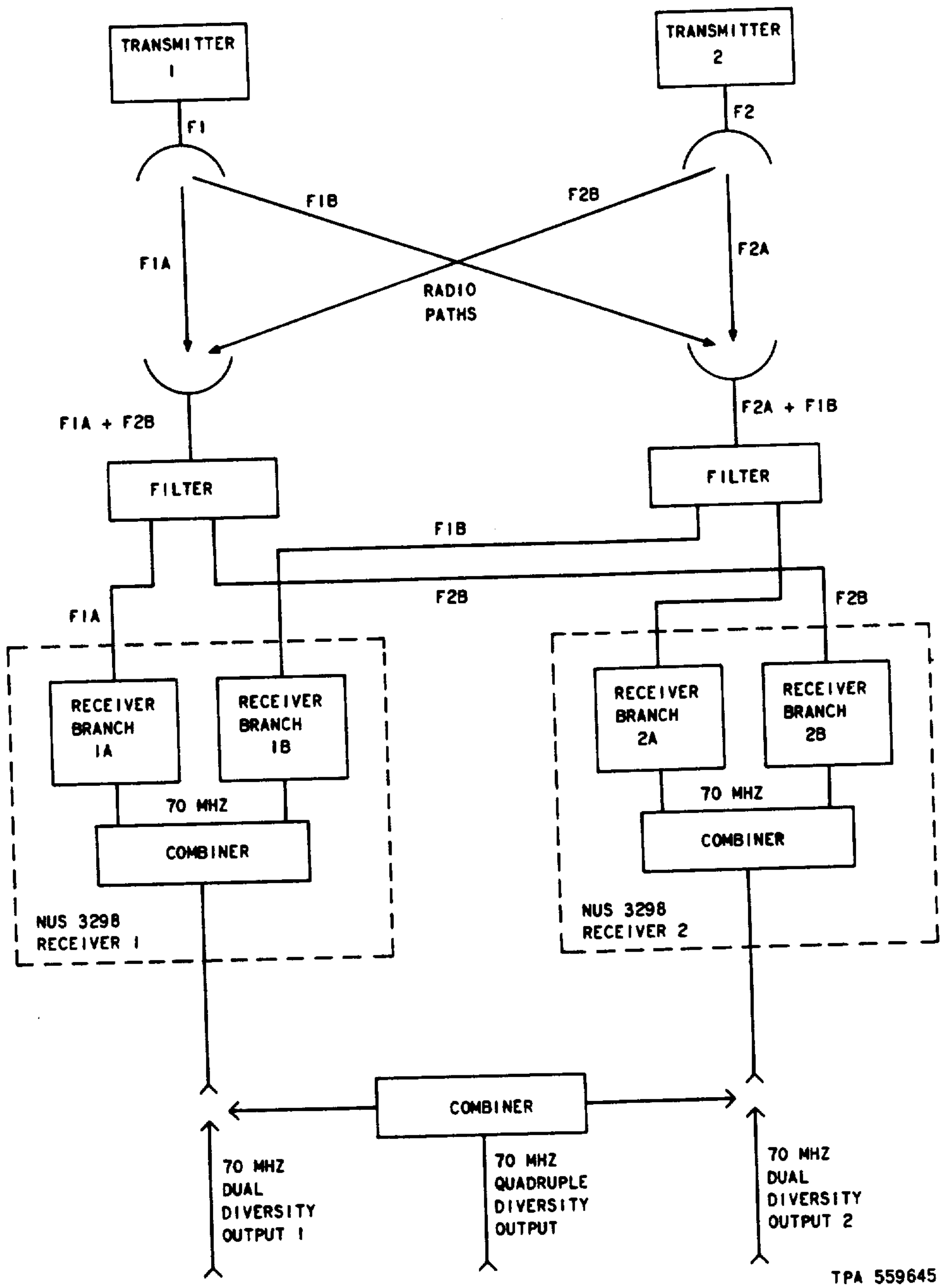

Fig. 1—Diversity Arrangement Using Two NUS 3298 Receivers—Block Diagram

2. CIRCUIT DESCRIPTION

A. General

2.01 The signals from the distant transmitter are received by two separated antennas and applied to the input terminals of two diplexer-preselector assemblies where signals other than those at the receiver frequency are rejected. Each diplexer arrangement provides two outputs permitting operation of one of two branches of each of two dual-diversity receivers from a single antenna as shown in Fig. 1.

2.02 Figure 3 shows the functional arrangement of the NUS 3298 dual-diversity receiver.

TABLE A

NUS 3298 RECEIVER – ELECTRICAL AND MECHANICAL SPECIFICATIONS

Dimensions	10 feet high 30 inches wide 24 inches deep
Weight	Approximately 400 pounds
Power requirements	117 Vac, 1 phase, 16 AMP 250 Vdc, 0.125 AMP 130 Vdc, 0.8 AMP 12 Vdc, 16 AMP
Input frequency range	692 to 880 MHz
Input impedance	50 ohms
Input connections	2–type N coaxial
Output frequency	70 MHz
Output impedance	75 ohms
Output connections	WECo type 477 coaxial
Output level	+9 dBm
Bandwidth	20 MHz, 0.25 dB
Noise figure	Better than 9 dB
Image rejection	Better than 28 dB

Each dual-diversity receiver consists of two identical branches providing frequency conversion and amplification of signals received on separated antennas. The 70-MHz outputs of the two branches are applied to a dual combiner from which a single 70-MHz output is obtained. A dc voltage, which is the rectified resultant of the two receiver branch outputs, is developed in the dual combiner, amplified, and applied to the two IF main amplifiers for gain regulation. This automatic gain control system provides a constant combiner output level and equality in branch gains with unequal and varying branch input and output levels, thus causing each branch to contribute a share of the combiner output which is related to its signal-to-noise ratio.

2.03 An automatic frequency control voltage is developed in the dual combiner phase-comparison circuit which is used to vary the two local oscillator frequencies over small ranges. This automatic phase control system maintains the relative phase angle of the two receiver branch outputs which result in the proper addition of signals in the combiner.

2.04 Using two dual-diversity receivers operating at different frequencies, it is possible to obtain the quadruple-diversity arrangement shown in Fig. 1. The NUS 3357 diversity switching panel provides means of switching the outputs of two dual-diversity receivers to a third dual combiner to obtain a single phase-corrected and stabilized 70-MHz output. Only one NUS 3357 diversity switching panel is required to control two adjacent dual-diversity receivers.

B. NUS 3300 Diplexer-Preselector

2.05 The diplexer-preselector panel consists of two assemblies each of which provides two outputs from a single input. Each branch includes a 3-cavity filter arrangement made up of parallel-resonant circuits separated by 1/2-wave transmission line sections. Two diplexer-preselector assemblies are used between two antenna transmission

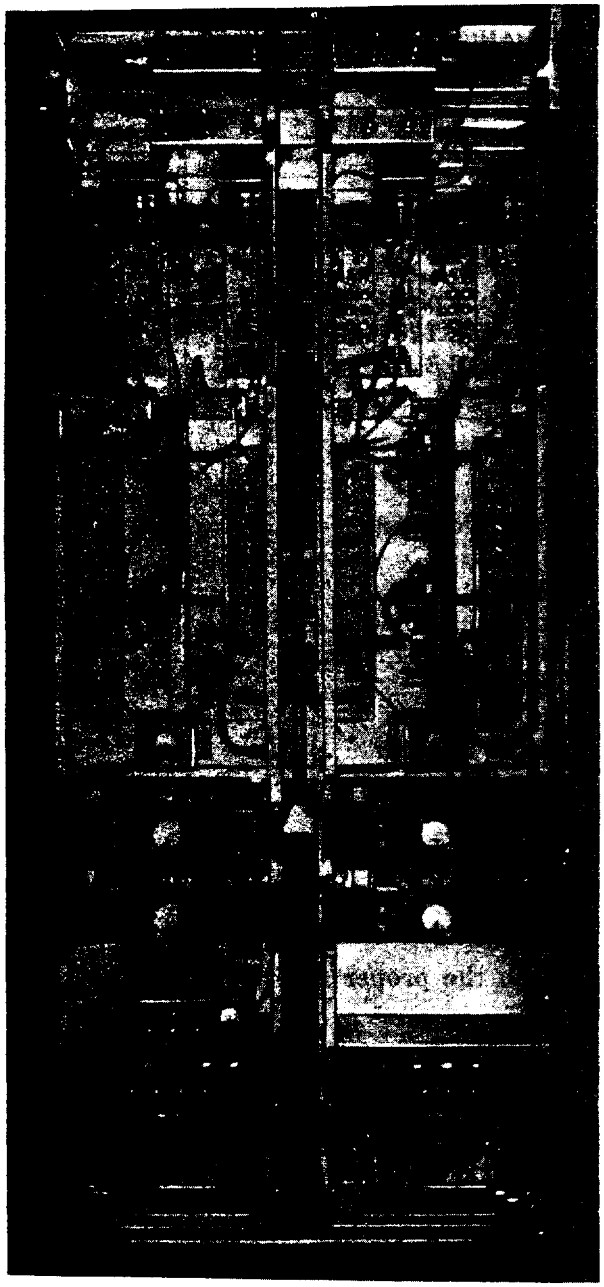

Fig. 2—Two NUS 3298 Dual-Diversity Receivers Arranged for Optional Quadruple-Diversity Operation

lines and two adjacent dual-diverisity receivers operating at different frequencies as shown in Fig. 1. The filters are tuned to pass the receiver frequencies and reject other frequencies, especially the frequency of the transmitter which shares the antenna with the receivers in an over-the-horizon system.

2.06 Table C lists the characteristics of the diplexer-preselector.

C. NUS 3354 RF Amplifier

2.07 The RF amplifier shown in Fig. 4 uses an air-cooled coplanar triode tube in a grounded-grid configuration. The RF input at J1 is applied to the tube cathode through a matching network consisting of C1, C2, and a short coaxial transmission line.

2.08 The amplifier output circuit consists of two coaxial lines tuned by adjustable capacitors C3 and C5 and coupled through adjustable capacitor C4. The amplifier output appears at jack J3 which can be positioned to provide adjustable loading of the output circuit.

2.09 Table D lists the characteristics of the RF amplifier.

D. NUS 3360 Local Oscillator

2.10 Figure 5 is a block diagram showing the arrangement of the local oscillator which consists of a crystal-controlled oscillator operated in the range of 50 to 56 MHz followed by four stages providing amplification and an overall frequency multiplication figure of either 12 or 18 depending on which of the upper and lower halves of the receiver frequency range is used.

2.11 Tube V1 is a dual triode arranged in a crystal-oscillator multiplier circuit. The oscillator portion is a cathode-coupled oscillator circuit in which V1A is operated as a grounded-grid amplifier and V1B is a cathode-follower for the fundamental frequency. The cathodes of two circuits are coupled through the oscillator crystal Y1. The oscillator frequency can be varied over a small range by application of a dc voltage to the grid of V1A as part of the receiver automatic phase-control system. The plate circuit of V1A is tuned by L1 to the fundamental frequency. The plate circuit of V1B is tuned to the second harmonic of the crystal frequency.

2.12 The output of V1B, in the frequency range of 100 to 112 MHz, is applied to the grid of V2, a pentode tube which operates as a buffer

TABLE B

COMPONENTS OF THE NUS 3298 RECEIVER

COMPONENT	DESIGNATION	DRAWING NUMBER
Local oscillator (2)	NUS 3360	ITTL 2081031
Diplexer-preselector	NUS 3300	ITTL 2088301
RF amplifier (2)	NUS 3354	ITTL 2083550
Mixer-IF preamplifier (2)	NUS 3355	ITTL 2088068
IF amplifier (2)	WE J68330A	WE SD59401
Receiver control panel (2)	NUS 3358	WE SD59405 and ITTL 2084063
Dual combiner	NUS 3306	ITTL 2084344
Diversity switching panel	NUS 3357	ITTL 2084064
Alarm and power distribution	NUS 3352	ITTL 2088126
Power supply	Sola 28332	ITTL 2170225
Cabinet assembly	NUS 3298	ITTL 2088438

amplifier. The plate circuit of V2 is tunable over the range of 100 to 112 MHz by means of variable capacitor C18 and coil L4.

2.13 The output of V2 is coupled through capacitor C20 to the grid of the pentode tripler V3. The plate circuit of V1 is tunable over the range of 300 to 336 MHz by means of coil L5 and variable capacitor C21.

2.14 The output of V3 is coupled through capacitor C22 to the cathode of the grounded-grid triode multiplier V4. Coils L6 and L7 in the heater-cathode circuit maintain the cathode above radio-frequency ground potential. Tube V4 is mounted in a radial-cavity assembly which constitutes a tuned circuit. The resonant frequency of the cavity is determined by cavity dimensions, the tube output capacitance, and the capacitance value of adjustable capacitor C48. Energy transfer to the output terminal J2 is accomplished through the use of an adjustable loop L10 in the cavity. The output cavity can be tuned, by means of adjustable capacitor C48, to the frequencies within the range of from 622 to 950 MHz. The output stage operates as a frequency doubler or tripler, as determined by the tuning of the output cavity.

2.15 The output of the local oscillator is applied to the receiver mixer through a fixed 6-dB attenuator which presents a nonreactive load to the local oscillator output circuit. The output level is adjusted by means of the POWER CONTROL potentiometer R19 in the cathode circuit of the output tube.

2.16 Test point jacks are provided for the measurement of all cathode currents.

2.17 Table E lists the characteristics of the local oscillator.

E. NUS 3355 Mixer-IF Preamplifier

2.18 The NUS 3355 mixer-IF preamplifier consists of a Western Electric Company J68330N IF preamplifier on which is mounted an ITTL 2082734 mixer assembly. The output of the receiver RF

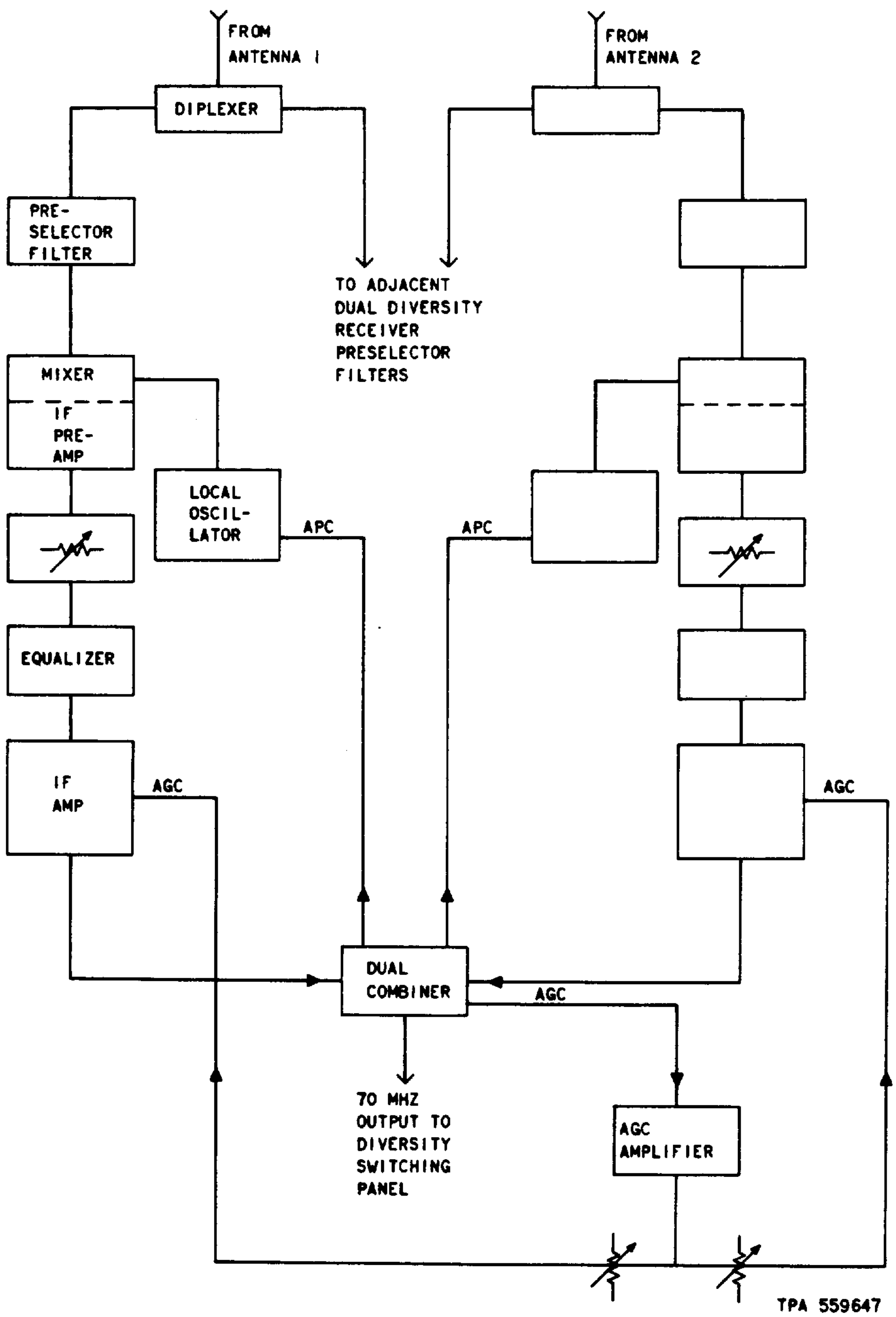

Fig. 3—Functional Arrangement of the NUS 3298 Dual-Diversity Receiver—Block Diagram

amplifier and the output of the receiver local oscillator are mixed in the mixer assembly to produce a 70-MHz intermediate-frequency signal. The intermediate-frequency signal is applied to the input terminals of the 3-stage, low-noise preamplifier where it is raised to levels required by the IF main amplifier.

2.19 The receiver frequency signal is applied in phase to the two mixer diodes through jack J1. The local oscillator energy is fed to the mixer diodes in phase through jack J2 and transmission lines which differ in length by one wavelength. Because the lengths of the two paths between jacks J1 and J2 differ by one-half wavelength,

TABLE C

NUS 3300 DIPLEXER-PRESELECTOR CHARACTERISTICS

Input connector	Type N coaxial
Input impedance	50 ohms
Input VSWR	Better than 1.2
Output connectors (2)	Type N coaxial
Output impedance	50 ohms
Branch filter bandwidth	20 MHz at 0.1 dB 40 MHz at 3.0 dB Approximately 100 MHz at 70 dB

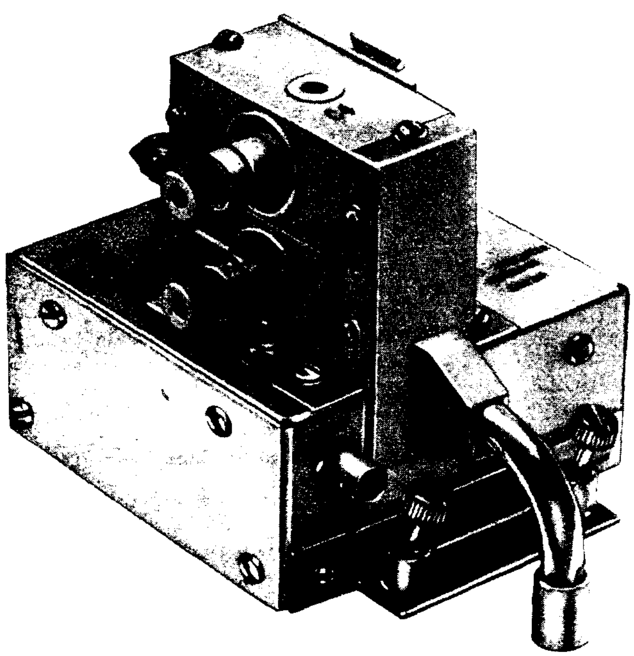

Fig. 4—NUS 3354 RF Amplifier

energies applied to jacks J1 and J2 are cancelled at the opposing jacks. However, cancellation does not occur between these terminals and the mixer crystals. The local oscillator and receiver frequencies are mixed in the two crystals to produce a 70-MHz intermediate frequency at the mixer output terminals.

TABLE D

NUS 3354 RF AMPLIFIER CHARACTERISTICS

Input connector	Type BNC coaxial
Input impedance	50 ohms
Output connector	Type BNC coaxial
Output impedance	50 ohms
Gain	11 dB
Bandwidth	15 MHz at 0.1 dB
Noise figure	9.5 dB
Voltage requirements	12 Vdc 250 Vdc

TABLE E

NUS 3360 LOCAL OSCILLATOR CHARACTERISTICS

Output frequency range	622 to 950 MHz
Output impedance	50 ohms
Output power	Approximately 8 milliwatts
Output connector	Type N coaxial
Power requirements	6.3 Vdc 12 Vdc 130 Vdc 250 Vdc
Tube complement	1--type 12AT7 2--type 404A 1--type 3CX100A5

One-quarter wavelength stubs between each crystal and ground provide a dc path which is part of the crystal-current metering circuit.

2.20 The J68330N IF preamplifier is described in Section 410-400-100.

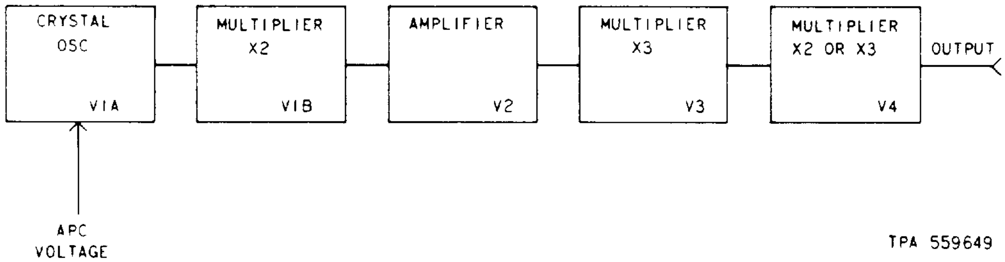

Fig. 5—Local Oscillator Functional Arrangement—Block Diagram

F. WE 315A IF Equalizer

2.21 An IF equalizer is used in each receiver branch intermediate-frequency path between the IF preamplifier output and the IF main amplifier input terminals for phase distortion correction. The equalizer is described in Section 410-400-100.

G. WE J68330A IF Amplifier

2.22 An IF main amplifier is used in each receiver branch to amplify the intermediate-frequency signal and to stabilize receiver output by means of an automatic gain-control system.

2.23 The IF main amplifier is described in Section 410-400-100. The outputs of each of the two IF main amplifiers used in the diversity receiver generally vary independently over wide ranges as the gain of each amplifier is controlled by an automatic gain-control voltage which is the resultant of the outputs of the two amplifiers having different and varying input signals. The rectified output of diodes CR1 and CR3 in each IF main amplifier is used to operate the alarm circuit in the receiver alarm panel.

H. NUS 3306 Dual IF Combiner

2.24 One NUS 3306 dual IF combiner is used in each of the dual-diversity receivers to combine the outputs of the two receiver branches. One additional dual combiner is provided in the installation of two adjacent diversity receivers making it possible to combine the outputs of two receivers in a quadruple-diversity arrangement. A photograph of the dual IF combiner is shown in Fig. 6. Two 70-MHz input jacks, J1 and J2, one output jack, J3, and a plug, J4, for dc connections are shown.

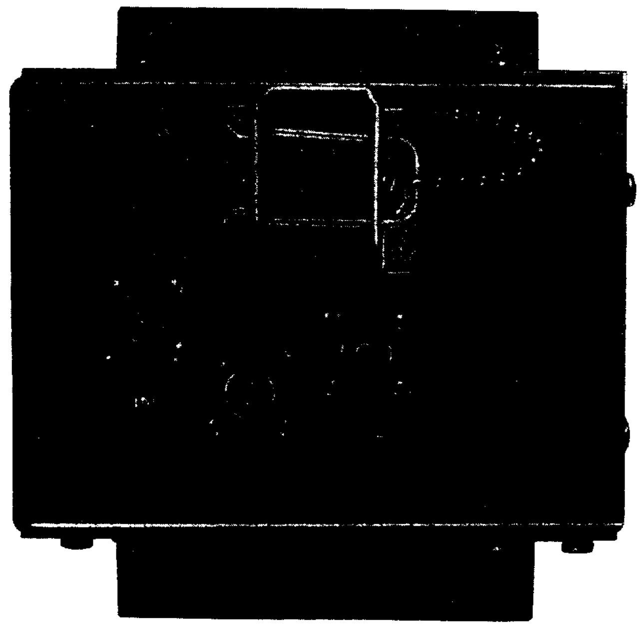

Fig. 6—NUS 3306 Dual IF Combiner

2.25 The dual IF combiner circuit consists of three main parts: the hybrid, the automatic gain-control detector, and the automatic phase-control detector. The signals at J1 and J2 are held 90 degrees apart. The input of J1 is shifted 90 degrees so that the two signals combine in phase in the hybrid transformer which is connected to the output terminal. An automatic gain-control detector monitors the output level. The automatic phase-control detector samples the inputs at J1 and J2. A phase-control voltage is obtained which goes positive and negative about a center responding to any variance from 90 degrees in the relational phase of the two input signals.

2.26 The signal from J1 passes through a quarter-wavelength cable which shifts the phase 180 degrees from the input at J2, and enters the hybrid through capacitor C6. This voltage is applied to the junction of the primary of transformer T1 and resistor R5. The opposite ends of these elements are connected to the opposing ends of the secondary winding of transformer T2. The secondary center tap is at ac ground potential by action of the dc isolation capacitor C4. With the output jack terminated in 75 ohms, the input impedance of the transformer is 150 ohms (the same as resistor R5). The currents passing through R5 and the primary of transformer T1 enter the secondary of transformer T2 in opposite directions and cancel. The ends of the transformers appear as grounds. The voltage from the input of J1 appears only across the primary of T1 and across the resistor R5 and is not transmitted by the transformer T2 to jack J2.

2.27 An input signal at jack J2, differing from the signal at J1 by 90 degrees, after passing through transformer T2, appears on the ends of the transformer secondary with a plus or minus phase relative to the input at jack J2. The voltage on this secondary winding is connected to the primary of transformer T1 and R5 in series. Because the circuit is balanced at the junction of the primary of transformer T1 and resistor R5 and the potential at the junction is the same potential as the center tap of the secondary of transformer T2, ie, ground potential, no power from the input at jack J2 goes back into the input at J1. With signals applied simultaneously, combination takes place as follows. With the signal from J1 lagging the signal from J2 by 90° at the end of the 1/4-wavelength line, a voltage of $-V_1$ is applied at terminal P1 of transformer T1. The signal from J2 is transformed by T2 so as to apply a voltage V_2 at terminal P of T1 and $-V_2$ at the lower end of R5. The potential across the primary of T1 is equal to $-V_1 - V_2$ or $V_1 + V_2$. The potential across R5 is $V_1 - V_2$, tending to be zero. The voltage transmitted to the output jack J3 is 0.7 of $V_1 + V_2$. Maximum output occurs when the inputs are in proper phase and of equal magnitude.

2.28 The phase-detector circuit in the combiner controls the relative phase of the two local oscillators in the receiver to correct the phase of received signals and obtain proper addition of signals in the combiner. Phase changes are made by means of opposing-polarity dc voltages that advance or retard each oscillator in respect to the other. The automatic phase-control voltage is obtained by phase comparison of the signals in the combiner.

2.29 The V_a voltage at the input jack J1 is applied to crystal diodes CR1 and CR2 directly through capacitors C2 and C3. The voltage at the input jack J2 is applied to the push-pull transformer, T2, to derive two voltages, V_2 and $-V_2$. The V_2 is applied to CR1 and $-V_2$ voltage is applied to CR2. The voltage difference appearing across CR1 is $V_a - V_2$ and across CR2 is $V_a + V_2$. These sum and difference voltages are rectified by the crystal diodes and the dc circuits are connected to subtract the resulting outputs. The difference appears between terminals 5 and 6 on jack J4. A positive or negative control voltage is obtained between terminals 5 and 6 if V_a is less or more than 90° from V_2, and the oscillators are driven to maintain V_a and V_2 at a 90° phase angle. To obtain the required relationship in the hybrid, V_1 and V_2 must be maintained at 180°. A quarter-wavelength line is used to derive a V_1 lagging V_a by 90°, and the phase detector is connected to maintain V_a lagging V_2 by 90°.

2.30 The third section of the combiner is the automatic gain-control detector. The output of transformer T1 connects to the AGC detector through the isolating capacitor C8. The 70-MHz signal is rectified in a voltage-doubling circuit. After filtering, the resulting dc voltage appears on terminals 2 and 4 for application to the receiver AGC amplifier.

I. NUS 3357 Diversity Switching Panel

2.31 The diversity switching panel contains the third IF combiner used in quadruple-diversity operation and provides means of switching the 70-MHz receiver outputs, automatic gain-control and automatic phase-control circuits. One switching panel is provided for two adjacent dual-diversity receivers.

2.32 ***70-MHz Switching:*** The receiver 70-MHz output switching arrangement is shown in Fig. 7. When the receivers are operated in dual diversity, independent outputs are obtained at the OUTPUT A and OUTPUT B jacks through the operated contacts of the type 223 switches. When the receivers are operated in quadruple diversity, the two dual receiver outputs are switched to the two input terminals of the third IF combiner and the combined output appears at the OUTPUT A jack through the nonoperated contacts of the type 223A switch.

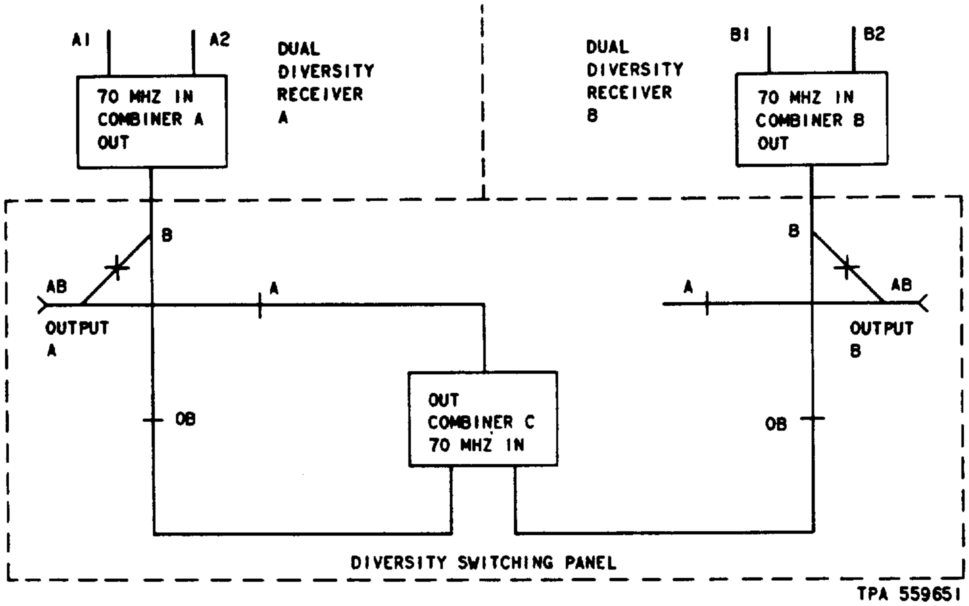

Fig. 7—70-MHz Switching Arrangement—Block Diagram

2.33 ***Automatic Gain-Control Switching:*** A simplified drawing of the low-level automatic gain-control circuits is shown in Fig. 8. With two adjacent receivers operating in dual diversity, the DIVERSITY switch is operated to the *2* position. The AGC voltage output of each receiver combiner is routed to the input terminals of one of two AGC amplifiers in each receiver as selected by the AGC SELECT switches.

2.34 When the receivers are operated in quadruple diversity, AGC voltage is developed in the third IF combiner located on the diversity switching panel and only one of the total of four available AGC amplifiers is selected for use by operation of the AGC AMPLIFIER SELECT switches.

2.35 A simplified drawing of the amplified AGC circuits is shown in Fig. 9. With the receivers operated in dual diversity, amplified AGC voltages are applied to the two IF main amplifiers in each receiver from one of two AGC amplifiers selected by the AGC AMP SELECT switches. With the diversity switch set for quadruple-diversity operation, one of four amplifiers is used to control the four IF main amplifiers.

2.36 ***Automatic Phase-Control Voltage Distribution:*** Automatic phase-control voltages are developed in the dual IF combiners and applied in opposing polarity to the two local oscillators in each receiver (Fig. 10). The APC output terminals of the third combiner provide the dc ground return for the two individual receiver APC circuits. During quadruple-diversity operation, the APC voltages appearing across the third combiner are added in series to the APC voltages developed in the individual receivers.

J. NUS 3352 Alarm and Power Distribution Panel

2.37 Alarm circuitry is provided in each dual-diversity receiver. The alarm and power distribution panels of two adjacent receivers differ in that the panel of one receiver contains alarm circuitry for quadruple-diversity operation. A buzzer is used as an alarm indicator and lamps provide alarm identification. The alarm panels are arranged for connection to a central office alarm system.

2.38 The alarm buzzer and the central-office alarm circuits are completed when the main alarm relay K12 is released. During an alarm condition, the buzzer can be silenced by means of the BUZZER DISABLE switch S4. To discourage operation with the buzzer disabled, the alarm circuit is arranged to sound the buzzer alarm during normal operation if the switch is left in the disabling position.

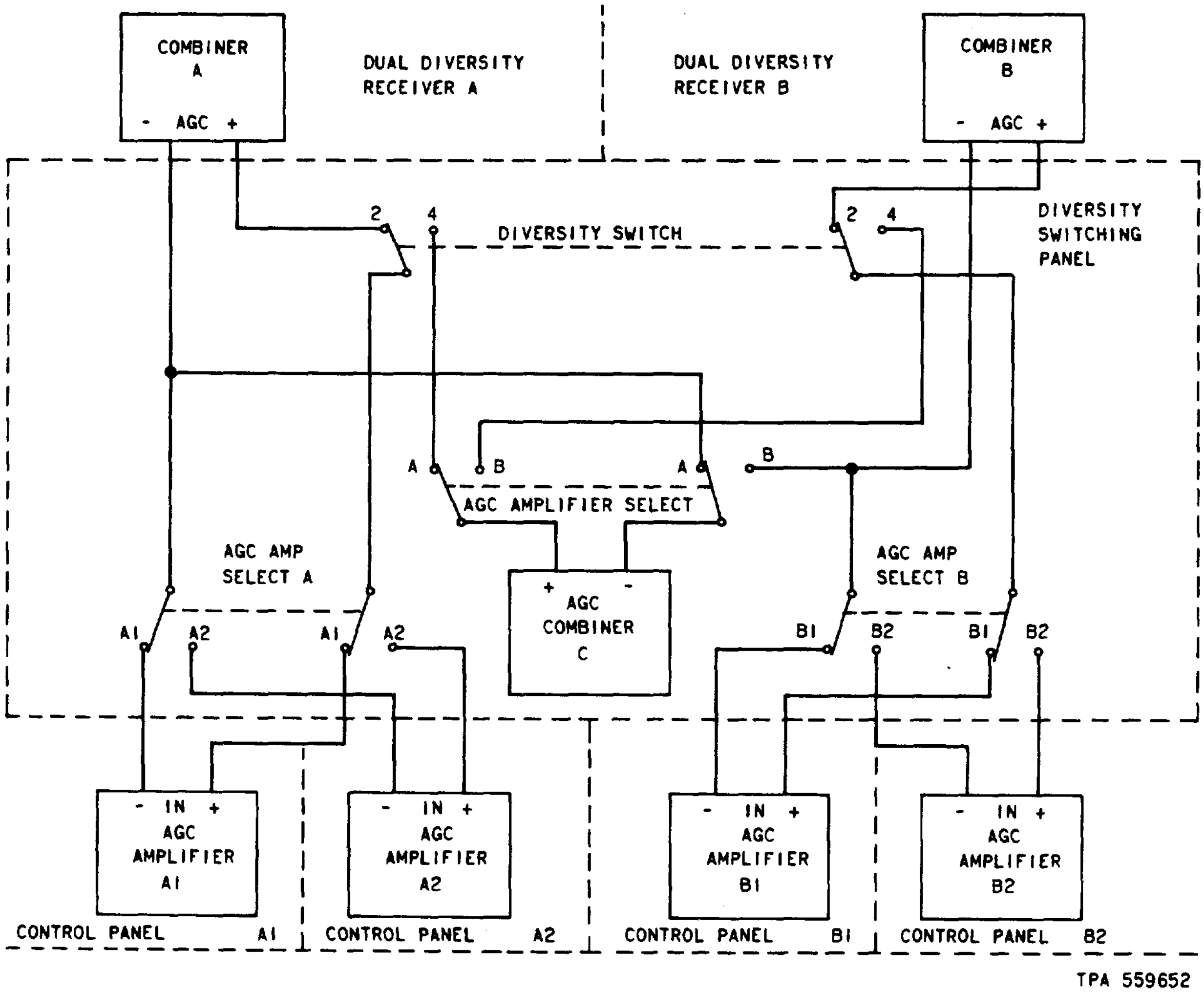

Fig. 8—Low-Level Automatic Gain-Control Circuits Switching Arrangement—Block Diagram

2.39 The alarm and power distribution panel distributes and provides fuse protection for the four externally connected power lines and the 6-Vdc filament circuits.

2.40 ***IF Output Alarm Circuits:*** A simplified schematic drawing of the IF output alarm circuits is shown in Fig. 11. By means of the 2-minute repeat-cycle timer M1 with its time staggered switch contacts and the two meter-type latching relays K1 and K2, any prolonged IF amplifier output failure will be sensed. The timer reset switch closes for a period of approximately five seconds each two minutes to energize the reset solenoids and lift the armature contacts off the magnetic latches on relays K1 and K2. A manually operated switch is provided for resetting of these contacts at any time. The moving contacts will return to the latches and stationary contacts if the relay coils sense IF amplifier output during the 2-minute interval between timer reset operations.

2.41 The coil of the IF-check relay K3 is energized when both moving contacts of relays K1 and K2 are operated to the latched position. Relay K3 is held operated by a circuit which includes its own operated contacts and the check switch contacts on the timer. The timer check switch is opened for five seconds at the conclusion of each 2-minute timer period. If either of the IF detector relay contacts are open during the check period, the IF-check relay K3 will release to operate the IF-alarm relay K4. Operation of K4 extinguishes the IF ALARM indicating lamps and releases the main alarm relay K12.

2.42 ***RF-Level Alarm Circuit:*** A simplified schematic drawing of the RF level alarm circuit is shown in Fig. 12. The RF level meter-type

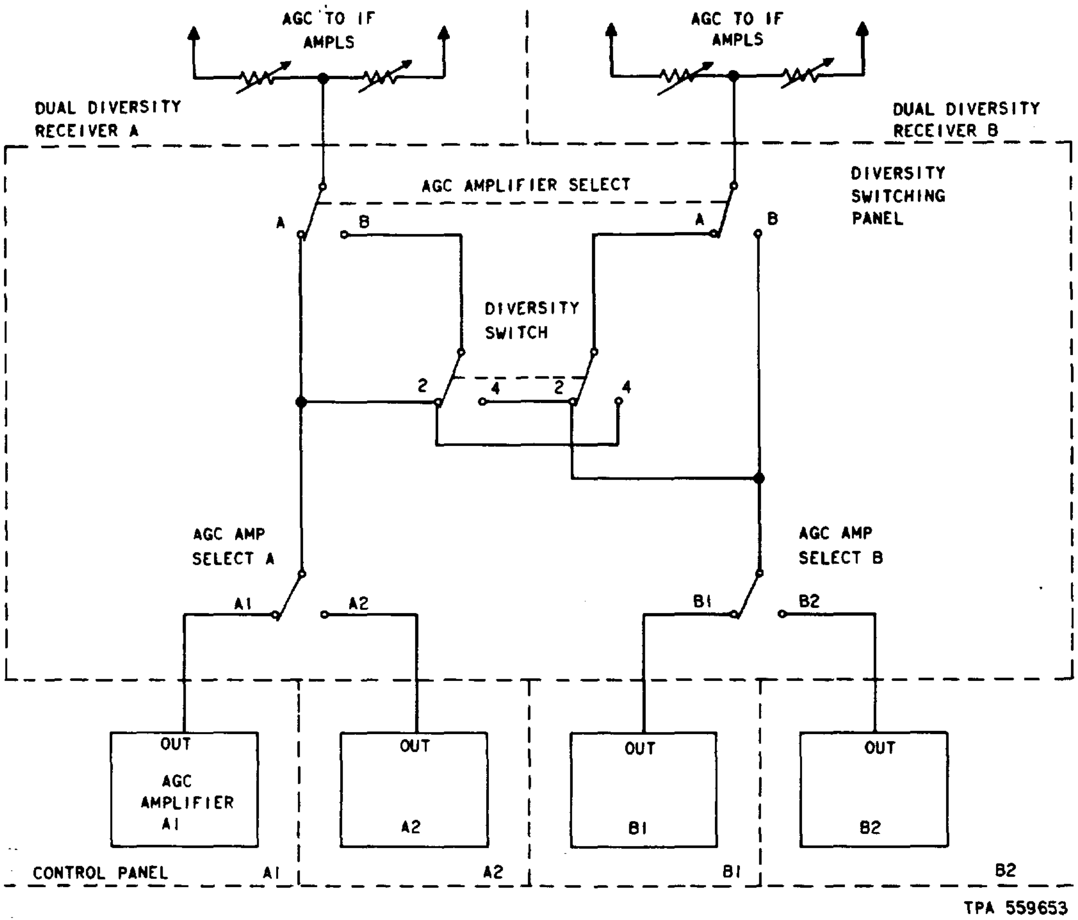

Fig. 9—Amplified Automatic Gain-Control Voltage Switching Arrangement—Block Diagram

relay coil is connected between the receiver amplified AGC line and a negative voltage, ie, between the RF LEVEL SENSITIVITY control R3 and the RF LEVEL CENTERING control R4. Normally, the RF level relay armature is centered. During periods of high or low received signal levels, abnormal AGC voltage causes the RF level relay contacts to close to operate relay K7. The RF level alarm relay pulsates through the recurrent operation of its own contacts to periodically operate the main alarm relay K12, producing a distinctive buzzer alarm and a blinking RF LEVEL lamp indication.

2.43 ***Phase-Lock Alarm Circuit:*** A simplified schematic drawing of the phase-lock alarm circuit is shown in Fig. 13. An audio detector circuit, consisting of a dc blocking capacitor and a diode, is placed across each of the receiver automatic phase-control lines to operate a latching relay when the result of improper phase lock (an audio-frequency voltage) is detected on the automatic phase-control lines. The phase lock alarm relay contacts close to release the main alarm relay K12, and to extinguish the PHASE LOCK alarm indicating lamp. The reset coil of the latching relay is energized by operation of the timer, once each two minutes, to automatically silence the alarm if an improper phase condition has been cleared.

2.44 ***Blower Alarm:*** A failure of the tube cooling air blower will cause the contacts of an air flow switch to operate the blower alarm relay K9, which extinguishes the BLOWER lamp and releases the main alarm relay.

K. Sola 28332 Power Supply

2.45 The receiver power supply developes two regulated 6-Vdc outputs isolated from ground to supply filament power for the local oscillator

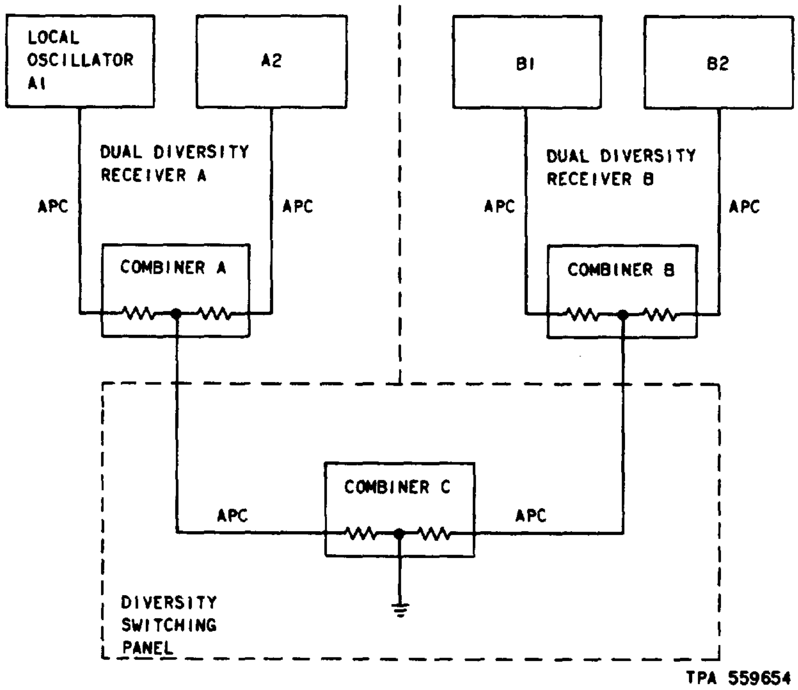

Fig. 10—Automatic Phase-Control Voltage Distribution Arrangement—Block Diagram

output tubes. A regulating transformer is used. The two secondary outputs are rectified and filtered.

L. WE J68330B Receiver Control Unit

2.46 Two receiver control units are used in each dual-diversity receiver to perform test functions for the receiver mixer-IF preamplifiers and IF main amplifiers in each of the two receiver branches and to control the IF main amplifier gains. Only one of the two AGC amplifiers contained in the two control units in each receiver is used at one time. The amplifier used is selected by operation of switches in the diversity switching panel. The control units are as described in detail in Section 410-400-100 except for the addition of two SLOPE ADJUST potentiometers in each unit to apportion the amplified AGC voltages between receiver branches.

M. NUS 3298 Cabinet Equipment

2.47 ***IF Attenuators:*** Four adjustable attenuators are mounted in the upper portion of the receiver cabinet. Two attenuators in series are used in the IF signal line between the IF preamplifier output and the IF equalizers input terminals in each receiver branch to control the levels applied to intermediate frequency amplifiers. Each branch includes one attenuator with values of 1, 2, 3, 4, and 10 dB and one attenuator with values of 10, 20, 20, and 20 dB. An attenuation range from 0 to 90 dB is provided in each receiver branch. Each attenuator is a resistive T network. Each unit of attenuation is switched by a single pushbutton control, consecutive operations of which connect the unit alternately in and out of the circuit. When any unit is connected in the circuit, it is evident from the fact that its push-button remains in a partially depressed position.

2.48 ***Air Blower:*** Each receiver cabinet contains a blower-filter assembly and air distribution system to cool the output tubes in the local oscillator and IF main amplifier assemblies.

3. DRAWING REFERENCES

3.01 The ITT Laboratories and Western Electric Company drawings applicable to the circuit descriptions given in this section are listed in Table B.

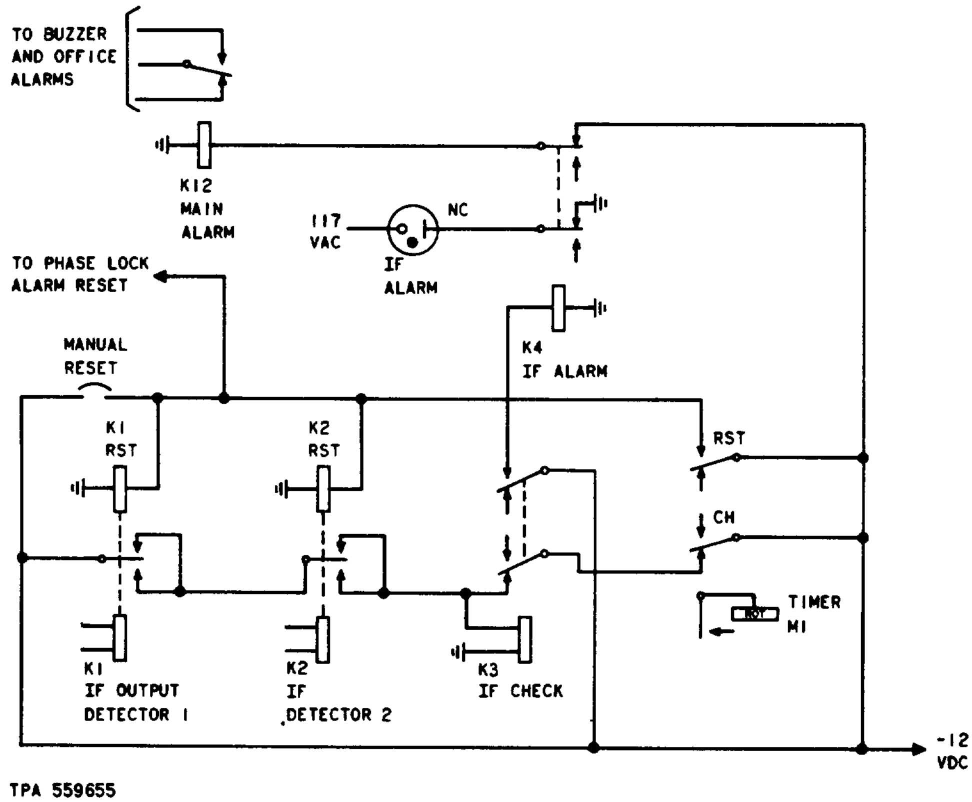

Fig. 11—IF Alarm Circuits—Simplified Schematic Diagram

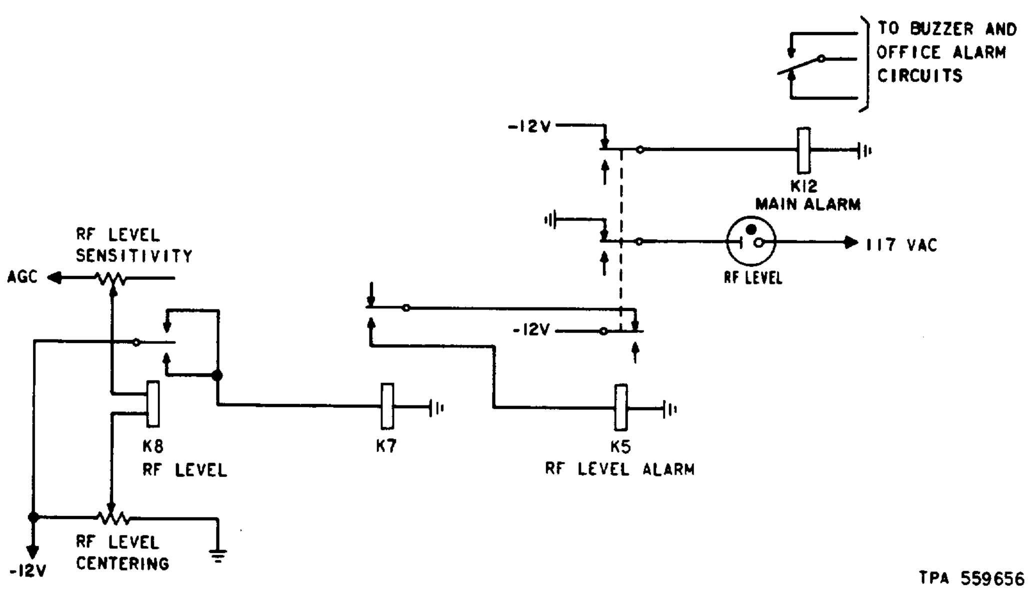

Fig. 12—RF-Level Alarm Circuit—Simplified Schematic Diagram

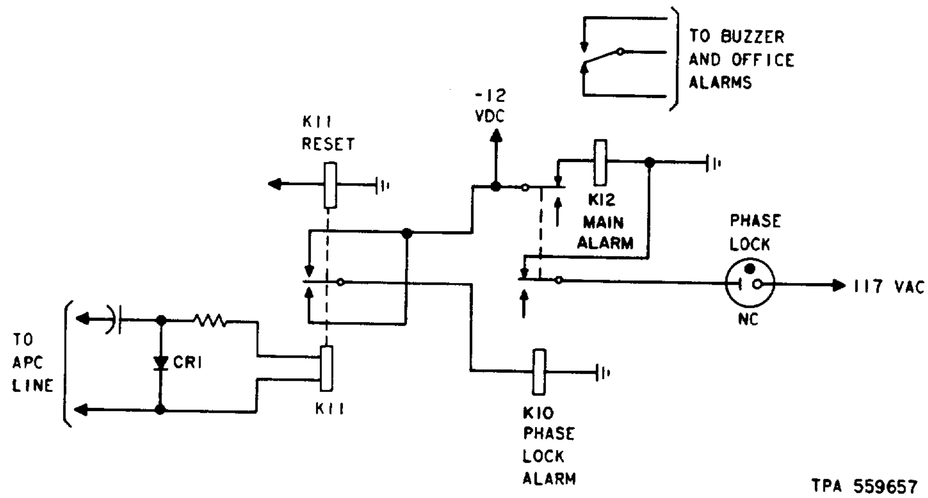

Fig. 13—Phase-Lock Alarm Circuit—Simplified Schematic Diagram