

# *Dresden* SECTION I *II* *type*

## INTRODUCTION AND DESCRIPTION

### 1.1 Introduction

This manual contains instructions covering General Electric Hydraulic Control Units, Part Nos. 237E918G2 through G5. Each such unit functions within a hydraulic system to position one locking-piston control rod drive mechanism in a General Electric boiling water reactor. These instructions consist of descriptive and operating information, replacement procedures, maintenance and trouble-analysis procedures, and a parts list. These instructions are identically applicable to Hydraulic Control Units Part Nos. 237E918G2 through G5. The specific differences in these Groups (G) are noted in subsection 1.3, at the conclusion of this section.

This manual is prepared for use in conjunction with the Control Rod Drive System Operating and Maintenance Manual for the particular nuclear power station for which hydraulic control units are provided. Consequently, this manual does not contain operation or maintenance instructions applicable to the overall control rod drive hydraulic system; these instructions are contained in the control rod drive system instruction manual referenced above.

### 1.2 Description and Operating Principles

The hydraulic control unit combines all operating valves and components required for the normal or scram (rapid control rod insertion) positioning of a single control rod drive mechanism. The unit functions on differential hydraulic pressures supplied by the control rod drive hydraulic system to insert or withdraw its associated drive mechanism, and to provide cooling water to the drive mechanism. The solenoid-operated valves which control normal directional movement of the drive mechanism respond to programmed signals from the reactor manual control system. The scram accumulator and scram valves are interconnected with the reactor protection system to function as required to rapidly insert the associated drive mechanism in the event of a scram signal.

All hydraulic risers in the control unit are provided with manual shutoff valves which isolate individual components for servicing during reactor operation. External electrical connections from the reactor manual control system are routed through terminals in a single wiring trough assembly on the front of the unit to simplify trouble-analysis and repair.

Each major component in the hydraulic control unit has been assigned an Equipment Piece (EP) number. Figure 1-1 shows a piping and instrumentation diagram of the unit and includes these EP numbers. The number appearing in parentheses after the name of a component in the following text and in the subsequent sections of this manual is the EP number by which that component is identified in Figure 1-1.

Figure 1-9, at the conclusion of this section, shows an over-all view of the hydraulic control unit and may be opened for simultaneous use with the discussions that follow. The EP numbers assigned to components shown on Figure 1-9 appear in the index to that figure, where they apply. In addition to the illustrations provided in this section, the engineering drawings included in Section VI of this manual provide supplemental detail to the contents of this section and should be referred to as required. For an assembly drawing of the hydraulic control unit, see Drawing 237E918 in Section VI.

7907 190 570



1-2

465-219

### 1.2.1 Piping Assembly

The piping assembly (see Drawing 237E972 in Section VI) is comprised of the seven hydraulic risers shown on Figure 1-9, the manifold, and the inlet and outlet scram valves (126, 127).

Internal porting in the manifold (see Drawing 237E973 in Section VI) directs water between the seven risers and the valves installed on the hydraulic control unit. In addition, porting in the manifold contains the cooling check valve (138), the driving water check valve (137), and the three filter elements (134, 135, 136) which protect the directional control valves mounted on the manifold as well as the drive mechanism from foreign matter in hydraulic system water. These components, and the four pressure test connections (P1 through P4), are accessible through individual threaded plugs in the outside wall of the manifold.

Figure 1-2 shows a hydraulic circuit diagram of the interior of the manifold, together with the scram valves and hydraulic risers. The directional control valves shown in Figure 1-2 are mounted on the front surface of the manifold.

Table 1-1 lists the seven hydraulic risers and the water flowing through each to and from the manifold during the various modes, or functions, of control rod drive operation: insert, withdraw, scram, and cooling when the drive is stationary at a latched position. Flow arrows on Figure 1-2 show the direction of water entering and leaving the manifold through the risers during the various modes of drive operation. The valve actions which result in these flows are described in the following subsections.

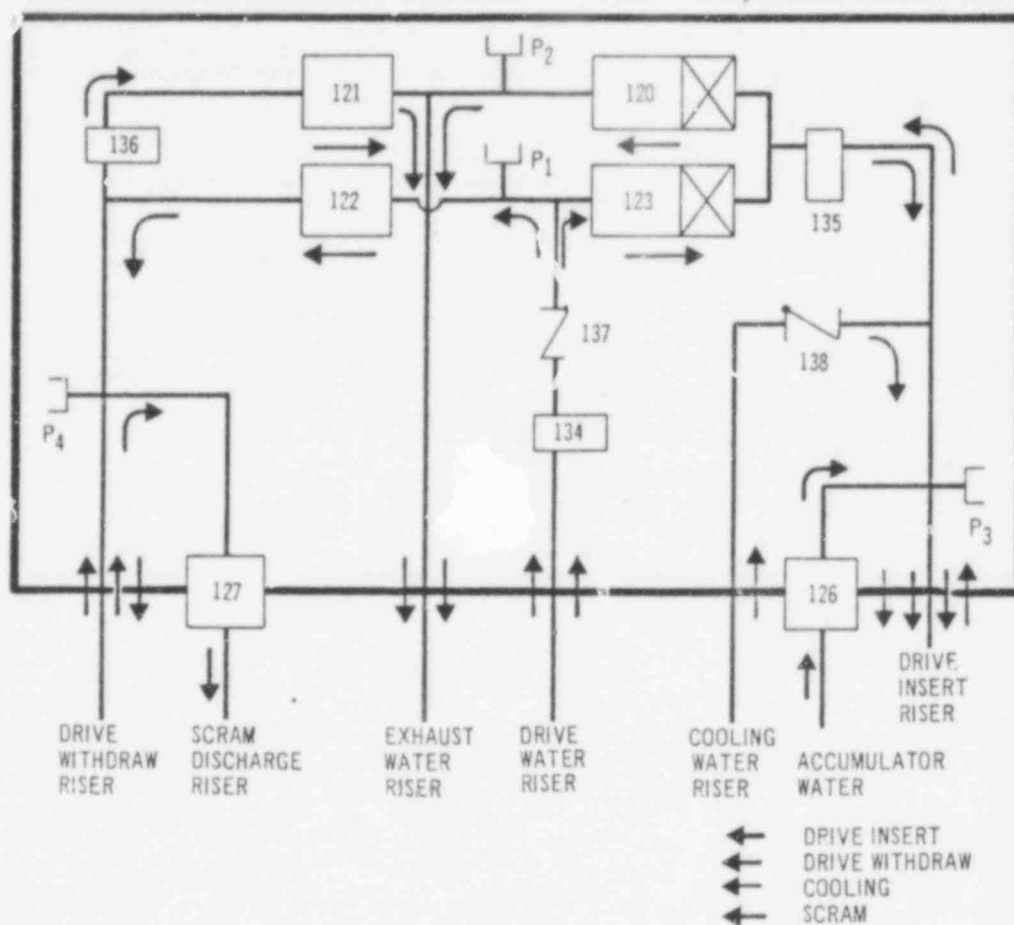
### 1.2.2 Cooling Section

The cooling section of the hydraulic control unit consists of the cooling water riser and the cooling check valve (138). Cooling water is provided from the hydraulic system cooling water header to the cooling water riser to cool the control rod drive, and is admitted to the drive-insert riser at all times that the control rod drive is at a stationary position. Normal flow from the cooling water riser to the drive-insert riser through check valve 138 is from 0.2 to 0.4 gpm at a pressure of approximately 20 psi above reactor pressure. When a drive is in motion, pressure in the manifold to the drive-insert riser is higher than the cooling water pressure and valve 138 shifts to close off the flow of cooling water.

### 1.2.3 Driving Section

#### 1.2.3.1 Description

The four solenoid-operated (SO) directional control valves (120, 121, 122, 123) shown in Figure 1-3 and on Drawing 112C2129 in Section VI, are mounted on a sub-plate installed on the piping assembly manifold. These valves are energized by the electrical relay action of the reactor manual control system to direct control pressures through the hydraulic control unit to the under- and over-piston ports in the associated control rod drive as required for normal drive operation.



## COMPONENTS

EP No.	
120	DIRECTIONAL CONTROL VALVE W/SPEED CONTROL ELEMENT (DRIVE-WITHDRAW)
121	DIRECTIONAL CONTROL VALVE (DRIVE-INSERT)
122	DIRECTIONAL CONTROL VALVE (DRIVE-WITHDRAW)
123	DIRECTIONAL CONTROL VALVE W/SPEED CONTROL ELEMENT (DRIVE-INSERT)
126	INLET SCRAM VALVE
127	OUTLET SCRAM VALVE
134	FILTER ELEMENT (HYDRAULIC SYSTEM WATER)
135	FILTER ELEMENT (WATER TO/FROM CRD UNDER-PISTON PORT)
136	FILTER ELEMENT (WATER FROM CRD OVER-PISTON PORT)
137	CHECK VALVE (DRIVE WATER)
138	CHECK VALVE (COOLING WATER)
P1	THREADED PLUG FOR TEST CONNECTION (LINE TO CRD UNDER-PISTON PORT)
P2	THREADED PLUG FOR TEST CONNECTION (EXHAUST LINE)
P3	THREADED PLUG FOR TEST CONNECTION (DRIVE WATER)
P4	THREADED PLUG FOR TEST CONNECTION (LINE TO CRD OVER-PISTON PORT)

FIGURE 1-2. HYDRAULIC CIRCUIT DIAGRAM—MANIFOLD

4867-9

POOR ORIGINAL

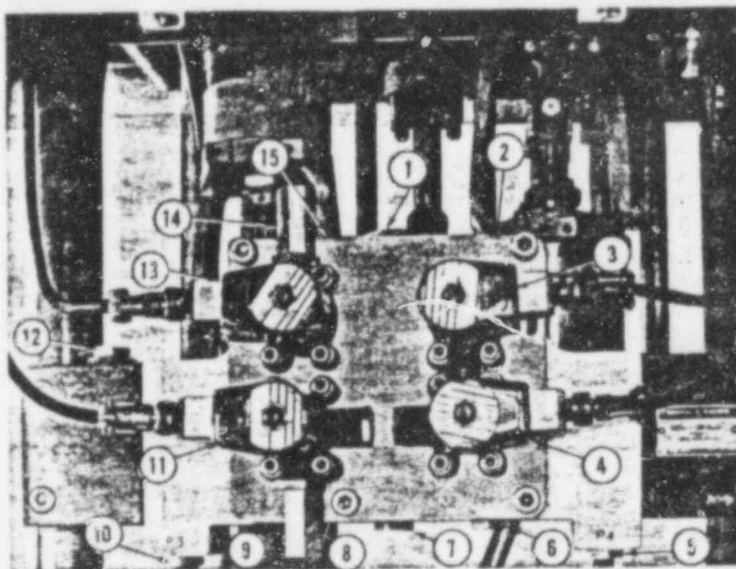


Table 1-1. FLOW FUNCTIONS THROUGH PIPING ASSEMBLY RISERS

Riser	Control Rod Drive Functions and Flow Functions			
	Drive-Insert	Drive-Withdraw	Scram	Drive Stationary
Accumulator Charging	Water from CRD hydraulic system accumulator charging header to scram accumulator water cylinder; continuous regardless of CRD function.			
Drive-Withdraw	Discharge water from CRD over-piston port to manifold.	Drive water from manifold to CRD over-piston port.	Scram discharge water from CRD over-piston port to manifold.	No Flow
Drive Water	Water from CRD hydraulic system drive water header to manifold.	Water from CRD hydraulic system drive water header to manifold.	No Flow	No Flow
Exhaust Water	Water from manifold to CRD hydraulic system exhaust water header.	Water from manifold to CRD hydraulic system exhaust water header.	No Flow	No Flow
Drive-Insert	Drive water from manifold to CRD under-piston port.	Discharge water from CRD under-piston port to manifold.	Accumulator water from manifold to CRD under-piston port.	Cooling water from manifold to CRD under-piston port.
Cooling Water	No Flow	No Flow	No Flow	Water from CRD hydraulic system cooling water header to manifold.
Scram Discharge	No Flow	No Flow	Discharge water from manifold to CRD hydraulic system scram discharge header.	No Flow

GEI-92807

465 222



1. THREADED PLUG - CHECK VALVE 137
2. THREADED PLUG - TEST CONNECTION P2
3. SO VALVE 121 - DRIVE INSERT (EXHAUST FROM OVER-PISTON)
4. SO VALVE 122 - DRIVE WITHDRAW (DRIVE WATER TO OVER-PISTON)
5. THREADED PLUG - TEST CONNECTION P4
6. THREADED PLUG - FILTER 136
7. THREADED PLUG - FILTER 134
8. DRIVE INSERT SPEED CONTROL - INTEGRAL WITH VALVE 123
9. THREADED PLUG - FILTER 135
10. THREADED PLUG - TEST CONNECTION P3
11. SO VALVE 123 - DRIVE INSERT (DRIVE WATER TO UNDER-PISTON)
12. THREADED PLUG - CHECK VALVE 138
13. SO VALVE 120 - DRIVE WITHDRAW AND SETTLE (EXHAUST FROM UNDER-PISTON)
14. DRIVE WITHDRAW SPEED CONTROL - INTEGRAL WITH VALVE 120
15. THREADED PLUG - TEST CONNECTION P1

4867-2

Figure 1-3. Manifold with Directional Control Valves

By energizing and opening two of the four valves simultaneously, the hydraulic system drive water header is connected through the manifold to either under or over the piston in the drive mechanism while the exhaust water header is simultaneously connected to the opposite side of the drive piston. In this manner driving pressure is supplied through the hydraulic control unit to insert or withdraw its associated control rod. The two directional control valves (120, 123) which include integral speed control elements are connected to the manifold so that they always pass flow to or from the drive-insert riser and the under-piston port in the control rod drive. These speed control elements are manually adjustable so that control rod drive speed may be regulated by increasing or decreasing the flow to or from the under-piston area. The flow through these valves is approximately 4 gpm when the drive mechanism is being inserted at a normal speed of 3 inches per second, and approximately 3 gpm during drive mechanism withdrawal.

Since common piping (see Figure 1-2 and Table 1-1) and porting in the manifold is used to and from the control rod drive for the purposes of cooling, driving, and scram, the directional control valves are periodically subjected to scram pressure. One of these valves (123) connected to the driving water riser can be opened by this higher pressure applied to its outlet ports. The check valve (137) installed in the manifold porting to valve 123 prevents significant water loss to the drive water riser during scram. The cooling check valve (138), discussed in subsection 1.2.2, above, provides the identical function for the cooling water riser.

- b. The solenoid-operated scram pilot valves (117, 118) and the manual isolation valve (116) in the air line to these valves.
- c. The scram accumulator and associated valves and monitoring instrumentation.

The two scram pilot valves (117, 118) are directly connected to the reactor protection system so that the inlet and outlet scram valves (126, 127) open in response to scram signals. When open, the inlet scram valve permits the scram accumulator to supply the initial hydraulic energy required to rapidly insert the associated control rod. The simultaneous opening of the outlet scram valve permits water vented from the control rod drive to exhaust into the hydraulic system scram discharge header during a scram insertion. The accumulator monitoring instrumentation is interconnected with the reactor manual control system so that a remote alarm is provided in the event of gas or water leakage.

#### 1.2.4.1 Scram Pilot Air Valves

During normal power station operation, each of the two channels of the reactor protection system energizes one of the two 3-way solenoid-operated scram pilot air valves (117, 118) (See Drawing 885D661 in Section VI). When energized, these pilot valves supply instrument air to the diaphragm actuators of the inlet and outlet scram valves (126, 127). Upon initiation of scram, both reactor protection system channels are de-energized and both pilot valves open, venting air pressure from the scram valves and permitting them to open. Figure 1-4 shows the energized and de-energized positions of the pilot valves.

To prevent spurious scrams, both pilot valves are interconnected so that both must be de-energized before control air pressure is vented from the inlet and outlet scram valves with the resulting scram insertion of the control rod drive associated with the hydraulic control unit. De-energizing of either one of the pilot valves will not result in scram since control air pressure will continue to be applied to the inlet and outlet scram valves through the remaining energized pilot valve.

Control air pressure is supplied to the pilot valves through an isolation valve (116) from the hydraulic system scram valve pilot air header. Valve 116 may be closed to isolate the pair of scram pilot air valves for maintenance.

#### 1.2.4.2 Inlet and Outlet Scram Valves

The inlet and outlet scram valves (126, 127) are held normally-closed by control air pressure applied to their respective diaphragm actuators by the scram pilot valves (117, 118). They open by internal spring pressure (approximately 700 pounds) upon the removal of control air pressure.

When opened, the inlet scram valve (126) opens the drive-insert riser to the scram accumulator through porting in the manifold so that accumulator pressure is applied to the under-piston port in the control rod drive. The outlet scram valve (127), when opened, opens the drive-withdraw riser to the scram discharge riser through porting in the manifold so that water vented from the over-piston port during the control rod drive scram insertion exhausts to the hydraulic system scram discharge header. Each of the valves starts to open within nominally 0.15 second after

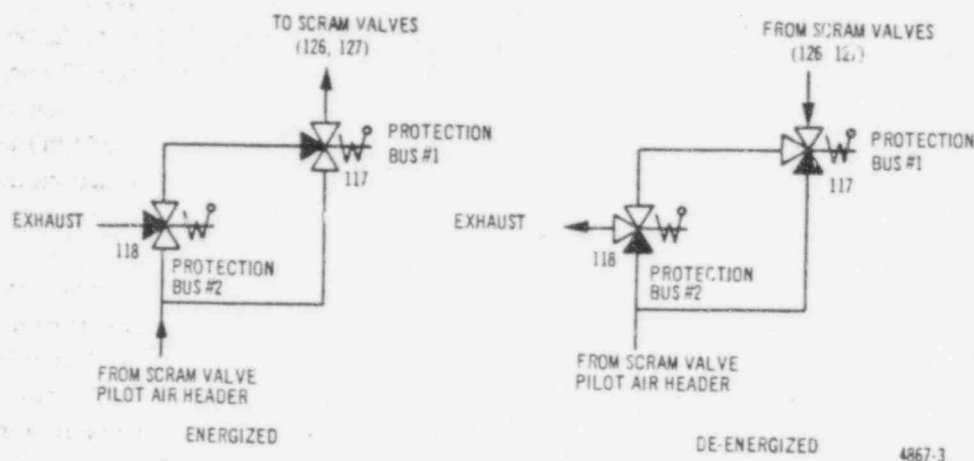


Figure 1-4. Functional Diagram—Scram Pilot Air Valves

loss of voltage to the pilot-valves (117, 118), and each is provided with a stem-mounted position switch (see Figure 1-5). The position switch actuates when the valve plug leaves the seat to provide a remote indication of the valve position.

Both valves are basically similar, except that the inlet scram valve (126) is a globe valve with an angular pattern while the outlet scram valve (127) is a straight-through globe pattern. The internal spring preload in the outlet scram valve is slightly greater than in the inlet scram valve in order to produce a faster opening characteristic. Both valves are provided with soft Teflon seats to minimize seat leakage.

#### 1.2.4.3 Scram Accumulator and Instrumentation

The scram accumulator, consisting of the piston-type water accumulator (125) connected to the  $N_2$  cylinder (128), serves as an independent source of energy to initiate scram insertion of the associated control rod drive. The accumulator and the instrumentation assembly occupy the lower section of the hydraulic control unit, as shown in Figure 1-6. The piston in the water accumulator (125) serves as a barrier between the high-pressure nitrogen used as the source of stored energy and the water used to initiate control rod scram. The piston is sealed against leakage by two Teflon seals and a synthetic-rubber O-ring installed in grooves around its outside wall.

The hydraulic system charging water header continuously pressurizes the water accumulator. The ball-check valve (115) in the charging riser prevents backflow from the accumulator into the charging header, and ensures that the accumulator will retain its charge for a limited time in the

event of loss of pressure in the charging water header. The nitrogen cylinder (128), with a volume of 1190 cubic inches, is initially precharged with gas from an external source through a connection (P6) in the instrumentation block to approximately 900 psig.

Initial charging of the accumulator with nitrogen is accomplished (when the reactor system is not pressurized) by closing the isolation valve (113) in the charging riser, then opening the needle valve (107) in the accumulator drain line to discharge any water from the top of the cylinder. Nitrogen is then introduced to the gas cylinder (128) through the connection (P6) in the instrumentation block. When pressure in the gas side of the accumulator reaches approximately 900 psig, the needle valve (111) on the gas side is closed tight, the nitrogen source is removed, the connection (P6) closed and sealed, and the gas-side needle valve (111) reopened. The valve (107) in the drain line is then closed and the isolation valve (113) reopened to apply water pressure at approximately 1500 psig from the charging riser to the water side of the accumulator.

To ensure that the accumulator is always capable of initiating control rod drive scram, it is continuously monitored for water and nitrogen leakage by components of the instrumentation assembly shown in Figures 1-7 and 1-8, and on Drawing 846D874 in Section VI. A float-type level detector (129), installed in the instrumentation block, activates a remote alarm should water leak past the piston and collect on the gas side of the accumulator. Gas pressure is monitored by the pressure indicator (131) and a remote alarm of low gas pressure is provided by the low-pressure switch (130) on the rear of the block. The rupture disc assembly (132) installed in the gas porting in the block is rated at 2000 psi and provides over-pressure protection for the accumulator. The shutoff valve (111), in addition to its function in charging the accumulator, permits the instruments to be isolated and serviced during power-station operation.

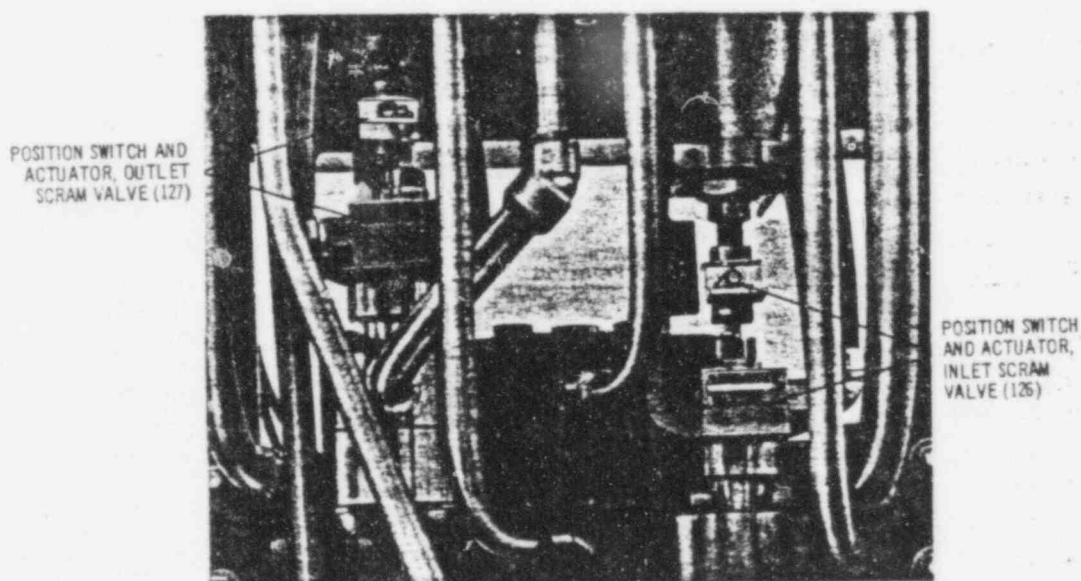
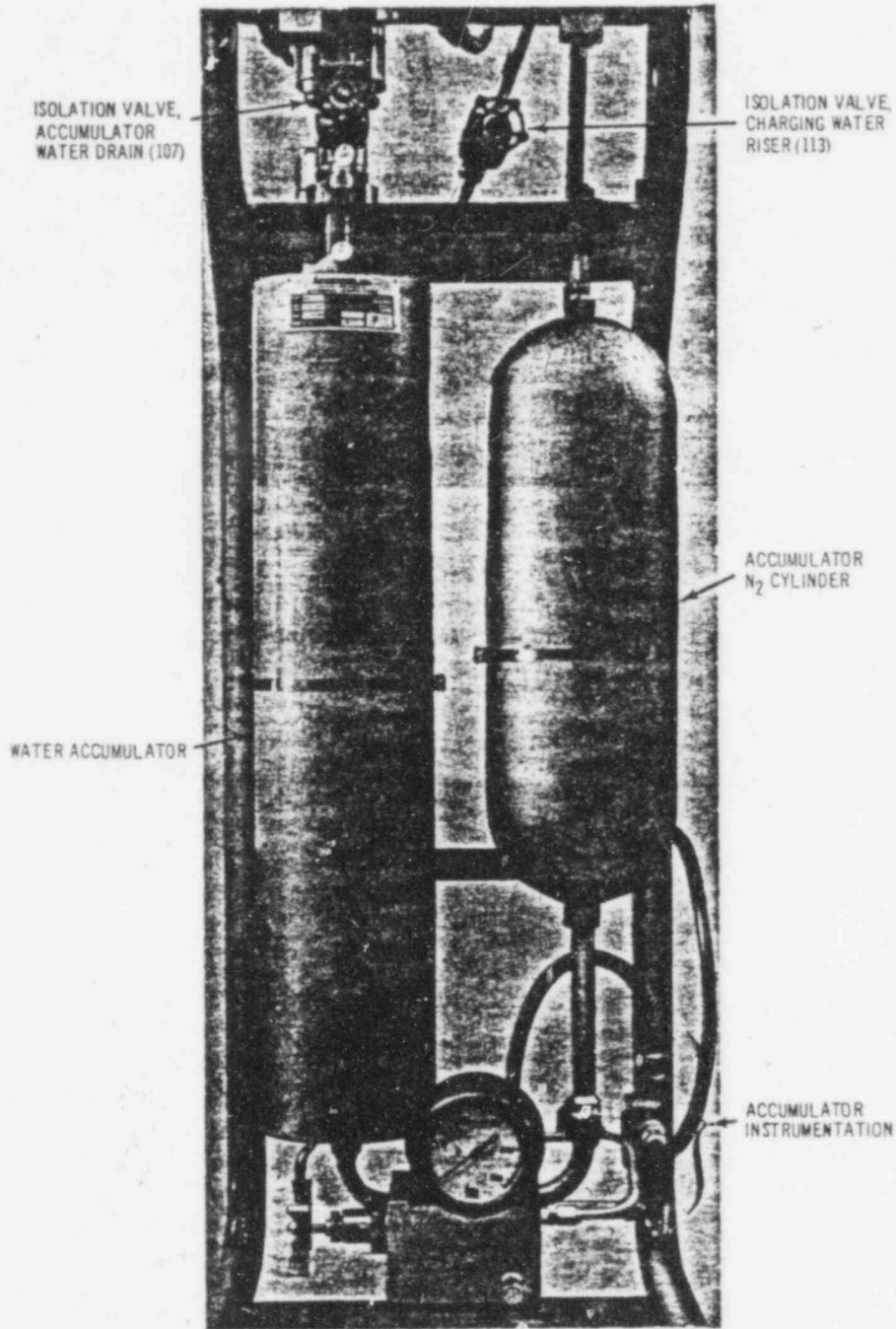


Figure 1-5. Scram Valve Position Switches



5485-4

Figure 1-6. Scram Accumulator and Instrumentation



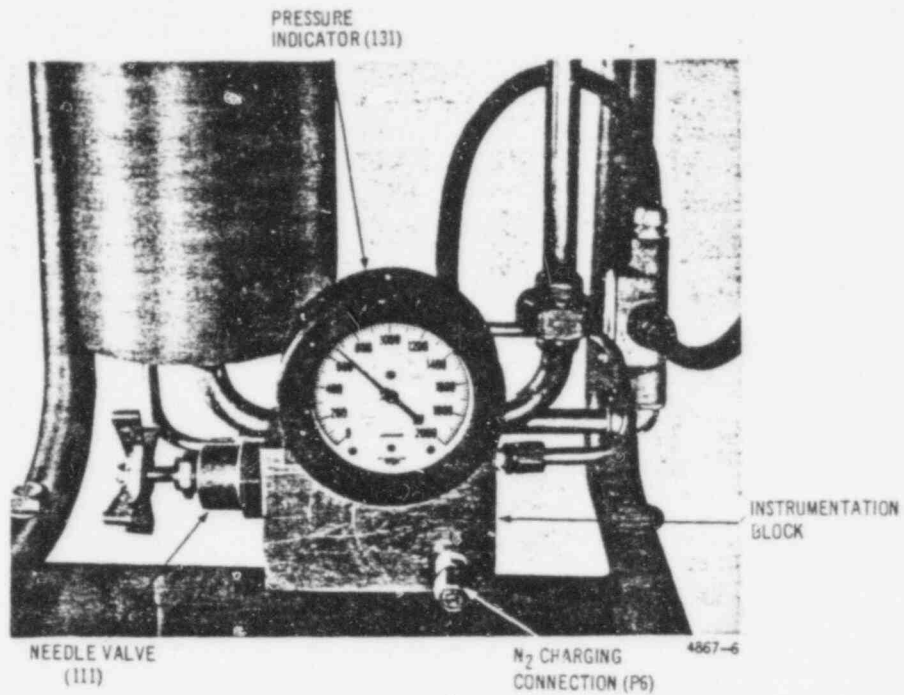


Figure 1-7. Accumulator Instrumentation—Front View

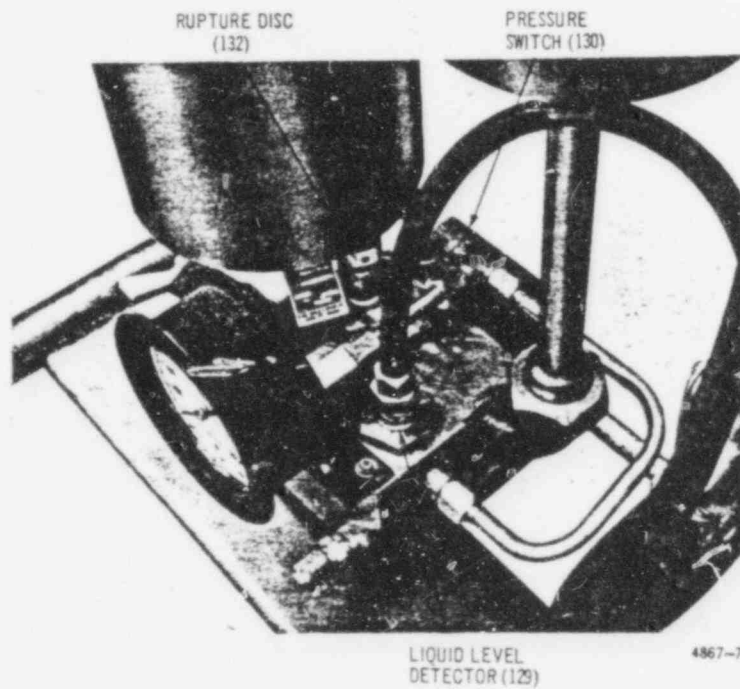
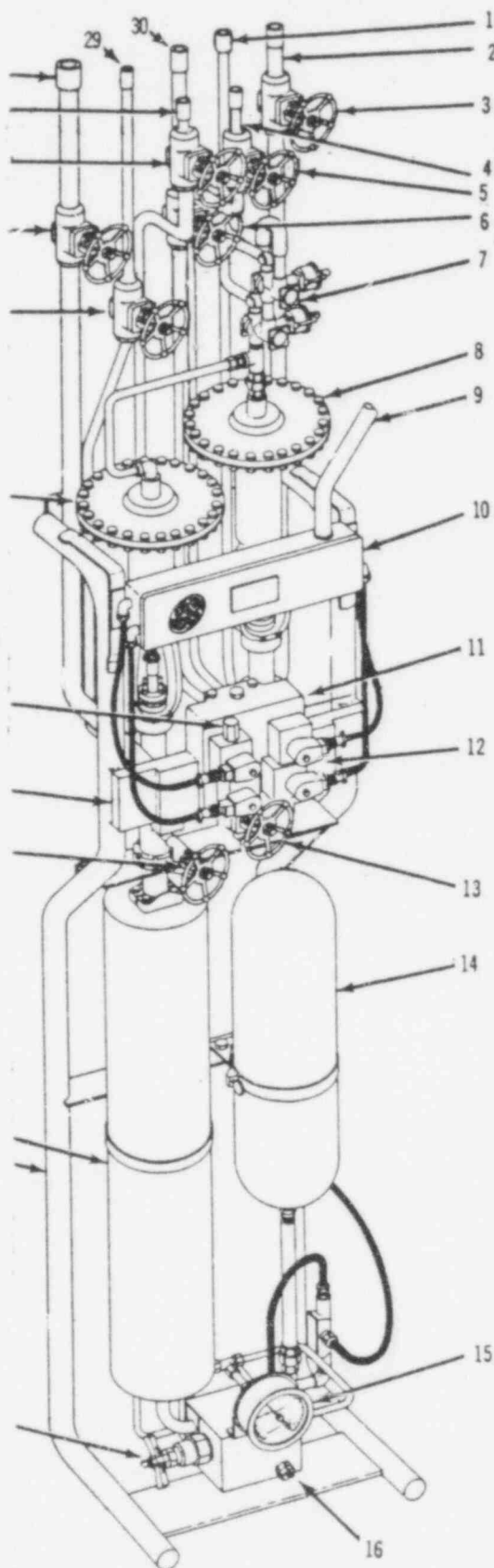


Figure 1-8. Accumulator Instrumentation—Top View



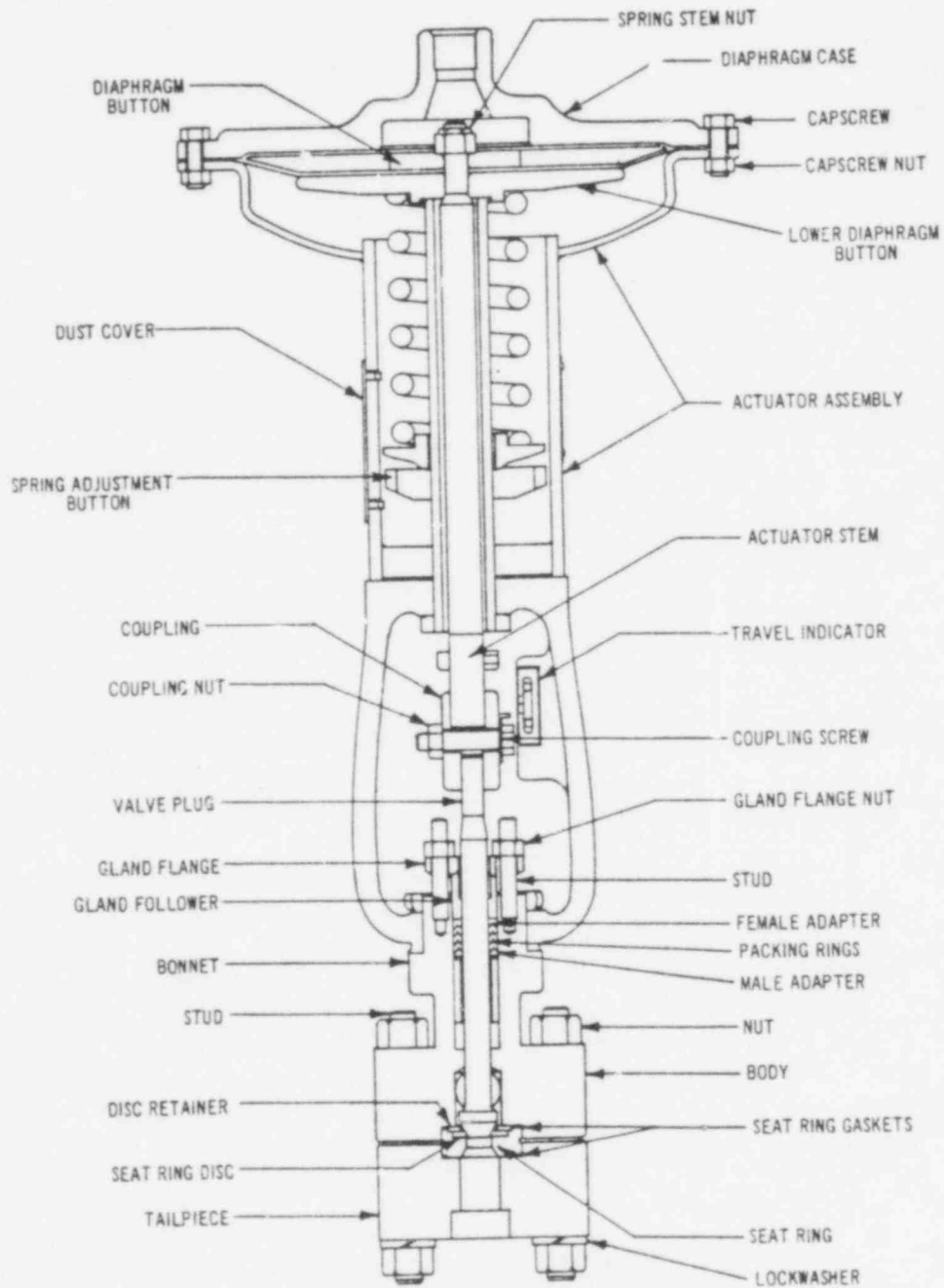
1. ACCUMULATOR CHARGING WATER RISER
2. DRIVE - WITHDRAW RISER
3. ISOLATION VALVE — DRIVE-WITHDRAW RISER (EP 102)
4. DRIVE WATER RISER
5. ISOLATION VALVE — DRIVE WATER RISER (EP 103)
6. ISOLATION VALVE — SCRAM DISCHARGE RISER (EP112)
7. SCRAM PILOT VALVE ASSEMBLY (EP 117, 118)
8. OUTLET SCRAM VALVE AND ACTUATOR (EP 127)
9. TYPICAL ELECTRICAL CONNECTION
10. WIPING TROUGH ASSEMBLY
11. MANIFOLD (PART OF PIPING ASSEMBLY)
12. DIRECTIONAL CONTROL VALVES (4 EACH) (EP 120, 121, 122, 123)
13. ISOLATION VALVE — ACCUMULATOR CHARGING WATER RISER (EP113)
14. SCRAM ACCUMULATOR — NITROGEN CYLINDER (EP 128)
15. ACCUMULATOR GAS PRESSURE INDICATOR (EP 131)
16. ACCUMULATOR INSTRUMENTATION ASSEMBLY
17. NEEDLE VALVE — ACCUMULATOR GAS CHARGING (EP 111)
18. FRAME
19. SCRAM ACCUMULATOR — WATER CYLINDER (EP 125)
20. NEEDLE VALVE — ACCUMULATOR WATER CYLINDER DRAIN (EP 107)
21. COOLING CHECK VALVE (IN MANIFOLD)
22. SPEED CONTROL VALVES (2 EACH)
23. INLET SCRAM VALVE AND ACTUATOR (EP 126)
24. ISOLATION VALVE — COOLING WATER RISER (EP 104)
25. ISOLATION VALVE — DRIVE-INSERT RISER (EP 101)
26. ISOLATION VALVE — EXHAUST WATER RISER (EP 105)
27. EXHAUST WATER RISER
28. DRIVE-INSERT RISER
29. COOLING WATER RISER
30. SCRAM DISCHARGE RISER



4867-8

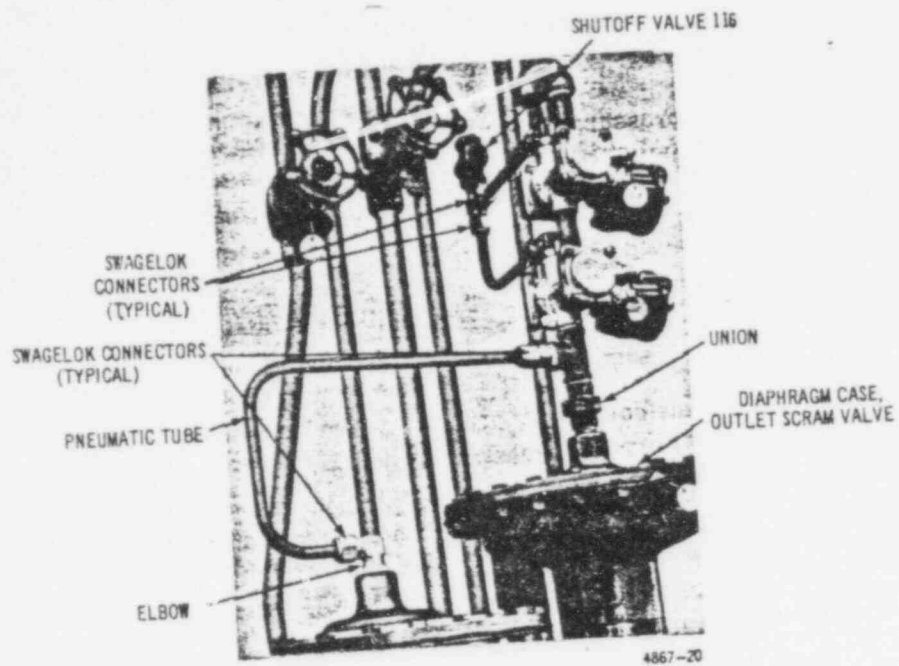
Figure 1-9. Hydraulic Control Unit

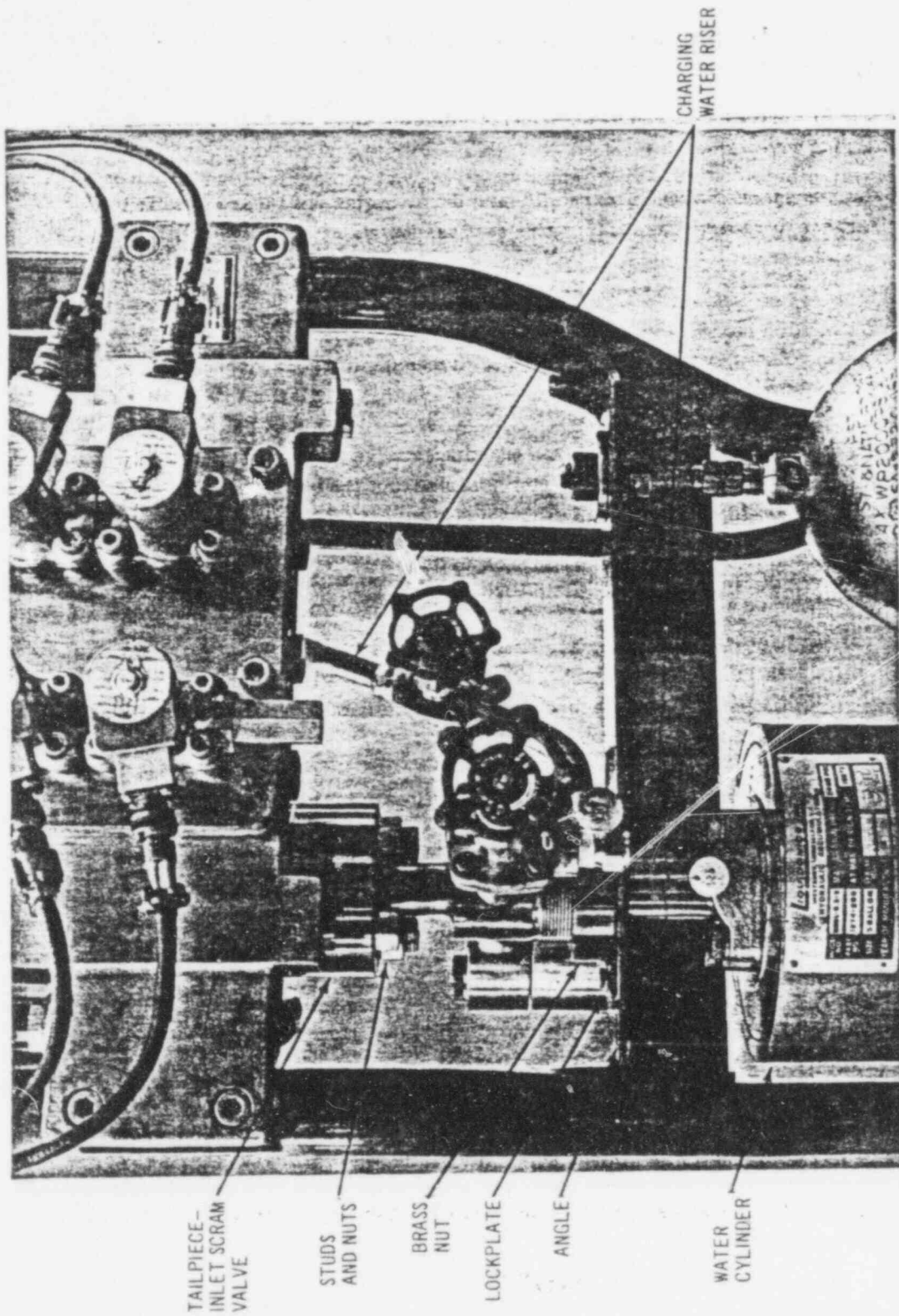
1-15/1-16



4867-21

Figure 4-10. Cutaway View—Typical Scram Valve





5485-6

Figure 4-12. Lower Details—Front View

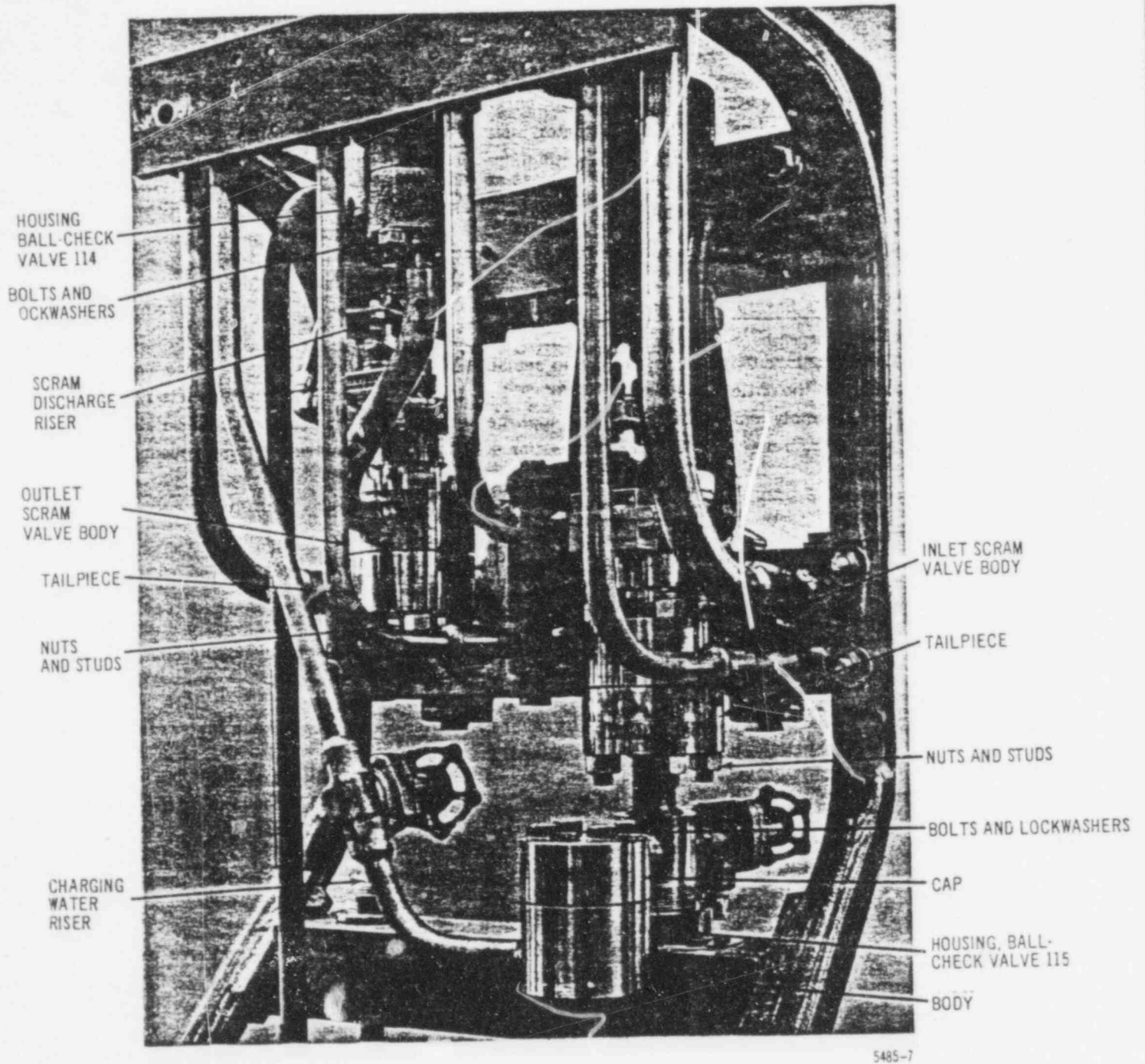
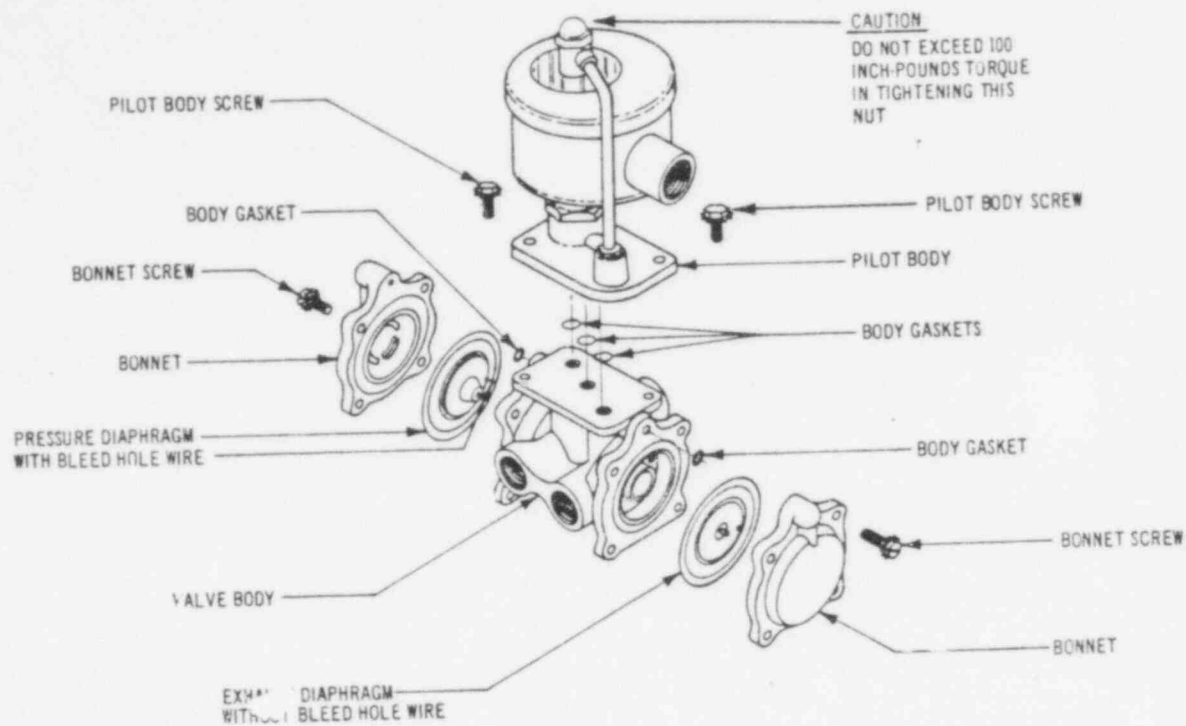


Figure 4-13. Lower Details—Rear View



4967-24

Figure 4-14. Exploded View—Scram Pilot Valve

POOR ORIGINAL

465

234



465 235  
~~465~~ ~~235~~





## SECTION II

### DESCRIPTION AND OPERATING PRINCIPLES

#### 2-1 INTRODUCTION

2-2 The description and operating principles in this section are identically applicable to HCU's part Nos. 761E500G1 thru G9. The common configuration of these units is illustrated in Figure 2-1 which calls out the nomenclature of significant components and provides EP numbers where applicable. Drawing No. 730E145 in Section VII is a piping and instrumentation diagram of the HCU. Refer to drawing No. 761E500 in Section VII for an assembly drawing of the HCU.

2-3 Each HCU functions within the control rod drive hydraulic system (CRDHS) to position one locking-piston CRD mechanism in the reactor. The HCU combines all operating valves and components required for normal (drive insert or drive withdraw) or scram (rapid control rod insertion) positioning of the associated CRD. The HCU directs differential hydraulic pressures supplied by the CRDHS to insert or withdraw the CRD and to provide cooling water to the CRD. The solenoid-operated valves that control normal directional movement of the CRD respond to timed signals from the rod drive control system (RDSCS). The RDSCS is an asynchronous multiplexing system which uses a transponder circuit board to decode terminal instructions and encode status data. The operating and maintenance instructions for the transponder circuit board are included in Section IV of this manual. The scram accumulator and scram valves are interconnected with the reactor protection system (RPS) to function as required to rapidly insert the CRD in response to a reactor scram signal. The state of readiness of the scram valves and accumulator is continuously monitored by instrumentation on the HCU and presented at the rod status display at the main control panel.

2-4 All hydraulic risers in the HCU are provided with manual shutoff valves which isolate individual components for servicing during reactor operation. External connections for all electrical components in the HCU except the scram pilot valve solenoids are routed through terminals in a single wiring through assembly on the front of the HCU to simplify trouble analysis and repair. Connections to the scram pilot valve solenoids are routed through the electrical junction box installed above the wiring trough.

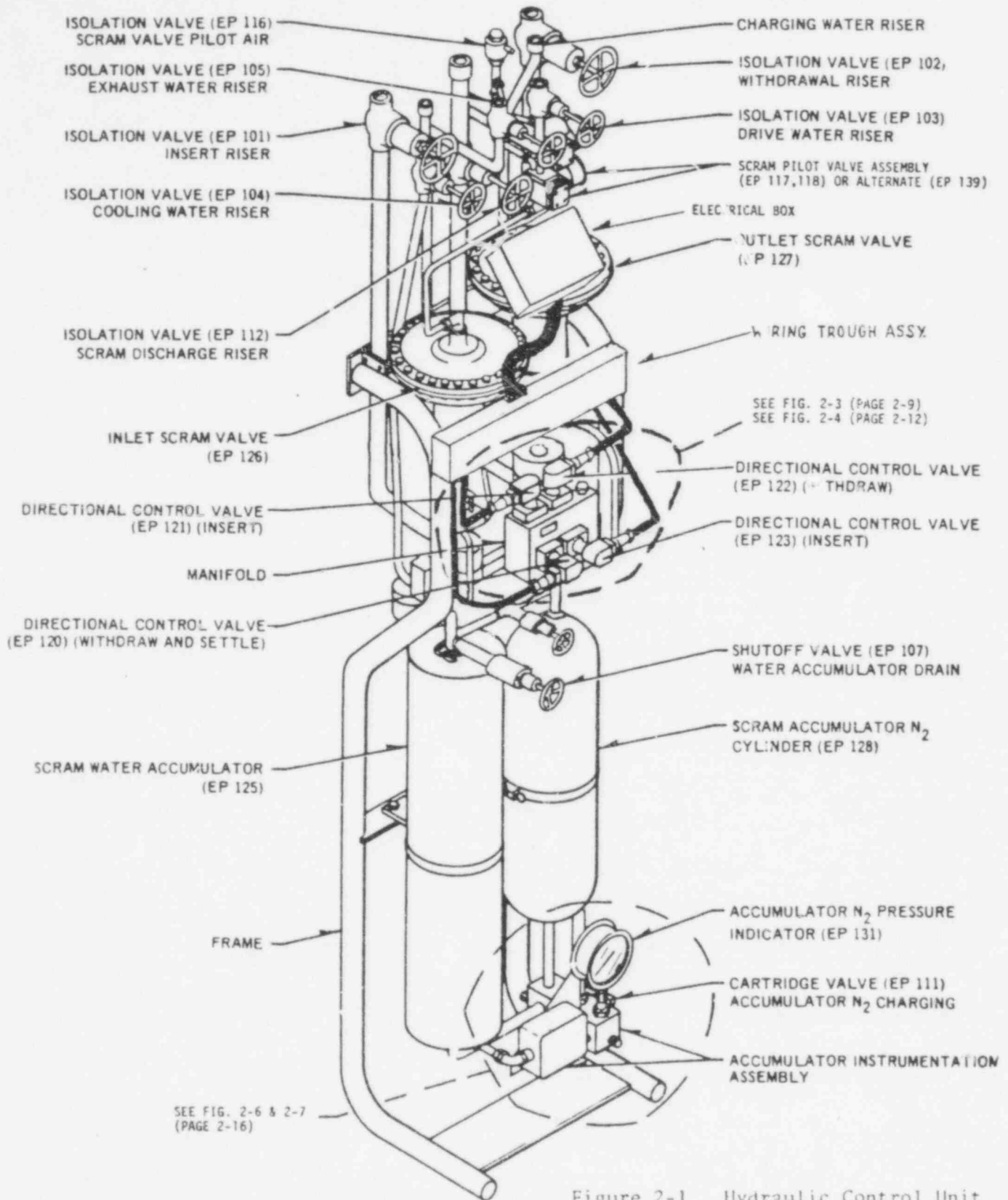


Figure 2-1. Hydraulic Control Unit,  
Part No. 761E500

2-5 The paragraphs that follow describe the physical and functional characteristics of the major HCU components. The equipment used for normal CRD in and out positioning is included in the manifold piping and valves assembly (paragraph 2-6). Paragraphs 2-19 through 2-22 describe the sequencing of the four directional control valves (120, 121, 122, 123) which results in the application of the required differential pressures for proper CRD movement. Equipment required for CRD scram insertion is included in the scram section of the HCU and described in paragraph 2-23.

## 2-6 MANIFOLD PIPING AND VALVES

2-7 The assembly consisting of the manifold piping and valves is shown in drawing No. 730E112 in Section VII. It comprises the seven hydraulic risers, the manifold, and the inlet and outlet scram valves (126, 127).

### NOTE

For a description of the scram function of the inlet and outlet scram valves, refer to paragraph 2-29.

2-8 HYDRAULIC CIRCUIT DESCRIPTION. Internal porting in the manifold and in the inlet and outlet scram valve bodies directs demineralized water between the risers, the directional control valves (120, 121, 122, and 123) installed on the manifold, and the CRD. A hydraulic circuit diagram of the manifold piping and valves assembly is shown in Figure 2-2. Refer to Figure 2-1 for EP number identification and refer to Table 2-2 for a list of the seven hydraulic risers and the water flowing through each during the various modes, or functions, of CRD operation.

Table 2-1. HCU Hydraulic Circuit Components Shown On Figure 2-2

EP NO.	COMPONENT
101	Shutoff Valve, Insert Riser
102	Shutoff Valve, Withdraw Riser
103	Shutoff Valve, Drive Water Riser
104	Shutoff Valve, Cooling Water Riser
105	Shutoff Valve, Exhaust Water Riser
112	Shutoff Valve, Scram Discharge Riser
113	Shutoff Valve, Charging Water Riser
114	Check Valve, Scram Discharge Riser
115	Check Valve, Accumulator Water
120	Directional Control Valve W/Speed Control (Withdraw & Settle-Exhaust Water From CRD Under-Piston)

Table 2-1. HCU Hydraulic Circuit Components Shown On Figure 2-2 (Continued)

EP NO.	COMPONENT
121	Directional Control Valve (Insert-Exhaust Water From CRD Over-Piston)
122	Directional Control Valve (Withdraw-Drive Water To CRD Over-Piston)
123	Directional Control Valve W/Speed Control (Insert-Drive Water To CRD Under-Piston)
126	Inlet Scram Valve
127	Outlet Scram Valve
134	Filter Element (Drive Water)
135	Filter Element (Water To/From CRD Under-piston Port)
136	Filter Element (Water From CRD Over-Piston Port)
137	Check Valve (Drive Water)
138	Check Valve (Cooling Water)
P1	Test Plug (Driving Pressure) (Integral W/FE 134)
P2	Test Plug (Exhaust Pressure)
P3	Test Plug (CRD Under-Piston Pressure) (Integral W/FE 135)
P4	Test Plug (CRD Over-Piston Pressure)
P5	Test Plug (Scram Discharge Pressure) (Integral W/Check Valve 134)

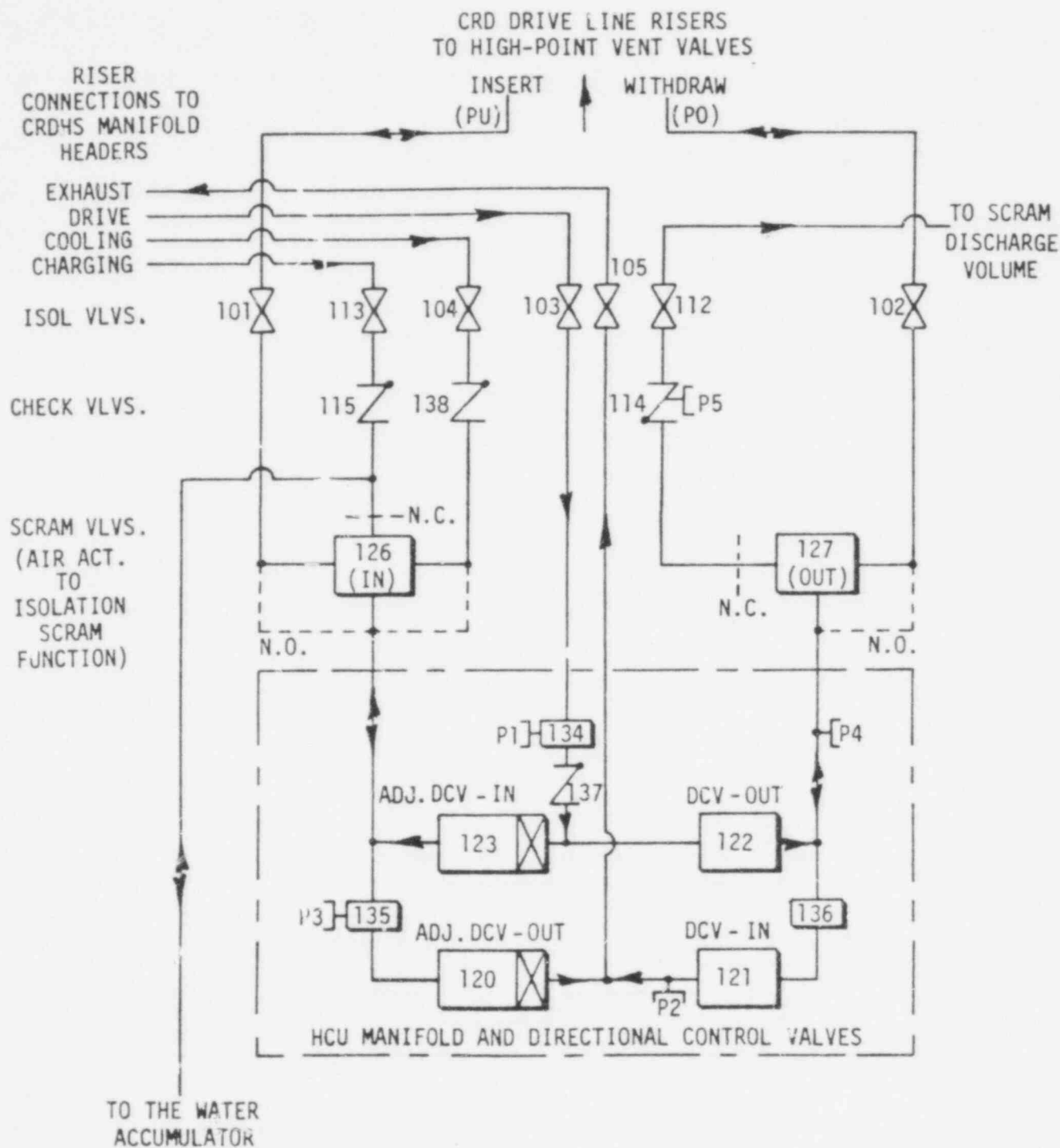


Figure 2-2. Hydraulic Control Unit Circuit Diagram - Hydraulic

Table 2-2. Flow Functions Through Risers

RISERS	CONTROL ROD DRIVE FUNCTIONS AND FLOW CONDITIONS			
	CRD INSERT	CRD WITHDRAW	SCRAM	CRD STATIONARY
Charging Water	Water from CRD hydraulic system accumulator charging header to scram water accumulator, continuously available regardless of CRD function. No flow except during and immediately after scram.			
Withdraw	Water exhausted from CRD over-piston port to valve 127 body.	Drive water from valve 127 body to CRD over-position port.	Scram discharge water from CRD over-piston port to valve 127 body.	No Flow
Drive Water	Water from CRDHS drive water header to manifold.	Water from CRDHS drive water header to manifold.	No Flow	No Flow
Exhaust Water	Water from manifold to CRDHS exhaust water header.	Water from manifold to CRDHS exhaust water header.	No Flow	No Flow
Insert	Drive water from valve 126 body to CRD under-piston port.	Discharge water from CRD under-piston port to valve 126 body.	Accumulator water from valve 126 body to CRD under-piston port.	Cooling water from valve 126 body to CRD under-piston port.
Cooling Water	No Flow	No Flow	No Flow	Water from CRDHS cooling water header to valve 126 body.
Scram Discharge	No Flow	No Flow	Discharge water from valve 127 body to CRDHS scram discharge header.	No Flow



2-9 Scram Valve Bodies. Independent of their scram function, the valve bodies of the inlet and outlet scram valves also serve as junction points between the manifold and the risers. Water flows through internal porting in the valve bodies of the inlet and outlet scram valves as follows for normal CRD operation.

- A. At all times when the CRD is stationary, cooling water enters the inlet scram valve (126) body from the cooling water riser and flows into the insert riser to the CRD.
- B. During the drive-insert sequence, drive water flows through internal porting and associated components in the manifold to the inlet scram valve body, and then through the insert riser to the CRD.
- C. Water exhausted from below the CRD drive piston during the withdraw or settle sequence enters the inlet scram valve body from the insert riser, passes through the manifold and associated components and is discharged through the exhaust water header to the CRDHS.
- D. During the drive-withdraw sequence, drive water flows through internal porting and associated components in the manifold to the outlet scram valve (127) body and thence through the withdraw riser to the CRD.
- E. Water exhausted from above the CRD drive piston during the insert sequence enters the outlet scram valve body from the withdraw riser, passes through the manifold, and is discharged through the exhaust water riser to the CRDHS.

2-10 The scram valves are closed during normal reactor operation with the valve plugs isolating the valve body porting used in the functions described above from the scram porting.

2-11 Ball-check valves 114, 115, and 138 are installed in blocks in the scram discharge riser, charging water riser, and cooling water riser, respectively. Valve 114 prevents CRDHS scram discharge header backflow from entering the HCU through the outlet scram valve during and following reactor scram. Valve 115 prevents accumulator water from backflowing into the charging water riser. Valve 138 protects the cooling water riser from driving pressure or scram pressure backflow through the inlet scram valve.

2-12 Manifold. Internal porting in the manifold directs water between the scram valve bodies, the directional control valves, the drive water risers and the exhaust water risers. These risers are directly connected to the manifold. In addition, porting in the manifold contains the drive water ball-check valve (137), which prevents backflow from the directional control valves into the drive water riser during a scram, and three filter elements (134, 135, 136), which protect the directional control valves and the CRD from particulate matter in CRDHS water.

2-13 Test plugs P1 through P4 in the manifold provide connections for testing pressures as shown in Figure 2-2. Test plugs P3 and P4 are used primarily for measuring CRD under-piston (PU) and over-piston (PO) differential pressures (dP) to determine CRD operating capabilities. Test plug P5 is installed in the block of ball-check valve 114 in the scram discharge riser.

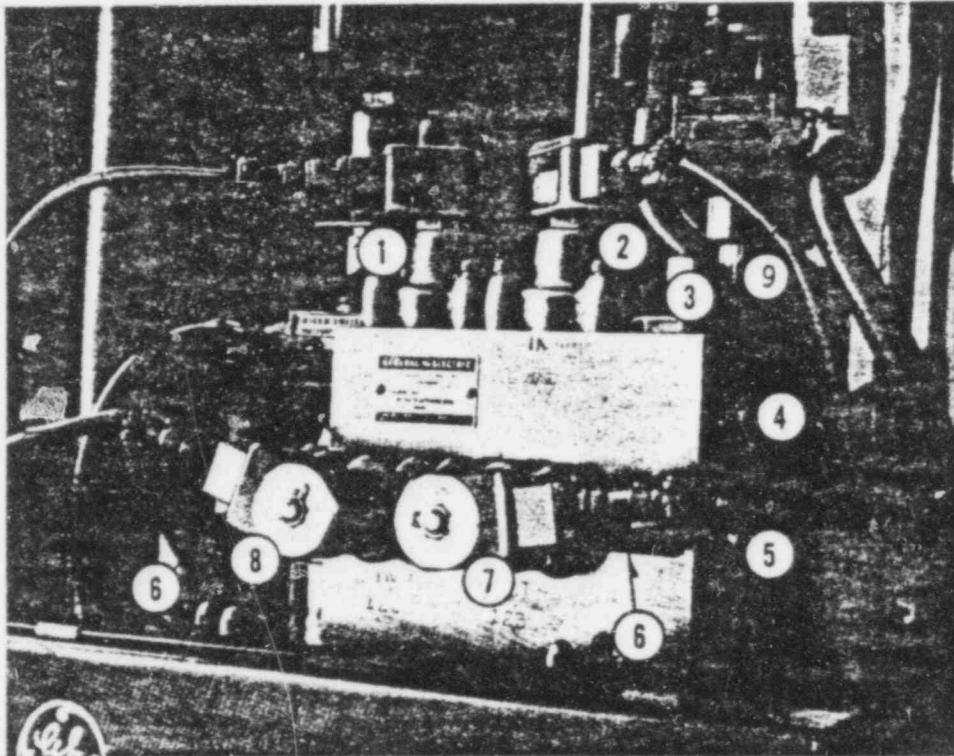
2-14 The test connections, filters, and drive water ball-check valve are accessible through threaded plugs in the outside wall of the manifold. The threaded plugs of filter elements 134 and 135 serve as test plugs P1 and P3.

2-15 Cooling Water Riser. Cooling water is provided, from the CRDHS cooling water header through the cooling water riser, to cool the CRD internal seals and bushings, and it is admitted through the inlet scram valve body to the insert riser at all times that the CRD is at a stationary position. Normal flow from the cooling water riser to the insert riser through ball-check valve 138 is from 0.22 to 0.34 gpm (0.83 to 1.29  $\ell/\text{min}$ ) at a pressure of from 12 to 25 psi (0.84 to 1.76  $\text{Kg}/\text{cm}^2$ ) above reactor pressure. When the CRD is in motion, pressure in the inlet scram valve body is higher than the cooling water pressure, and check valve 138 shifts to close off the flow of cooling water. The check valve opens again to admit cooling water to the insert riser when the CRD is stationary.

2-16 Directional Control Valves. The four directional control valves mounted on the manifold (see Figure 2-3) are energized by the rod drive control system (RDCS) to direct driving pressure and exhaust water through the HCU to and from the under-and over-piston ports in the associated CRD for normal control rod in and out positioning. By energizing and opening the directional control valves in coordinated pairs, the drive water riser can be connected under or over the CRD piston while the exhaust water riser is connected to the opposite side of the drive piston.

2-17 Two directional control valves (120, 123) include speed control elements and are connected to the manifold so that they always pass flow to or from the CRD under-piston port. This flow is approximately 3 gpm (11.4  $\ell/\text{min}$ ) through valve 120 when the CRD is moving in the withdraw direction, and approximately 4 gpm (15.1  $\ell/\text{min}$ ) through valve 123 when the CRD is moving in the insert direction at the normal speed of 3 in./sec (76 mm/sec). The balance of forces in the CRD is such that the pressure under the drive piston is approximately PR+ 90 psi (6.33  $\text{Kg}/\text{cm}^2$ ) whenever the CRD is either inserting or withdrawing. Proper speed for control rod insertion is obtained when the speed control element in valve 123 is set so that a flow of 4 gpm (15.1  $\ell/\text{min}$ ) through the valve and piping to the CRD will produce a local pressure drop of approximately 160 psi (11.25  $\text{Kg}/\text{cm}^2$ ) (from PR+ 260 psi [PR+ 18.28  $\text{Kg}/\text{cm}^2$ ] in the CRDHS drive water header to PR+90 psi [PR+ 6.33  $\text{Kg}/\text{cm}^2$ ] under the CRD drive piston). Similarly, for proper control rod withdrawal speed, the speed control

element in valve 120 should be set so that a flow of 3 gpm will produce a local pressure drop of 95 psi (6.68 Kg/cm<sup>2</sup>) (from PR+ 110 psi [PR+ 7.73 Kg/cm<sup>2</sup>] under the CRD drive piston to PR+ 15 psi [PR+ 1.05 Kg/cm<sup>2</sup>] in the CRDHS exhaust water header). Once the speed control elements in directional control valves 120 and 123 are properly set, no further readjustment is required except to compensate for changes in CRD internal piston seal leakage.



1. DIRECTIONAL CONTROL VALVE (121)
2. DIRECTIONAL CONTROL VALVE (122)
3. PLUG-DRIVE WATER CHECK VALVE (137)
4. PLUG-FILTER (136)
5. PLUG - FILTER (135) AND TEST CONNECTION (P3)
6. FLOW CONTROL
7. DIRECTIONAL CONTROL VALVE (123)
8. DIRECTIONAL CONTROL VALVE (120)
9. TEST CONNECTION (P4)

Figure 2-3. Manifold and Directional Control Valves

465 245

2-18 During scram, the directional control valves are subject to scram pressure through the porting in the manifold and scram valve bodies. The two directional control valves (122, 123) connected to the drive water riser can be opened if subjected to this higher pressure at their outlet ports. The check valve (137) installed in the manifold prevents significant loss of water to the drive water riser during scram. The cooling check valve (138) performs the same function for the cooling water riser.

2-19 A timed device capable of phasing numerous voltages of specified duration upon command from the RDCS energizes the four directional control valves in proper sequence and duration for CRD movement. For single-step control rod insertion, valves 121 and 123 are energized for only the time (approximately 2 seconds) required to insert the control rod drive slightly more than one notch (approximately 6 inches [15.2 cm]). Valve 123 opens the drive water riser to the insert riser so that driving pressure from the CRDHS is applied to the under-piston port of the CRD. Valve 121 opens the withdraw riser to the exhaust water riser so that water venting from the CRD over-piston port is discharged to the CRDHS exhaust water header.

2-20 Following the deenergizing of valves 121 and 123, the settling circuitry of the control system automatically energizes and opens valve 120 for a period of several seconds. This opens the insert riser to the exhaust water riser so that the under-piston area of the CRD exhausts to the CRDHS, permitting the CRD piston and index tube to settle downward to the next latched position.

2-21 For control rod withdrawal, valves 121 and 123 are energized for approximately one-half second as described above in order to remove the load from the collet latch and cam it into the open position. Immediately following this brief notch-in signal, valves 120 and 122 are automatically energized for CRD withdrawal. Valve 122 opens the drive water riser to the withdraw riser so that driving pressure is applied to the over-piston port of the CRD and to the annulus below the collet piston. Valve 120 opens the insert riser to the exhaust water riser so that water venting from the under-piston port is discharged to the CRDHS exhaust water header. Following this, valve 122 closes to remove the force from the spring-loaded collet assembly and to reduce the rate of decent of the index tube. Valve 120 is maintained energized by the settling circuit, as described above.

2-22 Provisions in the RDCS permit the interruption of the preset time intervals for single-notch insertion or withdrawal sequencing of the directional control valves in order to extend their duration. In this event, valves 121 and 123 or valves 120 and 122 remain energized and open until deenergized by the release of a manual switch on the operators benchboard. The settling circuit, however, functions to energize and open valve 120 upon termination of any insert or withdraw signal, whether single-notch or continuous, due to the resumption and completion of the normal timing cycle.

## 2-23 SCRAM SECTION

2-24 The HCU components defined for the purpose of these instructions, as the scram section, consist of the following:

- A. The inlet and outlet scram valves (126, 127)
- B. The scram pilot air valves (117, 118) or alternate scram pilot air valve (139) and the isolation shutoff valve (116) in the air line to these valves.
- C. The scram accumulator and associated valves and monitoring instrumentation.

2-25 The two scram pilot valves (EP 117, 118) or alternate scram pilot air valve (139) are energized through an electrical circuit which includes the functions of the electrical box (see Table 2-3). For a schematic of the electrical circuitry (EP 117, 118) refer to connection diagram 922D248 or for (EP 139) refer to 105D5634 in Section VII. The initial opening of the outlet scram valve connects the withdraw riser to the scram discharge riser so that water vented from above the CRD piston during the scram stroke is discharged into the CRDHS scram discharge header. A fraction of a second later, the inlet scram valve admits water from the scram accumulator and charging water header to the insert riser to supply the hydraulic energy to rapidly insert the associated CRD. The accumulator monitoring instrumentation provides an input to the RDCS so that a remote alarm is provided in the event of accumulator gas or water leakage at any time.

2-26 SCRAM PILOT VALVES. During normal reactor operation, each of the two logic channels (A and B) of the RPS energizes one of the two 3-way solenoid-operated scram pilot valves (117, 118) or the dual solenoids on the 3-way redundant scram pilot valve (139). When energized, the pilot valve or valves supply control air pressure to the diaphragm actuators of the inlet and outlet scram valves, maintaining the scram valves closed. Upon initiation of scram, both RPS logic channels are deenergized thereby venting control pressure from the scram valve actuators and permitting the stem and plug assemblies to withdraw from the valve bodies (to open). Figure 2-4 shows the energized and deenergized positions of the pilot valves (117, 118 and 139).

2-27 To reduce the probability of spurious scrams, the valve or valves are pneumatically configured so that both solenoids must be deenergized before control pressure is vented from the inlet and outlet scram valve actuators, with the resulting CRD scram insertion. Deenergizing of either one of the valve solenoids will not result in a scram since control pressure will continue to be applied to the scram valve actuators. Failure of electrical power to both valve solenoids will produce a scram of the CRD.

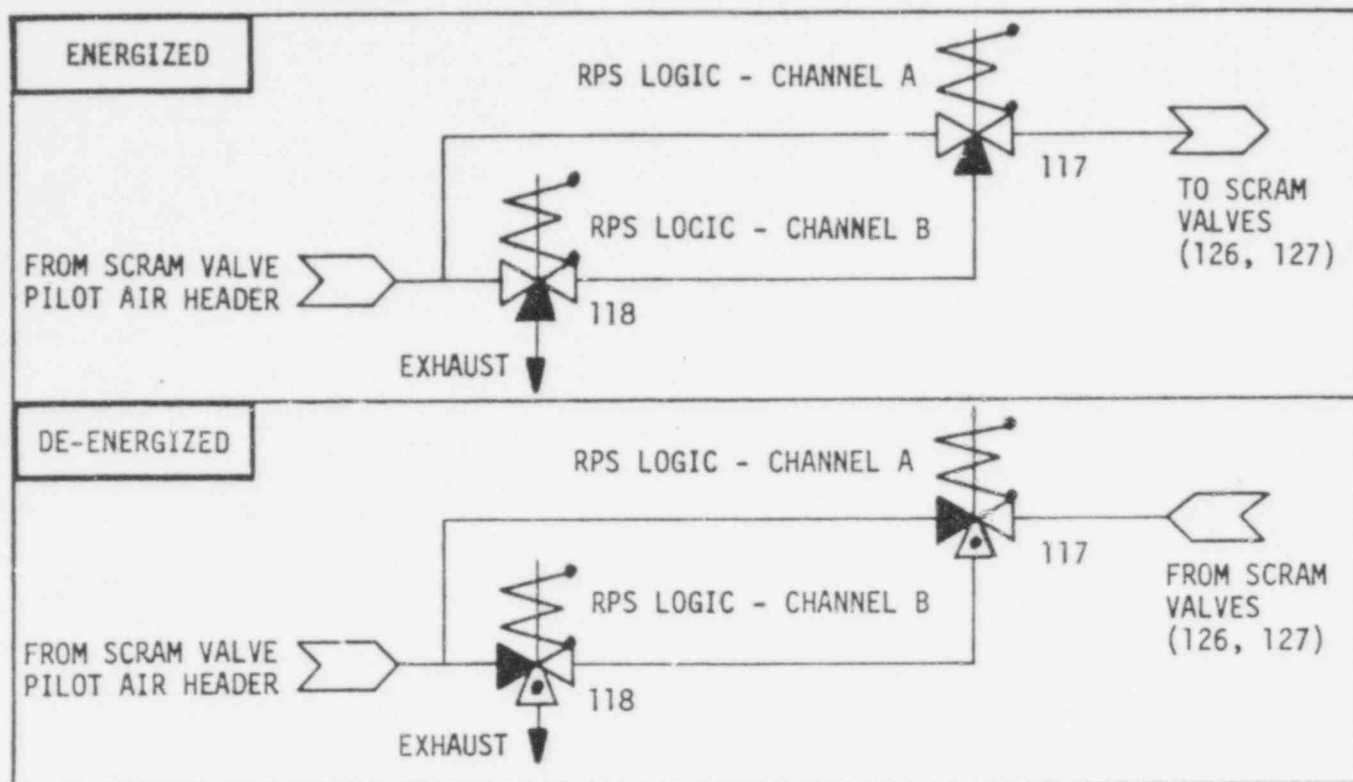


Figure 2-4A. Scram Pilot Valves EP 117 & 118 (Functional Diagram)

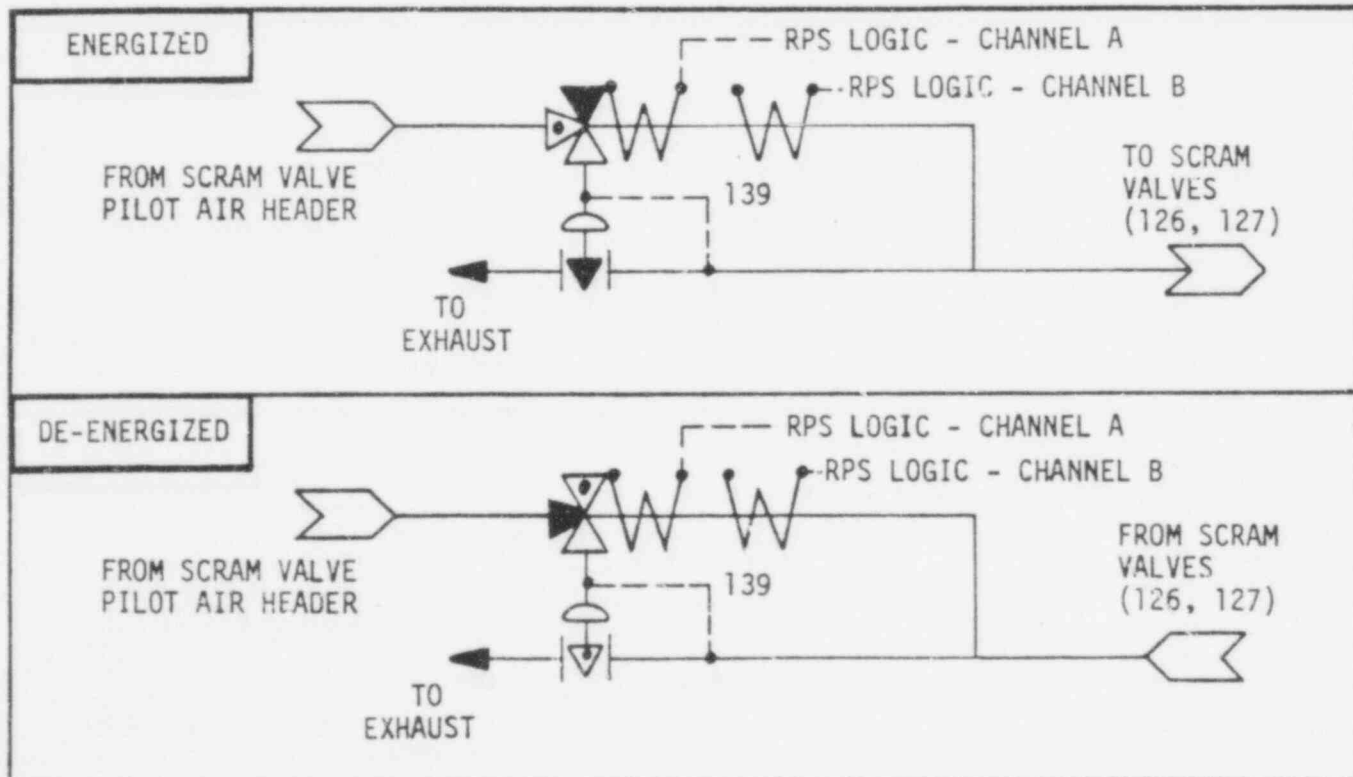


Figure 2-4B. Alternate Scram Pilot Valve EP 139 (Functional Diagram)



2-28 Control pressure is supplied to the pilot valves through isolation shut-off valve 116, which may be closed to isolate the scram pilot valves for maintenance purposes.

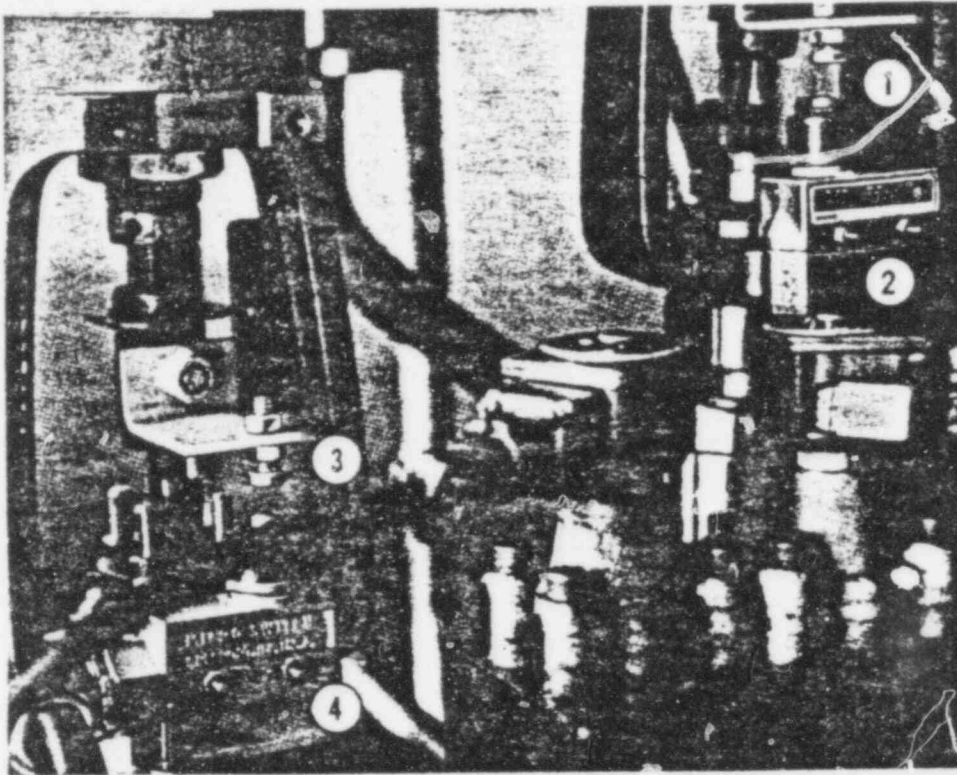
2-29 INLET AND OUTLET SCRAM VALVES. The inlet and outlet scram valves (126, 127) are normally open valves held closed during normal reactor operation by control air pressure supplied to the tops of their diaphragm actuators by the scram pilot valves (117, 118) or alternative scram pilot air valve (139). single air line from the scram pilot valve or valves supplies control pressure to both scram valves. The scram valves open by internal spring pressure plus reactor water pressure and charging water pressure as a result of the removal of control air pressure. The internal spring preload in the outlet scram valve (127) is slightly greater than in the inlet scram valve (126). This permits the outlet scram valve to open before the inlet scram valve opens in order to prevent a backpressure buildup above the CRD drive piston upon application of scram pressure below the drive piston.

2-30 The outlet scram valve, when opened, connects the withdraw riser to the scram discharge riser, and water from above the CRD drive piston is discharged into the CRDHS scram discharge header as the result of reactor pressure acting through the ball-check valve located in the insert port of the CRD. In turn, the inlet scram valve opens the insert riser to the charging water header and the scram accumulator (refer to Figure 2-2) so that maximum pressure is applied to the CRD drive piston. Each of the scram valves is fitted with a stem-mounted position switch (see Figure 2-5). The position switch is actuated when the valve plug has left the seat, and causes a SCRAM indicating light to energize on the associated rod status display in the control room to provide a remote indication that the scram valves for the particular CRD have opened.

Table 2-3. Function of Electrical Box

POSITION OF TEST SWITCHES	FUNCTION OF CIRCUIT CONFIGURATION	TEST SWITCH SIGNAL TO RDGS
A - NORM. B - NORM.	Each valve solenoid connected between respective RPS channel and neutral bus. CRD in normal standby mode.	1
A - TEST B - TEST	Both valve solenoids deenergized. CRD in scram mode.	0
A - S.R. I. B - S.R. I.	Valve solenoids connected between respective RPS channel and select rod insert bus. CRD in normal standby mode.	0





1. ACTUATOR
2. POSITION SWITCH-OUTLET SCRAM VLV. (127)
3. ACTUATOR
4. POSITION SWITCH-INLET SCRAM VLV. (126)

Figure 2-5. Scram Valve Position Switches

2-31 Both scram valves are basically similar globe valves; however, the outlet valve has a slightly higher pressure spring setting. Both valves have soft seats to minimize seat leakage.

2-32 SCRAM ACCUMULATOR. The scram accumulator consists of the piston-type water accumulator (125) pressurized by a volume of nitrogen contained in the  $N_2$  cylinder (128). The accumulator and its instrumentation occupy the lower portion of the HCU as shown in Figure 2-1. The piston in the water accumulator forms a barrier between the high-pressure nitrogen used as the source of stored energy and the water used to initiate control rod scram. The piston is sealed against leakage past the barrier by O-rings installed in grooves around its outside wall. The purpose of the accumulator assembly is to provide a local source of kinetic energy in the event that reactor pressure is low and/or that the CRDHS fails or is depleted momentarily in a general scram.

2-33 The CRDHS continuously pressurizes the water accumulator through the charging water riser at the HCU. Check valve 115 in the charging water riser retains the water in the accumulator for a limited time in the event supply pressure fails and prevents backflow from the water accumulator into the charging water riser. Upon initiation of scram, when the inlet and outlet scram valves (126, 127) open, the charging water pressure (approximately 1400 psi [98.43 Kg/cm<sup>2</sup>]) is admitted through the insert riser to the under-piston area of the CRD. In the event charging water fails, there is adequate water capacity in the accumulator to complete the CRD scram stroke within the required time provided that reactor pressure is normal. If the reactor pressure should exceed the accumulator or charging water pressure, the check valve in the insert port of the CRD shifts, admitting reactor pressure to the under-piston area of the CRD. Reactor pressure then furnishes the force required to complete the scram stroke.

2-34 When the scram signal is manually cleared from the RPS logic circuitry the inlet and outlet scram valves again close, and the scram discharge volume is automatically drained. Full scram accumulator pressure is restored because the closed inlet scram valve blocks the charging water access to the CRD insert port.

2-35 Excessive loss of nitrogen will cause a decrease in nitrogen pressure which actuates the pressure switch (130) in the instrumentation block to provide an alarm in the control room.

2-36 The water accumulator is also continuously monitored for water leakage across the piston. The level switch (129) actuates a control room alarm if water leaks past the accumulator piston and collects in the instrumentation block. The instrumentation block is installed below the accumulator in such a manner that it will receive all water leaking past the piston.

2-37 The accumulator N<sub>2</sub> cylinder is initially precharged with nitrogen from an external source through connection P6 in the instrumentation block. Once precharged, further charging is not required unless low nitrogen pressure is indicated by the pressure indicator (131) on the instrumentation block.

2-38 ACCUMULATOR INSTRUMENTATION. The accumulator instrumentation is mounted on the instrumentation block below the scram accumulator as shown in Figures 2-6 and 2-7. The pressure switch (130) and liquid level switch (129) are interconnected with the RDCS to provide a control room alarm in the event of low gas pressure or water leakage at the scram accumulator. The contacts of the pressure switch open on decreasing pressure at 970 to 940 psig (68.19 to 66.08 Kg/cm<sup>2</sup>g). The contacts of the float-type liquid level switch open when approximately 60 cc of water exists in the instrumentation block. These instruments provide a local indication of the affected accumulator, in addition to the control room alarm of low pressure of water leakage.

1. PRESSURE INDICATOR (131)
2. PRESSURE SWITCH (130)
3. N<sub>2</sub> CHARGING CONNECTION (P6)

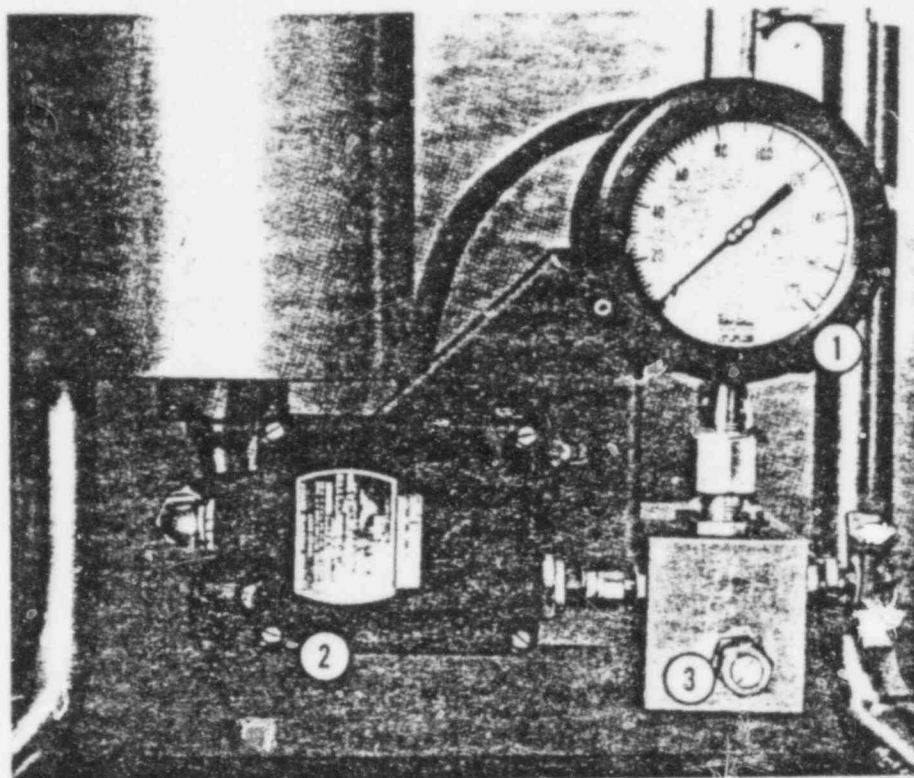


Figure 2-6. Accumulator Instrumentation (Front View)

1. LIQUID LEVEL SWITCH (129)
2. CARTRIDGE VALVE (111)
3. RUPTURE UNIT (132)
4. INSTRUMENTATION BLOCK

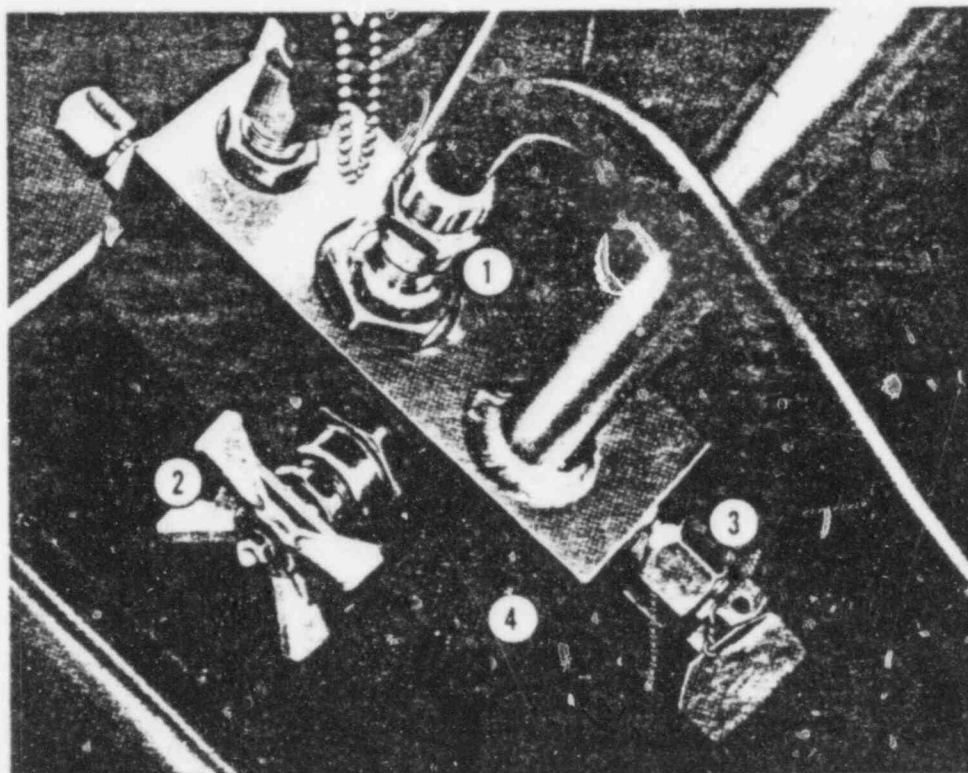
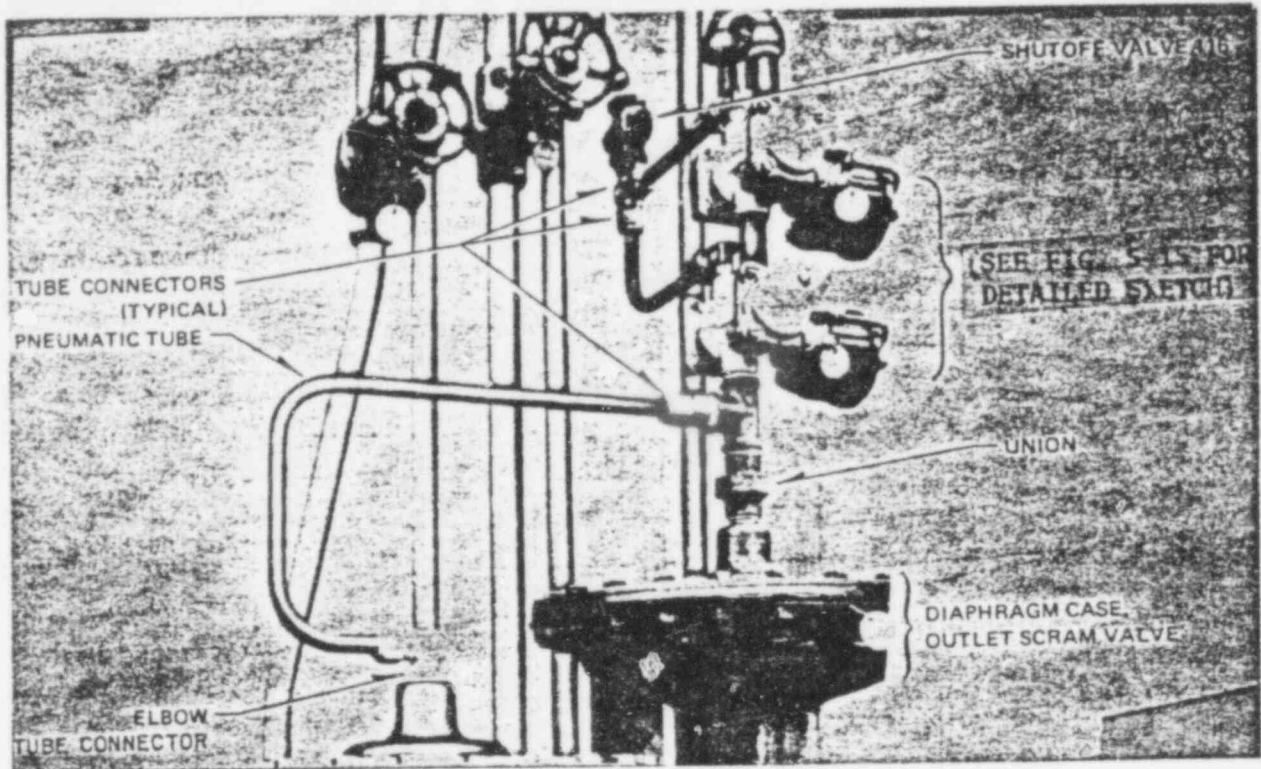


Figure 2-7. Accumulator Instrumentation (Side View)

2-39 The rupture unit (132) installed in the outside wall of the instrumentation block provides over-pressure protection for the accumulator and instrumentation. It contains a rupture disc which will burst to relieve pressure at 1900 to 2100 psig (133.57 to 147.65 Kg/cm<sup>2</sup>).

2-40 The cartridge valve (111) on the instrumentation block may be used to isolate the gas side of the accumulator for gas precharging and to isolate a portion of the accumulator instrumentation for periodic servicing.

2-41 Accumulator gas pressure is read at pressure indicator 131 on the instrumentation block, which has a scale range of 0 to 2500 psig (0 to 175.75 Kg/cm<sup>2</sup>).



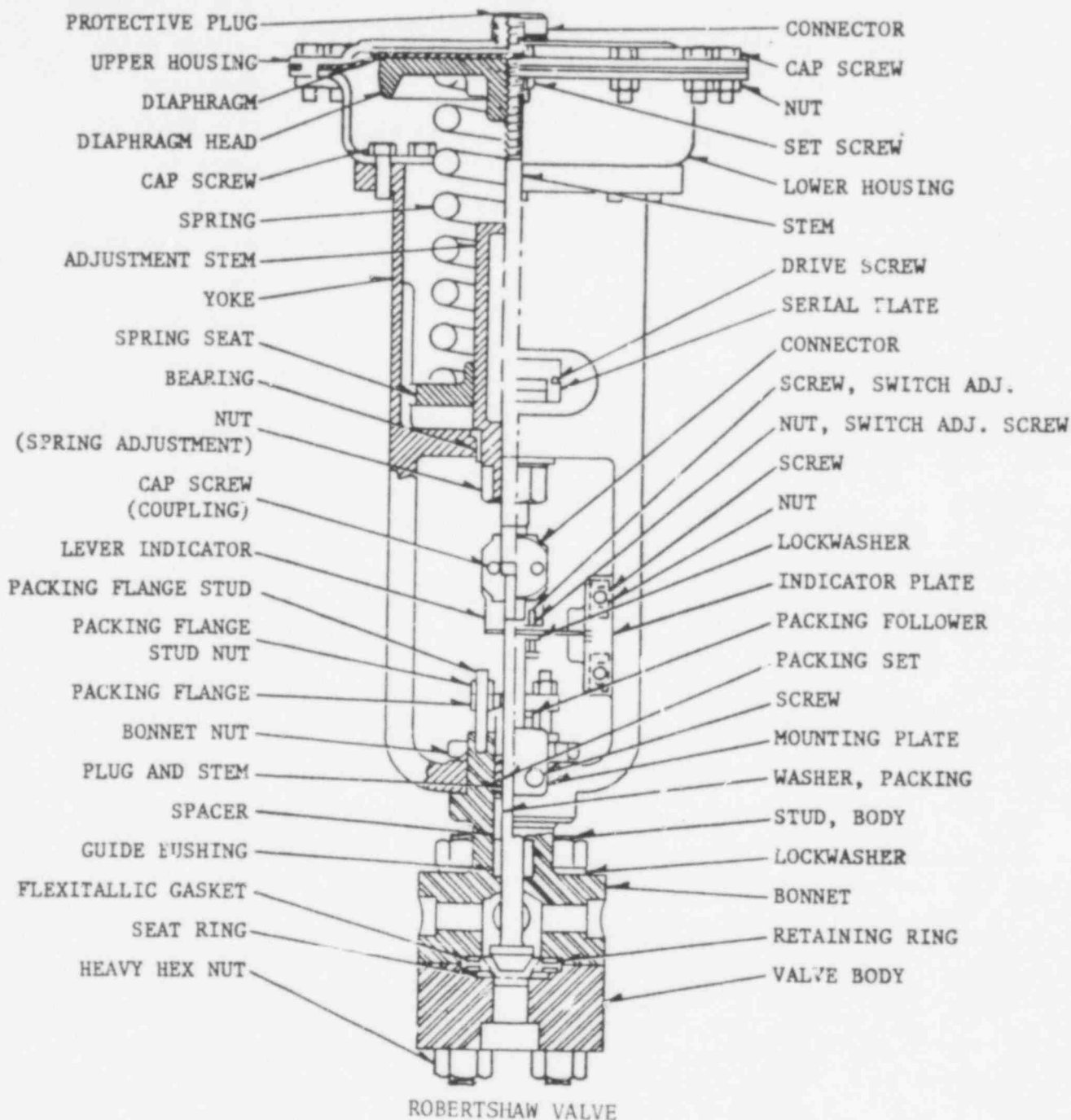


Figure 5-13. Typical Scram Valve (Cutaway View)

465 255



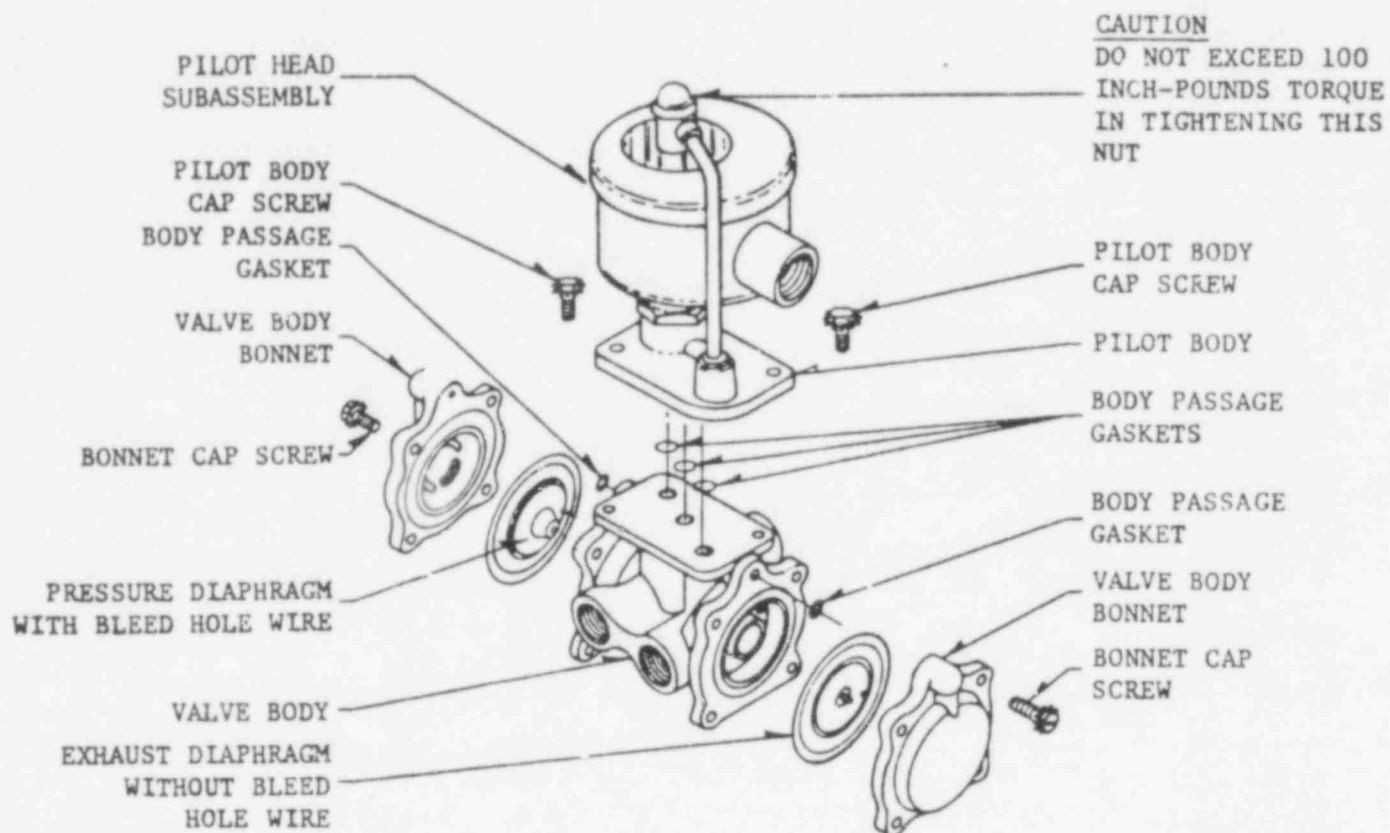
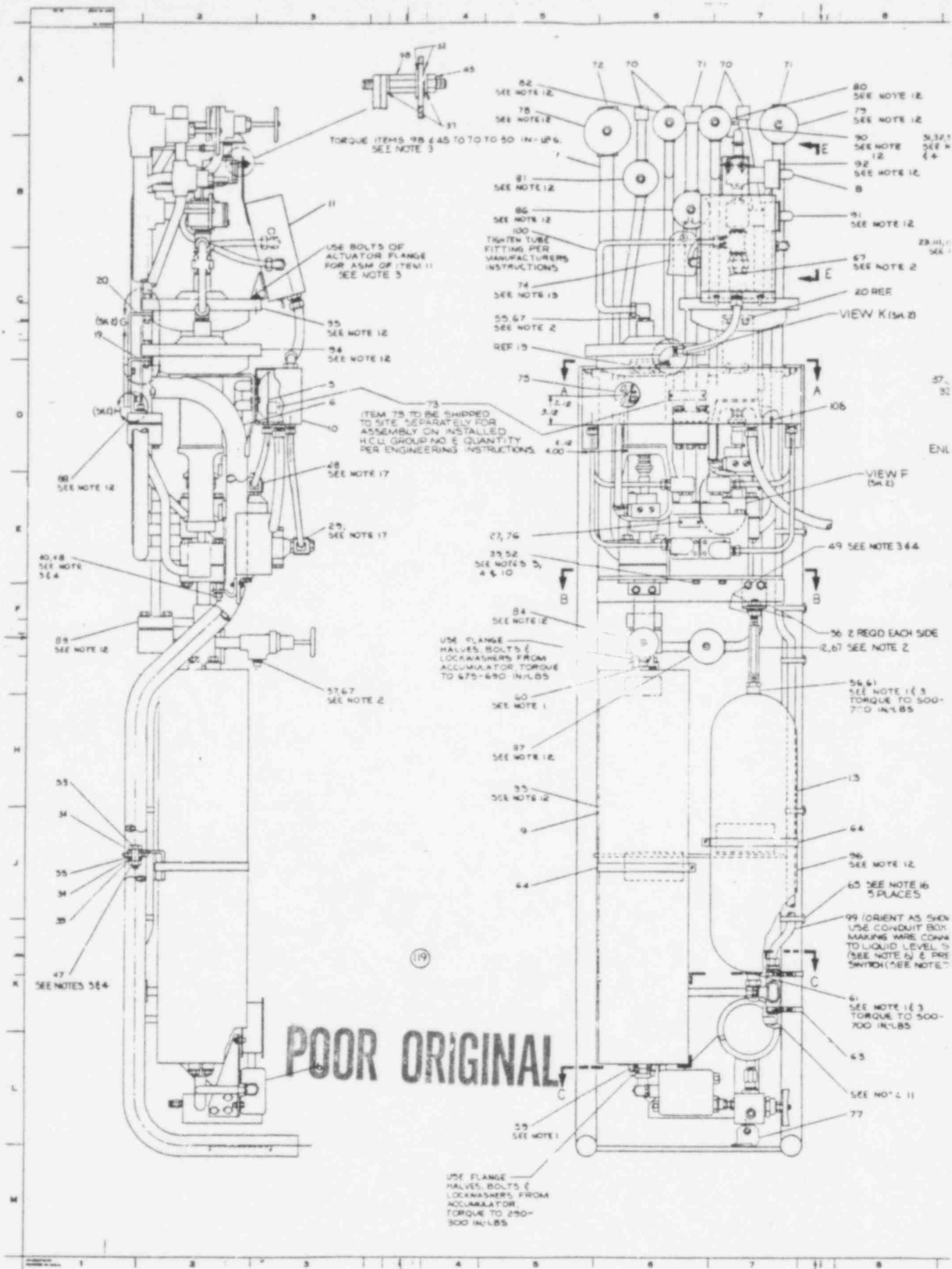


Figure 5-15. Scram Pilot Valve (117, 118) - Exploded View)







JOB 3447  
3589

SARGENT & LUNDY  
INCORPORATED  
ENGINEERS  
CHICAGO

SPECIFICATION K-2204  
December 16, 1966  
Revised for Purchase Order  
January 21, 1967

SPECIFICATION FOR  
INDOOR MOTOR CONTROL CENTERS  
FOR 440 VOLT AUXILIARIES

1. PURCHASER: GENERAL ELECTRIC COMPANY.
2. NAME OF PROJECT: DRESDEN UNITS 2 AND 3.
3. OWNER: COMMONWEALTH EDISON COMPANY.
4. LOCATION OF PROJECT  
Dresden Nuclear Power Station is located in Grundy County, Illinois, about 47 air miles southwest of Chicago, just west of the confluence of the Des Plaines and Kankakee rivers and south of and adjacent to the Dresden Heights Lock and Dam on the Illinois River.
5. RAILROAD FACILITIES  
A sidetrack from the Elgin, Joliet & Eastern Railway runs on the station property.
6. SCOPE OF WORK  
A. Furnish and deliver f.o.b. cars Dresden Nuclear Power Station, consigned to General Electric Company, c/o United Engineers and Constructors, Inc., the following equipment for Unit 2:  
Seventeen (17) Indoor Motor Control Centers for 480 Volt a-c service as follows:

Item 1.	Turbine Building Motor Control Center	25-1
Item 2.	Turbine Building Motor Control Center	25-2
Item 3.	Turbine Building Motor Control Center	26-1
Item 3A	Turbine Building Motor Control Center	26-4
Item 4	Turbine Building Motor Control Center	27-1
Item 5	Turbine Building Motor Control Center	28-2
Item 6	Turbine Building Motor Control Center	28-3
Item 7	Turbine Building Motor Control Center	29-2
Item 8	Reactor Building Motor Control Center	27-3
Item 9	Reactor Building Motor Control Center	28-1A
Item 10	Reactor Building Motor Control Center	28-1B
Item 11	Reactor Building Motor Control Center	29-1
Item 12	Crib House Motor Control Center	26-2
Item 13	Crib House Motor Control Center	26-3
Item 14	Radwaste Building Motor Control Center	27-2
Item 15	Radwaste Building Motor Control Center	27-4
Item 16	Radwaste Building Motor Control Center	27-5

- B. Furnish and deliver f.o.b. cars, Dresden Nuclear Power Station, consigned to General Electric Company, c/o United Engineers and Constructors, Inc., twelve (12) Indoor Motor Control Centers for 480 Volt a-c service which will essentially duplicate the scope of the Unit 2 equipment listed above, except omit Items 3A and 13 through 16; as follows:

Item 17	Turbine Building Motor Control Center	35-1
Item 18	Turbine Building Motor Control Center	35-2
Item 19	Turbine Building Motor Control Center	36-1
Item 20	Turbine Building Motor Control Center	37-1
Item 21	Turbine Building Motor Control Center	38-2
Item 22	Turbine Building Motor Control Center	38-3
Item 23	Turbine Building Motor Control Center	39-2
Item 24	Reactor Building Motor Control Center	37-3
Item 25	Reactor Building Motor Control Center	38-1A
Item 26	Reactor Building Motor Control Center	38-1B
Item 27	Reactor Building Motor Control Center	39-1
Item 28	Crib House Motor Control Center	36-2

**7. DEFINITIONS**

Wherever the word "Contractor" appears in the Bid Documents it shall be construed to mean "Vendor".

**8. SUPPLEMENTS**

Attached hereto and forming a part hereof:

- |    |             |   |
|----|-------------|---|
| A. | Form 1817-E | - Standard Specifications for 600 V. Motor Control Centers.     |
| B. | STD-EC-141  | - Typical Wiring Diagram for A.C. Combination Starter (5-1-57). |
| C. | C-2325      | - Small Wiring (dated 6-30-64).                                 |
| D. | EM-19621    | - Multiple Terminal Link (dated 3-22-56).                       |
| E. | EM-19622    | - Terminal Block (dated 3-21-63).                               |
| F. | EM-29105    | - 600 Volt Rubber Insulated Power Cable (dated 8-19-64).        |
| G. | EM-30105    | - Switchboard Wire (dated 6-30-64).                             |
| H. | EM-40275    | - Copper Lug (dated 2-27-64).                                   |
| I. | EM-40276    | - Insulated Connectors (dated 6-30-64).                         |

**9. DRAWINGS (CONSULTING ENGINEERS')**

The following drawing by the Consulting Engineers forms a part hereof:

ES-40, Rev. B (1-18-67) - Station Key Diagram of Auxiliaries - Unit 2.

465 260

10. INFORMATION REQUIRED FROM CONTRACTOR

- A. After award, Contractor shall submit prints and sepia reproductions of all drawings and data (per Section 19 of Form 1817-E) for approval.

Distribution shall be made as follows:

	<u>Transmittal</u>	<u>Drawings</u>	
	<u>Letter</u>	<u>Sepias</u>	<u>Prints</u>
Sargent & Lundy, Inc.	3	2	4
Mr. D. McDaniel (G.E. Co.-APED)	1	1	3
EUSD-Chicago	1	-	1

- B. If the drawings are returned "Approved Except as Noted", Contractor shall revise the drawings in accordance with the markings and comments and then resubmit seven (7) prints and two (2) sepias for approval.
- C. After drawings have been fully approved, Contractor shall send the following to the Consulting Engineers:
- Sixteen (16) prints and three (3) sepias of all drawings, marked "Certified for Construction".
  - Twenty-five (25) copies of Instruction Books.
  - Reverse reading negatives of wiring and schematic diagrams. Diagrams shall be 26" x 36" overall.
  - Twelve (12) copies of Spare Parts Bulletins and list of recommended spare parts to be stocked by Purchaser.
  - Twelve (12) copies of Test Reports.

11. GENERAL SPECIFICATIONS

- A. The Motor Control Centers included in this Specification will control 440-volt, 60-cycle, a-c auxiliaries in a power station.
- B. Wherever the Specification and the listed standards refer to 440 volts the operating voltage shall be considered as 480 volts.
- C. The Motor Control Centers will not be required to match existing equipment.
- D. Motor Control Centers shall have ample front compartment space for entrance of and termination of Purchaser's multiconductor control and power cables. Purchaser's cables will enter rear compartment from above and below; removable plates with concentric knockouts shall be provided at cable entrance points.
- E. Motor Control Centers shall have holes for mounting Purchaser's cable rack on top of the assembly. Weight of cable rack and cables will be 35 pounds per square foot and the rack will be of the same area as the associated Motor Control Center.
- F. Auxiliary contacts shall be suitable for 250 volt d-c service.
- G. Insulation shall be minimum hygroscopic.

- H. A pilot light, fed from a separate control transformer, shall be provided on each center to indicate an energized bus.
- I. In order to determine the extent of the field installation, Bidder shall list all items which will be shipped separately. It is understood that items not so listed in the Summary of Proposal will be shipped completely assembled and wired.
- J. All Motor Control Centers shall be designed to be capable of withstanding earthquake forces of 0.2g (horizontal) without any effect on operation. Bidder shall state in his proposal that this requirement can be met.
- K. Name plate data shown is preliminary.
- L. Each compartment shall be completely wired with power and control leads connected to terminal boards located on the respective units, per NEMA Type B construction for motor control centers. Control circuits, and 480 volt power circuits, shall be on separate terminal blocks.

12. EXCEPTIONS TO FORM 1817-E

## A. Purchaser's Cable:

- a. Purchaser's control cable will be #14 AWG stranded copper wire, unless specified otherwise.
- b. Purchaser's power cable will be stranded copper cable with sizes as listed in the detailed tabulations. Lugs for Purchaser's power cables shall be in accordance with EM-40275.
- c. Contractor shall furnish terminal blocks for control wiring per Commonwealth Edison Company Standard EM-19622, and with marking strips.  
The compression type lugs for Purchaser's control cables, which are called for in Paragraph 14E of Form 1817-E, shall be omitted. Lugs shall be furnished in accordance with Commonwealth Edison Company Standard EM-40276.
- e. All points where lugs are to be bolted to bus shall be silver plated.
- B. Name plates shall be lamicoid, black letters on a white background. A name plate list will be furnished later.
- C. Acceptance tests, when made by Purchaser, will be in accordance with latest issue of ASA Standards.
- D. Control wiring by Contractor shall be #14 AWG stranded wire and shall conform to Commonwealth Edison Company Specifications C-2325 and EM-30105.
- E. The exterior of the motor control centers shall be painted with Contractor's standard primer and finish coats except the color of the finish coat shall match ASA color No. 61 (light gray) for indoor service.
- F. Removable barriers shall be provided over the vertical 480 volt bus in the rear compartments.
- G. The back of each vertical group of compartments shall have a hinged cover plate eq with captive knurled head screws which are large enough to be loosened the fingers.
- H. Operating coils on magnetic starters and auxiliary relays shall be rated for continuous duty at 120 volts, 60-cycles.



- I. To Paragraph 4 C add: "Provision for locking the unit in the disengaged position, with the starter unit in the compartment, and the door closed, shall be included".
- J. Air circuit breakers shall be adjustable to "15 times the motor current" in place of "11 times the motor current", as stated in Paragraph 6B.
- K. Space heaters, with suitable thermostats, shall be installed in all Reactor Building Motor Control Centers (Items 8-11 inclusive and Items 24-27 inclusive) to provide protection against the effects of moisture and condensation.

13. EQUIPMENT RATINGS

- A. Design voltage..... 600 volts a-c
- B. Operating voltage..... 480 volts a-c
- C. Control voltage..... 120 volts a-c
- D. Bus continuous current..... 600 amperes
- E. Bus momentary..... 25,000 amperes
- F. Air circuit breaker, frame size.....  
100 amperes - "F"  
225 amperes - "J"
- G. Air circuit breaker interrupting capacity,  
symmetrical amperes at 480 volts.....  
F frame - 14,000  
J frame - 18,000
- H. Temperature rise at rated current above  
outside ambient of 40°C:
  - a. Buses and silver surfaced, welded or  
brazed connections..... 50°C
  - b. Connections to insulated cables..... 45°C
  - c. Air surrounding outgoing insulated  
cables..... 15°C
  - d. Instrument panels, control panels and  
doors..... 30°C
  - e. Other noncurrent carrying parts of  
structure..... 70°C

14. DETAILED SPECIFICATIONS:

- A. A list of Control Centers required is included in this Job Specification. For each Control Center Item listed for Unit 2, there is a corresponding Equipment Tabulation which shows the requirements of the center. Corresponding Motor Control Centers for Unit 3 will have essentially the same equipment requirements.
- B. The Contractor is not restricted to the exact arrangement of Units shown on the tabulation, and may relocate the Units within the Control Center to provide the most economical assembly, provided that the total number of units (including unassigned positions) is not reduced.

- C. In each tabulation a column headed "Ref. Note" provides reference to Notes listed at the end of this Specification under Section 15. These Reference Notes outline further details and requirements of the various Units of each Control Center.
- D. Reactor Building Motor Control Centers 27-3, 28-1A, 28-1B and 29-1 shall be provided with space heaters and thermostatic control.
- E. The 12 inch pull box compartment shall be at the bottom of Motor Control Centers 25-1, 26-2, 26-3, 28-1A and 28-1B. In all other centers, it shall be at the top.

15. REFERENCE NOTES REFERRED TO IN THE TABULATIONS

Note A: This unit consists of two (2) circuit breakers.

Note B: This unit shall consist of a motor reversing type starter including an a.c.b. and two 3-pole contactors mechanically and electrically interlocked with overload elements in the motor leads.

Note C: This unit shall consist of provisions for future addition of one Size 1 reversing combination starter unit.

Note D: This unit shall consist of provisions for future addition of one Size 2 nonreversing combination starter unit.

Note E: This unit consists of a circuit breaker only.

Note F: This unit shall consist of provisions for future addition of one (1) 100 ampere, 3-pole, circuit breaker.

Note G: This unit shall consist of the following:

- 1 - Distribution panel with removable trim hinged door with combination lock. Circuit breakers shall be rated 120/240 volt, 5000 ampere interrupting capacity with inverse time thermal trip elements. All circuit breakers shall be provided with card holders for circuit identification. Panel bus shall be 3-phase, 4-wire or single phase, 3-wire (as indicated) and neutral bar shall be insulated and connected to motor control center ground bus and shall have sufficient terminals for branch circuits. The following circuit breakers are to be provided and shall be connected for 120 volt service.

18 - 30 ampere, one-pole, single throw.

3 - 30 ampere, two-pole, single throw.

Note H: This unit shall consist of a nonreversing combination starter suitable for a two-speed, two-winding, constant torque motor.

Note I: This unit shall consist of the following:

- 1 - 10 kva, 480-240/120 volt, single phase, dry type transformer, 80C temperature rise, with two taps, 5% and 10% below 480 volts. The secondary shall be connected to the distribution panel. The primary shall be connected to the associated air circuit breaker.

Note J: This unit shall consist of the following:

1 - 9 kva, 480-120/208 volt, delta-wye, three-phase, dry type transformer, 80°C temperature rise, with two taps, 5% and 10% below 480 volts. The low voltage terminal shall be connected to the distribution panel buses. High voltage connections to associated breaker shall be provided.

Note K: This unit shall consist of a nonreversing combination starter suitable for a two-speed, two-winding, constant horsepower motor.

16. PROPOSAL

- A. Proposal shall include a statement that the apparatus offered will be in accordance with this specification, either completely or with specifically stated exceptions.
- B. If the equipment proposed includes any changes in design, construction, or material (other than charges specifically called for by Purchaser's specification) from vendor's most recent shipment of similar equipment to Commonwealth Edison Company, these changes shall be specifically listed as exceptions in the proposal. Any such changes will be considered by the Purchaser in evaluating the proposal.

SPECIFICATION FOR  
A.C. AND D.C. DISTRIBUTION CENTERS

1. PURCHASER: GENERAL ELECTRIC COMPANY.

2. NAME OF PROJECT: DRESDEN UNITS 2 AND 3.

3. OWNER: COMMONWEALTH EDISON COMPANY.

4. LOCATION OF PROJECT

Dresden Nuclear Power Station is located in Grundy County, Illinois, about 47 air miles southwest of Chicago, just west of the confluence of the Des Moines and Kankakee Rivers and south of and adjacent to the Dresden Heights Lock and Dam on the Illinois River.

5. RAILROAD FACILITIES

A sidetrack from the Elgin, Joliet & Eastern Railway runs on the station property.

6. SCOPE

Contractor shall furnish and deliver f.o.b. cars Dresden Nuclear Power Station, c/o General Electric Company, the following equipment as hereinafter specified:

For Unit 2:

- ITEM 1 - ONE 250 VOLT D.C. TURBINE BLDG. MOTOR CONTROL CENTER
- ITEM 2 - ONE 250 VOLT D.C. REACTOR BLDG. MOTOR CONTROL CENTER
- ITEM 3 - ONE 125 VOLT D.C. TURBINE BLDG. DISTRIBUTION PANEL
- ITEM 4 - ONE 125 VOLT D.C. REACTOR BLDG. DISTRIBUTION PANEL
- ITEM 5 - ONE 48/24 VOLT D.C. DISTRIBUTION PANEL "A"
- ITEM 6 - ONE 48/24 VOLT D.C. DISTRIBUTION PANEL "B"
- ITEM 7 - ONE 120/240 VOLT A.C. INSTRUMENT BUS DISTRIBUTION PANEL
- ITEM 8 - ONE 120/240 VOLT A.C. ESSENTIAL SERVICE BUS DISTRIBUTION PANEL

For Unit 3:

- ITEM 1 - ONE 250 VOLT D.C. TURBINE BLDG. MOTOR CONTROL CENTER
- ITEM 2 - ONE 250 VOLT D.C. REACTOR BLDG. MOTOR CONTROL CENTER
- ITEM 3 - ONE 125 VOLT D.C. TURBINE BLDG. DISTRIBUTION PANEL
- ITEM 4 - ONE 125 VOLT D.C. REACTOR BLDG. DISTRIBUTION PANEL
- ITEM 5 - ONE 48/24 VOLT D.C. DISTRIBUTION PANEL "A"
- ITEM 6 - ONE 48/24 VOLT D.C. DISTRIBUTION PANEL "B"
- ITEM 7 - ONE 120/240 VOLT A.C. INSTRUMENT BUS DISTRIBUTION PANEL
- ITEM 8 - ONE 120/240 VOLT A.C. ESSENTIAL SERVICE BUS DISTRIBUTION PANEL

7. SUPPLEMENTS

Attached hereto and forming a part hereof:

- A. C-2325 - Small Wiring (dated 6-30-64).
- B. EM-19622 - Terminal Block (dated 3-21-63).
- C. EM-19621 - Multiple Terminal Link (dated 3-22-56).
- D. EM-30105 - Switchboard Wire (dated 6-30-64).
- E. EM-40275 - Copper Lug (dated 2-27-64).

F. EM-40276 - Insulated Connectors (dated 5-4-65).

G. Form 1817-E - Standard Specifications for 600 V. Motor Control Centers.

8. DRAWINGS (CONSULTING ENGINEERS)

The following drawings by the Consulting Engineers, dated April 17, 1967, form a part hereof:

- ES-123 - Key Diagram of 250 Volt D.C. Motor Control Centers
- ES- 74 - Key Diagram of 125 Volt D.C. Distribution Panels
- ES-116 - Key Diagram and Elevation 48/24 V. D.C. Distribution Panels
- ES- 82 - Key Diagram 120 and 120/240 V. A.C. Distribution Panels
- ES- 75 - Elevations of 250 V. D.C. Motor Control Centers and 125 V. D.C. Distribution Panels
- ES- 83 - Elevations of 120 and 120/240 V. A.C. Distribution Panels

9. INFORMATION REQUIRED FROM CONTRACTOR

- A. After award, Contractor shall submit seven (7) prints and two (2) sepia reproductions of all drawings and data to the Consulting Engineers for approval.
- B. If the sepias are returned "Approved Except as Noted", Contractor shall revise the drawings in accordance with the markings and comments and then resubmit seven (7) prints and two (2) sepias for approval.
- C. After drawings have been fully approved, Contractor shall send the following to the Consulting Engineers:
  - a. Twelve prints and three (3) sepias of physical drawings, marked "Certified for Construction".
  - b. Twenty-five (25) copies of Instruction Books.
  - c. Reverse reading negatives of wiring and schematic diagrams. Diagrams shall be 26" x 36" in size. Contractor must furnish these negatives on one of the following negative papers:
 

Keuffel & Esser	No. 31-1139 "Photact"
Eugene Dietzgen & Co.	No. 237 PG-15 "Copy All"
Remington-Rand	No. G-90 Bromide
Anken Paper Co.	No. 80 G "Super Gamma"
Eastman Kodak Co.	No. C 3 "Kodagraph Contact Fine-Line"
  - d. Twelve (12) copies of Spare Parts Bulletins and list of recommended spare parts to be stocked by Purchaser.
  - e. Twelve (12) copies of Test Reports.
- D. Contractor shall submit the following drawings, data and information as soon as possible after order is placed:
  - a. Elevations, floor plans and section views for each distribution center.
  - b. Operating and Maintenance Instructions for all components.
  - c. Bills of Material of components.
  - d. Spare Parts lists.
  - e. Internal Wiring Diagrams.
  - f. Other Drawings as required by the Standard Specifications.

10. GENERAL SPECIFICATIONS

- A. Distribution centers shall be in accordance with Form 1817-E, where applicable, and shall conform to the following specifications.
- B. The distribution centers in this Specification will control 250, 125, 48/24 volt d-c and 120/240 volt a-c auxiliaries, battery chargers and batteries in a power station.
- C. The Distribution Centers will not be required to match existing equipment.
- D. The Distribution Centers shall have ample front compartment space for entrance of and termination of Purchaser's multiconductor control and power cables. Purchaser's cables will enter rear compartment from above and below; removable plates with concentric knockouts shall be provided at cable entrance points.
- E. Auxiliary contacts shall be suitable for 250 volt d-c service.
- F. Insulation shall be minimum hygroscopic.
- G. Main and reserve breakers (for Items 1, 3 and 8) shall be furnished with short time delay selective trip attachment so as to coordinate with all feeder breakers.
- H. In order to determine the extent of the field installation, Bidder shall list all items which will be shipped separately. It is understood that items not so listed in the Summary of Proposal will be shipped completely assembled and wired.
- I. All Distribution Centers shall be designed to be capable of withstanding earthquake forces of 0.2g (horizontal) without any affect on operation. Bidder shall state in his proposal that this requirement can be met.
- J. Name plate data shown is preliminary.
- K. Each compartment shall be completely wired with power and control leads connected to terminal boards located on the respective units, per NEMA Type B construction for motor control centers. Control circuits and power circuits shall be on separate terminal blocks.

11. EXCEPTIONS TO FORM 1817-E

A. Purchaser's Cable:

- a. Purchaser's control cable will be #14 AWG stranded copper wire, unless specified otherwise.
  - b. Purchaser's power cable will be stranded copper cable with sizes as listed in the detailed tabulations. Lugs for Purchaser's power cables shall be in accordance with EM-40275.
  - c. Contractor shall furnish terminal blocks for control wiring per Commonwealth Edison Company Standard EM-19622, and with marking strips.
  - d. The compression type lugs for Purchaser's control cables, which are called for in Paragraph 14E of Form 1817-E, shall be omitted. Lugs shall be furnished in accordance with Commonwealth Edison Company Standard EM-40276.
  - e. All points where lugs are to be bolted to bus shall be silver-plated.
- B. Name plates shall be lamicoid, black letters on a white background. A name plate list will be furnished later. Name plates shall be mounted with rust-proof machine screws.



- C. Acceptance tests, when made by Purchaser, will be in accordance with latest issue of ASA Standards.
- D. Control wiring by Contractor shall be #14 AWG stranded wire and shall conform to Commonwealth Edison Company Specifications C-2325 and EM-30105.
- E. The exterior of the distribution centers shall be painted with Contractor's standard primer and finish coats except the color of the finish coat shall match ASA color No. 61 (light gray) for indoor service.
- F. Removable barriers shall be provided over the vertical 480 volt bus in the rear compartments.
- G. The back of each vertical group of compartments (Items 1, 2, 3 and 4 only) shall have a hinged cover plate equipped with captive screws which are large enough to be loosened by the fingers. Items 5, 6, 7 and 8 shall be fully accessible from the front since back of distribution center will be against a wall. Cabinet ventilation shall be designed for this arrangement.
- H. Operating coils on magnetic starters and auxiliary relays shall be rated for continuous duty at 120 volts, 60 cycles or 250 and 125 volts d-c as indicated.
- I. Contractor shall furnish sample terminal block for power circuits for approval by Consulting Engineers. Pressure type box connectors are not acceptable.
- J. Circuit breakers on distribution panels shall have an interrupting rating of 10,000 amperes, and shall have provisions for attaching plant electrician's "Out of Service" cards which are suspended by strings.

12. EQUIPMENT RATINGS

	Items 1 & 2	Items 3 & 4	Items 5 & 6	Items 7 & 8
A. Design voltage.....(volts)	250V d-c	250V d-c	250V d-c	240V a-c
B. Operating voltage.....(volts)	250V d-c	125V d-c	48V d-c	240V a-c
C. Control voltage.....(volts)	250V d-c	125V d-c	24V d-c	240V a-c
D. Bus continuous current.....(amps)	800	400	100	200
E. Bus momentary.....(amps)	10,000	10,000	10,000	10,000
F. Interrupting rating (min) (rms asym. amps at design voltage).....	10,000	10,000	10,000	10,000

G. Air Circuit Breakers - Frame Size:

- a. 800 ampere - I-T-E Type "MN" (or equal) with selective trip attachment.
- b. 400 ampere - G.E. Type "TJJ" (or equal).
- c. 225 ampere - G.E. Type "TFJ" (or equal).
- d. 100 ampere - G.E. Type "TEF" (or equal).

H. Temperature rise at rated current above outside ambient of 40°C:

- a. Buses and silver surfaced, welded or brazed connections .....50°C
- b. Connections to insulated cables.....45°C
- c. Air surrounding outgoing insulated cables.....15°C
- d. Instrument panels, control panels and doors.....30°C
- e. Other noncurrent carrying parts of structure.....70°C

13. DETAILED SPECIFICATIONS

- A. A list of Distribution Centers required for Unit 2 is included in this Job Specification. For each Item listed, there is a corresponding Equipment Tabulation which shows the requirements of the center. Corresponding Centers for Unit 3 will have the same equipment requirements.
- B. The Contractor is not restricted to the exact arrangement of Units shown on the tabulation, and may relocate the Units within the Control Center to provide the most economical assembly, provided that the total number of units (including unassigned positions) is not reduced. Final arrangement to be subject to approval by the Consulting Engineers.
- C. In each tabulation a column head "Ref. Note" provides reference to Notes listed at the end of this Specification under Section E. These Reference Notes outline further details and requirements of the various units of the auxiliary switch center.
- D. Strip heaters, to prevent condensation, shall be provided in the distribution centers covered by Items 2 and 4.
- E. Reference Notes Referred to in the Tabulations:

Note A: This unit shall contain a combination starter with three definite time acceleration steps and necessary resistors. Starter will be furnished by G.E. (LSTG). Contractor to furnish ACB, mount and wire starter (G.E. Model #IC-4061-T1).

Note B: This unit shall contain a combination starter with three definite time acceleration steps and necessary resistors.

Note C: This unit shall be a reversing, across-the-line starter, 4 pole with field discharge resistor.

Note D: This unit consists of a 2 pole circuit breaker only with thermal magnetic overload protection.

Note E: Circuit breaker shall be furnished with short time selective trip attachment to coordinate with feeder breakers.

Note F: This unit shall consist of the following:

- 1 - Distribution panel, dead front, with removable trim hinge door with two point latch and lock, keyed alike for all panels. Minimum width of each side gutter shall be 6".

Circuit breakers shall be rated 250 volt d-c, 10,000 ampere interrupting capacity, 100 ampere frame, with instantaneous magnetic and inverse thermal trip elements. All circuit breakers shall be provided with terminal lugs (per EM-40275) and card holders for circuit indication. Quantity, number of poles, and trip ratings shall be as shown on the drawings.

Note G: Circuit breaker shall be furnished with auxiliary switch (bell alarm contact) which will close when breaker is tripped by any means other than manual.

Note H: This unit shall contain the following:

- 1 - Voltmeter, General Electric Type DB-18 or approved equal, 0-150 volts, d-c.

- 1 - Voltmeter switch, G.E. Type SB-1 or equal, 6 position, escutcheon plate marked "Mn. Bus", "Res. Bus", "Off", "Batt.", "2-Batt. Chgr.", "2/3-Batt. Chgr."
- 1 - Ammeter, General Electric Type DB-18 or approved equal, d-c, complete with 500A shunt, 200-0-500 amp. scale.
- 2 - Ammeters, General Electric Type DB-18 or approved equal, d-c, each complete with 150A shunt, 0-150 amp. scale.
- 2 - Control switches G.E. Type SB-1 or approved equal, 3-stage, escutcheon plate marked "Stop", "Off", "Start", red and green indicating lamps for 120 V. a-c operation shall be furnished. For control of battery charger MG set motor starters.
- 2 - Mounting and wiring only for battery charger field rheostats furnished by Purchaser.
- 1 - Ground detector recorder, Esterline-Angus Model AW or equal, 1000 ohms per volt, high resistance graphic voltmeter, flush mounted, scale 150-0-150 volts d-c, chart speed 1-1/2" per hour. Chart shall be driven by a 115 volt, 60-cycle motor mechanism. Recorder shall be equipped with adjustable contacts to close for 125 volt d-c annunciator in event ground occurs on either polarity. Necessary resistors shall be included.
- 2 - Push buttons, two pole, 600 volt rated, normally closed, momentary break contacts. For "Positive to Ground" and "Negative to Ground" voltage indication.

Note I: This unit shall be blank.

Note J: This unit consists of a two pole circuit breaker with thermal magnetic protection, bell alarm contacts and an undervoltage trip unit with 110 volt a-c coil for external connection.

Note K: This compartment shall be suitable for future installation of breaker or combination starter.

Note L: This unit shall contain following:

- 1 - Voltmeter, General Electric Type DB-18 or approved equal, 0-300 volts, d-c.
- 1 - Voltmeter switch, G.E. Type SB-1 or equal, 5 position, escutcheon plate marked "Bus", "Off", "Batt.", "2-Batt. Chgr.", "2/3-Batt. Chgr."
- 1 - Ammeter, General Electric Type DB-18 or approved equal, d-c, complete with 800A shunt, 200-0-800 amp. scale.
- 2 - Ammeters, General Electric Type DB-18 or approved equal, d-c, each complete with 150A shunt, 0-150 amp. scale.
- 2 - Control switches G.E. Type SB-1 or approved equal, 3-stage, escutcheon plate marked "Stop", "Off", "Start", red and green indicating lamps for 120 V. a-c operation shall be furnished. For control of battery charger MG set motor starters.
- 2 - Mounting and wiring only for battery charger field rheostats furnished by Purchaser.

1 - Ground detector recorder, Esterline-Angus Model AW or equal, 1000 ohms per volt, high resistance graphic voltmeter, flush mounted, scale 300-0-300 volts d-c, chart speed 1-1/2" per hour. Chart shall be driven by a 115 volt, 60-cycle motor mechanism. Recorder shall be equipped with adjustable contacts to close for 125 volt d-c annunciator in event ground occurs on either polarity. Necessary resistors shall be included.

2 - Push buttons, two pole, 600 volt rated, normally closed, momentary break contacts. For "Positive to Ground" and "Negative to Ground" voltage indication.

Note M: This unit shall contain a removable, 2 pole copper link, of same rating as bus, for connecting incoming supply to main bus station-ary and movable contact surfaces shall be silver-plated. Link shall be suitable for insertion in "Main" or "Reserve" supply compartments.

Note N: This unit shall contain a combination starter with four definite time acceleration steps and necessary resistors.

Note O: This unit shall consist of a panel with the following equipment mounted and wired thereon:

2 - Undervoltage relays, G.E. Type 12PJV11BA4A, 30 volt d-c continuous duty coil, with adjustable contacts set to close on decreasing voltage at 20 V. d-c. Contacts shall be suitable for actuating Purchaser's 125 V. d-c annunciator.

2 - Overvoltage relays, G.E. Type 12PJV11AM4A, 30 volt continuous duty coil, with adjustable contacts set to close on increasing voltage at 30 volts d-c. Contacts shall be suitable for actuating Purchaser's 125 V. d-c annunciator.

2 - Voltmeters, G.E. Type DB-18, 0-30 volts d-c scale.

1 - Test switch, flush mounted, 12 pole, Superior Electric Co.

Note P: This unit shall consist of panel with the following equipment mounted and wired thereon:

1 - Undervoltage relay, G.E. Type IAV, 240 V. a-c coil, Cat. No. 121AV54E2A, with adjustable contacts set to close on decreasing voltage at 207 volts.

Note Q: This unit shall contain an automatic transfer switch for a 120/240 V. a-c 3 wire "Normal" and "Emergency" supply. Transfer switch shall be mechanically held, Automatic Switch Company Catalog No. X-907212, except with special protective metal boxes (without covers) around the normal and emergency contacts, two-pole, single-phase, 3-wire, front connected, 60-cycle, 200 ampere, Form B full protection with accessories #5 (momentary type test switch on panel) and #14b (auxiliary contact to close on "Emergency"). The incoming "Normal" and "Emergency" supply cables shall be separated by rigid metal barriers. Lugs (per EM-40275) shall be provided for Purchaser's cables.

Note R: This unit shall consist of a panel with the following equipment mounted and wired thereon:

- 1 - Ammeter, a-c, 5 ampere coil, 0-200 ampere scale, General Electric Type AB-18.
- 2 - Current transformers, 200-5A, metering accuracy, for use with the above ammeter.
- 1 - Ammeter switch, General Electric Type SB-1, 3 position, "Line 1 - Off - Line 2".
- 1 - Undervoltage relay, General Electric Type IAV 240 volts a-c coil, Cat. No. 12IAV54E2A, with adjustable contacts set to close on decreasing voltage.
- 1 - Voltmeter, a-c, 0-150 volt scale, General Electric Type AB-18.
- 1 - Voltmeter switch, General Electric Type SB-1, 3 position, "Line 1 - Off - Line 2".

Note S: This unit shall contain two 2-pole, 225 ampere, Type "TFJ" manually operated circuit breakers with inverse time overload trip and instantaneous short circuit trip and bell alarm contact. The two breakers shall be provided with "Walking beam" mechanical interlock to prevent simultaneous closing of "Normal" and "Reserve" breakers. The two breakers and the incoming "Normal" and "Reserve" supply cables shall be separated by rigid metal barriers. Lugs (per EM-40275) shall be provided for Purchaser's cables.

Item 1 - Two Control Centers (one for Unit 2 and One for Unit 3) as follows:

Unit No.	Motor H.P.	ACB Rating Amps.	Starter Size NEMA	Cable Size AWG	Extra Aux. Switch Each Contactor		Ref. Note (See Spec.)	Nameplate Data		
					N.O.	N.C.		First Line	Second Line	Third Line
A01	-	800	-	750MCM	-	-	D,E,G	250 V. BATTERY	TO	MAIN BUS
A02	30KW	175	-	#1/0	-	-	J	#2/3 M.G. SET	TO	BATTERY
A03	30KW	175	-	#1/0	-	-	J	#2 M.G. SET	TO	BATTERY
B01	-	-	-	-	-	-	L	BATTERY	CHARGER	CONTROL
B02	-	-	-	-	-	-	I	(BLANK)		
C01	40	350	4	250MCM	2	2	A	MAIN TURB. 2	EMERG. BRG.	OIL PUMP
D01	7.5	100	2	#6	2	2	B	GEN. 2	EMERG. SEAL	OIL PUMP
D02	40	500	-	#4/0	-	-	D	ESSENTIAL BUS	M.G. SET	DRIVE MOTOR
D03	-	-	-	-	-	-	I	(BLANK)		
E01	-	600	-	250MCM	-	-	D,G	REACTOR BLDG.	M.C.C. #2	MN. FEED
E02	1.5	30	1	#14	-	-	C	H <sub>2</sub> & STAT. COOL.	SERV. WATER	SUPPLY VALVE
F01	0.5	15	1	#14	-	-	C	FIRE PUMP	DISCHARGE	VALVE
F02	0.5	15	1	#14	-	-	C	TURB. BRG. COOL.	WTR. HT. EXCH.	ISOL. VALVE 2B
G01	0.5	15	1	#14	-	-	C	TURB. BRG. COOL.	WTR. HT. EXCH.	ISOL. VALVE 2A
G02	0.5	15	1	#14	-	-	C	M.G. SET OIL	COOLERS S.W.	DISCH. VALVE
H01	0.5	15	1	#14	2	2	B	RECIR. M.G. SET	COAST-DOWN	L.O. PUMP 2A
H02	0.5	15	1	#14	2	2	B	RECIR. M.G. SET	COAST-DOWN	L.O. PUMP 2B
H03	-	-	-	-	-	-	I	(BLANK)		
I01	-	600	-	250MCM	-	-	D,G	REACTOR BLDG.	MCC #3	RES. FEED
I02	-	-	-	-	-	-	K	(FUTURE)		
I03	-	-	-	-	-	-	I	(BLANK)		

K-2225

REFERENCE:

SARGENT & LUNDY, ENGINEERS, CHICAGO, ILL.

General Arrangement Sketch No. ES-75

KEY DIAGRAM SKETCH NO. ES-123

ITEM 1



Item 2 - Two Control Centers (one for Unit 2 and One for Unit 3) as follows:

Unit No.	Motor H.P.	ACB Rating Amps.	Starter Size NEPA	Cable Size AWG	Extra Aux. Switch Each Contactor		Ref. Note (See Spec.)	Nameplate Data		
					N.O.	N.C.		First Line	Second Line	Third Line
A01	-	-	-	250MCM	-	-	M	SUPPLY FROM	250 V. MN. BUS	UNIT 2
A02	-	70	-	-	-	-	D	SPARE		
A03	-	50	1	-	-	-	C	SPARE		
B01	50	500	5	#4/0	2	2	N	HPCI TURB.	AUX. OIL	PUMP
CO1	7.5	100	2	#6	2	2	B	HPCI TURB.	EMERG. BRG.	OIL PUMP
CO2	5	50	2	#10	2	2	B	HPCI TURB.	GLAND COND.	EXHAUSTER
CO3	-	-	-	-	-	-	I	(BLANK)		
DO1	1.5	30	1	#14	2	2	B	HPCI TURB.	TURNING	GEAR
DO2	1	20	1	#14	2	2	B	HPCI TURB. GL.	COND. HOTWELL	DRAIN PUMP
DO3	-	-	-	-	-	-	I	(BLANK)		
EO1	0.33	15	1	#14	-	-	C	MAIN STEAM	LINE	DRAIN VALVE 2B
EO2	4	40	1	#10	-	-	C	SHUTDOWN	PUMP 2A	SUCTION VALVE
FO1	4	40	1	#10	-	-	C	SHUTDOWN	PUMP 2B	SUCTION VALVE
FO2	4	40	1	#10	-	-	C	SHUTDOWN	PUMP 2C	SUCTION VALVE
GO1	2.7	30	1	#14	-	-	C	CLEANUP SYS.	HEAT EXCH.	INLET VALVE
GO2	2	30	1	#14	-	-	C	CLEANUP SYS.	AUX. PUMP	SUCTION VALVE
HO1	4	40	1	#10	-	-	C	ISOL. COND.	RETURN LINE	ISOL. VALVE
HO2	5	50	2	#10	-	-	C	ISOL. COND.	SUPPLY LINE	ISOL. VALVE

K-2225

SARGENT & LUNDY, ENGINEERS, CHICAGO, ILL.

REFERENCE

General Arrangement Sketch No. ES-75

KEY DIAGRAM SKETCH NO. ES-123

ITEM 2

## Item 2, (Cont'd)

Unit No.	Motor H.P.	ACB Rating Amps.	Starter Size NEMA	Cable Size AWG	Extra Aux. Switch Each Contactor		Ref. Note (See Spec.)	Nameplate Data		
					N.O.	N.C.		First Line	Second Line	Third Line
I01	13.3	150	3	#4	-	-	C	SHUTDOWN PUMP	2A	DISCH. VALVE
I02	13.3	150	3	#4	-	-	C	SHUTDOWN PUMP	2B	DISCH. VALVE
J01	13.3	150	3	#4	-	-	C	SHUTDOWN PUMP	2C	DISCH. VALVE
J02	1.33	30	1	#14	-	-	C	LPCI DRYWELL	SPRAY VALVE	2B
K01	1.33	30	1	#14	-	-	C	LPCI DRYWELL	SPRAY VALVE	2D
K02	2.7	30	1	#14	-	-	C	HPCI TURBINE	STEAM SUPPLY	VALVE
L01	2.7	30	1	#14	-	-	C	HPCI STEAM	SUPPLY LINE	ISOL. VALVE
L02	1	20	1	#14	-	-	C	HPCI PUMP DISCH.	MIN. FLOW BYPASS	VALVE TO TORUS
M01	1	20	1	#14	-	-	C	HPCI PUMP DISCH.	MIN. FLOW BYPASS	VALVE TO COND. ST.
M02	10	100	1	#6	-	-	C	HPCI SYS. TEST	BYPASS VALVE TO	COND. STORAGE
N01	2	30	1	#14	-	-	C	HPCI PUMP	DISCH. TEST	CHECK VALVE
N02	5.3	50	2	#10	-	-	C	HPCI PUMP	DISCHARGE	VALVE
O01	5.3	50	2	#10	-	-	C	HPCI PUMP	DISCHARGE	ISOL. VALVE
O02	1	20	1	#14	-	-	C	HPCI PUMP SUCTION	FROM TORUS	VALVE 2A
P01	1	20	1	#14	-	-	C	HPCI PUMP SUCTION	FROM TORUS	VALVE 2B
P02	1	20	1	#14	-	-	C	HPCI PUMP SUCTION	VALVE FROM COND.	STORAGE TANK
Q01	-	-	-	250MCM	-	-	M	SUPPLY FROM	250 V. MN. BUS	UNIT 3
Q02	-	70	-	-	-	-	D	SPARE		
Q03	-	50	1	-	-	-	C	SPARE		

Note: This Control Center to be split in two sections (A through I and J through Q)  
Contractor to furnish Lugs (per EM-40275) on main bus for interconnecting  
two sections with Purchaser's 250 MCM cables (one/polarity)

## REFERENCE:

General Arrangement Sketch No. ES-75

KEY DIAGRAM SKETCH NO. ES-123

SARGENT &amp; LUNDY, ENGINEERS, CHICAGO, ILL.

ITEM 2

K-2225

465774

K-2225

General Arrangement Sketch No. ES-75  
KEY DIAGRAM SKETCH NO. ES-74

ITEM 3

125 V. D.C. Distribution Panel #2 (Turb. Bldg.)









Item 7 - Two Distribution Centers (one for Unit 2 and one for Unit 3) as follows:

[illegible]

K-2225

H. F. H. H. H.

General Arrangement Sketch No. ES-43

Key Diagram Sketch No. ES-82

SAIGENT & LURDY, ENGINEERS, CHICAGO, ILL.

Item 7

120/240 V, A.C. Instrument Bus Distribution Panel



PROPOSAL PRICES FOR  
A.C. AND D.C. DISTRIBUTION CENTERS  
DRESDEN UNITS 2 AND 3  
COMMONWEALTH EDISON COMPANY

Name of Bidder: CUTLER-HAMMER, Inc.

	(Insert all prices in this column)
<b>1. FIRM PRICES FOR UNIT 2</b>	
Firm prices, furnished f.o.b. cars points of shipment for the complete equipment for Unit 2 covered by Specification K-2225 subdivided as follows:	
A. Item 1 - One 250 Volt D.C. Turbine Bldg. Motor Control Center .....	\$12,225.00
B. Item 2 - One 250 Volt D.C. Reactor Bldg. Motor Control Center .....	\$17,319.00
C. Item 3 - One 125 Volt D.C. Turbine Bldg. Distribution Panel .....	\$ 6,170.00
D. Item 4 - One 125 Volt D.C. Reactor Bldg. Distribution Panel .....	\$ 1,533.00
E. Item 5 - One 48/24 Volt D.C. Distribution Panel "A" ...	\$ 2,002.00
F. Item 6 - One 48/24 Volt D.C. Distribution Panel "B" ...	\$ 2,002.00
G. Item 7 - One 120/240 Volt A.C. Instrument Bus Distribution Panel .....	\$ 3,102.00
H. Item 8 - One 120/240 Volt A.C. Essential Service Bus Distribution Panel .....	\$ 2,032.00
I. Total Firm Price - Items 1 to 8 inclusive .....	\$46,385.00
J. Amount to be added to the above price for freight points of shipment to Dresden Nuclear Power Station....	\$Freight allowed
K. Total Firm Price (Items 1I and 1J above) for A.C. and D.C. Distribution Centers for Unit 2 as specified, f.o.b. cars Dresden Nuclear Power Station (excluding all Illinois Taxes).....	\$46,385.00
<b>2. FIRM PRICES FOR UNIT 3</b>	
Firm prices, furnished f.o.b. cars points of shipment for the complete equipment for Unit 3 covered by Specification K-2225 subdivided as follows:	
A. Item 1 - One 250 Volt D.C. Turbine Bldg. Motor Control Center.....	\$12,225.00
B. Item 2 - One 250 Volt D.C. Reactor Bldg. Motor Control Center .....	\$17,319.00
C. Item 3 - One 125 Volt D.C. Turbine Bldg. Distribution Panel .....	\$ 6,170.00
D. Item 4 - One 125 Volt D.C. Reactor Bldg. Distribution Panel .....	\$ 1,533.00
E. Item 5 - One 48/24 Volt D.C. Distribution Panel "A" ....	\$ 2,002.00
F. Item 6 - One 48/24 Volt D.C. Distribution Panel "B" ....	\$ 2,002.00

Proposal Prices for  
A.C. and D.C. Distribution Centers, Cont.  
Dresden Units 2 and 3

K-2225

Name of Bidder:

CUTLER-HAMMER, Inc.

FIRM PRICES FOR UNIT 3, Cont.

(Insert all prices  
in this column)

G. Item 7 - One 120/240 Volt A.C. Instrument Bus Distribution Panel .....	\$ 3,102.00
H. Item 8 - One 120/240 Volt A.C. Essential Service Bus Distribution Panel .....	2,032.00
I. Total Firm Price - Items 1 to 8 inclusive .....	\$ 46,385.00
J. Amount to be added to the above price for freight points of shipment to Dresden Nuclear Power Station ...	\$ Freight allowed
K. Total Firm Price (Items 2I and 2J above) for A.C. and D.C. Distribution Centers for Unit 3 as specified, f.o.b. cars Dresden Nuclear Power Station (excluding all Illinois taxes) .....	\$ 46,385.00
3. TOTAL FIRM PRICE Total firm price (Items 1K and 2K) for A.C. and D.C.. Distribution Centers for Units 2 and 3 .....	\$ 92,770.00
4. SPARE PARTS Firm Unit Price for each recommended spare part. (Itemize below recommended stock of spare parts and firm unit price for each. Price shall be firm up to the date of delivery of the equipment covered by Speci- fication K-2225) .....	\$ Not available at this time

465 284

Name of Bidder \_\_\_\_\_

5. TAXES

The Contractor shall not include in his bid any amounts for Illinois local or state retail sales, occupation or use taxes. Purchaser holds a Certificate of Resale, Illinois Registration No. 6706, and hereby certifies that the material specified in this inquiry - Purchase Order is for resale in the form of Tangible Personal Property or is to be used as component part of Tangible Personal Property subsequently to be sold. As a condition to final payment, the Contractor shall certify on the invoice his actual cost of the Tangible Personal Property incorporated in the product transferred to General Electric.

6. ADDENDA

Bidder represents that this proposal includes the following addenda (Bidder shall insert addenda Numbers and dates. If none included, so state) ..

Addendum No. None,  
dated \_\_\_\_\_;  
Addendum No. \_\_\_\_\_,  
dated \_\_\_\_\_;  
Addendum \_\_\_\_\_,  
dated \_\_\_\_\_.

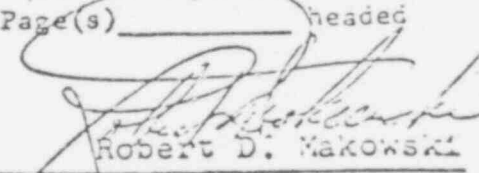
7. BID DOCUMENTS

Bidder shall be bound by and shall comply with the following Bid Documents:

- A. This Proposal Form;
- B. Specification K-2225 dated April 25, 1967 (including addenda referred to in Paragraph 10 above, if any);
- C. Purchaser's General Conditions (Form 207 GE; 6-1-65);

~~D. Conditions of Purchase (Form A-27g);~~

except as otherwise clearly stated in specific Exceptions (Bidder's printed terms and conditions are not specific exceptions) set forth on Page(s) \_\_\_\_\_ headed Exceptions attached hereto.

  
\_\_\_\_\_  
Signature of Bidder

June 21, 1967

\_\_\_\_\_  
Date of Bid

Revised for Purchase Order June 30, 1967

6-21-67

Revised for Purchase  
Order June 30, 1967

The Motor Control Centers offered in this proposal are Cutler-Hammer Unitrol Class I, Type B, as described in the attached Motor Control Center handbook LE-161. The equipment is in complete accordance with Sargent & Lundy Specification K-2225 with only the following exceptions:

- 1 - There are no concentric knockouts in the removable plates.
- 3 - The horizontal bus bar would be in the center of the top part of the section as shown in Motor Control Center Handbook publication LE-161, pages 10 to 12, rather than in the front part of the section as called for in the specifications.

Grommets pass through holes are provided next to each unit so that wiring from rear half of section can be brought through to the front connected terminal boards.

Rear bus guards are provided at rear of vertical bus to prevent accidental contact with vertical bus when working in rear of section.

All distribution centers shall be designed to be capable of withstanding earthquake forces of 0.2g (horizontal) without any effect on operation.

af

Yours very truly,

CUTLER-HAMMER, Inc.

*W.M. Depew*  
W.M. Depew

District Sales Engineer



PROPOSAL DATA FOR  
A.C. AND D.C. DISTRIBUTION CENTERS  
DRESDEN UNITS 2 AND 3  
COMMONWEALTH EDISON COMPANY

Name of Bidder: CUTLER-HAMMER, Inc.

		(Insert all data in these columns)
1. DRAWINGS		
Time required after contract is awarded before drawings will be submitted for approval:		
A. General Arrangement and Floor Plan Dimension Drawings.....(weeks)		14 weeks
B. Elevation and Section Drawings and Bills of Material.....(weeks)		14 weeks
C. Wiring Diagrams.....(weeks)		16 weeks
2. DELIVERY		
Delivery required:		
A. A.C. and D.C. Distribution Centers (Unit 2)....		September 1, 1967
B. A.C. and D.C. Distribution Centers (Unit 3)....		March 1, 1968
Bidder shall state here whether the above delivery dates can be met and, if not, what are the earliest possible delivery dates.....		
3. POINTS OF SHIPMENT...Elk Grove Village, Ill...		
4. NET WEIGHT of assembled equipment:		
Item 1 - 250 V. D.C. Turb. Bldg. MCC.....(lbs.)		
Item 2 - 250 V. D.C. Reactor Bldg. MCC...(lbs.)		
Item 3 - 125 V. D.C. Turb. Bldg. Distr. Pnl.....(lbs.)		
Item 4 - 125 V. D.C. Reactor Bldg. Distr. Pnl.....(lbs.)		
Item 5 - 48/24 V. D.C. Distr. Pnl. "A"...(lbs.)		
Item 6 - 48/24 V. D.C. Distr. Pnl. "B"...(lbs.)		
Item 7 - 120/240 V. A.C. Instr. Distr. Pnl. ....(lbs.)		
Item 8 - 120/240 V. A.C. Ess. Service Pnl. ....(lbs.)		

A Unit-2 If order placed by 7-1-67 we would submit dwgs. 9-22-67  
 If approved by 10-8-67 the start shipment 11-3-67 & complete shipment by 12-8-67  
 7500 lbs.  
 15,300 lbs.

4500 lbs.

750 lbs.

1500 lbs.

1500 lbs.

750 lbs.

750 lbs.

Name of Bidder: CUTLER-HAMMER, Inc.

5. OVERALL DIMENSIONS (LxDxH):

	(Insert all data in these columns)
Item 1 - 250 V. D.C. Turb. Bldg. MCC.....(in.)	200 Inches
Item 2 - 250 V. D.C. Reactor Bldg. MCC.....(in.)	340 "
Item 3 - 125 V. D.C. Turb. Bldg. Distr. Pnl.....(in.)	120 "
Item 4 - 125 V. D.C. Reactor Bldg. Distr. Pnl... (in.)	20 "
Item 5 - 48/24 V.D.C. Distr. Pnl. "A".....(in.)	40 "
Item 6 - 48/24 V. D.C. Distr. Pnl. "B".....(in.)	40 "
Item 7 - 120/240 V. A.C. Instr. Distr. Pnl.....(in.)	20 "
Item 8 - 120/240 V. A.C. Ess. Service Pnl.....(in.)	20 "

6. CIRCUIT BREAKER DATA (Items 1 through 6):

- A. Manufacturer.....
- B. Type.....
- C. Voltage rating.....(volts)
- D. Interrupting ratings at 250  
volts d-c.....(amps.)
- E. Interrupting ratings at 12<sup>1/2</sup>  
volts d-c.....(amps.)
- F. Short time ratings.....(amps.)

100 A Frame	225 A Frame	800 A Frame
Westinghouse	Westinghouse	Westinghouse
F	JA	MA
600	600	600
10,000	10,000	10,000
WILL SUPPLY AT A LATER DATE		

7. SWITCHGEAR DATA (Items 1 through 6):

- A. High potential test in factory on assembled switchgear for  
60 seconds.....(volts)
- B. Temperature rise of bus or connections at full load,  
above outside ambient.....(C)
- C. Maximum mechanical stress with short circuit current  
of 10,000 amperes:  
On main bus.....(lb/ft.)  
On bus supports.....(lbs.)
- D. Type of bus supports.....

2500 volts

50°C

Braced for  
25000 amps.

-----

Fiberglass

Name of Bidder: CUTLER-HAMMER, Inc.

SWITCHGEAR DATA, Cont.

(Insert all data  
in these columns)

E. Type of insulation on bus.....	NONE
F. Minimum clearance between buses:	
Conductor-to-conductor.....(in.)	2 inches
Conductor-to-ground.....(in.)	1 inch
G. Type and description of bus joints.....	Silver plated and bolted
H. Size of bus.....	1/4" X 2"
I. Material used for bus and connections.....	Copper bus

	Mfr.	Type
J. Indicating instruments.....	General Elec.Co.	DB-18
K. Recording ground voltmeter.....	Esterline Angus	AW
L. Voltmeter, ammeter and control switches.....	General Elec.Co.	SB-1
M. Undervoltage relays.....	General "	12PJV11BA4A
N. Overvoltage relays.....	General "	12PJV11AM4A
O. Push buttons.....	Cutler-Hammer	T
P. Test switches.....	Superios Elec.	----
Q. Indicating lamps.....	Cutler-Hammer	T

8. MAGNETIC CONTACTORS IN  
CONTROL CENTERS (Items 1  
and 2):

A. Manufacturer.....

B. Type.....

C. Continuous rating..(amps.)

D. Interrupting rating at  
250 volts (d-c)....(amps.)

	Size 1	Size 3	Size 4	Size 5
	Cutler-Hammer	Cutler-Hammer	Cutler-Hammer	Cutler-Hammer
	805	913	914	915
	25	100	150	300
	250	1000	1500	3000

Proposal Data for  
A.C. and D.C. Distribution Centers, Cont.  
Dresden Units 2 and 3

K-2225

Name of Bidder: CUTLER-HAMMER, Inc.

MAGNETIC CONTACTORS IN CONTROL  
CENTERS, Cont.

(Insert all data in these columns)				
	Size 1	Size 3	Size 4	Size 5
E. Momentary rating, peak....(amps.)	75	600	900	1800
F. Coil voltage.....(volts)	240	240	240	240
G. Coil current-closing.....(amps.)	.043	.100	.125	.171
H. Coil current-holding... (amps.)	.043	.100	.125	.171
I. Dropout voltage.....(volts)	96	24	24	24

9. CIRCUIT BREAKER DATA (Items 7 and 8):

	100 A Frame	225 A Frame
A. Manufacturer.....	Westinghouse	Westinghouse
B. Type.....	F	JA
C. Voltage rating.....(volts)	600	600
D. Interrupting rating at 240 volt a-c.....(amps.)	20,000	25,000
E. Short time rating.....(amps.)		

10. AUTOMATIC TRANSFER SWITCH (Items 7 and 8):

A. Manufacturer.....	ASCO
B. Type.....	907
C. Catalog number.....	X907212

11. MISCELLANEOUS EQUIPMENT (Items 7 and 8)

	Manufacturer	Catalog No.
A. Undervoltage relay.....	General Elec.	121AV54E2A
B. Ammeter.....	" "	50-100131- LSRL
C. Voltmeter.....	" "	50-16002TZ PZ
D. Ammeter switch.....	" "	Type AB-10
E. Current Transformer.....	" "	631X29

12. MAIN AND RESERVE BREAKERS with short time selective  
trip attachment data:

	Item 1	Item 3	Item 5
A. Manufacturer.....	G.E.Co.	G.E.co.	G.E.Co.
B. Type.....	AK50	AK50	TFJ
C. Frame size.....(amps.)	800	400	225 A.

Robert D. Makowski

Signature of Bidder

June 21, 1967

Date of Bid

## INSTRUCTION SHEET

### For No. 789 Adjustable Thermal Overload Relay

#### DESCRIPTION

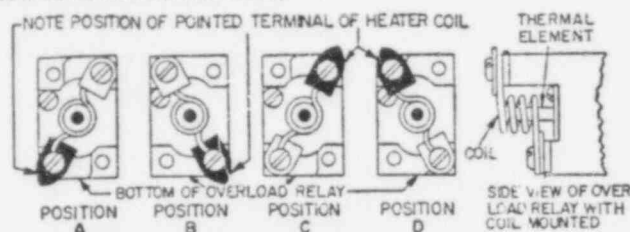
This is an adjustable type thermal overload relay. The relay is constructed having either one, two or three heater coils.

Reset only, start with stop reset and three position selector switch with reset are the three general groups of operators. Each of these groups have relays constructed with connection terminals to accommodate wiring for the starters with which they are intended to be used.

There is also a group of overload relays for certain applications which are known as the "compact type". This group of relays is constructed in only the one and two heater coil type.

A long button type of overload relay is available in "Reset" or "Start Stop-Reset". In the normal position the long button has 13/16" extension as compared with 13/32" extension on the standard relay.

How to install heater coils;



#### RENEWAL PARTS

##### COMPLETE RELAYS

Complete relays are offered as renewal parts. The relay part number may usually be found stamped on the top surface of the relay. Relays which do not have the part number stamping should be selected as described below.

The illustrations below and on page 2 are provided to aid in selecting and to identify relays which may not be stamped with a part

#### OPERATION

The essential operating parts of the No. 789 overload relay are the heater coils, the thermal elements, the ratchet mechanism, the tension spring and the control contacts.

Under normal conditions the contacts of the relay are closed. The spring is then under tension and tends to open the contacts but is prevented from doing so by the ratchet mechanism being held by the alloy film between the outer and inner part of the thermal elements.

When the current through any one heater coil becomes great enough to melt the alloy film, the inner part of the element rotates and releases the ratchet mechanism to open the control contacts. The opening of these contacts breaks the circuit to the coil of the contactor handling the power circuit, and the circuit is opened. As soon as the power circuit is opened the alloy film cools and hardens. The relay is then ready to be reset with the reset button.

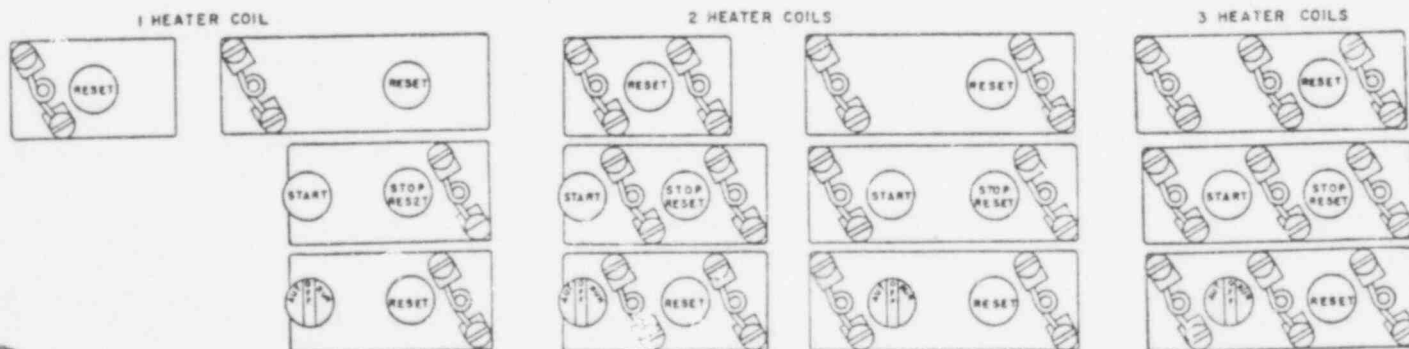
This overload relay is adjustable in four steps or mounting positions as shown above. The tripping value of the current will increase when progressing from mounting position A through mounting position D in the approximate ratio of 1.00-1.03-1.06-1.09. Mount the coils in the position corresponding to the column in the starter heater coil publication table in which the motor ampere rating is found. A heater coil must be provided for each thermal element. All coils must be placed in the same position around the thermal element.

number. The part number of the relay can be determined by referring to these illustrations and the chart on page 3 and 4.

#### DETAIL PARTS

Detail parts such as heater coils, thermal elements, "start" operator", 3 position pilot switch operator and some terminal hardware are available for repairs. Unit moldings and factory assembled components are not available for repairs. Order a complete overload relay if parts other than those listed on page 2 are required.

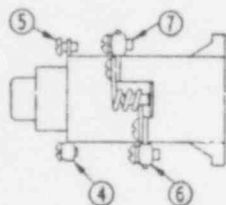
#### Combination of operators and Thermal Elements



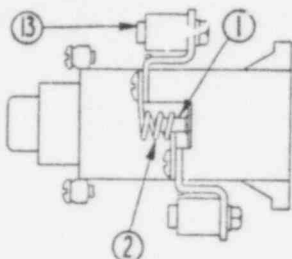
These relays are not intended for protection against short circuit. Provision should be made to protect against short circuit in accordance with the requirements of the National Electrical Code.

POOR ORIGINAL

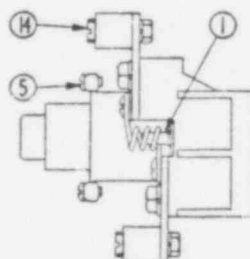
To remove the thermal element assembly, (item 1), remove the heater coil, item 2, and the screw, item 3. The thermal element assembly is a precision built part and should not be handled roughly by grasping the tube shank with a pliers.



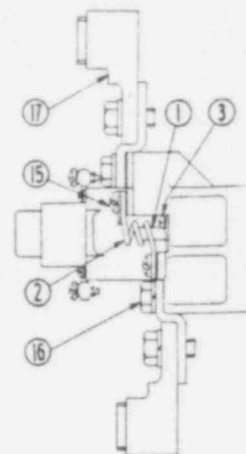
40 Amp. Terminals



50 Amp. Terminals

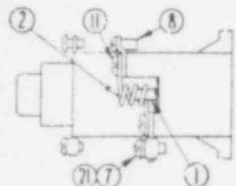


100 Amp. Terminals

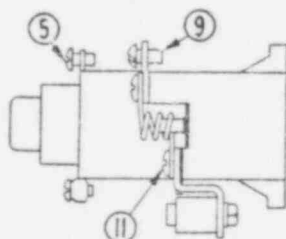


150 Amp. Terminals

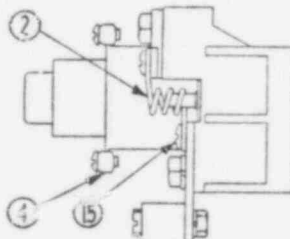
NO. 789 OVERLOAD RELAY WITH OUTGOING TERMINALS ON TOP AND BOTTOM



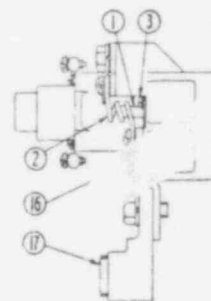
40 Amp. Terminals



50 Amp. Terminals



100 Amp. Terminals



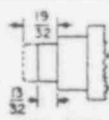
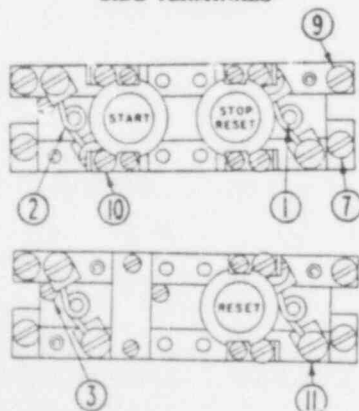
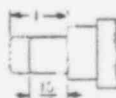
150 Amp. Terminals

NO. 789 OVERLOAD RELAY WITH OUTGOING TERMINALS ON BOTTOM ONLY

**RENEWAL PARTS — Information Required —** Parts CANNOT be sent promptly unless you include the FOLLOWING with your order: PUBLICATION NO. 8972, PART No., DESCRIPTION, and either the STARTER INDEX No. or the Serial Number Stamped on the Controller Name Plate.

AVAILABLE PARTS FOR NO. 789 OVERLOAD RELAY

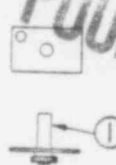
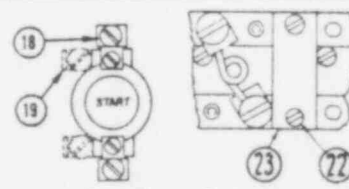
Item No.	Description of Part	No. Req.	Part Number	Item No.	Description of Part	No. Req.	Part Number
1	Thermal element	As Req.	10176H150	14	ILSCO Solderless Lug	As Req.	80-1515
2	Heater coil	As Req.	Give No. on Tag	15	Heater coil mounting screw	As Req.	11-1694
3	Thermal element mtg screw 6/32 x 7/16"	As Req.		16	Screw 1/4-20 x 5/8" long slotted hex.	As Req.	911-5445FZ
4	long, rd. hd.	As Req.	911-334F1	17	ILSCO solderless lug	As Req.	80-1947
5	Clamp	As Req.	55-787	18	Start Button Operator (Standard Button)	As Req.	49-1837
6	Screw	As Req.	11-1221	19	Star. Button operator (Long Button)	As Req.	49-1837-2
7	Clamp	As Req.	55-1146	20	Start Button Operator (Standard Button)	As Req.	49-1897
8	Screw #8-32 x 3/8" long rd. hd.	As Req.	11-1393	21	(With side terminals shown dotted)	As Req.	49-3480
9	Screw #10-32 x 3/8" long rd. hd.	As Req.	911-4122	22	3 Position Pilot Switch Operator	As Req.	80-2893
10	Screw #8-32 x 5/32" long rd. hd.	As Req.	911-4902Z	23	Solderless lug (40 Amp.) Not shown	As Req.	11-2533
11	Heater coil mtg. screw	As Req.	11-27	24	Screw #6-32 x 1-1/2 long	As Req.	49-1782
13	ILSCO Solderless Lug	As Req.	80-1511				

NO. 789 OVERLOAD RELAY  
COMPACT TYPE WITH 40 AMP.  
SIDE TERMINALSSTANDARD  
BUTTON

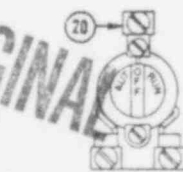
LONG BUTTON

Dotted Line Indicates  
Tripped Position

CONTROL CIRCUIT

Normally  
ClosedNormally  
Open and  
Normally  
ClosedThermal  
Element

Start Button Operator

3 Position Pilot Switch  
Operator (Run-Off-Aut.)





## COMPLETE NO. 789 OVERLOAD RELAY WITH 40 AMP. TERMINALS

Item No.	Number of Heater Coils			Operators			Control Circuit		Compact Type Overload Relay With Side Terminals	Outgoing Terminals		Part Number
	1	2	3	Reset	Start Stop Reset	3-Position Pilot Reset	Normally Closed	Normally Open Normally Closed		Top and Bottom	Bottom Only	
26	✓			✓			✓				✓	10-1308
27	✓			✓			✓	✓		✓	✓	10-1308-2
28	✓			✓			✓			✓		10-1308-11
29	✓			✓			✓	✓		✓		10-1308-12
30	✓			✓			✓		✓			10-1407-2
31	✓				✓		✓		✓		✓	10-1309
32	✓				✓		✓		✓			10-1408-2
33	✓				✓		✓			✓		10-1798
34	✓				✓		✓	✓		✓		10-1798-4
35	✓				✓		✓			✓		10-1310
36	✓					✓	✓			✓	✓	10-1801
37		✓		✓			✓				✓	10-1308-3
38		✓		✓			✓	✓			✓	10-1308-4
39		✓		✓			✓			✓		10-1308-13
40		✓		✓			✓	✓		✓		10-1308-14
41		✓		✓			✓		✓			10-1407
42		✓			✓		✓				✓	10-1309-2
43		✓			✓		✓		✓		✓	10-1309-6 *
44		✓			✓		✓		✓			10-1408
45		✓			✓		✓			✓		10-1798-2
46		✓			✓		✓	✓		✓		10-1798-5
47		✓				✓	✓				✓	10-1310-2
48		✓				✓	✓				✓	10-1310-6 *
49		✓				✓	✓			✓		10-1801-2
50			✓				✓			✓	✓	10-1308-5
51			✓				✓	✓			✓	10-1308-6
52			✓				✓			✓		10-1308-15
53			✓				✓	✓		✓		10-1308-16
54			✓		✓		✓				✓	10-1309-3
55			✓		✓		✓			✓		10-1798-3
56			✓		✓		✓	✓		✓		10-1798-6
57			✓			✓	✓			✓	✓	10-1310-3
58			✓			✓	✓			✓		10-1801-3
59		✓		✓			✓			✓		10-1959 ▲ *
60		✓		✓	✓		✓			✓		10-1960 ▲ *

## COMPLETE NO. 789 OVERLOAD RELAY WITH 50 AMP. TERMINALS

75	✓			✓			✓			✓		10-1308-21
76	✓			✓			✓	✓		✓		10-1308-22
77	✓				✓		✓			✓		10-1802
78	✓				✓		✓	✓		✓		10-1802-4
79	✓					✓	✓			✓		10-1800
80		✓		✓			✓				✓	10-1308-7
81		✓		✓			✓	✓			✓	10-1308-8
82		✓		✓			✓			✓		10-1308-17
83		✓		✓			✓	✓		✓		10-1308-18
84		✓			✓		✓				✓	10-1309-4
85		✓			✓		✓			✓		10-1309-7 *
86		✓			✓		✓			✓		10-1802-2
87		✓			✓		✓	✓		✓		10-1802-5
88		✓				✓	✓				✓	10-1310-4
89		✓				✓	✓			✓		10-1310-7 *
90		✓				✓	✓			✓		10-1800-2 *
91			✓	✓			✓				✓	10-1308-9
92			✓	✓			✓	✓			✓	10-1308-10
93			✓	✓			✓			✓		10-1308-19
94			✓	✓			✓	✓		✓		10-1308-20
95			✓		✓		✓			✓		10-1309-5
96			✓		✓		✓			✓		10-1802-3
97			✓		✓		✓	✓		✓		10-1802-6
98			✓			✓	✓			✓	✓	10-1310-5
99			✓			✓	✓			✓		10-1800-3

## COMPLETE NO. 789 OVERLOAD RELAY WITH 100 AMP. TERMINALS

115		✓		✓			✓				✓	10-1430
116		✓		✓			✓	✓			✓	10-1430-2
117		✓		✓			✓			✓		10-1430-3
118		✓		✓			✓	✓		✓		10-1430-4
119		✓		✓			✓			✓		10-1430-5
120		✓		✓			✓	✓		✓		10-1430-6
121		✓		✓			✓			✓		10-1430-7
122		✓		✓			✓	✓		✓		10-1430-8
123		✓		✓			✓			✓		10-1431
124		✓			✓		✓				✓	10-1431-2
125		✓			✓		✓			✓		10-1432
126		✓			✓		✓			✓		10-1432-2
127		✓		✓			✓			✓		10-1430-9 *
128	✓			✓			✓			✓		10-1430-10
129	✓			✓			✓	✓		✓		10-1430-11
130		✓		✓			✓				✓	10-1431-3 *
131		✓		✓			✓			✓		10-1431-4
132		✓		✓			✓			✓		10-1431-5
133		✓		✓			✓	✓		✓		10-1431-6
134		✓		✓			✓			✓		10-1431-7
135	✓			✓			✓			✓		10-1431-8
136	✓			✓			✓			✓		10-1431-9
137		✓			✓		✓				✓	10-1432-3 *
138		✓			✓		✓			✓		10-1432-4
139		✓			✓		✓			✓		10-1432-5
140	✓				✓		✓			✓		10-1432-6

\*Two heater coils with three outgoing terminals on the bottom.

▲ With long button.

POOR ORIGINAL

## COMPLETE NO. 789 OVERLOAD RELAY WITH 150 AMP. TERMINALS

Item No.	Number of Heater Coils			Operators			Control Circuit		Compact Type Overload Relay With Side Terminals	Outgoing Terminals		Part Number
	1	2	3	Reset	Start Stop Reset	3-Position Pilot Reset	Normally Closed	Normally Open Normally Closed		Top and Bottom	Bottom Only	
150		✓		✓			✓				✓	10-2333-2
151		✓		✓			✓				✓	10-2333-3 *
152		✓		✓			✓			✓		10-2333-5
153		✓		✓				✓				10-2333-6
154		✓			✓		✓				✓	10-2336-2 *
155		✓			✓		✓				✓	10-2336-3
156		✓			✓			✓		✓		10-2336-4
157		✓			✓		✓			✓		10-2336-5
158		✓			✓		✓				✓	10-2337-2 *
159		✓			✓		✓				✓	10-2337-3
160		✓			✓		✓			✓		10-2337-4
161				✓			✓				✓	10-2333
162			✓	✓			✓			✓		10-2333-4
163			✓	✓			✓			✓		10-2333-7
164			✓		✓		✓				✓	10-2336
165			✓		✓			✓		✓		10-2336-6
166			✓		✓		✓			✓		10-2336-7
167			✓		✓		✓				✓	10-2337
168			✓		✓		✓			✓		10-2337-5

\* Two heater coils with three outgoing terminals on the bottom.

POOR ORIGINAL

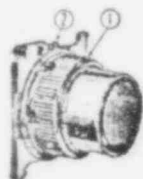
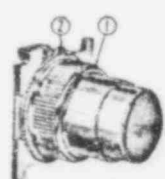
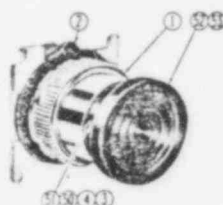
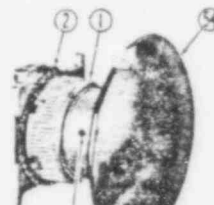
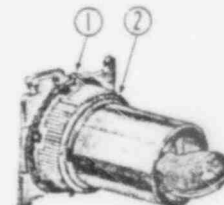
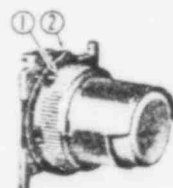
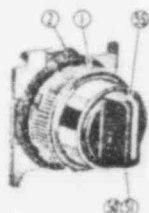
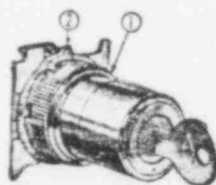
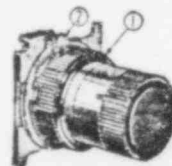
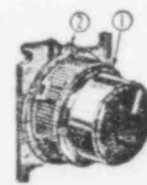
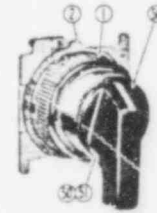


## INSTRUCTION SHEET

Bulletin 10250 Heavy Duty Oil Tight Control Units  
RENEWAL PARTS — Information Required

Parts CANNOT be sent promptly unless you include the following with your order: PUBLICATION NO. 10459, ITEM NO., PART NO., DESCRIPTION and QUANTITY REQUIRED.

For items pictured but not listed and items not pictured or listed refer to the Cutler-Hammer Catalog.

Flush Head  
Pushbutton OperatorLong Button  
Pushbutton OperatorMushroom Head  
Pushbutton OperatorJumbo Mushroom  
Head OperatorPushbutton with  
Cylinder LockHalf Shrouded  
Pushbutton OperatorKnob-Operated  
Selector Switch  
OperatorKey-Operated  
Selector Switch  
OperatorRoto-Push  
OperatorCoin-Operated  
Selector Switch  
OperatorLever Operated  
Selector Switch  
Operator

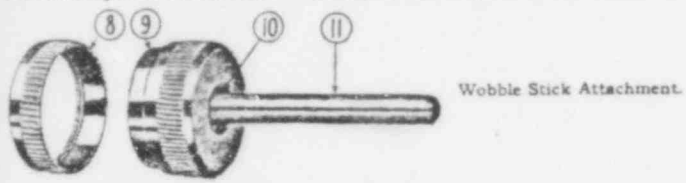
Item No.	Description	No. Req.	Part Number	Item No.	Description	No. Req.	Part Number
1	Retaining Nut (1 3/8" x 15/32" High)	1	15-676	55	Knob (Melamine—Includes items 50 and 51)	1	
2	Gasket	1	16-1548		Black	...	53-1317-13
3	Set Screw (No. 10-32 x 1/4" Long)	1	11-544		Red	...	53-1317-14
4	Hollow Hex	1	24-3673		Green	...	53-1317-15
50	Wrench (Allen) for item 4 (Not Shown)	1	24-4223		Yellow	...	53-1317-16
51	Set Screw (#6-32 x 1/4" Long Hollow Hex)	1	11-2014		Gray	...	55-1317-17
52	Wrench (Allen) for item 50 (Not Shown)	1	24-4223		Brown	...	53-1317-18
53	Mushroom Head Button (Melamine—Includes items 50 and 51)	1			White	...	53-1317-19
	Black	...	53-1317		Blue	...	53-1317-20
	Red	...	53-1317-2		Orange	...	53-1317-21
	Yellow	...	53-1317-3	56	Lever (Melamine—Includes items 50 and 51)	1	
	Green	...	53-1317-4		Black	...	24-5140
54	Mushroom Head Button (Aluminum—Includes items 3 and 4)	1			Red	...	24-5140-2
	Black	...	53-1317-5		Green	...	24-5140-3
	Red	...	53-1317-6		Yellow	...	24-5140-4
	Yellow	...	53-1317-7		Gray	...	24-5140-5
	Green	...	53-1317-8		Brown	...	24-5140-6
	Jumbo Mushroom Head Button (Aluminum—Includes items 3 and 4)	1			White	...	24-5140-7
	Red	...	53-1317-9		Blue	...	24-5140-8
	Black	...	53-1317-10		Orange	...	24-5140-9
	Yellow	...	53-1317-11				
	Green	...	53-1317-12				

86-1440, 86-1512, 86-1517, 86-1527, 86-1535, 86-1582, 86-1946, 86-1752, 86-1843, 86-2193, 86-1925, 86-1926, 86-2075, 86-2076, 86-2098, 86-2135, 86-2136, 86-2153, 86-2177, 86-2334.

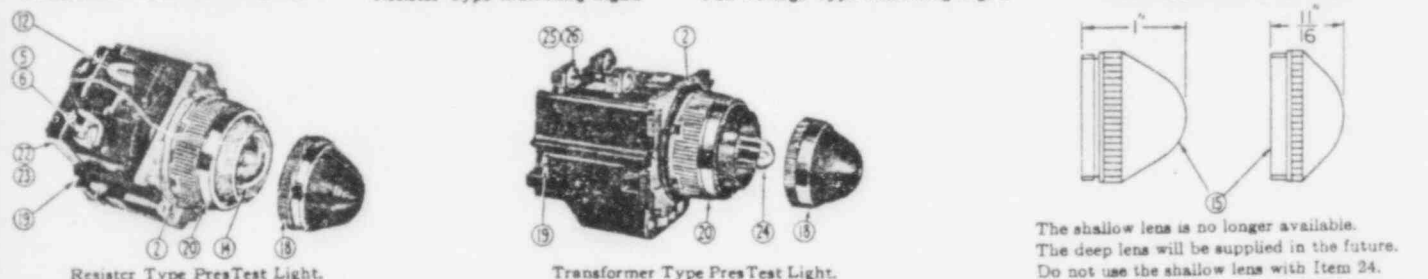
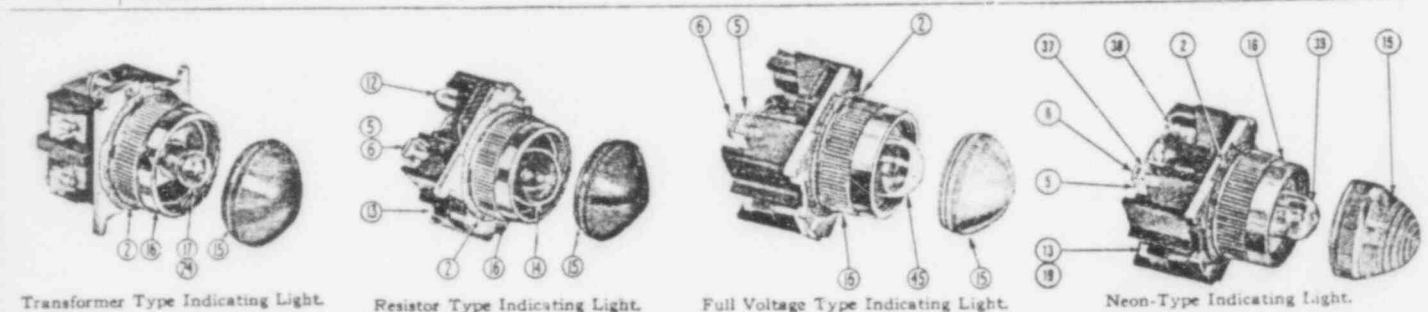
INSTRUCTION SHEET

Parts CANNOT be sent promptly unless you include the following with your order: PUBLICATION NO. 10459, ITEM NO., PART NO., DESCRIPTION and QUANTITY REQUIRED.

For items pictured but not listed and items not pictured or listed refer to the Cutler-Hammer Catalog.



Item No.	Description	Number Required	Part Number
8	Retaining Nut (1 3/8" x 23/64" High).....	1	15-701
9	Retaining Nut (1 3/8" x 3/4" High).....	1	15-702
10	Spring Washer.....	1	16-1609
11	Handle.....	1	53-937



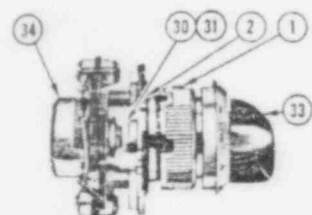
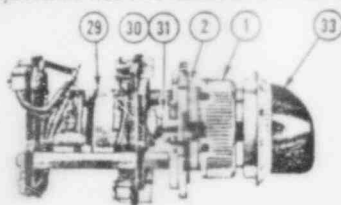
The shallow lens is no longer available.  
The deep lens will be supplied in the future.  
Do not use the shallow lens with Item 24.

Item No.	Description	N <sup>o</sup> . Req'd.	Part No.	Item No.	Description	N <sup>o</sup> . Req'd.	Part No.
12	Resistor 110 Volt (1000 Ohms)..... 220 Volt (3000 Ohms).....	1 1	57-926 57-926-2	16	Retaining Nut (1 3/8" x 11/16" High).....	1	15-678
13	Mounting Screw For Base Mounting..... For One Hole Mounting.....	2 2	11-1612 11-1632	17	Lamp..... G.E. #51..... G.E. #259.....	1 ... ...	28-531 28-049
14	Lamp 110 Volt Type S-6 (6 Watt, 110 Volt)..... 220 Volt Type 10S6 (10 Watt, 250 Volt).....	1 1	28-81 28-352	18	Lens (Glass) includes gasket Red..... Green..... Amber..... Blue..... White..... Clear.....	As Req'd.	28-571 28-571-2 28-571-3 28-571-4 28-571-5 28-571-6
15	Lenses (Plastic) Red..... Green..... Amber..... Blue..... Clear..... White.....	As Req'd.	28-166 28-166-2 28-166-3 28-166-4 28-166-5 28-166-6	19	Mounting Screw (No. 6-32 x 1-9/16" Long). Lockwasher.....	2 2	11-1685 16-1547
	Lenses (Glass) Red..... Green..... Amber..... Blue..... Clear..... White.....	As Req'd.	28-592 28-592-2 28-592-3 28-592-4 28-592-5 28-592-6	20	Retaining Nut (3/8" High).....	1	15-715
				22	Switch For Resistor Type PresTest....	1	86-1684-2
				23	Terminal Screw for Item 22.....	2	11-285-2
				24	Lamp (G.E. #44).....	1	28-672
				25	Terminal Lug.....	3	80-2034
				26	Terminal Screw.....	3	911-408Z

# INSTRUCTION SHEET

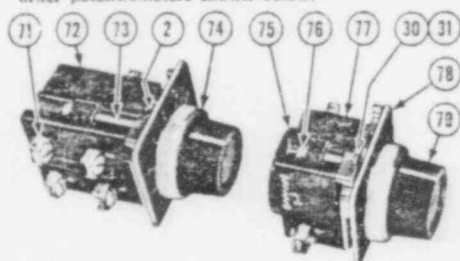
Parts CANNOT be sent promptly unless you include the following with your order: PUBLICATION NO. 10459, ITEM NO., PART NO., DESCRIPTION and QUANTITY REQUIRED.

For items pictured but not listed and items not pictured or listed refer to the Cutler-Hammer Catalog.

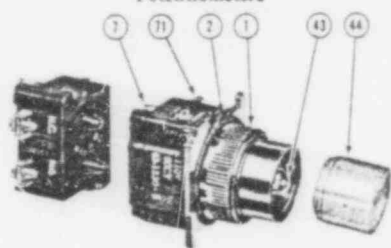


Potentiometers

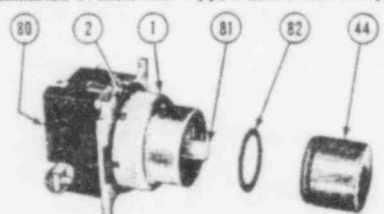
The potentiometers shown above are no longer manufactured. Only parts listed are available for repairs. If parts other than those listed are needed order potentiometers shown below.



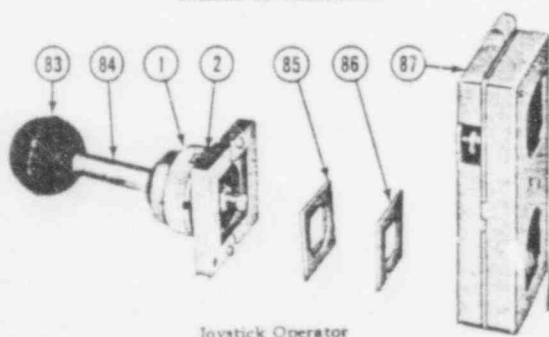
Potentiometers



Contact Block (See Page 4)  
Illuminated Transformer Type Pushbutton Complete



Full Voltage and Resistor Type Illuminated Pushbutton



Joystick Operator

Item No.	Description of Part	No. Req.	Part No.
29	Dual potentiometer (order from item 72).....	1	29-2823
30	Coupling.....	1	11-1845
31	Set screw #6-32 x 1/8 long.....	1	25-1912-3
33	Knob (order from item 79).....	1	25-1912-4
34	Single potentiometer (order from item 77).....	1	25-1912
37	Terminal plate.....	1	80-1901
38	Resistor and capacitor combination:		
	440 volts A-c.....	1	25-1912-3
	550 volts A-c.....	1	25-1912-4
	Resistor combination:		
	100 volts A-c.....	1	25-1912
	220 volts A-c.....	1	25-1912-2
	Resistor:		
	440 volts A-c.....	1	25-1912-5
	550 volts D-c.....	1	25-1912-6
39	Lamp (G E. No. 45).....	1	28-320
43	Lamp (G E. No. 12).....	1	28-769
44	Lens (Glass):		
	White.....	As Req.	28-766
	Clear.....	As Req.	28-865-2
	Blue.....	As Req.	28-766-3
	Amber.....	As Req.	28-766-4
	Green.....	As Req.	28-766-5
	Red.....	As Req.	28-766-6
45	Lamp Type S-6:		
	Volts.....Watt.....		
	4-6.....6.....	1	28-760
	8-12.....12.....	1	28-516
	14-17.....18.....	1	28-761
	18-23.....24.....	1	28-399
	32-39.....40.....	1	28-763
	48-59.....60.....	1	28-764
	60-74.....75.....	1	28-380
71	Screw with lug.....	As Req.	80-2926
72	Dual potentiometer (encapsulated) (does not include items 71 or 73)		
	1,000 ohms.....	1	41-1096-2
	2,500 ohms.....	1	41-1096-3
	10,000 ohms.....	1	41-1096-4
	25,000 ohms.....	1	41-1096-5
	50,000 ohms.....	1	41-1096-6
73	Mounting screw.....	2	11-2437
	#6 lockwasher.....	2	16-1547
74	Retaining nut.....	1	15-708-2
75	Resistor (used with single potentiometer) (connect to terminals No. 1 and No. 3) not shown.....	1	57-1443-10
76	Mounting screw (#6-32 x .750 long).....	2	11-1632
	#6 lockwasher.....	2	16-1547
77	Single potentiometer (encapsulated) (does not include items 71 or 76)		
	1,000 ohms.....	1	41-1095-2
	2,500 ohms.....	1	41-1095-3
	10,000 ohms.....	1	41-1095-4
	25,000 ohms.....	1	41-1095-5
	50,000 ohms.....	1	41-1095-6
78	Indicating plate:		
	Without legend.....	1	30-4460
	Specify legend.....	1	39-4460-2
79	Knob.....	1	53-1314
	Socket set screw (#6-32 x .250 long).....	1	11-2014
80	Resistor (not shown)		
	120 volts.....	2	57-1791
	240 volts.....	2	57-1791-2
81	Lamps:		
	6 volts.....	1	28-1022
	12 volts.....	1	28-1025
	24 volts.....	1	28-1028
	28 volts.....	1	28-1027
	48 volts.....	1	28-1026
	120 or 240 volts.....	1	28-1029
82	Lens sealing washer.....	1	16-1876-2
83	Knob (supplied with item 84).....	1	
84	Handle (includes item 83).....	1	24-5045
85	Common gate (supplied with item 87).....	1	
86	Position gate:		
	2 position.....	1	54-7172
	3 position.....	1	54-7173
	4 position.....	1	54-7174
	8 position.....	1	54-7175
87	Mechanism (includes item 85).....	1	83-1513

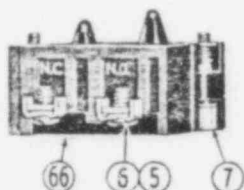
POOR ORIGINAL

## INSTRUCTION SHEET

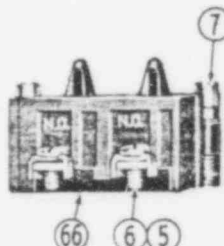
Parts CANNOT be sent promptly unless you include the following with your order: PUBLICATION NO. 10459, ITEM NO., PART NO. CATALOG NO., DESCRIPTION and QUANTITY REQUIRED.

For items pictured but not listed and items not pictured or listed refer to the Cutler-Hammer Catalog.

Contact Block  
(One Hole Mounting  
Type)



Contact Block  
(Base Mounting Type)



Item No.	Description	Number Required	Part Number
5	Terminal Lug (not supplied, furnished with item 6 only)	4	80-2926
6	Terminal Screw and Lug (Captive)	2	11-1605
7	Mounting Screw (61/64" Long)	2	16-1547
	Lockwasher	2	16-466
	Washer (Fiber)	2	16-466
66	Contact Block (Select From Table Below)		Give The Catalog Ordering No. For Each Block Ordered.

Select A Contact Block That Agrees With The Block Being Renewed.

Circuit Symbol	Circuit	Mounting	Feature	Factory No. 10250	Catalog Ordering No. 10250T
	1 NC-1 NO	One Hole	.....	H3028	1
	2 NO	One Hole	.....	H3029	2
	2 NC	One Hole	.....	H3030	3
	1 NO	One Hole	.....	H3885	53
	1 NC	One Hole	.....	H3886	51
	1 NC-1 NO	Base	.....	H3031	6
	2 NO	Base	.....	H3032	7
	2 NC	Base	.....	H3033	8
	1 NO	Base	.....	H3887	54
	1 NC	Base	.....	H3888	52
	1 NC-1 NO	One Hole	*Overlap	H3909	55
	2 NO	One Hole	▲	H3910	57
	1 NC-1 NO	Base	*Overlap	H3911	56
	2 NO	Base	▲	H3912	58

\*The NO Contacts Close 1/16" Nominal Before the NC Contacts Open.

▲One NO Contact Closes 1/16" Nominal Before the other NO makes.

POOR ORIGINAL



# INSTRUCTION SHEET

## For No. 912 — Normally Open Single Pole D-c Contactor

### 8 Hour Current Rating — 50 Amperes Max.

(Actual Rating Depends on Blowout Used)

#### CARE

##### Main Contacts

Main contacts should not be lubricated. Grease, dust or copper oxide have insulating qualities which increase the contact resistance and result in unnecessary heating. The contacts are normally self-cleaning. Dust and grease can be wiped off. A fine file should be used to remove excessive copper oxide, or to dress rough or pitted contacts. Care should be taken to remove as little copper as necessary.

##### Renewal of Contacts and Wear Allowance

Both contacts should be renewed when worn so that the distance "A" with the contactor in the closed position as indicated in Fig. 1 becomes 1 inch, or before clearance gap measured at "C" in Figure 3 has decreased to zero.

Failure to renew the contacts at the proper time may cause serious damage to the contactor.

Silver faced contacts should be replaced as soon as the silver is worn off.

**Magnetic Air Gap**—Shunt contactors are shipped from the factory with a magnetic gap of 9/32" nominal. This is measured at "B" in Figure 2 below. Adjustment of this gap is made with item 15.

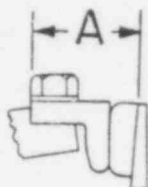


Fig. 1

#### Contact Spring Pressure

The contact pressure spring, item 9, is made of stainless steel. It is designed for long life and will retain its operating characteristics under heavy service conditions. Should excessive contact temperatures occur the spring may be checked as described below. It is only necessary to check the initial contact pressure. The final contact pressure may be checked only if equipped with new contacts.

The illustrations below, figures 2 and 3, provide the spring pressure range of values and the means of measuring. If the spring pressures are measured and found to be within the values given, the contact pressure spring is satisfactory. If the measured spring pressures are less than the values given, the spring should be replaced.

Self-locking nut, item 8, is used to adjust spring pressure. Before replacing any associated parts note the location of this nut with respect to the flat-fillet on the screw. This is a nominal gauge of initial adjustment. As shipped from the factory the top of nut lines up with the extent of this flat.

#### ADJUSTMENT

These contactors are adjusted at the factory for normal conditions. If it is desired to change the voltage value at which the contactor closes it can readily be done.

Turning adjusting screw, item 15, clockwise will decrease this voltage value, while turning it counter-clockwise will increase it. After making any adjustment be sure to lock the screw in position.

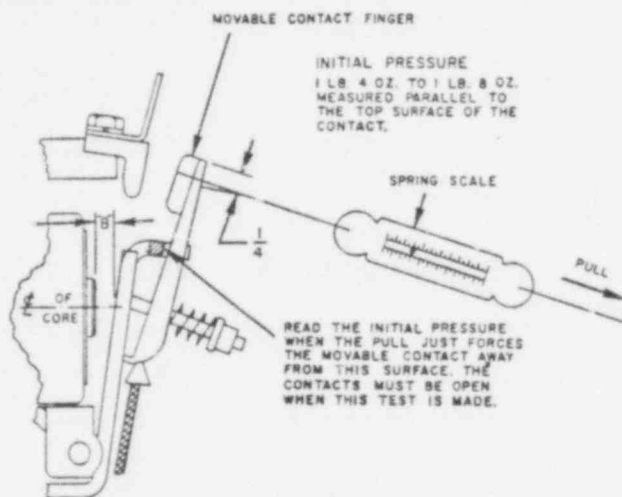


Fig. 2 (Initial Contact Pressure)

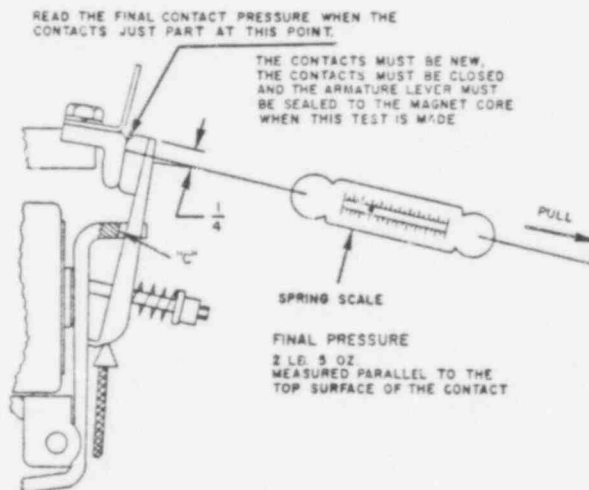


Fig. 3 (Final Contact Pressure)

#### Contact Heating and Application of Silver Contacts

Copper oxide forms very rapidly at excessive contact tip temperatures. If this condition occurs, check the remaining wear allowance (see Fig. 1 and paragraph "Renewal of Contacts") and the current carried by the contactor. If these are satisfactory, it is advisable to check the contact pressures (see Figs. 2 and 3 and paragraph "Contact Spring Pressure"). Copper contacts that are operated fairly often within their rating and wear allowance and with sufficient spring pressure seldom form oxide or require dressing.

Silver faced contacts are used where the contactor remains closed for long periods of time and is not subject to frequent operation, (nominally eight hours or more). Do not use silver faced contacts unless the contactor was so equipped originally. Silver faced contacts should not be filed or dressed unless sharp projections, caused by heavy arcing, extend beyond the contact surface. Such projections should be filed down to the surface only.

#### Armature Lever and Magnet Core

Keep the surface of the magnet core, item 14, and the armature lever, item 23, which come together when the contactor closes, clean and free of dirt and oil.

The armature lever shaft, item 26, should be lubricated occasionally with a drop or two of SAE No. 10 oil. Lubricate moderately at point where contact lever pivots in the armature lever recess.

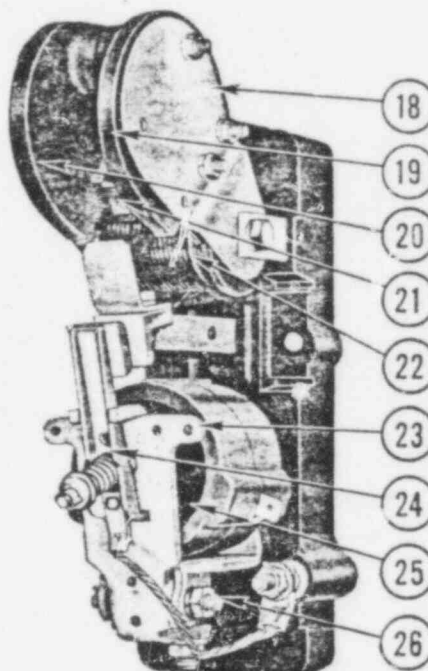
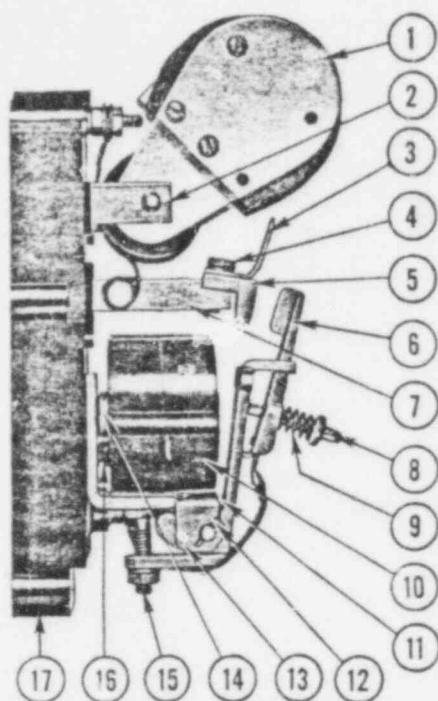
Wipe off excess oil.

#### Arc Shields

The arc shields, items 19 and 20, should be replaced before they wear through, so the arc will not touch the metal pole pieces, item 18.

The arc shields can easily be raised for inspection or renewal of the contact parts. However, be sure that they are lowered to their normal position before the contactor is allowed to operate. If this is not done, no blowout effect is obtained and the contacts will wear very rapidly.

## RENEWAL PARTS



NOTE: Pictures show arc shields in raised position. Lower before operating.

10-2913

Note: Do not use more than two unit electrical interlocks on one contactor. (4 circuits). (See page 4 or 5).  
It is recommended that not more than two N.C. electrical interlock circuits be used per contactor.

## RENEWAL PARTS — Information Required

Parts CANNOT be sent promptly unless you include the FOLLOWING with your order: PUBLICATION NO. 11273, ITEM NO., PART NO., DESCRIPTION and the Number Stamped on the Contactor Moulded Base.

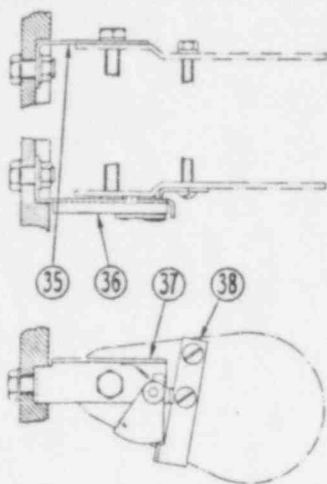
Item No.	Description of Part	No. Req.	Part No.	Item No.	Description of Part	No. Req.	Part No.
1	Blowout complete (includes items 18, 19, 20 and 21)	1	62-474	13	Magnet frame	1	17-6904
2	Bracket (used with blowout only)	1	79-5375-2	14	Core	1	51-64
▲3	Arc guard (used with blowout only)	1	62-440	15	Adjusting screw	1	11-1812
4	Contact screw	1	911-5445Z		Nut	1	915-803Z
	1/4" lockwasher	1	916-682Z		5/16" lockwasher	1	916-198
▲5	Stationary contact			16	Spring	1	69-2312
	Copper	1	23-3286	17	Molded base		
*	Silver faced	1	23-1258		For contactor with blowout	1	81-7145
▲6	Movable contact finger with connector				For contactor without blowout	1	81-7302
	With copper contact	1	40-522-4	18	Pole piece	2	62-474-3
*	With silver faced contact	1	40-522	19	Arc shield	1	73-1194
7	Contact post without contact			20	Arc shield	1	73-1194-2
	1-15/16" long (Marked "Low")	1	18-1395-2	21	Protecting clip	1	23-3311-3
	2" long	1	18-1395	22	Blowout coil (Give No. on Coil)	1	
8	Self-locking cup nut	1	15-797	23	Armature lever	1	24-4025-2
▲9	Spring	1	69-95	24	Spring gland	1	49-1204-13
▲10	Coil (Give No. on Coil)	1		25	Washer	1	4416-134
11	Spring			26	Shaft	1	13-3239
	For use without and with off delay timing interlock		69-179		1/4" hex. nut	1	915-24Z
	Orange colored. For use with on delay timing interlock		69-2482		Pal Nut	1	915-209
12	Spring pin	1	13-3186	▲30	Renewal set of copper contacts (includes items 4, 5, 6, 8, 9 and 24)	1	6-169-3
				31	Power terminal pressure lug	As Req.	80-1696-2

\*Silver faced contacts are used only where the contacts remain closed for long periods. (nominally eight hours or more.)

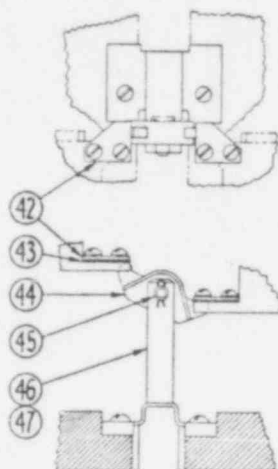
Do not use silver faced contacts unless the contactor was so equipped originally.

▲We recommend that these items be stocked. The quantity to be stocked will depend on the total number in use.

POOR ORIGINAL



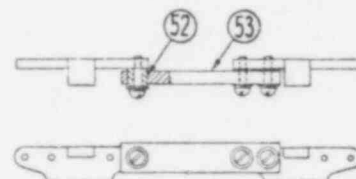
Blowout Latch



Mechanical Interlock

### Mechanical Interlock Adjustment

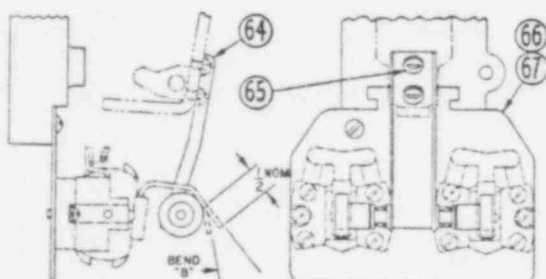
With contacts of one contactor just touching, add or remove shims, item 43, so that a minimum of .188 inch arc gap is obtained on the other contactor.



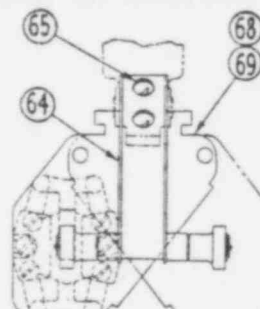
Tie Bar

Item No.	Description of Part	No. Req.	Part No.	Item No.	Description of Part	No. Req.	Part No.	Item No.	Description of Part	No. Req.	Part No.
Blowout Latch				Mechanical Interlock				Tie Bar			
35	Bracket	1	79-7416	42	Stop	2	18-718	52	Spacer	1	29-273
36	Blowout latch complete (includes items 35, 37 and 38)	1	52-846	43	Shim	As req.	825-45	53	Tie Bar	1	61-75
37	Latch with spring and bracket	1	52-845	44	Lever includes bushing	1	24-4029				
38	Bracket	1	79-5641		Bushing	1	20-919				
				45	Pin	1	13-1797-9				
				46	Post with mounting plate	1	17-6914				
				47	Mechanical interlock complete (includes items 42, 43, 44, 45, and 46)	1	6002H634A				

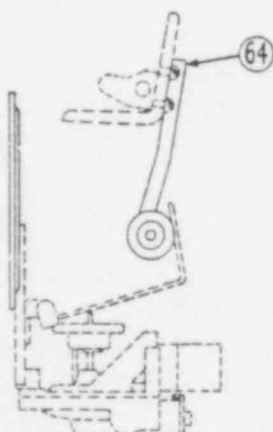
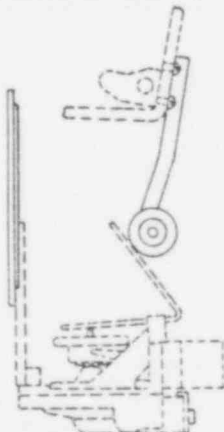
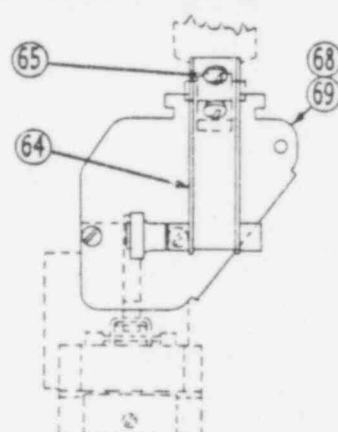
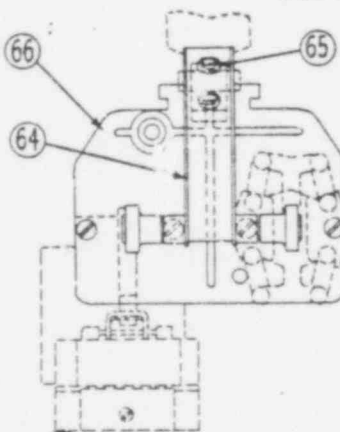
## LOWER ELECTRICAL INTERLOCK MOUNTING AND OPERATING BAR



Double Unit Interlock Mounting



Single Unit Interlock Reversible Mounting

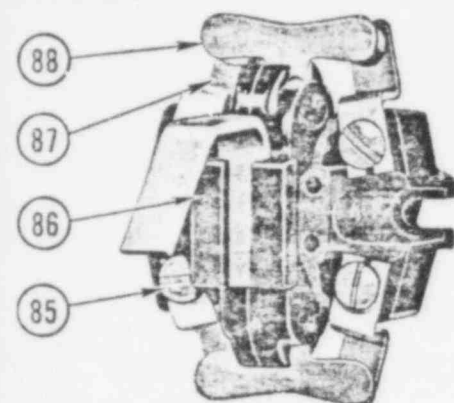

Off Delay Timing  
▲ Cat. No. 10923H26

On Delay Timing  
▲ Cat. No. 10923H24


We recommend that these items be stocked as required.

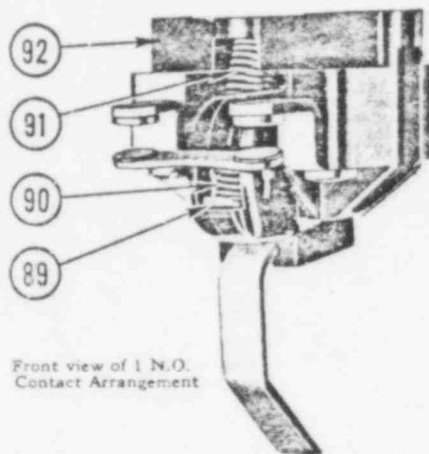
Item No.	Description of Part	No. Req.	Part No.
64	Operating lever	1	24-4024
65	Mounting screw #8-32 x .312 R.H. semi screw	2	11-1524
66	Mounting plate	1	17-6908
67	Mounting and operator bar for two unit electrical interlocks or one pneumatic timing interlock and one unit electrical interlock (includes items 64, 65 and 66)	1	10923H11A
68	Mounting plate	1	17-7754
69	Mounting unit interlock operator for one unit electrical interlock or one pneumatic timing interlock (includes items 64, 65 and 68)	1	10923H17A

# FOR LOWER UNIT INTERLOCK MOUNTING UNIT TYPE ELECTRICAL INTERLOCKS—RENEWAL PARTS—Information Required

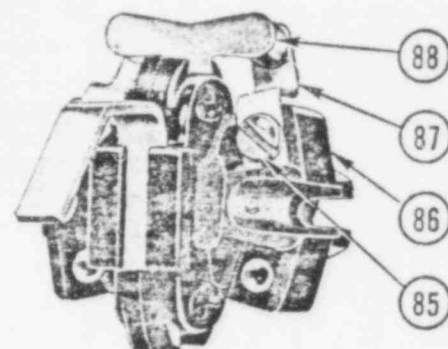
Parts CANNOT be sent promptly unless you include the FOLLOWING with your order: PUBLICATION NO. 11273, PART NO., DESCRIPTION and either the Interlock Index No. or the Index or Order No. stamped on the Controller.



2 Circuit Interlock  
Top View



Front view of 1 N.O.  
Contact Arrangement



1 Circuit Interlock  
Top View

Item No.	Description of Part	One Normally Open Unit Interlock		One Normally Closed Unit Interlock		One Normally Open and Normally Closed Unit Interlock		Two Normally Open Unit Interlock		Two Normally Closed Unit Interlock	
		No. Req.	Part No.	No. Req.	Part No.	No. Req.	Part No.	No. Req.	Part No.	No. Req.	Part No.
85	Contact mounting screw	2	11-1649	2	11-1649	4	11-1649	4	11-1649	4	11-1649
86	Unit interlock complete (includes items 85, 87, 88, 91, and 92)	1	10923H1A	1	10923H4A	1	10923H3A	1	10923H2A	1	10923H5A
87	Stationary contact	2	23-2892	2	23-2892	4	23-2892	4	23-2892	4	23-2892
88	Movable contact	1	23-2893	1	23-2893	2	23-2893	2	23-2893	2	23-2893
89	Spring plate (not supplied separately)										
90	Spring (not supplied separately)										
91	Plain spring	1	69-2476	1	69-2476	1	69-2476	1	69-2476	1	69-2476
92	Unit interlock base with formed lever (includes items 89 and 90)	1	10-2485-10	1	10-2485-10	1	10-2485-10	1	10-2485-10	1	10-2485-10
93	Add interlock circuit kit (includes items 85, 87, 88, and 91)	As Req.	10923H10A	As Req.	10923H10A	As Req.	10923H10A	As Req.	10923H10A	As Req.	10923H10A
94	Renewal set of contacts for one circuit interlock	1	6-185	1	6-185	1	6-185	1	6-185	1	6-185

▲The add an interlock circuit kit includes two operating springs, the orange spring is for use only when both circuits are arranged for normally closed for one interlock.

The interlock lever is to be bent as pictured in, Double Unit Interlock Mounting, Page 3. BEND "A" is to be made so that the normally open and normally closed interlocks just pick up at 170 - 190 magnetic gap on the Contactor measured at "B" (Fig. 2, Page 1). BEND "B" is to be made so that the normally open and normally closed interlocks can be adjusted for the following:

## WEAR ALLOWANCE SPECIFICATIONS TO INSURE PROPER OPERATION OF: NORMALLY OPEN ELECTRICAL INTERLOCKS

With the Contactor in the closed (magnet sealed) position, a gap of .039 - .051 inch measured at "C" is required.

### NORMALLY CLOSED ELECTRICAL INTERLOCKS

With the Contactor in the normally open position, a gap of .039 - .051 inch measured at "C" is required. In addition, the operating roller is not to touch the interlock lever.

## ARC GAP SPECIFICATION TO INSURE PROPER OPERATION OF: NORMALLY OPEN ELECTRICAL INTERLOCKS

With the Contactor in the normally open position, an arc gap of at least .094 - .218 inch measured at "F" is required. In addition, the operating roller is not to touch the interlock lever.

### NORMALLY CLOSED ELECTRICAL INTERLOCKS

With the Contactor in the closed (magnet sealed) position, an arc gap of .094 - .218 inch measured at "F" is required.

## ADJUSTMENT INSTRUCTIONS FOR: NORMALLY OPEN AND CLOSED ELECTRICAL INTERLOCKS

With the Contactor in the normally open position, carefully bend the end of the interlock lever using two flat nosed pliers, one to hold and one to bend the lever end.

## ADJUSTMENT OF NORMALLY CLOSED LATE OPENING ELECTRICAL INTERLOCK

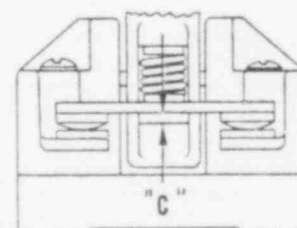
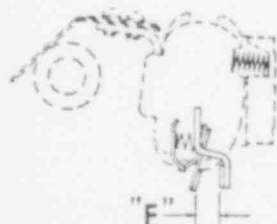
With the Contactor in the normally open position, a Wear Allowance gap of .039 - .051 inch measured at "C" is required. In addition, the operating roller is not to touch the interlock lever.

With the Contactor in the closed (magnet sealed) position, an Arc gap of .094 - .218 inch measured at "F" is required.

TO ADJUST — Loosen the two screws securing the two piece lever. Slide the lever and retighten the screws.

## REPLACEMENT OF CONTACTS

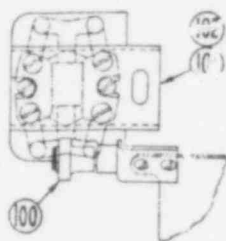
Replace normally open and normally closed contacts when one of the silver contact tips has worn away or before Gap "C" has diminished to .005.



POOR ORIGINAL

## RENEWAL PARTS — Information Required (Continued)

### SIDE ELECTRICAL INTERLOCK MOUNTING AND OPERATING BAR



Left Side Mounting Pictured

#### Electrical Interlock Adjustment

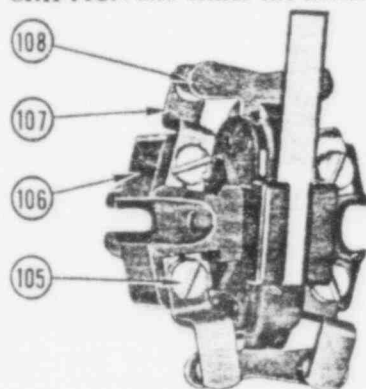
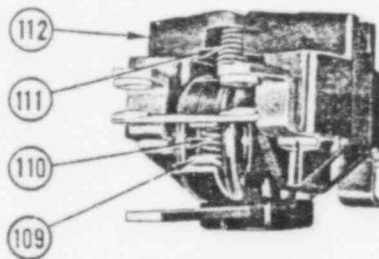
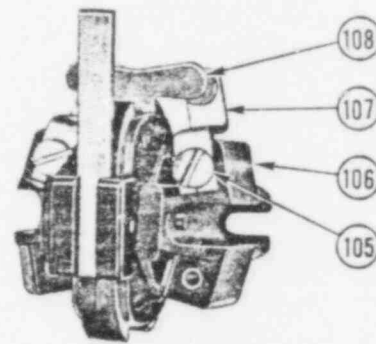
Bend the interlock lever with the contactor sealed so that gap "C" on the electrical interlock (shown on bottom of previous page) is .039" — .051".

Item No.	Description of Part	No. Req.	Part No.
100	Interlock roller assembly (for right or left side)	1	29-2796
	Mounting screws #8—32 x 5/16" long	2	11-1524
101	Mounting plate (for right or left side)	1	17-6909
102	Unit interlock mounting complete (includes items 100 and 101)	1	10923H12A

### FOR SIDE MOUNTING

### UNIT TYPE ELECTRICAL INTERLOCKS

Parts CANNOT be sent promptly unless you include the FOLLOWING with your order: PUBLICATION NO. 11273, PART NO., DESCRIPTION and either the Interlock Index No. or the Index or Order No. stamped on the Controller.


2 Circuit Interlock  
Top View

Front view of 2 N.O.  
Contact Arrangement

1 Circuit Interlock  
Top View

Item No.	Description of Part	One Normally Open Unit Interlock		One Normally Closed Unit Interlock		One Normally Open and One Normally Closed Unit Interlock		Two Normally Open Unit Interlock	
		No. Req.	Part No.	No. Req.	Part No.	No. Req.	Part No.	No. Req.	Part No.
105	Contact mounting screw	2	11-1649	2	11-1649	4	11-1649	4	11-1649
106	Unit interlock complete (includes items 105, 107, 108, 111 and 112)	1	10923H6A	1	10923H9A	1	10923H8A	1	10923H
107	Stationary contact	2	23-2892	2	23-2892	4	23-2892	4	23-2892
108	Movable contact	1	23-2893	1	23-2893	2	23-2893	2	23-2893
109	Spring plate (not supplied separately)								
110	Spring (not supplied separately)								
111	Return spring (plain)	1	69-2476	1	69-2476	1	69-2476	1	69-2476
112	Unit interlock base with straight lever (includes items 109 and 110)	1	10-2485-11	1	10-2485-11	1	10-2485-11	1	10-2485-11
113	Add interlock circuit kit (includes items 105, 107, 108 and 111)	As Req.	10923H10A	As Req.	10923H10A	As Req.	10923H10A	As Req.	10923H10A
114	Renewal set of contacts (for one circuit interlock)	1	6-185	1	6-185	1	6-185	1	6-185

▲ The add an interlock circuit kit includes two return springs. The orange spring is for use only when both circuits are arranged for normally closed for one unit interlock. The two normally closed arrangement is not to be used with the contactor. Discard the orange spring.

#### WEAR ALLOWANCE SPECIFICATIONS TO INSURE PROPER OPERATION OF:

##### NORMALLY OPEN ELECTRICAL INTERLOCKS

With the Contactor in the closed (magnet sealed) position, a gap of .039 — .051 inch measured at "C" (See Bottom of page 4) is required.

##### NORMALLY CLOSED ELECTRICAL INTERLOCKS

With the Contactor in the normally open position, a gap of .039 — .051 inch measured at "C" (See Bottom of page 4) is required. In addition, the operating roller is not to touch the interlock lever.

#### ARC GAP SPECIFICATION TO INSURE PROPER OPERATION OF:

##### NORMALLY OPEN ELECTRICAL INTERLOCKS

With the Contactor in the normally open position, an arc gap of at least .094 — .218 inch measured at "F" (See Bottom of page 4) is required. In addition, the operating roller is not to touch the interlock lever.

##### NORMALLY CLOSED ELECTRICAL INTERLOCKS

With the Contactor in the closed (magnet sealed) position, an arc gap of .094 — .218 inch measured at "F" (See Bottom of page 4) is required.

#### ADJUSTMENT INSTRUCTIONS FOR:

##### NORMALLY OPEN AND CLOSED ELECTRICAL INTERLOCKS

With the Contactor in the normally open position, carefully bend the end of the interlock lever using two flat nosed pliers, one to hold and one to bend the lever end.

#### REPLACEMENT OF CONTACTS

Replace all normally open and normally closed contacts when any of the silver contact tips has worn away or before Gap "C" has diminished to .005 inch.



OPERATING COILS

The coil numbers listed in the table at the right are for common d-c voltages on continuous duty applications. Coils for other voltages or intermittent duty are to be ordered by specifying the coil number appearing on the coil together with the complete nameplate data on the controller.

D-C	
Volts	Part No.
115	9-1549-2
230	9-1549-1
550	9-1549-3

UNIT TYPE ELECTRICAL INTERLOCKS

Instructions for Renewal of, Changing or Adding Circuits

1. Assemble stationary contacts first. Refer to the sketches at the bottom of this sheet for positioning in assembly for the desired circuit arrangement.

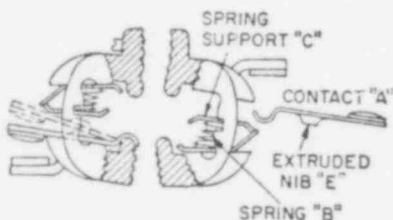


Fig. 4

2. To Remove or Assemble Movable Contacts

Removal of contact "A". — See Fig. 7. Remove contact "A" by compressing spring "B" with contact "A", and at the same time when spring "B" is compressed, remove the contact by pulling in an outward direction with a slight twist.

Renewal of contact "A". — See Fig. 7. Insert the renewal contact "A" into the area vacated by the old contact and at the same time compress spring "B" until contact "A" can be pushed in and the extruded nib "E" is seated in the spring support "C".

3. Adding a Circuit to One Circuit Interlocks.

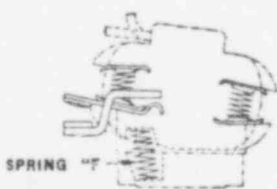
See Figure 4 and sketches at the bottom of this sheet.

The top two sketches below are of single circuit interlocks. Single circuit interlocks are supplied with the additional spring "B" and spring supports "C". A circuit may be added to obtain any of the two circuit arrangements shown in the lower two sketches below.

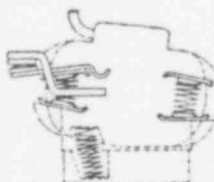
A kit of parts is available for adding a circuit to single circuit interlocks. This kit supplies one movable contact, two stationary contacts and two springs. These springs are "F" indicated in the top left hand sketch below. Only one of these springs is used. The orange spring may be discarded because 2 N. C. circuits in one interlock should not be used with this contactor.

For renewal parts, application and installation see the proper contactor publication. Contactor publications can be ordered from the nearest Cutler-Hammer District Office.

SINGLE CIRCUIT INTERLOCKS

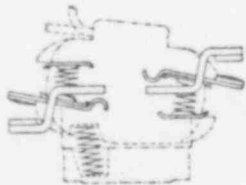


1 Normally Open

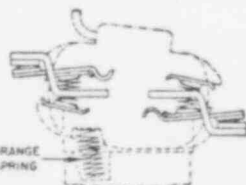


1 Normally Closed

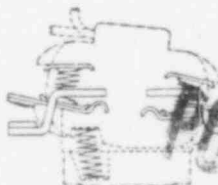
DOUBLE CIRCUIT INTERLOCKS



2 Normally Open



2 Normally Closed



1 Normally Open, & 1 Normally Closed

POOR ORIGINAL



## INSTRUCTION SHEET

### No. 673 Definite Time Armature Accelerating Contactor

#### DESCRIPTION

##### FUNCTION

The function of this contactor is to short out steps of armature resistance. One contactor will short out a maximum of two steps of resistance. The center bridging contact is an interlock in the control circuit and its timing is not adjustable.

##### OPERATION

As the main line contactor closes to start the motor with resistance in series with the motor armature, the No. 673 contactor coil, which is paralleled with a condenser, is disconnected from the line. The condenser immediately discharges through this coil to keep the number 1 and number 2 contacts open for a definite time depending upon their settings. Number 1 contact operates first to short out the first step of the resistor, increasing the rate of acceleration. Number 2 contact then closes to short out another step of resistance to connect the armature across-the-line.

The maximum total timing is about 4 seconds and the number 1 contact must always be adjusted to close before the number 2 contact closes.

##### ADJUSTMENT

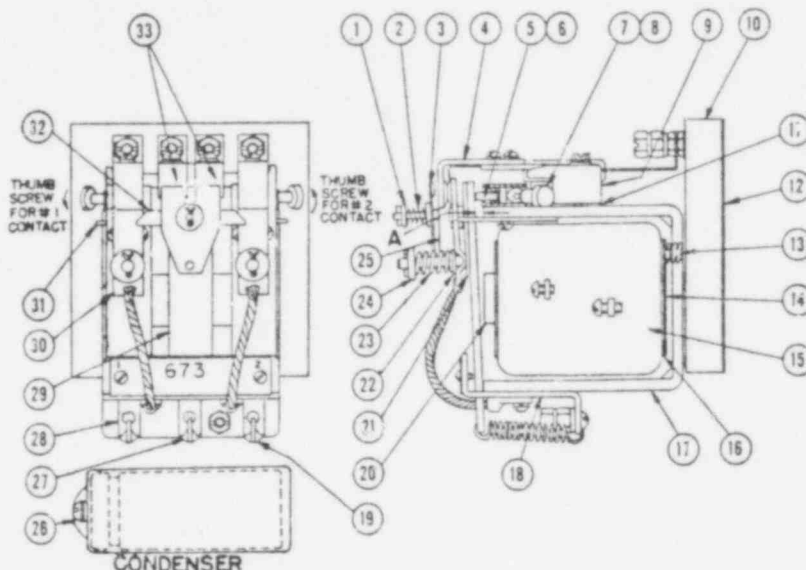
The contactor is set at the factory for average operating conditions. If it is necessary to change the adjustment, proceed as follows, remembering that contact number 1 must close before contact number 2 closes. The timing on each contact is independent of the setting on the other contact.

##### TO INCREASE THE TIMING ON THE CONTACTS

Face the contactor and:

- 1—Turn the thumb screws out a slight amount (about  $\frac{1}{8}$  to  $\frac{1}{4}$  turn) against the direction of the arrow, turning the screw for contact number 2 slightly more than the screw for contact number 1. The armatures of the contactor should be held closed (contacts open) when this is done. Turning the screws in this direction will allow the armatures to move closer to the frame of the contactor, increasing the timing.

- 2—Try the new settings and make further adjustments if necessary.



##### TO DECREASE THE TIMING OF THE CONTACTS

Face the contactor and:

- 1—Turn the thumb screws in a slight amount (about  $\frac{1}{8}$  to  $\frac{1}{4}$  turn) in the direction of the arrow, turning the screw for contact number 2 slightly less than the screw for contact number 1. The contactor should be held with its armature closed (contacts open) when this is done, with the contact fingers free to move. Turning the screws in this direction will force the contact fingers away from the frame of the contactor.
- 2—Try the new settings and if not satisfactory make further adjustment.

**Important:** If it is necessary to replace the contacts, replace all of them at the same time. When replacing these contacts place a  $\frac{13}{64}$ " spacer between the outside levers and the ends of the frame at "A" and then set the adjustable stationary contact bracket item 4 so the contacts just touch. Lock the brackets in this position with the locking screws. For the center contact the dimension "A" should be slightly less than  $\frac{7}{32}$ ".

The above dimensions will provide the proper wear allowance on the contacts which need not be adjusted during their normal life.

### RENEWAL PARTS—Information Required

Parts CANNOT be sent promptly unless you include the FOLLOWING with your order: PUBLICATION NO. 12396, ITEM NO., PART NO., DESCRIPTION and COMPLETE NAMEPLATE DATA ON THE CONTROLLER.

Item No.	Description of Part	No. Req.	Part No.	Item No.	Description of Part	No. Req.	Part No.
1	Cupwasher	2	16-934-10	20	Core plate	1	51-303
2	Spring	1	69-348	21	Plate	2	20-448
3	Contact plate	1	21-385	22	Sleeve	2	29-1841
4	Stationary contact bracket	2	21-377	23	Spring	2	69-1110
	Insulator (not shown) used between item 4 and item 9.	As Req.	56-1938	24	Cupwasher	2	916-561Z
5	Pin	2	13-1027	25	Base	1	17-1145-2
6	Spring	2	69-645	26	Condenser		
7	Thumb screw	2	11-592		For steel panel or insulated panel		
8	Locking spring	1	69-392		115 volts		42-143-6
9	Contact base	1	17-1149		230 volts		42-143-5
10	Base (when used)	1	81-2488	27	Spring (center)	1	69-643
11	Insulator	1	56-867	28	Armature lever (For No. 1 & 2 contact fingers)	2	24-2161
12	Insulator (when used)	1	56-1166	29	Armature lever (center)	1	24-1186
13	Spring	1	69-600	30	Contact finger w/connector	2	40-376
14	Steel washer	1	16-1944	31	Guide	1	54-606
15	Coil (Give No. on Coil)	1		32	Interlock bar	1	61-419
16	Bakelite washer	2		33	Stationary contact bracket	2	21-387-2
17	Frame	1			Insulator (not shown) used between item 33 and item 9.	As Req.	56-1938
18	Guide	1		34	Renewal set of contacts (includes items 4, 24, 31)	1	6-167-4
19	Spring (For No. 1 & 2 contact fingers)	2					

▲ We recommend that these items be stocked. The quantity to be stocked will depend upon the total number in use.

# INSTRUCTION SHEET

## No. 538 Definite Time Armature Accelerating Contactor

### DESCRIPTION

#### FUNCTION

The function of this contactor is to short out steps of armature resistance. One contactor will short out a maximum of two steps of resistance. The center bridging contact is an interlock in the control circuit and its timing is not adjustable.

#### OPERATION

As the main line contactor closes to start the motor with resistance in series with the motor armature, the No. 538 contactor coil, which is paralleled with a condenser, is disconnected from the line. The condenser immediately discharges through this coil to keep the number 1 and number 2 contacts open for a definite time depending upon their settings. Number 1 contact operates first to short out the first step of the resistor, increasing the rate of acceleration. Number 2 contact then closes to short out another step of resistance to connect the armature across-the-line.

The maximum total timing is about 4 seconds and the number 1 contact must always be adjusted to close before the number 2 contact closes.

#### ADJUSTMENT

The contactor is set at the factory for average operating conditions. If it is necessary to change the adjustment, proceed as follows, remembering that contact number 1 must close before contact number 2 closes. The timing on each contact is independent of the setting on the other contact.

#### TO INCREASE THE TIMING ON THE CONTACTS

Face the contactor and:

- 1—Turn the thumb screws out a slight amount (about  $\frac{1}{8}$  to  $\frac{1}{4}$  turn) against the direction of the arrow, turning the screw for contact number 2 slightly more than the screw for contact number 1. The armatures of the contactor should be held closed (contacts open) when this is done. Turning the screws in this direction will allow the armatures to move closer to the frame of the contactor, increasing the timing.

- 2—Try the new settings and make further adjustments if necessary.

#### TO DECREASE THE TIMING OF THE CONTACTS

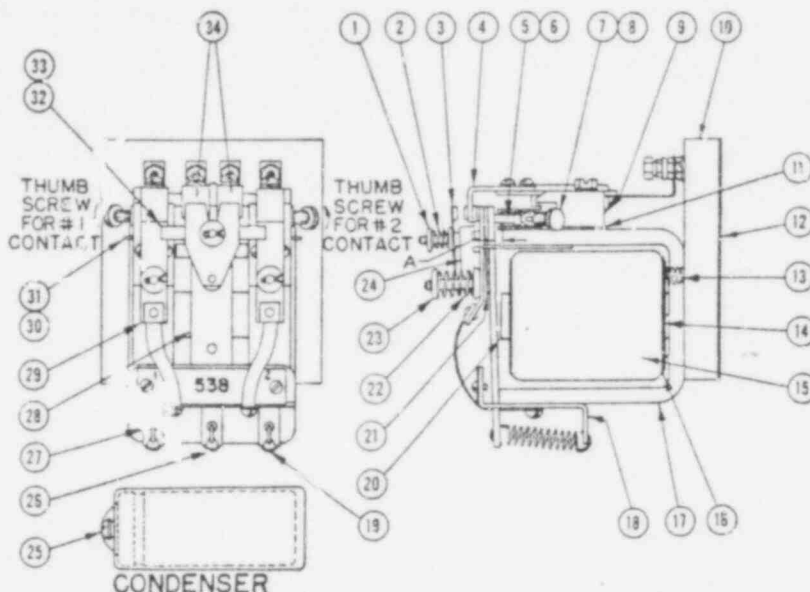
Face the contactor and:

- 1—Turn the thumb screws in a slight amount (about  $\frac{1}{8}$  to  $\frac{1}{4}$  turn) in the direction of the arrow, turning the screw for contact number 2 slightly less than the screw for contact number 1. The contactor should be held with its armature closed (contacts open) when this is done, with the contact fingers free to move. Turning the screws in this direction will force the contact fingers away from the frame of the contactor.

- 2—Try the new settings and if not satisfactory make further adjustment.

**Important:** If it is necessary to replace the contacts, replace all of them at the same time. When replacing these contacts place a  $\frac{13}{64}$ " spacer between the outside levers and the ends of the frame at "A" and then set the adjustable stationary contact bracket, item 4, so the contacts just touch. Lock the brackets in this position with the locking screws. For the center contact the dimension "A" should be slightly less than  $\frac{7}{32}$ ", but not equal to  $\frac{13}{64}$ ".

The above dimensions will provide the proper wear allowance on the contacts which need not be adjusted during their normal life.



C10-3486

## RENEWAL PARTS—Information Required

Parts CANNOT be sent promptly unless you include the FOLLOWING with your order: PUBLICATION NO. 12394, ITEM NO., PART NO., DESCRIPTION and COMPLETE NAMEPLATE DATA ON THE CONTROLLER.

Item No.	Description of Part	No. Req.	Part No.	Item No.	Description of Part	No. Req.	Part No.
1	Cup washer	2	16-934-10	21	Plate	2	20-196-2
2	Spring	1	69-348	22	Spring	2	69-698
3	Contact plate	1	21-385	23	Cup washer	4	16-934-11
4	Stationary contact bracket	2	21-470	24	Base	1	17-1145-2
5	Insulator (not shown) used between item 4 and item 9	As Req.	56-1938	25	Condenser	1	
6	Pin	2	13-1027		115 volt		42-143-6
7	Spring	2	69-645		230 volt		42-143-5
8	Thumb screw	1	11-592		550 volt (bridging circuit used to provide only 230 volts on condenser)		42-143-5
9	Locking spring	1	69-592	26	Spring	1	69-643
10	Contact base	1	17-1149	27	Armature lever (For No. 1 & 2 contact fingers)	2	24-1186-2
11	Base	1	81-3488	28	Armature lever (center)	1	24-1186
12	Insulator	1		29	Contact finger with connector	2	21-471
13	Insulator	1		30	Guide	1	54-866
14	Spring	1		31	Guide (For No. 1 contact finger)	1	54-606
15	Steel washer	1		32	Interlock bar (For No. 1 contact finger)	1	61-420
16	Coil (Give No. on Coil)	1		33	Interlock bar (For No. 1 and 2 contact fingers)	1	61-419
17	Bakelite washer	2	4416-134	34	Stationary contact bracket	2	21-357-2
18	Frame	1	17-1147		Insulator (not shown) used between item 34 and item 9	As Req.	56-1938
19	Guide	1	54-867	35	Renewal set of contacts (includes items 4, 22 & 29)	1	6-167-2
20	Spring	2	69-843				
21	Core plate	1	51-303				

▲ We recommend that these items be stocked. The quantity to be stocked will depend upon the total number in use.