

**OVER-THE-HORIZON RADIO SYSTEMS**  
**2-GHZ OVER-THE-HORIZON RADIO SYSTEM**  
**ITTL POWER AMPLIFIER, NUS-3653-8**  
**OPERATION**

This section describes the procedures required to activate, operate, and deactivate the NUS-3653-8 10-kW power amplifier. These procedures must be coordinated with the distant receiver terminal.

**Warning:** *The power amplifier is equipped with interlock systems designed to prevent dangerous electrical shock to operating personnel. Do not tamper with or attempt to defeat the purpose of these interlock systems.*

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**CHART 1**  
**PLACING-IN-SERVICE OPERATIONS**

This chart describes the procedures for placing the power amplifier in service following (a) a complete shutdown operation and (b) after a removal-from-service operation in which only the beam voltage has been removed from the klystron.

**Note:** The power amplifier should not be energized unless the output is terminated in either the antenna transmission line or a water-cooled load. The power amplifier should not be energized for long periods of time with the driver disabled.

STEP	PROCEDURE
1	<p><b>A. Placing in Service following Complete Shutdown</b></p> <p>Operate power amplifier controls (Fig. 1) to the positions shown below:</p>

CHART 1 (Cont)

STEP	PROCEDURE																																					
	<table border="1"> <thead> <tr> <th>CONTROL</th> <th>POSITION</th> </tr> </thead> <tbody> <tr> <td>KLYSTRON FILAMENT variac</td> <td>FULLY CCW</td> </tr> <tr> <td>BEAM VOLTAGE variac</td> <td>FULLY CW</td> </tr> <tr> <td>BOOST-BUCK switch</td> <td>BUCK</td> </tr> <tr> <td>MASTER switch</td> <td>OFF</td> </tr> <tr> <td>AMPLIFIER ALARM switch</td> <td>OFF</td> </tr> <tr> <td>REFLECTOMETER switch</td> <td>INPUT INCIDENT</td> </tr> <tr> <td>REGULATOR MOTOR SUPPLY switch</td> <td>ON</td> </tr> <tr> <td>REGULATOR AUTOMATIC AND TEST switch</td> <td>AUTOMATIC</td> </tr> <tr> <td>CONTROL circuit breaker</td> <td>ON</td> </tr> <tr> <td>RECTIFIER FILAMENT circuit breaker</td> <td>ON</td> </tr> <tr> <td>KLYSTRON FILAMENT circuit breaker</td> <td>ON</td> </tr> <tr> <td>MAGNETS BODY 1 circuit breaker</td> <td>ON</td> </tr> <tr> <td>MAGNETS BODY 2 circuit breaker</td> <td>ON</td> </tr> <tr> <td>MAGNETS BODY 3 circuit breaker</td> <td>ON</td> </tr> <tr> <td>CABINET COOLING circuit breaker</td> <td>ON</td> </tr> <tr> <td>HEAT EXCHANGER circuit breaker</td> <td>ON</td> </tr> <tr> <td>REGULATOR circuit breaker</td> <td>ON</td> </tr> </tbody> </table>	CONTROL	POSITION	KLYSTRON FILAMENT variac	FULLY CCW	BEAM VOLTAGE variac	FULLY CW	BOOST-BUCK switch	BUCK	MASTER switch	OFF	AMPLIFIER ALARM switch	OFF	REFLECTOMETER switch	INPUT INCIDENT	REGULATOR MOTOR SUPPLY switch	ON	REGULATOR AUTOMATIC AND TEST switch	AUTOMATIC	CONTROL circuit breaker	ON	RECTIFIER FILAMENT circuit breaker	ON	KLYSTRON FILAMENT circuit breaker	ON	MAGNETS BODY 1 circuit breaker	ON	MAGNETS BODY 2 circuit breaker	ON	MAGNETS BODY 3 circuit breaker	ON	CABINET COOLING circuit breaker	ON	HEAT EXCHANGER circuit breaker	ON	REGULATOR circuit breaker	ON	
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2	Verify that all amplifier compartments and doors are closed and that all keys are in place in the KEY TRANSFER BOX A.																																					
3	Remove the top key from the key transfer box and insert into the MAIN DISCONNECT switch.																																					
4	Operate the MAIN DISCONNECT switch to ON. Depress the indicator reset button on each of the three phase failure relays.																																					
5	Operate the MASTER switch (Fig. 2) to ON. When the COOLANT FLOW indicator lamp lights, operate the COOLANT ALARM switch to ON.																																					
	<p><b>Note:</b> At this point, all six control circuit indicating lamps located in a row immediately below the BODY MAGNET 1 control (Fig. 2) should be lighted. An extinguished lamp in this row indicates an abnormal condition in the designated part of the control circuit. If the control circuit lamp indications are normal, proceed with Step 6.</p> <p><b>B. Placing in Service following Removal-from-Service operation during which only the beam voltage has been removed from klystron.</b></p>																																					
6	Adjust the BODY MAGNET 1, BODY MAGNET 2, and BODY MAGNET 3 controls to obtain the associated MAGNETS meters (Fig. 3) values established and recorded in the most recent klystron alignment test.																																					

CHART 1 (Cont)	
STEP	PROCEDURE
7	Adjust the KLYSTRON FILAMENT control to obtain the klystron FILAMENT VOLTS meter value established and recorded in the performance of the most recent klystron alignment test.
8	Verify that the driver has been placed in service.
9	Verify that the TIME DELAY and BEAM TIME DELAY lamps are lighted.
10	Verify that the BOOST-BUCK switch is in the BUCK position.
11	Operate the BEAM switch to ON. Operate the AMPLIFIER ALARM switch to ON. If circumstances permit, allow the equipment to warm approximately 5 minutes before proceeding.
12	Verify that the klystron FILAMENT VOLTS meter indication is the value established in Step 7. If necessary, make minor adjustments of the KLYSTRON FILAMENT control to compensate for change in the meter indication.
13	Adjust the BEAM VOLTAGE control slowly counterclockwise to obtain the system operating level on the RF POWER meter. If the operating level cannot be reached, adjust the BEAM VOLTAGE control fully counterclockwise and operate the BOOST-BUCK switch to BOOST. Adjust the BEAM VOLTAGE control slowly clockwise to obtain the required RF POWER meter indication.
<b>CHART 2</b>  <b>IN-SERVICE OPERATIONS</b>	
<p>This chart describes the procedures required to keep the NUS-3653-8 power amplifier operating within design limits and on a continuous basis. Certain meter checks and control adjustments must be made from time to time, at periods determined by local supervision, in order for operating personnel to be kept constantly aware of the equipment performance.</p>	
STEP	PROCEDURE
1	<p>Record the value indicated by the RF POWER meter (Fig. 3).</p> <p><b>Requirement:</b> As determined by local supervision and in no case greater than 10 kW.</p> <p><b>Note:</b> If the requirement is not met, carefully adjust the BEAM VOLTAGE control (Fig. 2) to obtain the correct RF output. Monitor the meters listed below while making the beam voltage adjustment.</p>

CHART 2 (Cont)

STEP	PROCEDURE																				
	<table border="1"> <thead> <tr> <th>METER</th> <th>TYPICAL VALUE</th> <th>MAX ALLOWABLE VALUE</th> </tr> </thead> <tbody> <tr> <td>RF POWER</td> <td>5.0 kW</td> <td>10.0 kW</td> </tr> <tr> <td>BEAM VOLTAGE</td> <td>14.0 kV</td> <td>16.0 kV</td> </tr> <tr> <td>BEAM CURRENT</td> <td>1.4 A</td> <td>2.3 A</td> </tr> <tr> <td>BODY CURRENT</td> <td>0.2 mA</td> <td>0.75 mA</td> </tr> <tr> <td>REFLECTOMETER (with REFLECTOMETER switch in the INPUT INCIDENT position)</td> <td>0.3 W</td> <td>0.5 W</td> </tr> </tbody> </table>			METER	TYPICAL VALUE	MAX ALLOWABLE VALUE	RF POWER	5.0 kW	10.0 kW	BEAM VOLTAGE	14.0 kV	16.0 kV	BEAM CURRENT	1.4 A	2.3 A	BODY CURRENT	0.2 mA	0.75 mA	REFLECTOMETER (with REFLECTOMETER switch in the INPUT INCIDENT position)	0.3 W	0.5 W
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2	<p>Record the value indicated by the BODY CURRENT meter (Fig. 3).</p> <p><b>Requirement:</b> Less than 0.75 mA.</p> <p><b>Note:</b> If the requirement is not met, carefully adjust the BODY MAGNETS controls (Fig. 2) for minimum body current. Maintain magnet currents as outlined below while adjusting for minimum body current.</p> <table border="1"> <thead> <tr> <th>METER</th> <th>TYPICAL VALUE</th> <th>MAX ALLOWABLE VALUE</th> </tr> </thead> <tbody> <tr> <td>BODY 1</td> <td>5.0A</td> <td>6.0 A</td> </tr> <tr> <td>BODY 2</td> <td>2.5 A</td> <td>5.0 A</td> </tr> <tr> <td>BODY 3</td> <td>2.0 A</td> <td>4.0 A</td> </tr> <tr> <td>BODY CURRENT</td> <td>0.2 mA</td> <td>0.75 mA</td> </tr> </tbody> </table> <p>Upon obtaining minimum body current, readjust the BEAM VOLTAGE control, if necessary, to compensate for any undesired increase in RF power.</p>			METER	TYPICAL VALUE	MAX ALLOWABLE VALUE	BODY 1	5.0A	6.0 A	BODY 2	2.5 A	5.0 A	BODY 3	2.0 A	4.0 A	BODY CURRENT	0.2 mA	0.75 mA			
METER	TYPICAL VALUE	MAX ALLOWABLE VALUE																			
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BODY 3	2.0 A	4.0 A																			
BODY CURRENT	0.2 mA	0.75 mA																			
3	<p>Record the values indicated by the klystron FILAMENT CURRENT and FILAMENT VOLTS meters.</p> <p><b>Requirement:</b> 15 A at no more than 3.5V.</p> <p><b>Note:</b> If the requirement is not met, adjust the KLYSTRON FILAMENT control to obtain the correct values.</p>																				

## CHART 2 (Cont)

STEP	PROCEDURE
4	<p>Record the coolant flow values indicated by the BODY FLOW and COLLECTOR FLOW meters (Fig. 3).</p> <p><b>Requirement:</b> At least 0.6 GPM through the body jacket and at least 7 GPM through the collector jacket.</p> <p><b>Note:</b> If the requirement is not met, adjust the heat exchanger operating pressure to increase both meter indications, or adjust the body flow balance valve V5 and the collector flow balance valve V6 to compensate for an unbalanced coolant flow condition (Fig. 4).</p>
5	<p>Record the value indicated by the AC LINE VOLTAGE meter with the LINE VOLTAGE switch in the REGULATED BC position.</p> <p><b>Requirement:</b> 208 <math>\pm</math>1V</p> <p><b>Note:</b> If the requirement is not met, realignment of the induction voltage regulator is indicated. The procedure requires system deactivation and is covered in Section 403-405-501.</p>

## CHART 3

## REMOVAL-FROM-SERVICE AND SHUTDOWN OPERATIONS

This chart describes the procedures for (a) removing the power amplifier from service and (b) effecting complete shutdown. The removal-from-service operation is defined as the suspension of transmission without the removal of all operating voltages. Shutdown means removal of all power and is necessary to gain access to interlocked amplifier compartments.

**Caution:** *The MAIN DISCONNECT switch should not be operated to the OFF position as the first step in a shutdown operation. The shutdown procedure described in this chart should be followed.*

STEP	PROCEDURE
<b>A. Removal-From-Service Operation</b>	
1	Operate the BEAM switch and the AMPLIFIER ALARM switch to OFF (Fig. 2).
2	Operate the BOOST-BUCK switch to BUCK.
3	Operate the BEAM VOLTAGE control fully clockwise.

## CHART 3 (Cont)

STEP	PROCEDURE
4	<p>Operate the KLYSTRON FILAMENT control fully counterclockwise.</p> <p><i>Note:</i> If a complete shutdown operation is required, continue with Step 5.</p> <p><b><i>B. Amplifier Shutdown Operation</i></b></p>
5	<p>After insuring that Steps 1 through 4 have been completed, operate the MASTER switch to OFF. Before proceeding to Step 6, wait approximately 2 minutes until the CONTROL lamp (Fig. 2) is extinguished.</p>
6	<p>Operate the MAIN DISCONNECT switch to OFF.</p>
7	<p>Remove the key from the MAIN DISCONNECT switch, and insert it into the top slot in the KEY TRANSFER BOX A.</p> <p><i>Note:</i> Completion of Step 7 prevents accidental closing of the MAIN DISCONNECT switch and simultaneously allows for operation of the key interlock system. Key interlock system operation is required to gain access to locked amplifier compartments. The key interlock operating sequence is shown in Fig. 5.</p>

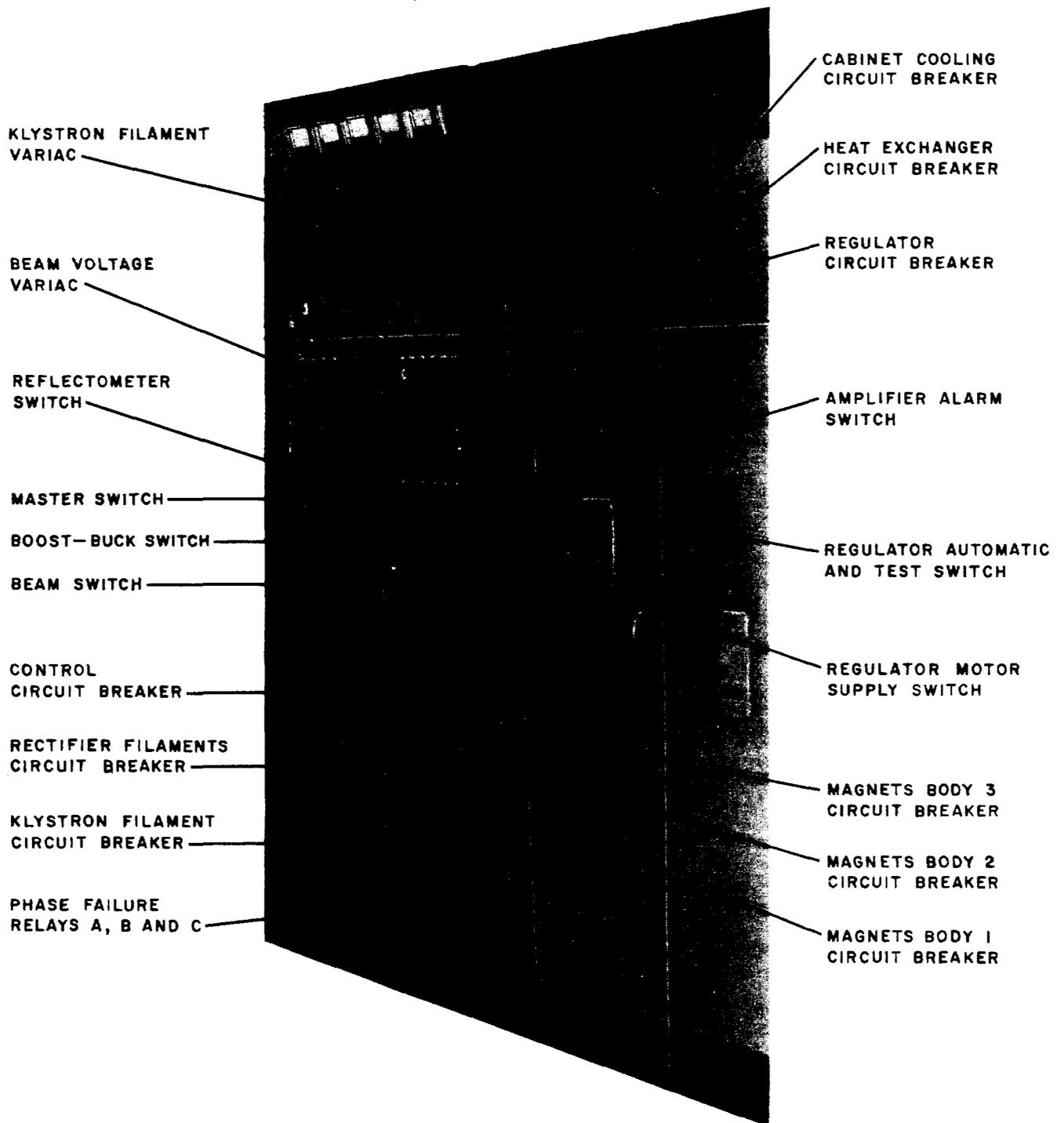


Fig. 1—Control Bay and Regulator Bay

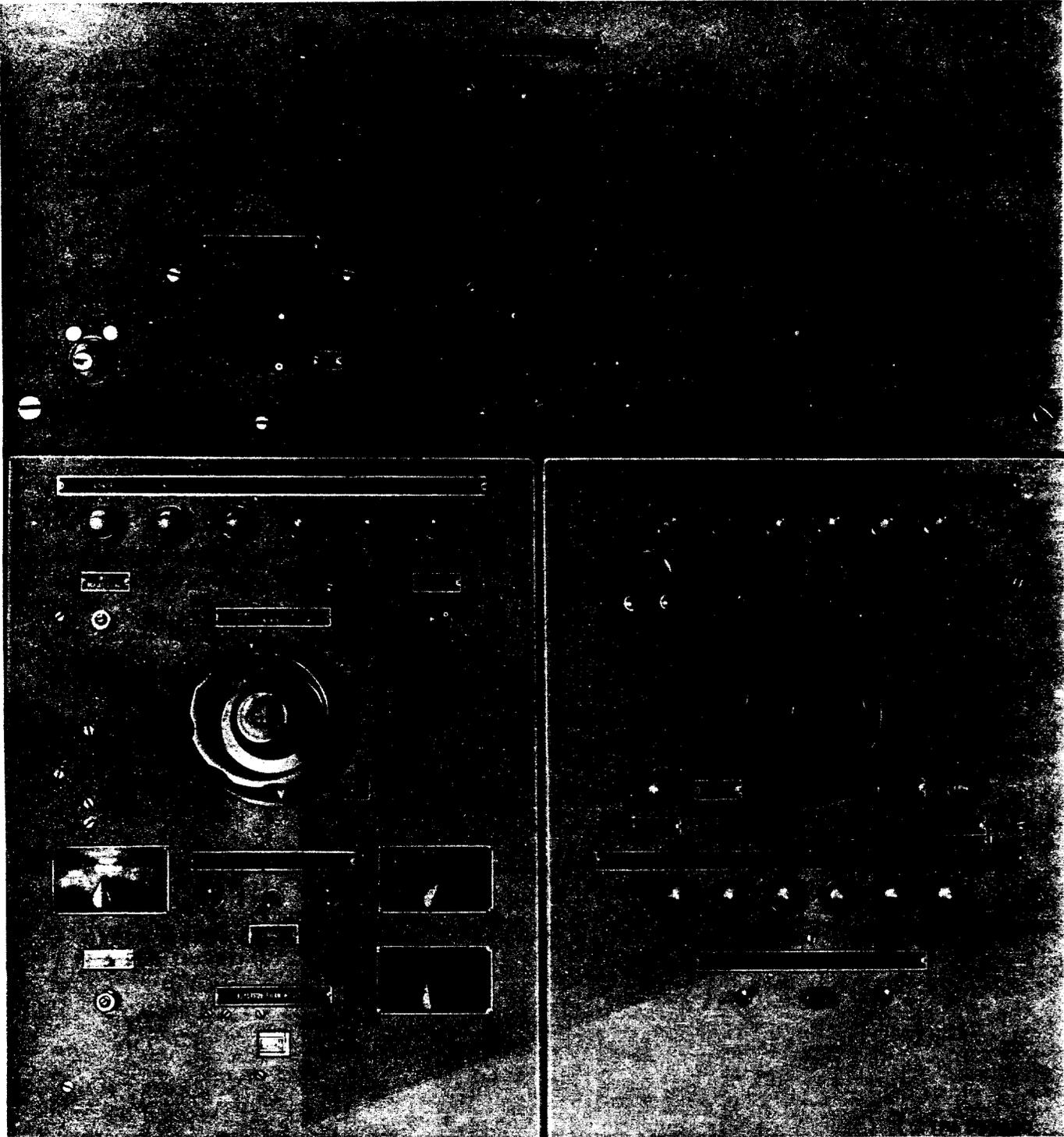
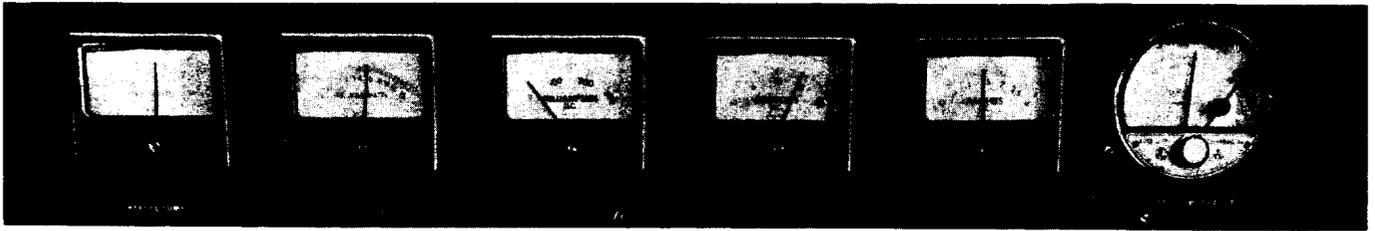


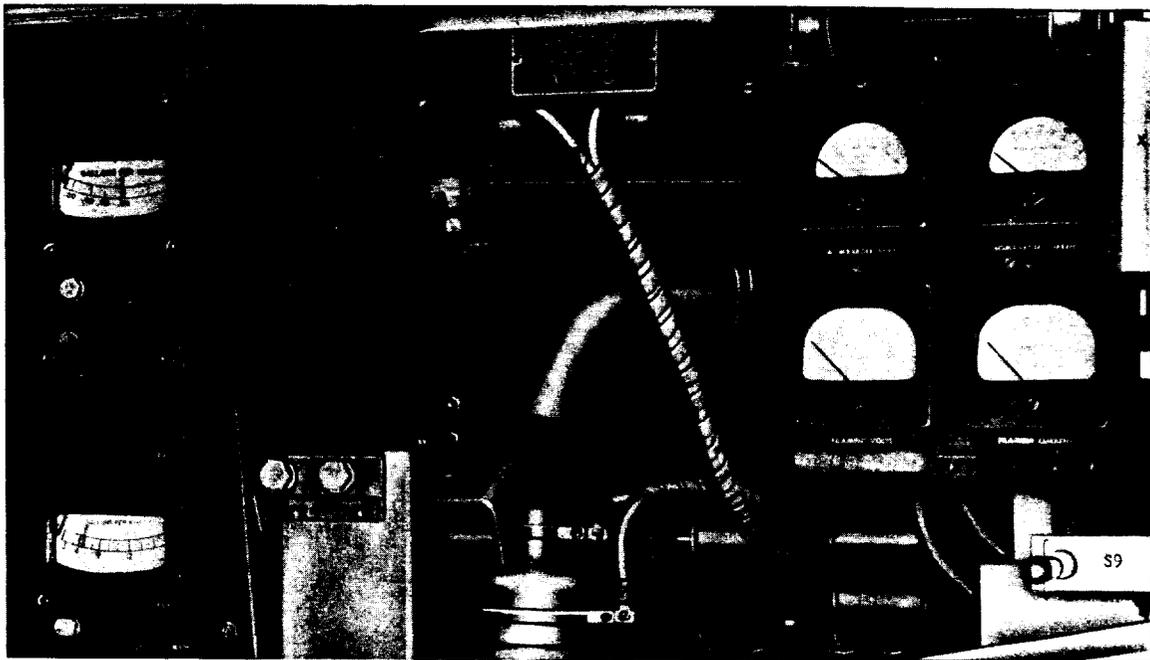
Fig. 2—Operating Controls and Lamps



A—PA CABINET—TOP LEFT



B—PA CABINET—TOP RIGHT



C—KLYSTRON BAY—HIGH VOLTAGE COMPARTMENT

Fig. 3—Power Amplifier Meters

BODY FLOW  
BALANCE  
VALVE  
V5

COLLECTOR  
FLOW  
BALANCE  
VALVE  
V6

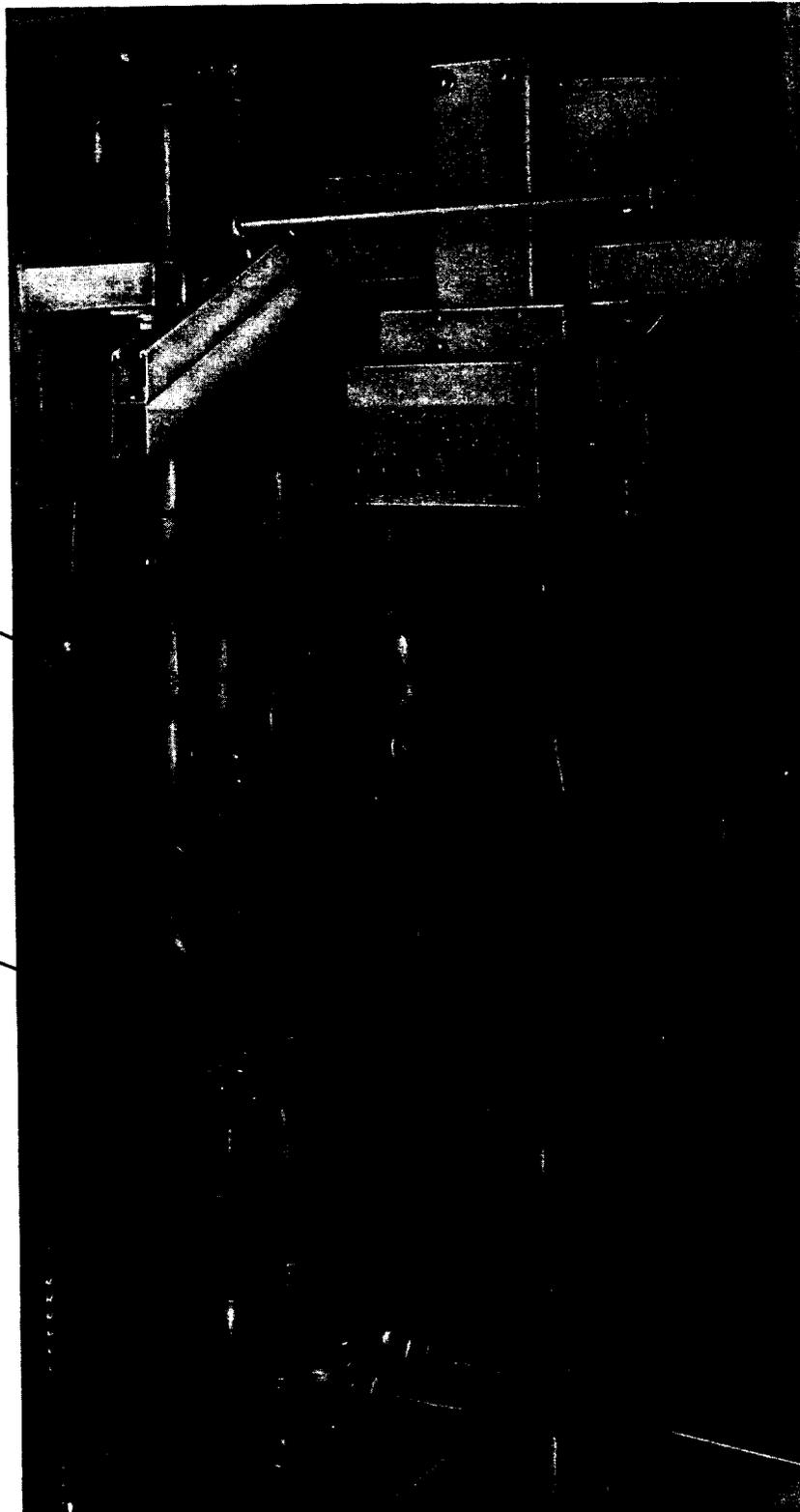


Fig. 4—Klystron Bay—Coolant Plumbing

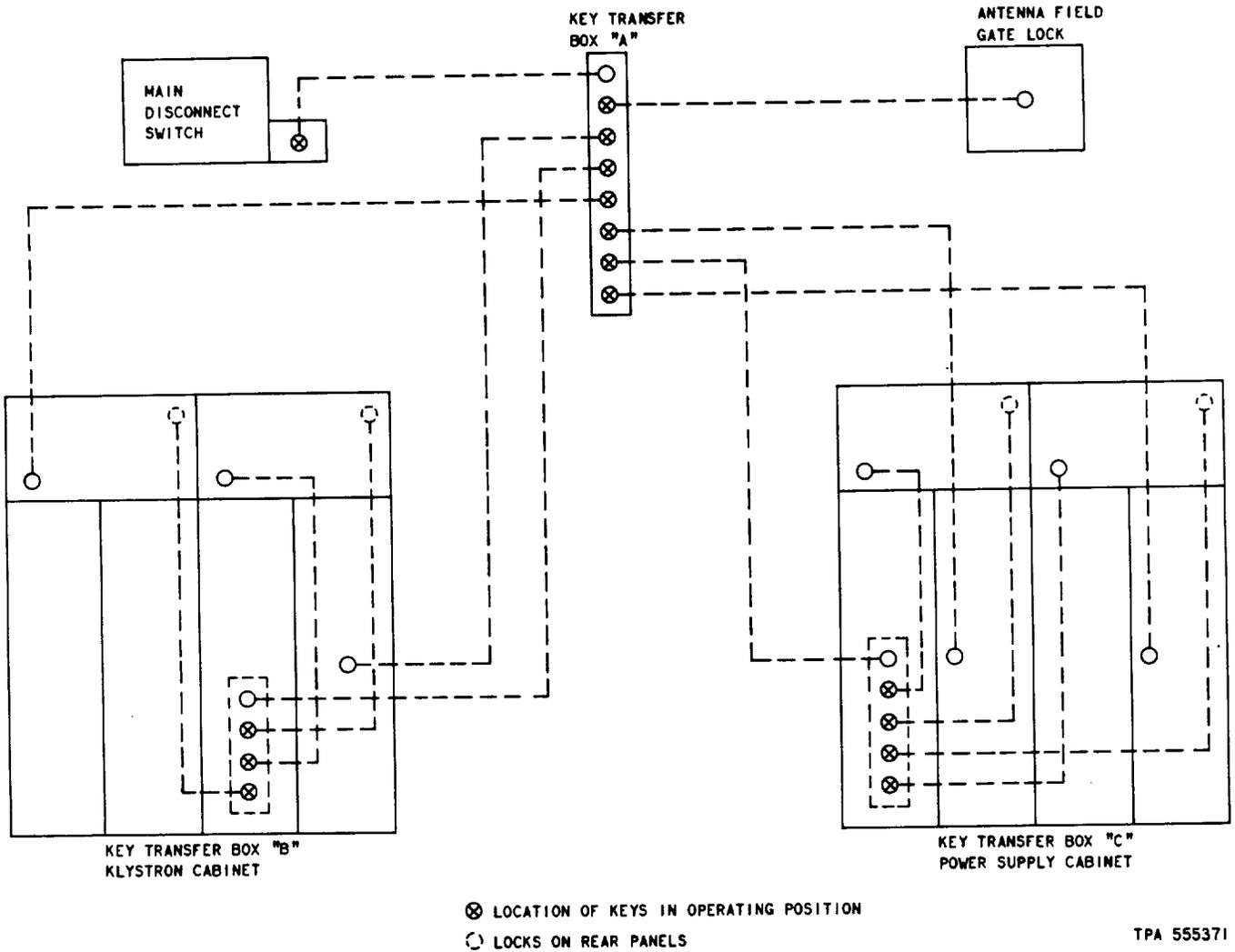


Fig. 5—Key Interlock System