THC-1
RVC

Remote Voltage and Current Control

Instruction Manual
800420 – Revision 1

Hypertherm®
The world leader in plasma cutting technology

INSTRUCTION MANUAL
IM-42 (C1)

THC-1/RVC

TORCH HEIGHT CONTROL

with Remote Voltage and Current Controls

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September 2002

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SECTION 1 INTRODUCTION

The Hypertherm THC-1/RVC is designed to provide reliable and precise control of torch height (arc voltage) and arc current for the Hypertherm PAC-500 Plasma Arc Cutting System. The THC-1/RVC performs its task by operating in two distinct modes: Initial Height Sensing (IHS), and Automatic Voltage Control (AVC). An independent system, which is also a part of the THC-1/RVC, controls arc current. This package provides a means for interfacing the plasma arc cutting system with the N/C controllers provided on many shape contouring machines. N/C control of the plasma cutting sequence is thereby achieved. Optional features include programmed control of voltage or current setting, or both.

The Initial Height Sensing mode sets the correct torch height above the workpiece prior to making a pierce start. Ideally, the position of the workpiece should be sensed directly under the torch. Errors due to holes previously cut in the workpiece, or to the proximity of the workpiece edge are thus avoided. The Initial Height Sensing System (Fluidic Type) meets this requirement by using the plasma torch itself as a detecting device. This exclusive Hypertherm technique operates by sensing a slight change in nozzle bore pressure as the torch approaches the workpiece with the arc gas flowing. When the work is detected, the torch then retracts to the correct piercing height using the point of detection as a reference height. This technique is designed for use with the Hypertherm .120, .166, and .187 nozzles. It may therefore be used when cutting materials up to two inches (50mm) in thickness and provides a very reliable and accurate means of initiating a cut by automatic methods.

When using the plasma system for underwater cutting, the above technique cannot be used. The sensing method would prevent the torch from proceeding below the water level because the water itself would be sensed as a solid object. In underwater applications, this problem is overcome by use of an inductive probe assembly which works in a similar manner (electronically) to the fluidic technique. This method may be used for cutting applications both above and below water. THC-1/RVC packages are available in which the Inductive IHS unit is substituted for the standard Fluidic unit. Existing THC-1/RVC packages equipped with the Fluidic unit may be converted to underwater cutting by means of a retrofit kit described as Underwater Cutting Option, Stock No. 028162.

Upon completion of the IHS sequence, the THC-1/RVC sends a start command to the plasma arc cutting control console. After arc ignition is obtained, the Automatic Voltage Control (AVC) commences. AVC works by comparing the actual arc voltage to a reference voltage set by the operator (or by the N/C controller on programmable versions.) The THC-1/RVC then activates the torch suspension motor to move the torch up or down as required to match the arc length (arc voltage) to the reference voltage. This technique is highly accurate and reliable, having the capacity to control torch height within ±.025 inches (0.635mm).

The current control portion of the THC-1/RVC provides a digital LED display of arc current value while the arc is on. The current setting is made by means of a potentiometer located adjacent to this display, or by means of the N/C software on THC-1/RVC units equipped with the programmable current feature. On programmable current units, the operator may manually trim the current value by ±10% with the potentiometer. A switch located on the Programmable Current Transmiter Module permits manual operation when desired.

TYPES OF THC-1/RVC UNITS AVAILABLE:

Six versions of the THC-1/RVC are available. All six versions permit N/C control of the cutting sequence. (Start, IHS, Hold, AVC, Corner, Stop.)

THC-1/RVC-F, Stock Number 050006, includes the Fluidic IHS Module for above water cutting only. Voltage and current settings are made manually by the operator with the Thumbwheel Switch and Potentiometer.

THC-1/RVC-F (PROG. CURR.), Stock Number 050009, includes the Fluidic IHS Module for above water cutting only. Current may be set either manually or by the N/C Controller. Voltage must be set manually on the Thumbwheel Switch provided.

THC-1/RVC-I, Stock Number 050011, includes the Inductive IHS Module and Probe Assembly for use in both above water and underwater cutting. Voltage and current settings are made manually by the operator.

THC-1/RVC-I (PROG. CURR.), Stock Number 050012, includes the Inductive IHS Module and Probe Assembly for use in both above water and underwater cutting. Current may be set either manually or by the N/C Controller. Voltage must be set manually.

THC-1/RVC-F (PROG. CURR./PROG. VOLT.), Stock Number 050014, includes the Fluidic IHS Module for above water cutting only. Current and voltage may be set either manually or by the N/C Controller.

THC-1/RVC-I (PROG. CURR./PROG. VOLT.), Stock Number 050016, includes the Inductive IHS Module and Probe Assembly for use in both above water and underwater cutting. Current and voltage may be set either manually or by the N/C Controller.

COMPONENTS INCLUDED IN THE THC-1/RVC PACKAGES

Pkg. Stock No.	Description	Component Stock No.
050006	THC-1/RVC-F	
	Control Module	053007
	Control Station	053010
	Transmitter-Manual	054002
	IHS Module - Fluidic	053013
	Voltage Divider	041007
	IHS Hose, 30" (762mm)	024088
050009	THC-1/RVC-F (PROG. CURR.)	
	Control Module	053007
	Control Station	053010
	Transmitter-Program.	054008
	IHS Module - Fluidic	053013
	Voltage Divider	041007
	IHS Hose, 30" (762mm)	024088

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COMPONENTS INCLUDED IN THE THC-1/RVC PACKAGES

Continued from previous page

050011	THC-1/RCV-I	
	Control Module	053007
	Control Station	053010
	Transmitter-Manual	054002
	IHS Module - Inductive	053012
	Inductive Probe Assembly	029044
	Voltage Divider	041007
050012	THC-1/RVC-I (PROG. CURR.)	
	Control Module	053007
	Control Station	053010
	Transmitter-Program.	054008
	IHS Module - Inductive	053012
	Inductive Probe Assembly	029044
	Voltage Divider	041007
050014	THC-1/RVC-F (PROG. CURR./PROG. VOLT.)	
	Control Module	053014
	Control Station	053010
	Transmitter-Program.	054008
	IHS Module - Fluidic	053013
	Voltage Divider	041007
	IHS Hose, 30" (762mm)	024088
050016	THC-1/RVC-I (PROG. CURR./PROG. VOLT.)	
	Control Module	053014
	Control Station	053010
	Transmitter-Program.	054008
	IHS Module - Inductive	053012
	Inductive Probe Assembly	029044
	Voltage Divider	041007

PLUGS AND CLAMPS SUPPLIED WITH ALL OF THE ABOVE PACKAGES

Quantity	Description	Stock No.
1	Clamp (MS-3057-16)	008034
*	Clamp (MS-3057-10)	008014
1	Clamp (MS-3057-12)	008010
1	Plug-20M (MS-3106B-28-16P)	008033
**	Plug-10M (MS-3106B-18-1P)	008116
1	Plug-10F (MS-3106B-18-1S)	008117
1	Plug-14F (MS-2106B-20-27S)	008077

* Quantity is (2) for Manual Units,
or (3) for Programmable Current Units.

** Quantity is (1) for Manual Units,
or (2) for Programmable Current Units.

NOTE: THC-1/RVC units are supplied with torch lifter motor control relays for use with A.C. motors. Relays for D.C. motors are available upon request. The motor control relays, 4 CRE and 5 CRE, are RED if for use with A.C. motors, BLUE if for D.C. motors.

The torch lifter motor is normally provided by the contouring machine manufacturer as part of the torch station.

SECTION 2 SAFETY

Installation or repair work on the THC-1 unit, as well as the other components of the plasma arc cutting system, should be performed only by those qualified to handle high voltages and high pressure liquid and gas lines. While most of the THC-1 logic circuitry operates at only 15 VDC, The signal input at the voltage divider is 400 VDC and input to the board power supplies is 120 VAC. Contact with these voltage sources could result in fatal electric shock. Gas and water pressures over 150 psig. are also present and should be respected as potential sources of injury if improperly handled. Prior to operation of any plasma arc cutting equipment, it is important to ascertain that all exposed personnel are protected from fumes, noise and ultraviolet radiation as recommended in the plasma cutting system instruction manual.

SECTION 3 SPECIFICATIONS

MODEL THC-1/RVC TORCH HEIGHT CONTROL

Control Module

Stock Number..... 053007
Power Input..... 120 VAC. 50/60 Hz, 50VA
Dimensions..... 6 in. High x 8 in. Wide x 18 in. Deep (152mm x 203mm x 457mm)
[allow additional 8 inches (203mm) in longest dimension for cable end connectors]
Weight..... 15 Lb. (6.8 kg)
Arc Voltage Setting Range..... 100-250 VDC
Control Accuracy..... ±2 volts
(equiv.to approximately ±0.025 inches [0.635mm] of arc length)
Environmental Tolerance..... 0-50°C

Fluidic Initial Height Sensing Module

Stock Number..... 053013
Input power..... 120 VAC from THC-1 Control Module
Pressure..... 150 psig. Maximum
Dimensions..... 4½ in. High, 9 in. Wide, 11½ in. Deep
(Including fittings..... 13½ in. Deep)
(114mm x 229mm x 292mm)
(Including fittings..... 343mm Deep)
Weight..... 10 Lb (4.5 kg)

Inductive Initial Height Sensor

Underwater Cutting Option (Stock No. 028162) includes Inductive Initial Height Sensor Module (Stock No. 053012) and Inductive Probe Assembly w/10ft. hose & cables (Stock No. 029044)

Inductive IHS Module:
Input Power..... 120 VAC from THC-1 Control Module
Air Pressure into solenoid valve.. 20 psig regulated shop air
Dimensions..... 4½ in. High, 9 in. Wide, 11½ in. Deep
(Including fittings..... 13½ in. Deep)
(114mm x 229mm x 292mm)
(Including fittings..... 343mm Deep)
Weight..... 13 Lb (6 kg)

Inductive Probe Assembly:
Power and Signal Input/Output... From/To Inductive IHS Module
Pressure into air cylinder-from Inductive IHS Module (20psig)
Cylinder Stroke..... 6 inches (152mm)
Torch Mounting Bracket Shaft Diameter..... 5/8 in. (16mm)
Overall Assembly Clearance Dimensions
(incl. cylinder air fitting)
Probes retracted... 20 in. High x 6½ in. Wide x 8 in. Deep
Probes extended.... 26 in. High x 6½ in. Wide x 8 in. Deep
Probes retracted..... (508mm x 165mm x 203mm)
Probes extended..... (660mm x 165mm x 203mm)
Note: Clearance depth of 8 inches (203mm) includes Water Muffler and its hose fitting.
Weight (Probe Assy Only)..... 6 Lb (2.7 kg)

SPECIFICATIONS Continued

CURRENT RECEIVER/DISPLAY

Enclosed within Control Station, Stock Number.....053010
Power Input(from transmitter)105-125 V.A.C., 50/60 Hz., 5 VA.
Maximum Cable Length to Transmitter.....500 ft. (150 m)
Digital Inputs (measured relative to ground):
Output Current (source capability).....+5 ma.
Open Circuit Voltage
at Strobe, Clock & Data Terminals.....+5 V.D.C.
Potentiometer.....Dual Potentiometer,
1K ohm, 2W. each section
Dimensions,
(Control Station) 2½ in. high x 8-7/8 in. wide x 8½ in. deep
(64 mm x 225mm x 216 mm)
Weight.....3 lb. (1.36 kg)

MANUAL TRANSMITTER

Stock Number.....054002
Power Input..... 105-125 V.A.C., 50/60 Hz., 5 VA.
Input Signal Range .....0 to +64 millivolts
Maximum Input Voltage.....±100 millivolts
(Input voltages measured at shunt connections #120 & #121)
Digital Outputs (measured relative to ground):
Maximum Current into
Strobe, Clock, and Data Terminals.....+10 ma.
Maximum Voltage at
Strobe, Clock, and Data Terminals.....+7 volts
Input-Output Voltage Isolation.....±100 volts
(Measured from shunt connections to output ground)
Measurable Current Range.....0-990 amperes
Maximum Current.....1270 amperes
Accuracy.....±5 amperes
Sample Rate.....Approximately 10/sec.
Environmental Temperature Tolerance.....0° to 50°C
Shunt Specifications:
(A shunt is provided in H-401 & H-601 power supplies)
Maximum Rated Current.....1000 amperes
Output Voltage.....50 mv. @ 1000 amperes
Accuracy.....±0.25%
Dimensions.....4½ in. high x 9 in. wide x 11½ in deep
(108 mm x 229 mm x 292 mm)
Weight.....11¼ lb. (5.11 kg.)

SPECIFICATIONS Continued

Programmable Transmitter

Stock Number.....054008
Digital Input Signals:
Six contact closures to ground required. (seven lines)
Open Circuit Voltage.....+15 V.D.C.
Surge Currents(pull-in)
Less than 10 ma. for 10 to 20 msec.(+15 volts/ 2K ohm)
Hold-in Current.....1.5 ma.(+15 volts/12K ohm)
Control Signal Output to Power Supply
(Measured relative to chassis ground)
Normal Range.....0 to -6 volts
Current Limit.....30 ma.
Controllable Current Range
Hypertherm H-401 Power Supply.....70 to 500 amperes
Hypertherm H-601 Power Supply.....100 to 680 amperes
Resolution-Programmed Input.....20 amperes
Accuracy-Programmed Control.....±20 amperes
[May be trimmed with potentiometer to within accuracy of LED display (±5 amperes)]
Trim Range.....±10% of programmed value
Power Input.....105-125 V.A.C., 50/60 Hz., 12 VA.
Input Signal Range.....0 to +64 millivolts
Maximum Input Voltage.....±100 millivolts
Digital Outputs to Receiver
(Measured relative to ground)
Maximum Current into
Strobe, Clock, & Data Terminals.....+10 ma.
Maximum Voltage at
Strobe, Clock, & Data Terminals.....+7 volts
Input-Output Voltage Isolation.....±100 volts
(Measured from shunt connections to output ground)
Measurable Current Range.....0-990 amperes
Maximum Current.....1270 amperes
Accuracy.....±5 amperes
Sample Rate.....Approximately 10/sec.
Environmental Temperature Tolerance.....0° to 50°C
Shunt Specifications:
(A shunt is provided in H-401 & H-601 power supplies)
Maximum Rated Current.....1000 amperes
Output Voltage.....50 mv. @ 1000 amperes
Accuracy.....±0.25%
Dimensions.....5¼ in. high x 10-3/4 in. wide x 14 in. deep (133 mm x 273 mm x 356 mm)
Weight.....17 lbs. (7.73 kg)

SECTION 4 PREINSTALLATION REQUIREMENTS

To make full use of the features of the THC-1/RVC, sufficient switching functions must be provided in either the N/C software or hardware. These requirements are described below.

MACHINE TRAVEL DELAY:
A means for delaying the start of machine travel for a short duration after arc ignition must be provided. In most cases, this may be done easily with proper N/C software. This function may also be provided in hardware (ie: an adjustable time delay relay), although such an arrangement will require the operator to control one additional function.

The amount of delay time required fits a general rule of one second of delay for each inch (25mm) of workpiece thickness. The delay gives the arc time to penetrate through the workpiece prior to the start of machine movement. In actual practice, the delay period required for material less than $\frac{1}{2}$ inch (12mm) thick is insignificant and may be omitted. However, it is essential to provide the proper delay time on greater thicknesses.

CORNER SLOW-DOWN and CORNER LOCK-OUT:
The N/C Controller should be capable of slowing machine travel speed down while processing small radius corners. This function will reduce the lag angle of the arc, thus insuring square cuts on the corners. Such speed changes can ordinarily be programmed into the N/C software with no difficulty. However, it is also necessary to mark these slow speed events with a contact closure to the THC-1/RVC so that the automatic height control (AVC) can be disabled during the completion of the corner. The N/C controller must therefore have the necessary switching capacity to mark these events.

SWITCHING CONTACTS REQUIRED:

Upper Limit Switch:
A limit switch must be provided on the torch lifter mechanism. This switch should be Normally Closed, opening when the torch reaches the fully raised position.

N/C Controller Activated Switches:

The THC-1/RVC requires five N/C Controller activated switches for the START, STOP, and CORNER functions, and the CONTROL, and ARC mode selections. (The CONTROL and ARC mode selection functions may be handled with toggle switches rather than computer switching if desired.)

Programmable Current Units require the five switches mentioned above, plus six additional switches for the programmed current feature.

Programmable Current/Programmable Voltage Units require a total of nineteen switches: five for the START, STOP, CORNER, CONTROL, and ARC functions, six for the Programmable Current Function, and eight for the Programmable Voltage Function.

These switches may be mechanical relays, D.C. solid state relays, or transistors. Mechanical relays offer the best isolation between the N/C controller and the plasma arc system. D.C. solid state relays of either the opto-isolated or transformer coupled type also offer ground isolation. If ground isolation is deemed unnecessary, transistors may be used.

Mechanical relays with precious metal or welded contacts are preferred. D.C. solid state relays must have a low leakage specification of 100 microamperes or less. Both relays and transistors must be able to handle 8 milliamperes per input at 15 volts.

Transistors should be of the NPN, open collector type. They may be discrete, or in high voltage integrated circuit buffers such as the Texas Instruments SN75462 (30 volts, 300 ma.)

Further switch specifications may be determined from their actual functions as described below.

SWITCH FUNCTIONS:

Function	Logic Input Required and Description of Function
STOP	Normally open. Momentary contact closure to logic ground initiates plasma stop. (approx 100 ms req'd)
START	Normally open. Momentary contact closure to logic ground initiates start function. (approx 100 ms req'd)
CONTROL	Contact closure maintained to logic ground selects automatic mode (enables IHS and AVC functions). If this contact remains open (manual mode), the IHS function will be bypassed and the plasma system will operate without benefit of the automatic height control (AVC). Closure may be made after arc initiation which facilitates manual pierce height setting on heavy plate while still permitting automatic height control.
ARC	Contact closure maintained to logic ground selects automatic mode (arc start enable). If this contact remains open (manual mode), the THC-1/RVC will proceed to the IHS Complete state and hold in that state. Occasionally, the operator may wish to use this hold state to verify proper torch position before permitting arc initiation. If he is satisfied with the torch position, he causes contact closure and plasma start begins.
UPPER LIMIT SWITCH	Located on the torch lifter, this switch is normally closed. It must open when the torch reaches the fully raised position.

HOLD

The hold function synchronizes the plasma start sequence of all THC-1/RVC units in multi-torch installations. It does not require a switch. However, it is convenient to provide a spare terminal at the Controller for hold connections. All hold terminals must be connected to this common point.

The hold terminal for each THC-1 Control Module is at logic state 0 until that module completes the IHS function, at which time it switches to logic 1. All modules must be at logic 1 before any module can proceed to plasma start. If a THC-1 Module is turned off, it will have no influence on other modules. The operator may therefore turn any module off if he does not wish to use its torch for the job at hand

CORNER

Normally open. Contact closure maintained to logic ground selects corner function (Disables AVC.). This feature prevents the torch from diving into the workpiece during cornering due to the abnormally low arc voltage produced by slowing the travel speed.

LOGIC GROUND

The logic ground connections of all THC-1 Control Modules must be connected together. This terminal point is also the other pole of the switches required above. Note, however, that each Control Module requires its own set of switch contacts. Do not attempt to operate identical functions of different modules with only one switch contact.

ADDITIONAL SWITCH REQUIREMENTS FOR PROGRAMMED CURRENT FEATURE

The input connections for programming the current setting consist of one Common Line (Logic Ground) and six Current Select Lines. A current value is selected by connecting the appropriate Current Select Lines to the Common Line (Logic Ground).

Six N/C controlled switches are required to permit selection of all combinations. The protocol for the programmed current function is further described in Section 7, page 23.

ADDITIONAL SWITCH REQUIREMENTS FOR PROGRAMMED VOLTAGE FEATURE

The input connections for programming the voltage setting consist of one Common Line (Logic Ground) and seven Voltage Select Lines. A voltage value is selected by connecting the appropriate Voltage Select Lines to the Common Line (Logic Ground).

In addition, it is necessary to select the Programmed Voltage Function by connecting the Programmed Voltage Select Line to Logic Ground. Eight N/C controlled switches are required to permit selection of all combinations. The protocol for the programmed voltage function is further described on page 24.

INDUCTIVE INITIAL HEIGHT SENSING

THC-1/RVC Units equipped with the Inductive Initial Height Sensing Feature (Underwater Cutting) require that shop air be supplied, regulated to 20 psig. (1.4 bar). This air supply is used for operation of the Probe Extending Cylinder. The air source should be connected to the Inductive IHS Module Inlet Connection. In addition, a user supplied $\frac{1}{4}$" (6mm) I.D. hose must be provided between the IHS Module Outlet Connection to the air cyclinder. A #4 JIC adapter is furnished with the Probe Assembly.

SECTION 5 INSTALLATION

UNPACKING AND INCOMING INSPECTION

Calibration, extensive testing, and careful inspection are performed on the THC-1/RVC components prior to shipment. All units are shipped in verified operating condition. Carefully inspect each unit for posssible damage sustained in shipment. If damage is found, notify the carrier and Hypertherm immediately. It is important to retain the shipping container and the packing material for examination by the carrier in order to place a claim for shipping damages. If return of any components to Hypertherm is required, refer to Section 8, page 29, "Return Shipments".

PHYSICAL LOCATION OF COMPONENTS

Control Module

The THC-1/RVC Control Module should be installed at a position where the operator can view the status lights on its front panel. In multiple torch installations, the Modules may be stacked at a position within the operator's view. This will enable him to identify command blockages and quickly determine the cause of any problems.

Refer to Figure 13, page 51 for Control Module mounting dimensions. Note that only three pre-tapped (8-32) holes are to be used in mounting this unit.

Control Station

The Control Station contains the Current Display LED and the Voltage and Current adjusting controls. It must therefore be within the immediate reach of the operator. Locate this Module directly on the contouring machine control panel.

Voltage Divider

The Voltage Divider, Figure 7, page 45, Should be installed in the PAC-500 Plasma Console. It should be placed on the floor of the console on the side where the Cathode Block is located. See Figure 17, page 55 for the proper location.

IHS Module

Either Fluidic or Inductive IHS Modules should be mounted near the plasma console for convenient hookup. This is especially true of the Fluidic Type module because it includes a hose of 30 inch (762mm) length which must be connected to the torch connection side of the plasma console. Be sure to check that this connection can be made before fastening down the IHS module. Refer to Figure 16, page 54 for the correct mounting dimensions.

Inductive Probe Assembly

The Inductive Probe Assembly includes a Torch Mounting Bracket. The bracket mounting shaft is 5/8 inch in diameter (16mm). The bracket (and entire assembly) should be installed on the torch station of the contouring machine. The plasma torch may then be installed in the bracket. Initially, the torch should be installed as high as possible in the torch bracket without making contact between the stainless steel torch body and the bracket. Final adjustment of torch position is described in the Initial Checkout Procedure at the end of this section (page 15, step 20).

ELECTRICAL HOOKUP

Ten wires and/or cables are required to interconnect the THC-1/RVC components and the shape contouring machine. The necessary connections are indicated in Figures 18 and 19, pages 56 and 57. These cables are listed below along with a recommendation for the type cable or conductor size to be used.

	CABLE OR WIRE NAME	RECOMMENDED TYPE	DESCRIPTION OF TYPE
	Control Module to N/C Controller	Belden 8778FR	22 AWG., Six Pairs
	Control Module to IHS Module	Belden 8778FR	22 AWG., Six Pairs
	IHS Module to Plasma Console	Belden 8778FR	22 AWG., Six Pairs
	Control Module to Control Station	Belden 8778FR	22 AWG., Six Pairs
	Control Station to Transmitter	Belden 8778FR	22 AWG., Six Pairs
*	Transmitter to N/C Controller	Belden 8778FR	22 AWG., Six Pairs
	Transmitter to Shunt	(Provided inside xmtr enclosure)	
**	Transmitter to Power Supply	Belden 8465FR	18 AWG. 5 Conductors
	Cntrl Module to Torch Lifter Motor	Belden 8465FR	18 AWG. 5 Conductors
	Voltage Divider to Star Ground	Stranded Copper Wire, 18 AWG.	
	Control Module to Star Ground	Stranded Copper Wire, 18 AWG.	

AWG. is American Wire Guage (diameter).
18 AWG.= 0.040in. (1.016mm), 22 AWG.= 0.025in. (0.635mm.)

* Required for Programmable Current Units only.
** Two cables required if two power supplies are to be connected in parallel

Belden Type 8778FR cable has six pairs of 18 AWG.conductors. Each pair has a shield wire for grounding purposes and a metalic foil wrap around each pair and its ground wire.

```
////////////////////////////// GROUNDING ////////////////////////////////////
//                                                                        //
// The THC-1/RVC is a high gain electrical sensing device and requires//
// specific grounding procedures to avoid response of the device to   //
// stray electrical noise.  Note that the Voltage Divider Ground      //
// Terminal and the Control Module Ground Stud (on rear panel) MUST   //
// be connected directly to a point, referred to as the Star Ground,  //
// on the Water Table.  Reliance on other grounding points invariably //
// leads to erratic operation due to pick up of stray voltages or to  //
// loss of signal through wheel bearings and such.                    //
//                                                                        //
////////////////////////////////////////////////////////////////////////////
```

Initial Height Sensing Module

Refer to Figure 18, page 56 for connections to the Fluidic Type IHS Module (Stock No.053013). Connections for the Inductive IHS Module (Stock Number 053012) are shown in Figure 25, page 63. This figure also shows the proper connections for the Inductive Probe Assembly. Assemble two cables using the 3 pin plugs provided. The plugs may then be inserted into the mating plugs provided on the Probe Assembly. A supply of shop air regulated to 20psig. (1.4 bar) must be provided for the Inductive IHS Module. Connect this air supply to the fitting labelled "INLET." Connect the Probe Assembly Air Cylinder to the fitting labelled "OUTLET."

Power Supply

When making connections to the power supply, a jumper located on power supply Terminal Strip 1T, must be removed from 1T-M and 1T-N and reinstalled on 1TL and 1T-M.

Simultaneous control of two power supplies connected in parallel is possible only with the Manual Current Control Transmitter Module. While it is possible to operate two power supplies in parallel with the Programmable Current Transmitter Module, the second power supply must be set manually.

INITIAL SYSTEM CHECKOUT

After all wiring has been completed, the system may be checked for proper operation as follows:

1. Insert the following parts into the plasma torch.
   a. Electrode Stock No. 020038
   b. Swirl Ring Stock No. 020039
   c. Nozzle .166 Stock No. 020035

2. Place a piece of scrap metal plate under the torch to be used for test cuts. It should be $\frac{1}{4}$ to $\frac{1}{2}$ inch (6mm to 13mm) thick.

3. Place Plasma TEST/RUN Switch in TEST position.

4. Turn on gas supply and adjust to 150 psig. (10.3 bar)

5. If the THC-I/RVC is equipped with the Programmable Current Feature, place the PROGRAM/MANUAL Switch, located on the Transmitter, in the MANUAL Position.

6. Turn plasma power supply ON.

7. Turn Chiller Pump or Water Supply Pump ON.

8. Adjust water supply pressure to 185 psig. (12.8 bar).

9. Turn ON 120 VAC Power to THC-1/RVC Unit.

10. Select MANUAL CONTROL Mode.

11. Select AUTO ARC Mode.

12. Operate Manual UP/DOWN Switch to verify movement of torch in proper direction.

    VERIFY THAT NO PERSONNEL ARE IN THE VICINITY OF THE PLASMA TORCH OR IN THE PATH OF MACHINE MOVEMENT.

13. Depress START Switch.
    Gas and water should now be flowing out of the torch.
    adjust the gas flowmeter to a setting of 45% of scale and the water flowmeter to a setting of 75% of scale.

--- CAUTION ---

Because the TEST/RUN Switch is in TEST position, no arc will strike. However, due to the way the plasma circuit is designed, after a 5 second preflow period, the plasma console will send an ARC ON Signal to the shape contouring machine and machine motion will begin unless the manufacturer has deliberately eliminated this condition.

14. If THC-1/RVC unit is equipped with Inductive (Underwater) IHS, skip to step 15. If equipped with standard Fluidic IHS, continue this step.

    With the gas and water continuing to flow, loosen the hose fitting at the IHS module and allow water to flow until all air is expelled from the hose; then retighten fitting.

15. Depress the STOP Switch to terminate the TEST sequence.

16. Select AUTO CONTROL Mode.
    The torch should now retract to the full up position.
    (unless it is already in that position.)

17. Select MANUAL ARC Mode.

18. If the THC-1/RVC Unit is equipped with Inductive IHS, adjust the gas pressure to the probe assembly air cylinder to 20 psig. (1.4 bar).

19. Depress the START switch.

    If the Fluidic IHS is used, Gas will now flow from the torch. Water will not spray from the torch except for the small residual amount remaining in the nozzle. If Inductive IHS is used, the air cylinder will extend the two inductive probes downward. With either system, after a four second delay, the torch will begin to move downward.

20. The torch should stop approximately 3/8 of an inch (10mm) above the workpiece. The THC-1/RVC will now remain in the IHS Complete state as indicated by the LED indicator on the THC-1/RVC Control Module. At this time, if the Inductive IHS is in use, the torch should be adjusted in its bracket to provide a standoff (torch to work distance) of 3/8 inch (10mm).

    If the torch strikes the workpiece, depress the STOP Switch. This will cause the torch to retract to the full up position. If this occurs with the Fluidic IHS, refer to Section 8, Troubleshooting, page 25 to remedy this problem. If this occurs with the Inductive IHS, reposition the torch in the torch bracket.

21. Set machine travel speed or feed rate at 100 ipm (2540 mm/min).

22. Set the voltage thumbwheel switch, on THC-1/RVC Control Station, to 155 volts

23. Using the potentiometer on the front panel of the Control Station, set the power supply for an output of 400 amperes. This will be a dial setting of approximately 60 for an H-401 power supply or 35 for an H-601 power supply. A final adjustment of arc current may be made after arc ignition.

--- CAUTION ---

Before proceeding, you must be familiar with the operation and safety requirements described in the plasma arc cutting system instruction manual (IM25, IM-37, or IM-46). Do not proceed until all safety requirements have been met.

24. Place the Plasma TEST/RUN Switch in the RUN position.

    VERIFY THAT NO PERSONNEL ARE IN THE VICINITY OF THE PLASMA TORCH OR IN THE PATH OF MACHINE MOVEMENT.

25. Select AUTO ARC Mode.
    Gas and water will begin to flow from the torch and after 5 seconds, the arc will strike.

26. Observe the LED indicators on the THC-1/RVC Control Module. One half second after arc ignition, the AVC-ON LED should light. The UP/ DOWN LED indicators will flash as variations in workpiece elevation are encountered.

    Stop the cutting operation by depressing the STOP Switch, or by allowing the torch to run off the edge of the workpiece.

    If the THC-1/RVC is equipped with the Manual only Current Control Feature, it is now ready for routine use if proper operation has been obtained.

    THC-1/RVC Units equipped with the Programmable Current Feature require field calibration described in the next section.

SECTION 6 CALIBRATION PROCEDURE FOR PROGRAMMABLE CURRENT CONTROL TRANSMITTER

The current programmer circuit is not a closed loop circuit. Because of this, each transmitter must be calibrated to match the characteristics of the power supply used. If the power supply control p.c. board or other significant components are replaced, the transmitter should be recalibrated. This procedure is not required for the Manual Type Current Transmitter

NOTE: Numbers without () are for H-601 power supplies.
Numbers inside () are for H-401 power supplies.

a. Place the MANUAL/PROGRAM switch, located on the transmitter enclosure, in the PROGRAM position.

b. Insert torch components into torch as listed:
   1. Electrode, Stock No. 020038
   2. Swirl Ring, Stock No. 020039
   3. Nozzle .187 Stock No. 020036 or
      (Nozzle .166 Stock No. 020035)

c. Set potentiometer, located on Control Station front panel, to 50% of scale.

d. Select a current setting of 500 (300) amperes with the computer control.

e. Set voltage thumbwheel on Control Station front panel at 170 volts.

f. Place plasma TEST/RUN switch in TEST position.

g. Press plasma START button and adjust gas and water flowmeters to 45% and 75%, respectively.

h. Press plasma STOP button.

i. Select AUTO CONTROL Mode

j. Position torch over workpiece. (Use a scrap piece of plate approximately ½ inch thick (12mm.)

k. Press plasma START button.

l. Adjust SLOPE potentiometer, located on current programmer board in transmitter, to obtain 500 (300) amperes on the LED display at the receiver.

m. Check current range available by varying the setting of the current setting potentiometer (located on Control Station). The correct range is 450±10 amperes to 550±10 amperes, (270±10 amperes to 330±10 amperes).

n. Reset the current setting potentiometer to obtain the programmed value, 500 (300) amperes as indicated on the LED display at the receiver.

o. WITHOUT CHANGING THE POTENTIOMETER SETTING, reprogram the computer for 300 (200) amperes and make a cut. The current obtained should be within ±10 amperes of the programmed value.

p. Repeat the previous step using a programmed value of 600 (400) amperes. Again, the result should be within ±10 amperes.

q. If errors observed in steps o. and p. exceed ±30 amperes, repeat the calibration procedure. Contact Hypertherm if linearity can not be obtained. (tel: 603-643-3441)

Normal operation should provide output within ±20 amperes of the programmed value. The current setting potentiometer should provide adjustment within 10% of programmed value.

Operating range of the H-601 power supply is 100 to 680 amperes.
Operating range of the H-401 power supply is 70 to 500 amperes.

SECTION 7 OPERATING PROCEDURES

SEQUENCE OF OPERATION: Prior to starting a cut, the operator must place an electrode and the proper swirl ring and nozzle into the torch as determined from the Operating Data Tables, pages 30 to 36. He should then set the following parameters:

Gas Flow Rate
Injection Water Flow Rate
Arc Current
Arc Voltage
Machine Travel Speed/Feed Rate
Travel Delay Time [1 second/inch (25mm) of workpiece thickness]

Some or all of the last four parameters may be programmed into the N/C software depending upon system configuration.

The cutting sequence is begun by a start command from the N/C Controller. This signal begins the Initial Height Sensing (IHS) sequence. With the Fluidic IHS Module, Gas begins flowing from the torch and, after a four second delay, the torch moves downward toward the workpiece. When the torch approaches within about $\frac{1}{4}$ inch (6mm) of the workpiece, it detects an increase in the gas pressure within the nozzle, stops the downward movement, and retracts the torch to a height of about 3/8 inch (10mm). The IHS Complete LED indicator lights at this time, and a start signal is automatically transmitted to the Plasma Console.

When the Inductive IHS system is used, there is no flow of gas from the torch during the IHS sequence. Instead, the Inductive probes are extended downward by the air cylinder to be approximately even with the end of the torch. After the workpiece is detected, the Probes automatically retract. This completes the IHS sequence and a start signal is transmitted to the Plasma Console.

In multiple torch installations, the start signal will be inhibited by the HOLD function until all THC-1/RVC units have completed the IHS sequence.

Torch ignition occurs five seconds after the IHS Complete state has occurred. The Plasma Console includes a multiple torch ignition synchronizing circuit which causes all torches to receive a high frequency starting pulse simultaneously. Arc ignition generates an ARC-ON signal from the plasma console which is used to initiate machine movement and Arc Voltage Control (AVC). AVC is accomplished in the THC-1/RVC Control Module which causes the torch lifter motor to adjust torch height up or down. The resulting adjustment of arc length matches the arc voltage to the reference voltage preset on the THC-1/RVC Voltage Thumbwheel Switch or N/C programmed reference voltage. The AVC function begins $\frac{1}{2}$ second after the ARC-ON signal is received. This delay permits establishment of a stable arc before automatic adjustment of torch height begins.

The cutting operation is terminated by a stop command when the operator depresses a STOP switch or by a similar stop signal generated by the N/C Controller. If no stop command is generated, the plasma system will stop when there is no material remaining under the torch, such as at the edge of a workpiece. Each time the arc is extinguished, the THC-1/RVC automatically raises the torch to the fully raised position to facilitate rapid traverse to the next piercing position without danger of torch collision with up-ended cut parts.

SPECIAL PERFORMANCE FEATURES OF THE THC-1/RVC:
The THC-1/RVC is capable of maintaining the torch height within ±.025 inch (0.635mm). Such performance requires a high degree of sophistication in the design of logic circuits used to process the raw arc voltage signal. The high level of electrical noise in the arc must be eliminated and the height control unit must not react to common disturbances in arc voltage such as caused by crossing previous cuts. In addition, it is necessary to prevent the torch from diving into the work as a result of arc voltage changes encountered when cutting through to the edge of the workpiece or when slowing travel speed during cornering.

The THC-1/RVC avoids these difficulties with appropriate logic circuits to discriminate between voltage changes due to workpiece elevation variations and voltage excursions due to momentary changes in the cutting operation. The CORNER function disables the AVC operation when corners are being cut at slower speeds. The slow speeds result in an increase in arc voltage which would cause the torch to dive into the workpiece if height adjustments were not inhibited. Operation of the CORNER function requires that a contact closure, provided by the N/C Controller, be maintained to the THC-1/RVC for the duration of each corner cutting operation.

It is worth stating again, the importance of using the proper grounding procedures as mentioned on page 13. Improper response of the THC-1/RVC Unit is almost invariably related to incorrect ground connections.

Input Functions: Under ordinary circumstances the THC-1/RVC should be used with the CONTROL and ARC Modes in AUTOMATIC. This will enable use of all THC-1/RVC functions as described above.

Some circumstances will make it desirable to defeat the IHS, AVC, or the Automatic Plasma Start functions to accomplish the task at hand. Understanding the functions of the N/C inputs to the THC-1/RVC will aid in obtaining the desired operation. These functions are described on the next page.

Function of N/C Inputs

CONTROL:
This input has an AUTO (automatic) and a MAN (manual) State.

In AUTO, a start command from either the N/C Controller or a START Switch will initiate the IHS function. It will also enable the AVC function to operate after plasma ignition and allow automatic torch retract after the arc is extinguished.

In MAN, both the IHS and AVC functions are defeated as is the torch retract function. A start signal from either the N/C Controller or a START Switch will cause the plasma console to begin its start sequence without going through the IHS step. After ARC ignition, AVC will not operate.

ARC:
This input has an AUTO (automatic) and a MAN (manual) State.

In AUTO, the plasma start sequence will occur after completion of IHS, if the CONTROL input is also in AUTO State, or immediately following the operator or controller generated start signal, if CONTROL is in the MAN State.

In MAN, starting of the plasma system is inhibited by any means. (Unless a separate start circuit has been connected directly to the plasma console.)

START:
This input will initiate the IHS function, followed by the Plasma Start Sequence, if CONTROL is in the AUTO State. If CONTROL is in the MAN State, START will initiate the Plasma Start Sequence without first going through the IHS sequence. However, in either of these cases, the Plasma Start Sequence will not occur unless (or until) the ARC input is in AUTO State.

STOP:
An N/C (or mechanical switch) STOP input to the THC-1/RVC will cause termination of all THC-1/RVC and Plasma System functions and if the CONTROL Switch is in AUTO position, will cause the torch to retract. STOP is effective during all system sequences, ie: during IHS and while the plasma arc is on.

USE OF SWITCHES TO MODIFY THC-1 OPERATION:

Heavy Plate:

On some applications, it may be desirable to eliminate or delay the IHS, AVC, or Plasma Start functions. Most commonly this will be when cutting heavy plate over two inches (50mm) thick. Piercing of this thickness is not recommended. It is therefore desirable to manually set the torch height for starting at the edge of the workpiece. This may be done by selecting the MAN CONTROL State and using the UP/DOWN switch (provided by the contouring machine manufacturer) to set torch height.

In the above situation, AVC will not operate. However, after the plasma arc is initiated, the CONTROL may be reset to the AUTO State to obtain AVC. Also note that when cutting at the slow speeds required for plate over two inches (50mm) thick, the THC-1/RVC may not be able to discriminate between previous cuts and changes in workpiece elevation, so it will be necessary to reset CONTROL in the MAN State while crossing a previous cut to prevent the torch from diving into the work.

Note: If plate between 1 and 2 inches (25mm - 50mm) thick is frequently cut, it may be desirable to permanently increase the pierce height obtained with the IHS sequence. Refer to Section 8, page 26, to see how this may be accomplished.

Delayed Arc Start:

Occasionally it is desireable to delay the plasma starting sequence until the torch piercing point can be observed for correct positioning. This may be done easily by selecting the ARC MAN State. The IHS sequence may then be allowed to proceed and the THC-1/RVC will remain in the IHS Complete state without starting the plasma system until the operator resets the ARC State to AUTO.

Elimination of Torch Retract Function:

Sometimes when many small pieces are to be cut in a small area, it is desirable to eliminate torch retract and IHS to save time. This may be done by setting CONTROL in the MAN State during the first cut. This will set the torch at the precise height required and keep it there until the CONTROL returned to the AUTO State. However, it should be remembered that AVC will not be operating with CONTROL in the MAN State, so if their are any variations in workpiece height, torch standoff distance will not be automatically adjusted. For this reason, this mode of operation should be limited to operations confined to a small area. It may be convenient to return CONTROL to the AUTO State for just a few seconds, while the arc is on, after a few cuts, in order to automatically readjust for variations in plate elevation.

Cutting with Large Nozzles:

When the .220 or .250 nozzles are in use, the IHS function should not be used. These nozzles do not provide reliable IHS operation and in most cases, they are used for materials of greater than two inches thick for which piercing is not recommended. The AVC function will work with all nozzles, however, and may be used by resetting CONTROL in AUTO State after arc ignition, keeping in mind that on thick materials, AVC should be turned off when crossing previous cuts.

PROTOCOL FOR PROGRAMMED CURRENT FUNCTION

The input connections for programming the current setting consist of one Common Line and six Current Select Lines. The Current Select lines are divided into two decades (hundreds and tens) of three lines each. Binary Coded Decimal (BCD) format is used with three (Hundreds Decade) lines called 400, 200, and 100, and three (Tens Decade) lines called 80, 40, and 20.

A current value is selected by connecting the appropriate Current Select Lines to the Common Line. Do not connect the Common Line to earth or computer chassis ground. It is already connected to chassis ground in the Current Control. Additional grounds may create ground loops.

To set a current value, select those lines which, when numerically added, sum to the desired value; eg: 560 amperes = (400 + 100) + (40 + 20). Lines 400, 100, 40, and 20 are all connected to the common line.

Illegal Codes: Do not select the combinations (80,40,20),(80,40), or (80,20). These are illegal BCD codes. These combinations may be avoided by selecting the 100 Line and an appropriate Decade Line. A list of all possible legal codes is given below.

CURRENT SELECT CODES
for Programmable Current Control

1 = select
0 = not select

CURRENT Amperes	HUNDREDS DECADE 400	200	100	TENS DECADE 80	40	20
100	0	0	1	0	0	0
120	0	0	1	0	0	1
140	0	0	1	0	1	0
160	0	0	1	0	1	1
180	0	0	1	1	0	0
200	0	1	0	0	0	0
220	0	1	0	0	0	1
240	0	1	0	0	1	0
260	0	1	0	0	1	1
280	0	1	0	1	0	0
300	0	1	1	0	0	0
320	0	1	1	0	0	1
340	0	1	1	0	1	0
360	0	1	1	0	1	1
380	0	1	1	1	0	0
400	1	0	0	0	0	0
420	1	0	0	0	0	1
440	1	0	0	0	1	0
460	1	0	0	0	1	1
480	1	0	0	1	0	0
500	1	0	1	0	0	0
520	1	0	1	0	0	1
540	1	0	1	0	1	0
560	1	0	1	0	1	1
580	1	0	1	1	0	0
600	1	1	0	0	0	0
620	1	1	0	0	0	1
640	1	1	0	0	1	0
660	1	1	0	0	1	1
680	1	1	0	1	0	0

ILLEGAL CODES

Do not use the following decade code combinations:
(80 + 20)
(80 + 40)
(80 + 40 + 20)

PROTOCOL FOR PROGRAMMED VOLTAGE FUNCTION

When the programmed voltage feature is used, a voltage value is selected by connecting the appropriate Voltage Select Lines to the Common Line (Logic Ground) by means of switches (relays, transistors, etc.) in the N/C Controller. Note that a line called Program Voltage must also be connected to Logic Ground to enable this function. (See Figure 19, page 57) Do not connect the Logic Ground Line to earth or Controller chassis ground. It is already connected to chassis ground in the THC-1 Control Module. Additional grounds may create ground loops.

The Voltage Select Lines are divided into three decades (Hundreds Decade, Tens Decade, and Ones Decade). Binary Coded Decimal (BCD) format is used with two (Hundreds Decade) lines called 200 and 100, four (Tens Decade) lines called 80, 40, 20, and 10, and one (Ones Decade) line called 5.

To set a voltage value, select those lines which, when numerically added, sum to the desired value; eg: 145 volts = 100 + 40 + 5. Lines 100, 40, and 5 are all connected to Logic Ground. The Program Voltage Line must also be connected to Logic Ground.

Illegal Codes: Do not select the combinations (80 + 40 + 20), (80 + 40) or (80 + 20). These are illegal BCD codes. These combinations may be avoided by selecting the 100 Line and an appropriate Decade Line. Also do not select codes for voltages above the maximum of 250 volts or below the minimum of 100 volts. A list of all possible legal codes is given below:

VOLTAGE SELECT CODES

1 = select
0 = not select

VOLTAGE	HUNDREDS DECADE		TENS DECADE				ONES DECADE	PROGRAMMED VOLTAGE SELECT LINE
	200	100	80	40	20	10	5	
100	0	1	0	0	0	0	0	1
105	0	1	0	0	0	0	1	1
110	0	1	0	0	0	1	0	1
115	0	1	0	0	0	1	1	1
120	0	1	0	0	1	0	0	1
125	0	1	0	0	1	0	1	1
130	0	1	0	0	1	1	0	1
135	0	1	0	0	1	1	1	1
140	0	1	0	1	0	0	0	1
145	0	1	0	1	0	0	1	1
150	0	1	0	1	0	1	0	1
155	0	1	0	1	0	1	1	1
160	0	1	0	1	1	0	0	1
165	0	1	0	1	1	0	1	1
170	0	1	0	1	1	1	0	1
175	0	1	0	1	1	1	1	1
180	0	1	1	0	0	0	0	1
185	0	1	1	0	0	0	1	1
190	0	1	1	0	0	1	0	1
195	0	1	1	0	0	1	1	1
200	1	0	0	0	0	0	0	1
205	1	0	0	0	0	0	1	1
210	1	0	0	0	0	1	0	1
215	1	0	0	0	0	1	1	1
220	1	0	0	0	1	0	0	1
225	1	0	0	0	1	0	1	1
230	1	0	0	0	1	1	0	1
235	1	0	0	0	1	1	1	1
240	1	0	0	1	0	0	0	1
245	1	0	0	1	0	0	1	1
250	1	0	0	1	0	1	0	1

SECTION 8 TROUBLESHOOTING

The THC-1/RVC unit is tested under extreme operating conditions and is carefully inspected before shipment. Every unit leaves the factory in good operating condition. If difficulties are encountered upon installation, wiring errors should be the first place to look for the cause of difficulty. Other causes are of course possible. The common causes of difficulty are listed below for use if checks on wiring do not locate the cause.

INITIAL HEIGHT SENSOR (IHS) MALFUNCTIONS:

A. TORCH DOES NOT MOVE DOWNWARD TO PIERCING POSITION. READY LED INDICATOR DOES NOT LIGHT.

1. Upper limit switch on torch lifter is misadjusted or malfunctioning. It should be normally closed and should open when torch reaches full up position.

B. TORCH MOVES DOWNWARD AND STRIKES WORKPIECE
(The following eight points apply to the Fluidic IHS Only.)

1. Insufficient nitrogen pressure at plasma console. Pressure must be 150psig. (10.3 bar) while gas is flowing.

2. Dirty or damaged swirl ring or nozzle. Excessive O-ring grease in nozzle or swirl ring openings. (Never use a cracked swirl ring as it may interfere with IHS operation, and could result in irreparable arc damage to torch.)

3. Air entrapped in IHS hose. Remove air by operating plasma system in TEST mode (injection water flowing) with the fitting loosened at the IHS Module. When all air is expelled, tighten fitting. Note: Loose fittings or damaged hose may allow air into IHS hose.

4. Do not use IHS feature when using .220 or .250 nozzles. These nozzles do not produce reliable IHS performance.

5. Make certain proper swirl ring is in use. Only swirl ring stock numbers 020039 or 020042 (ccw) should be used.

6. No power to IHS Module circuit board. Check LED D4 on the board. It should remain lighted during the IHS sequence. If it does not, check relays 1 CR in the IHS Module and 1CRE in the THC-1 Control Module for proper operation.

7. Faulty Pressure Transducer. Turn the THC-1/RVC power off and replace transducer. Note: The transducer and guage protector should be handled as one unit and NOT disassembled. It is filled with oil at the factory using special procedures. Field disassembly will cause it to be inoperable.

8. Faulty IHS circuit board. If the above steps do not correct the problem, replace the IHS circuit board.

C. INSUFFICIENT PIERCE HEIGHT.

The THC-1/RVC is factory adjusted to provide a piercing height of approximately 3/8 inch (10mm). This height should be sufficient for piercing operations on plate up through 1 inch (25mm) thick. Piercing of thicker plate may require increased pierce height. If such operations are only done occasionally, increased height may be obtained with manual operation of the THC-1/RVC (See page 16).

If heavy plate is cut on a frequent basis, the pierce height may be adjusted to a higher setting. This adjustment is made by increasing the retract time following the sensing of plate position. Potentiometer R8 located on the Digital Circuit Board in the THC-1/RVC Control Module controls the retract time. To obtain a higher pierce height, increase the time interval. This must be done on a trial and error basis making only small adjustments to R8. Refer to Figure 27, page 65 to identify the R8 potentiometer and to determine the correct direction of adjustment.

Note: The above applies to Fluidic IHS Units only. Pierce Height on Inductive IHS Units may be adjusted by sliding the torch up or down in the torch bracket. Do not permit the bracket to make contact with the stainless steel torch body.

ARC VOLTAGE CONTROL MALFUNCTIONS

A. TORCH DIVES INTO WORKPIECE DURING CUTTING OR TORCH HEIGHT DRIFTS ERRATICALLY

1. Voltage set too low on Thumbwheel Switch. Refer to Operating Data Tables I through V, pages 31 through 35. It may be necessary to increase these voltage settings slightly (+5 volts).

2. Inadequate ground connections. The Ground Terminal on the Voltage Divider and the Ground Stud at the rear of the THC-1/RVC Control Module must both be connected directly to a Star Ground located on the Water Table (cutting bed). Grounding through the frame of the contouring machine is unreliable. It is also essential to prevent ground loops which can easily produce small voltages to which the THC-1/RVC will respond. Direct connection of the above mentioned two points to the Star Ground is the only way to eliminate all possibility of ground loops.

3. R12 Resistor or D1 Zener Diode burned out. (See photo: THC-1/RVC Card Enclosure Detail, Figure 11, page 49.) R12 serves as a fuse to protect D1 (provides faster fuse action than an actual fuse). D1 is the signal input point from the Voltage Divider to the THC-1/RVC Control Module. If R12 is burned out, D1 may also be damaged. The most likely causes of R12/D1 failure are reversed polarity connections at the Voltage Divider or incorrect wiring of Terminal Strip 1TB in the THC-1/RVC Control Module . A defective Voltage Divider may also cause failure of these components, but is unlikely.

4. Defective Voltage Divider. The Voltage Divider reduces the arc voltage by a ratio of 25:1. It may be checked by energizing the Plasma Power Supply and measuring the Divider output. At the power supply open circuit voltage of 400 VDC, the Divider Output should be approximately 16 VDC. This measurement may be made with a voltmeter connected between the Signal and Ground Terminals of the Voltage Divider. Use caution as the high frequency start pulse may destroy your meter if care is not used. Place the CONTROL Switch in MAN position and the ARC Switch in AUTO position. The Plasma TEST/RUN Switch should be in RUN position. Depress START and take the reading quickly before the High Frequency Generator is energized. The H.F. Generator comes on five seconds after you press START. Take your reading and press STOP, before it comes on, to protect the meter.

--- CAUTION ---

High Voltage is present on the white wire protruding from the Voltage Divider Case and in various parts of the plasma console including the large brass Cathode Block. Use care not to touch these components as fatal electric shock may result.

B. UP/DOWN LIGHTS FLASH, BUT TORCH DOES NOT MOVE UP OR DOWN

1. Torch lifter motor defective or incorrectly wired.

2. Relays 4 CRE or 5 CRE defective. These relays have a built-in LED indicator which lights when the relay is energized. This light does not indicate that the relay is actually closing. Check for relay closure using a voltmeter with a load connected to the relay.

REPLACEMENT OF DIGITAL AND ANALOG CIRCUIT BOARDS

The THC-1/RVC Control Module is shipped with both Digital and Analog Boards installed. To change these boards, proceed as follows.

--- CAUTION ---

Circuit components on the boards are static sensitive. Avoid contact with the conductive areas and terminals on the boards. Always install conductive jumper bars across the board terminal connections if the boards are left out of the unit.

Spare jumper bars are provided on the inside of the circuit board access panel

1. Turn power OFF.

2. Remove access Cover Plate. (Two No. 8 thumbscrews)

3. Loosen retaining screw on circuit board enclosure.

4. Pull board enclosure straight out.

5. When inserting replacement board, be sure that you are inserting the correct board in the correct slot. See Figure 10, page 48. Also be certain board is oriented correctly (retaining screw at bottom).

   Viewed from the rear of the THC-1/RVC Control Module, the Digital Board is on the Left, Analog Board on the Right.

   The board receptacles are keyed to accept only the correct board. Insertion of the incorrect board with excessive pressure will damage the receptacle.

6. After board is properly seated, tighten retaining screw, replace access cover and tighten two thumbscrews.

RETURN SHIPMENTS

In the event that it becomes necessary to return materials to Hypertherm, please follow the instructions below. Adherence to these instructions insures prompt and correct handling of your request and avoids loss of your material.

Do not return any material to Hypertherm without first obtaining a Return Goods Authorization Number (RGA #). No shipments are accepted without prior authorization. Contact your supplier to obtain an RGA # and shipping instructions.

To obtain a return authorization, the following information is required:

1. Stock Number
2. Serial Number - If component does not have a serial number, use the serial number of the unit from which it was removed.
3. Date of Delivery
4. Nature of damage or failure or other reason for return - BE SPECIFIC ABOUT DETAILS

REPACKAGING FOR RETURN SHIPMENTS

1. Before packing, attach a tag to the component showing the owner's name, service or repair required, serial number, and RGA #.

2. Do not ship circuit boards without first installing conductive jumper bars across the terminals. Spare jumper bars are attached to the rear access panel of the THC-1/RVC Control Module. Avoid touching the conductive areas of the boards, as they are static sensitive.

3. Place boards in conductive shipping bags.

4. Pack all materials securely. Damage incurred in shipping due to improper packing is the customer's loss.

SECTION 9 OPERATING DATA TABLES

TABLE I

Operating Data for Mild Steel

Material Thickness Inches	mm	Nozzle and Swirl-ring Size Inches	Gas Type and Flowmeter Setting %	Injection Water Flow Setting %	Torch to Work Distance Inches	mm	Arc Voltage Setting Volts	Arc Current Setting Amperes	Travel Speed ipm	mm/min
.035	1				1/8	3	125	250	450	11430
.075	2	.120	N_2 30	85	1/8	3	130	250	300	7620
1/8	3				3/16	5	135	260	200	5080
1/4	6	Maximum current for this nozzle is 260 amp.			1/4	6	145	260	150	3810
1/8	3				1/4	6	140	300	200	5080
1/4	6	.166	N_2 45	75	1/4	6	145	350	150	3810
3/8	10				1/4	6	150	380	125	3175
1/2	13	Maximum current for this nozzle is 400 amp.			1/4	6	155	400	100	2540
1/2	13				3/8	10	160	500	115	2920
3/4	19	.187	N_2 45	75	3/8	10	165	500	75	1905
1	25				3/8	10	165	600	60	1525
1 1/4	32	Maximum current for this nozzle is 600 amp.			3/8	10	175	600	45	1145
1 1/4	32				1/2	13	185	700	50	1270
1 1/2	38	.220	N_2 70	100	1/2	13	195	700	40	1015
1 3/4	44				1/2	13	200	725	35	890
2	50	Maximum current for this nozzle is 750 amp.			1/2	13	205	725	30	760

Use the brass tapered retaining cap stock no. 020034 above 400 amperes.

To obtain optimum cut quality, plasma arc cutting nozzles are usually operated at an arc current slightly below the level that results in double-arcing. Attempting to operate nozzles above the maximum limit will cause a deterioration in performance.

The conditions listed above are chosen for optimum cut quality (not speed) and will generally produce excellent results. If deviations from these conditions are necessary, they should be limited to changes in arc current, arc voltage, and travel speed. These parameters have a significant effect on cut quality. Do not deviate from specified gas and water flows.

TABLE II

Operating Data for Stainless Steel

Material Thickness Inches	Material Thickness mm	Nozzle and Swirl-ring Size Inches	Gas Type and Flowmeter Setting %	Injection Water Flow Setting %	Torch to Work Distance Inches	Torch to Work Distance mm	Arc Voltage Setting Volts	Arc Current Setting Amperes	Travel Speed ipm	Travel Speed mm/min
.035	1	.120	N_2 30	85	1/8	3	125	250	450	11430
.075	2				1/8	3	130	250	300	7620
1/8	3				3/16	5	135	260	200	5080
1/4	6	Maximum current for this nozzle is 260 amp.			1/4	6	145	260	150	3810
1/8	3	.166	N_2 45	75	1/4	6	140	300	200	5080
1/4	6				1/4	6	145	350	150	3810
3/8	10				1/4	6	150	380	125	3175
1/2	13	Maximum current for this nozzle is 400 amp.			1/4	6	155	400	100	2540
3/4	19				5/16	8	160	400	50	1270
1	25				3/8	10	165	400	30	760
3/4	19	.187	N_2 45	75	3/8	10	165	500	75	1905
1	25				3/8	10	165	550	60	1525
1 1/2	38				3/8	10	170	580	30	760
2	50	Maximum current for this nozzle is 600 amp.			3/8	10	170	600	20	510
2	50	.220	N_2 70	100	1/2	13	190	700	25	635
3	75	Maximum current for this nozzle is 750 amp.			5/8	16	200	750	12	305

When cutting materials greater than 1½ inches (40mm) thick, lower the level of water in the water table to 3 inches (75mm) below the lower surface of the workpiece. Also de-energize the Water Muffler pump to improve arc penetration.

Use the brass tapered retaining cap stock no. 020034 above 400 amperes.

For cutting thicker plate refer to the chart "Operating Data for High Current Cutting."

TABLE III

Operating Data for Aluminum

Material Thickness Inches	mm	Nozzle and Swirl-ring Size Inches	Gas Type and Flowmeter Setting %	Injection Water Flow Setting %	Torch to Work Distance Inches	mm	Arc Voltage Setting Volts	Arc Current Setting Amperes	Travel Speed ipm	mm/min
.035	1				1/8	3	125	250	540	13715
.075	2	.120	N_2 30	85	1/8	3	130	250	360	9145
1/8	3				3/16	5	135	260	240	6095
1/4	6	Maximum current for this nozzle is 260 amp.			1/4	6	145	260	180	4570
1/8	3				1/4	6	140	300	240	6095
1/4	6				1/4	6	145	325	180	4570
3/8	10				1/4	6	150	350	150	3810
1/2	13	.166	N_2 45	75	1/4	6	155	375	120	3050
3/4	19				5/16	8	160	400	60	1525
1	25	Maximum current for this nozzle is 400 amp.			3/8	10	165	400	35	915
1	25				3/8	10	165	500	70	1830
1 1/2	38	.187	N_2 45	75	3/8	10	170	550	35	915
2	50	Maximum current for this nozzle is 600 amp.			3/8	10	170	600	25	610
2	50	.220	N_2 70	100	1/2	13	190	700	30	760
3	75	Maximum current for this nozzle is 750 amp.			5/8	16	200	750	15	355

Use the brass tapered retaining cap stock no. 020034 above 400 amperes.

For cutting thicker plate refer to the chart "Operating Data for High Current Cutting."

TABLE IV

Sample Operating Data for Other Materials

Material Type	Thickness Inches	Thickness mm	Nozzle and Swirl-ring Size Inches	Gas Type & Flowmeter Setting %	Injection Water Flow Setting %	Torch To Work Distance Inches	Torch To Work Distance mm	Arc Voltage Setting Volts	Arc Current Setting Amperes	Travel Speed ipm	Travel Speed mm/min
Titanium	½	13	.166	N_2 45	75	¼	6	155	400	90	2285
Brass	½	13								70	1780
Copper	½	13								60	1525
Cast Iron	⅝	16								80	2030
Titanium	1	25	.187	N_2 45	75	⅜	10	165	550	50	1270
Copper/ Nickel-20%	1	25								45	1145

TABLE V

Operating Data for High Current Cutting

Material Thickness Inches	mm	Nozzle and Swirl-ring Size Inches	Gas Type and Flowmeter Setting %	Injection Water Flow Setting %	Torch to Work Distance Inches	mm	Arc Voltage Setting Volts	Arc Current Setting Amperes	Travel Speed ipm	mm/min
			Stainless Steel							
3	75	.250	Premixed 65% Argon 35% Hydrogen 70	100	1	25	215	900	15	380
4	100	.250	Premixed 65% Argon 35% Hydrogen 70	100	1	25	225	1000	10	255
5	130	.250	Premixed 65% Argon 35% Hydrogen 80	100	1	25	235	1000	6	150
			Aluminum							
3	75	.250	70	100	1	25	210	900	18	460
4	100	.250	70	100	1	25	210	900	12	305
5	130	.250	Premixed 65% Argon 35% Hydrogen 70	100	1	25	210	1000	8	200
6	150	.250	Premixed 65% Argon 35% Hydrogen 70	100	1	25	210	1000	7	180

High Current Cutting is conventional cutting. It does not use the Water-Injection principle. The water sprayed from the nozzle is for nozzle cooling purposes only. It does not constrict the arc.

Always remove the Water-Muffler and lower the water level in the Water-Table when operating in the High Current Mode.

Use only the brass, tapered nozzle retaining cap — Stock No. 020-1-034.

WARNING: The plasma console is not vented for combustible gases. The optional ARGON/HYDROGEN MANIFOLD Stock Number 028-1-057 is required when using Argon/Hydrogen gas mixtures.

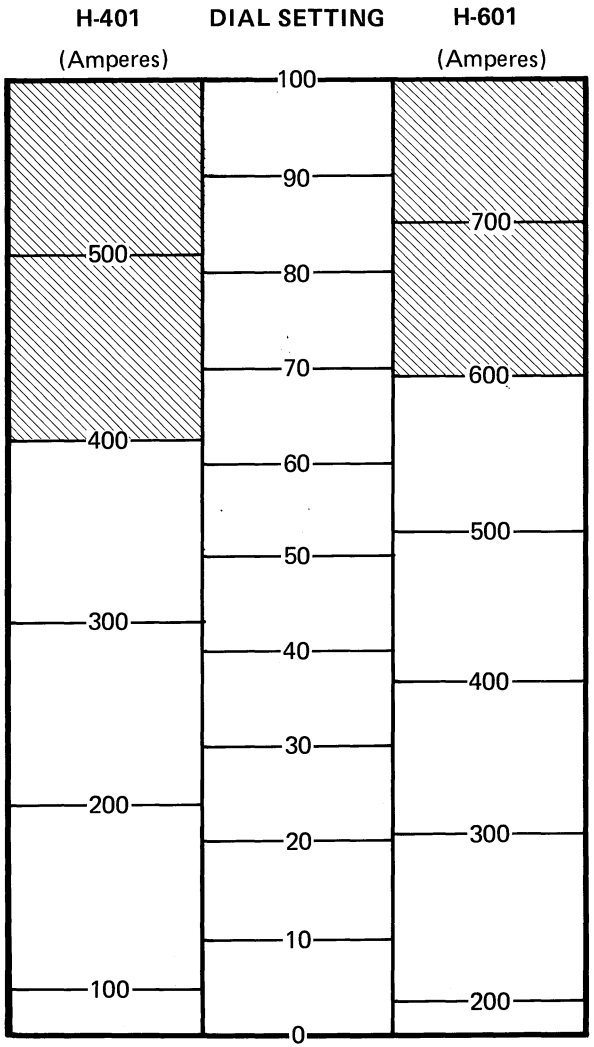
CAUTION: Never operate Water-Injection nozzles with Argon/Hydrogen gas mixtures.

Table VI
Nozzle Thickness Ranges and Limits

Nozzle Size	Nozzle Stock No.	Swirl-ring Size	Swirl-ring Stock No.	Thickness Range	Current Limit	Piercing Limit
**********		**********		(inches)	(amperes)	(inches)
.120	020050	.032	020039	.035 - 1/4	260	1/4
.166	020035	.032	020039	1/8 - 1	400	1
.187	020036	.032	020039	1/2 - 2	600	1-1/2
.220	020037	.052	020040	2 - 3	750	2
.250	020047	.062	020048	3 - 5	1000	Not Permitted

NOTE: The .250 Nozzle is for conventional cutting only. It must be used only with the Argon-Hydrogen Manifold.

Single Power Supply



Two Power Supplies in Parallel

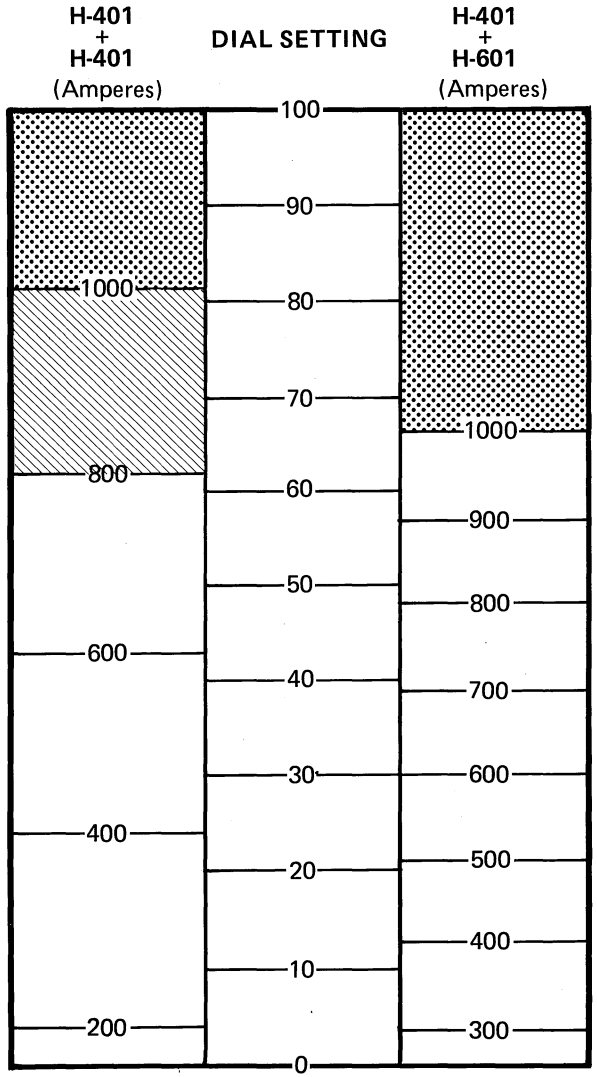


TABLE VII

Output Current Obtained for a Given Dial Setting for Various Power Supply Configurations

KEY

Reduced Duty Cycle

Exceeds Current Limit of Torch

SECTION 10 ILLUSTRATIONS AND SCHEMATICS

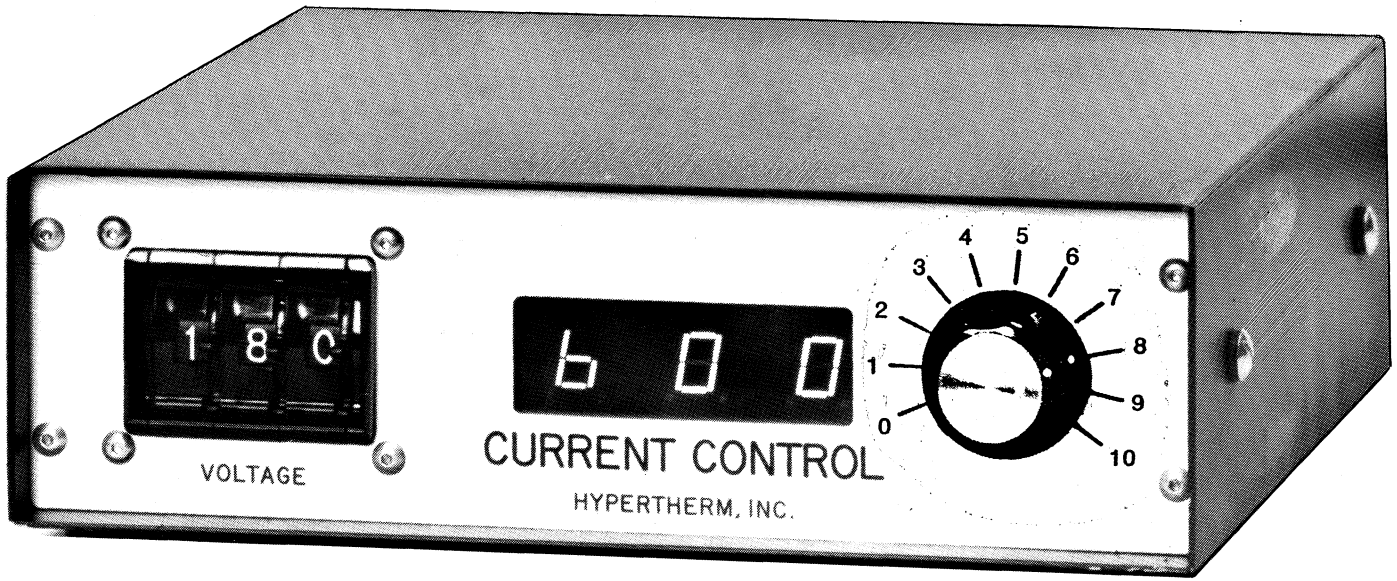


Figure 1

CONTROL STATION

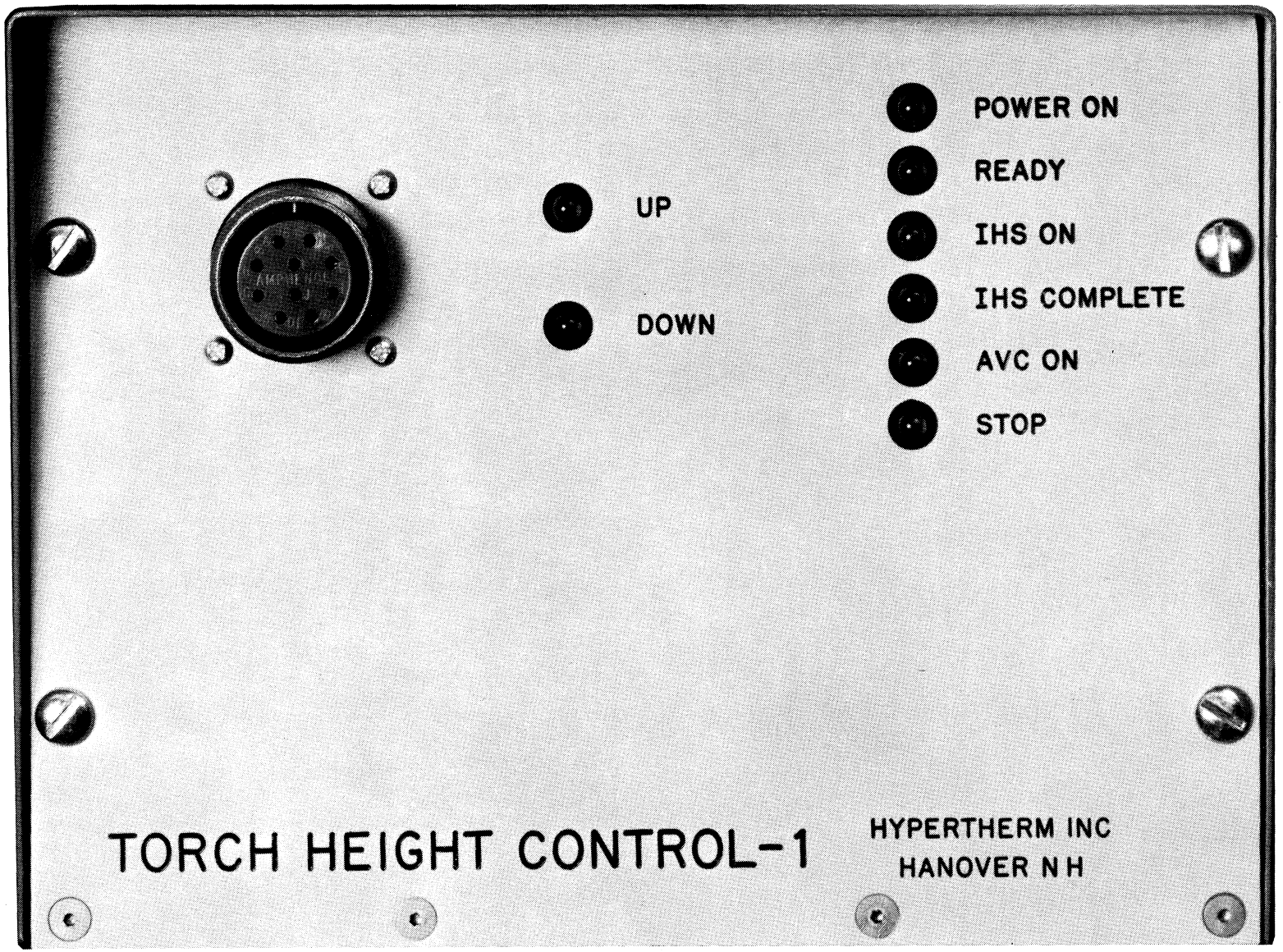
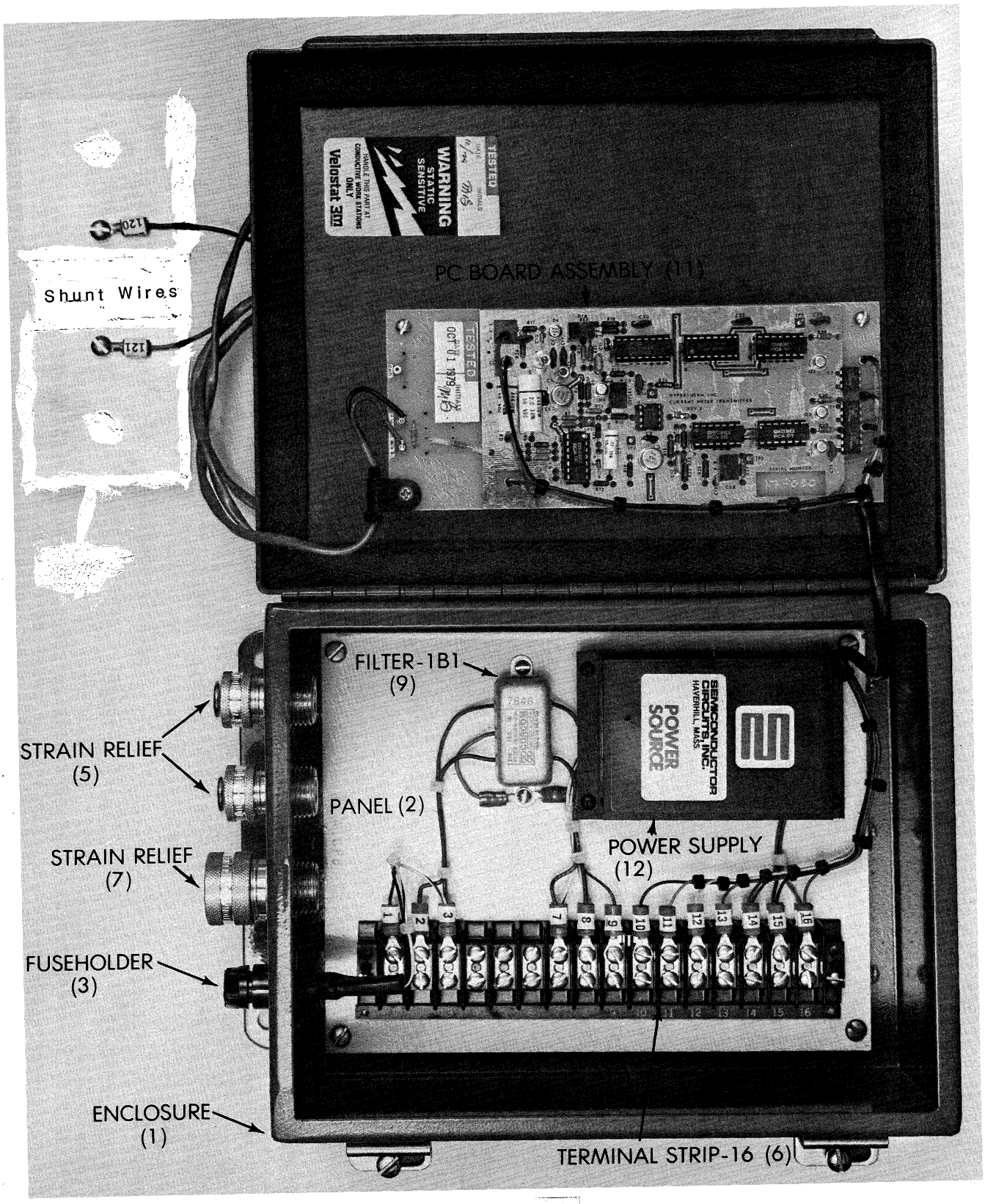


Figure 2

THC-1/RVC CONTROL MODULE - Front View



MANUAL

CURRENT CONTROL TRANSMITTER

Figure 3

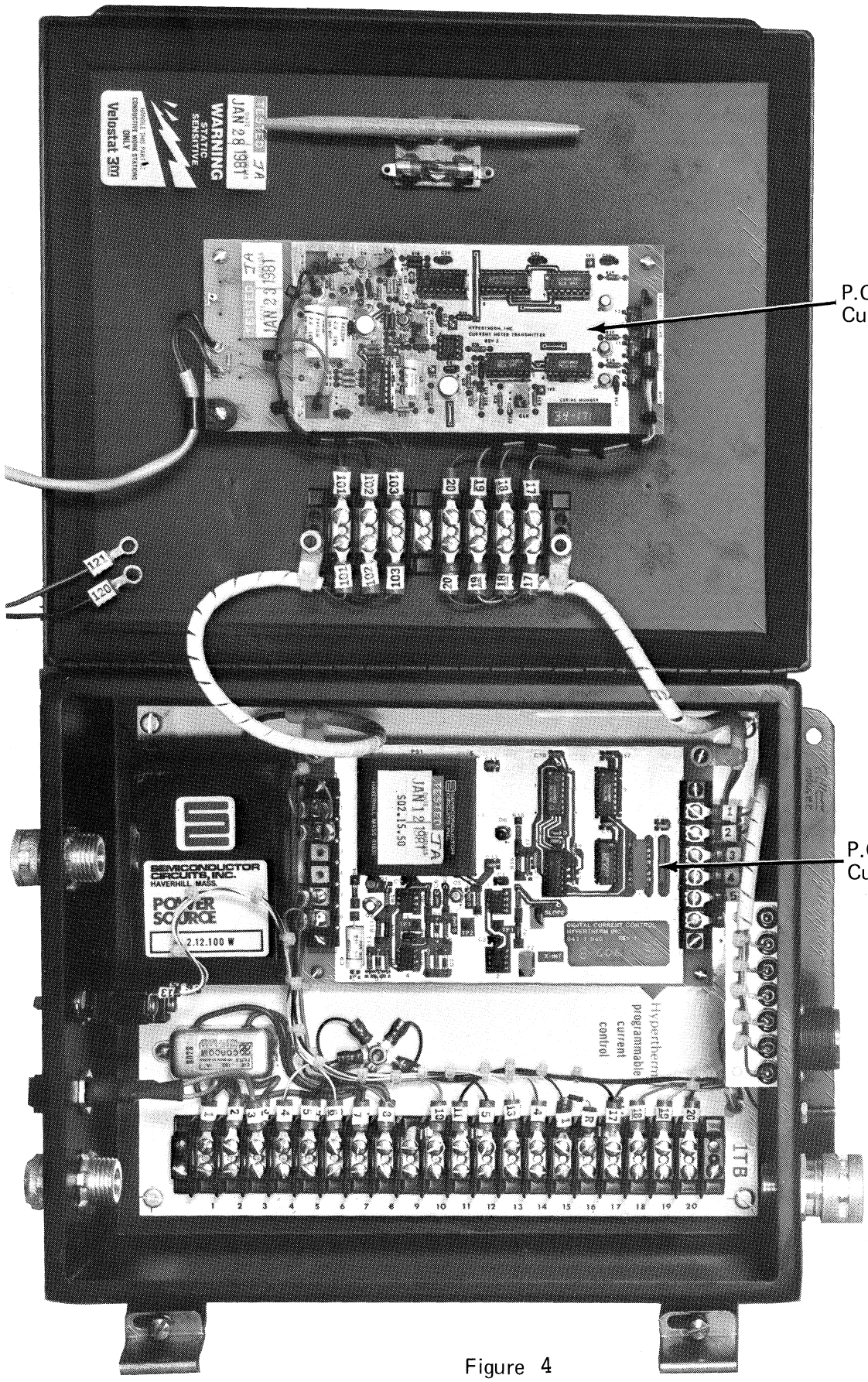


Figure 4

PROGRAMMABLE CURRENT CONTROL TRANSMITTER

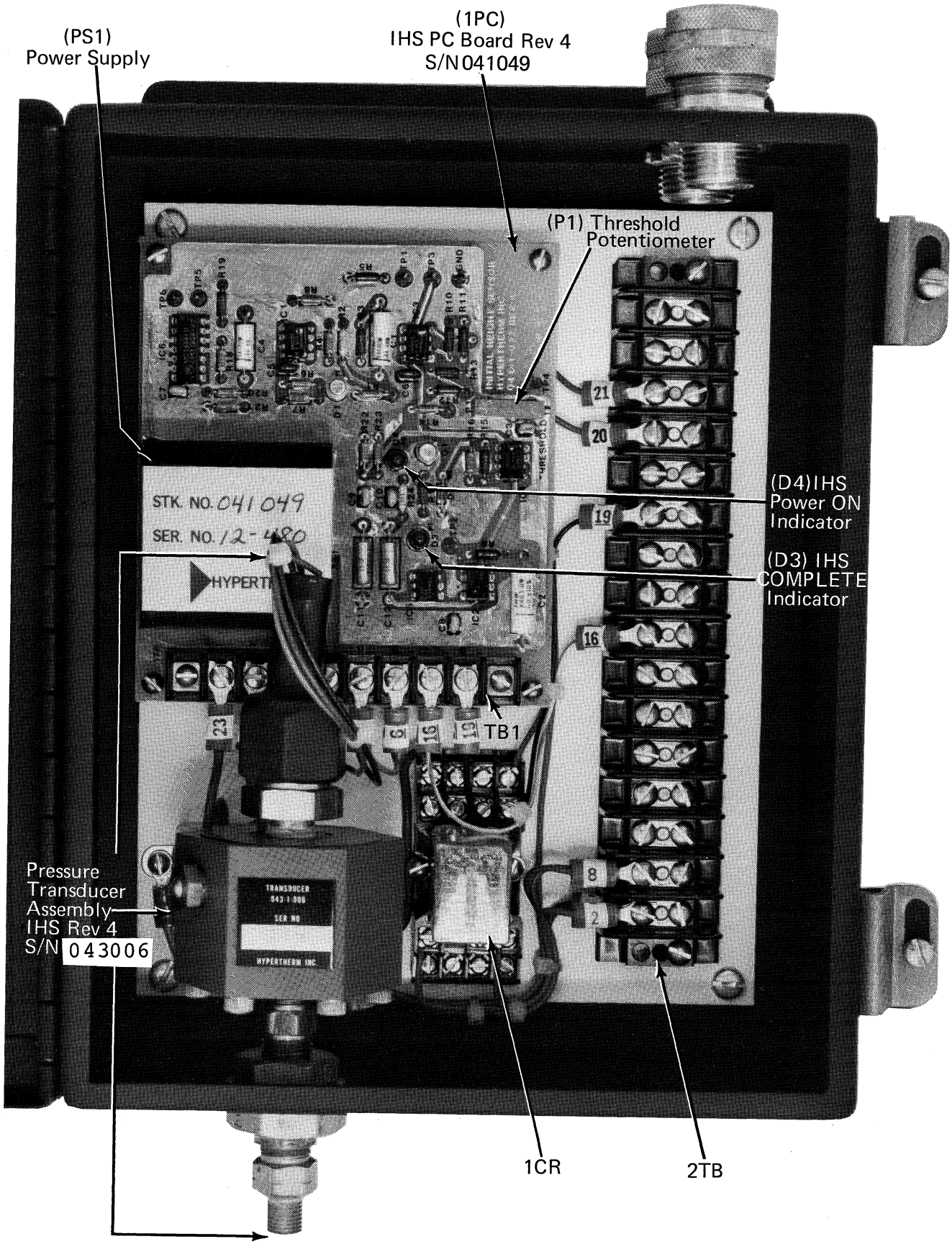


Figure 5
Fluidic Initial Height Sensor Module

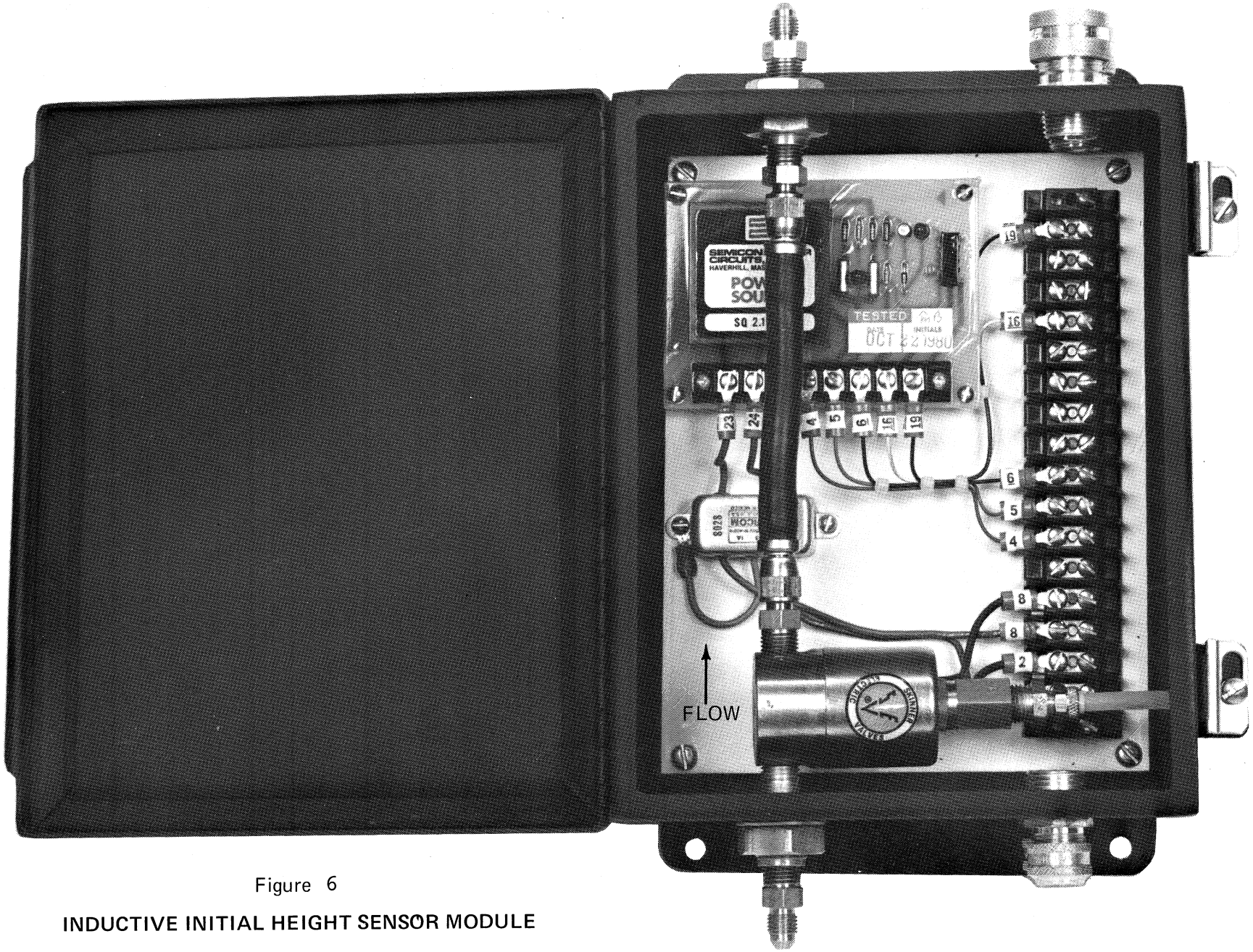
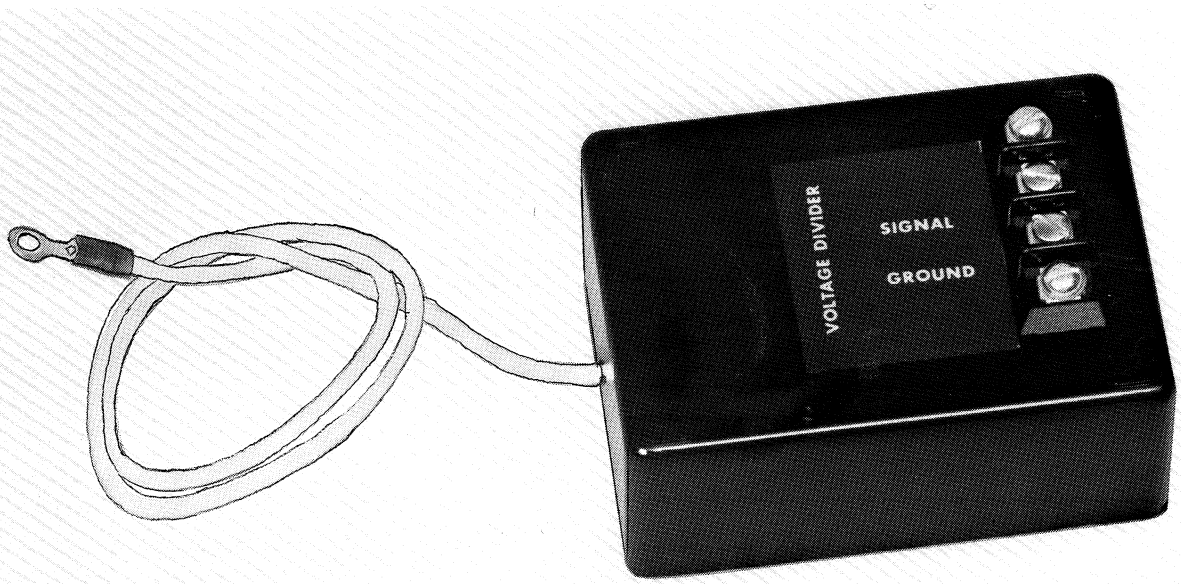


Figure 6

INDUCTIVE INITIAL HEIGHT SENSOR MODULE



25:1 VOLTAGE DIVIDER FOR TORCH HEIGHT CONTROL
Stock No. 041007

Figure 7

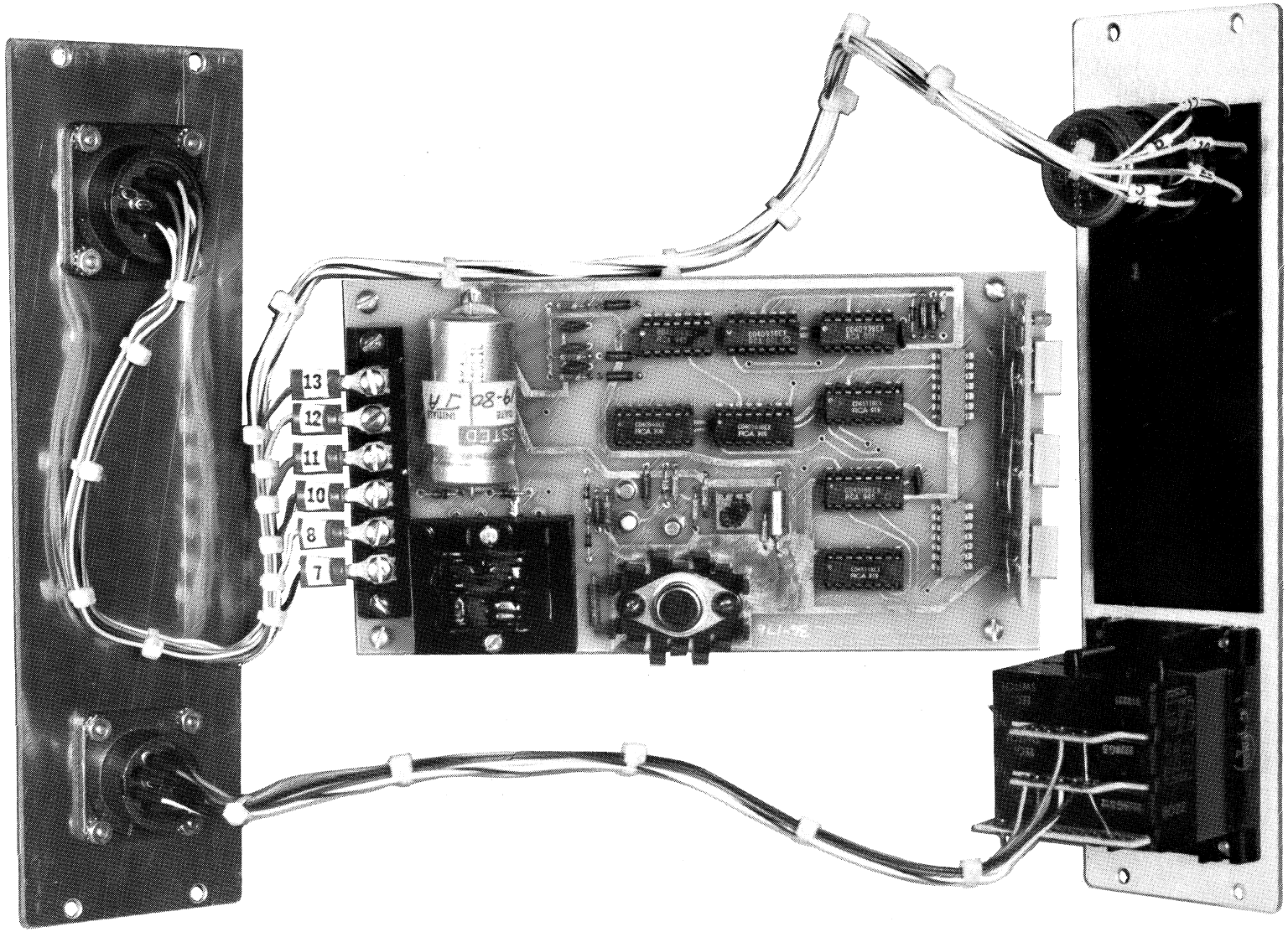


Figure 8

CONTROL STATION

Interior View

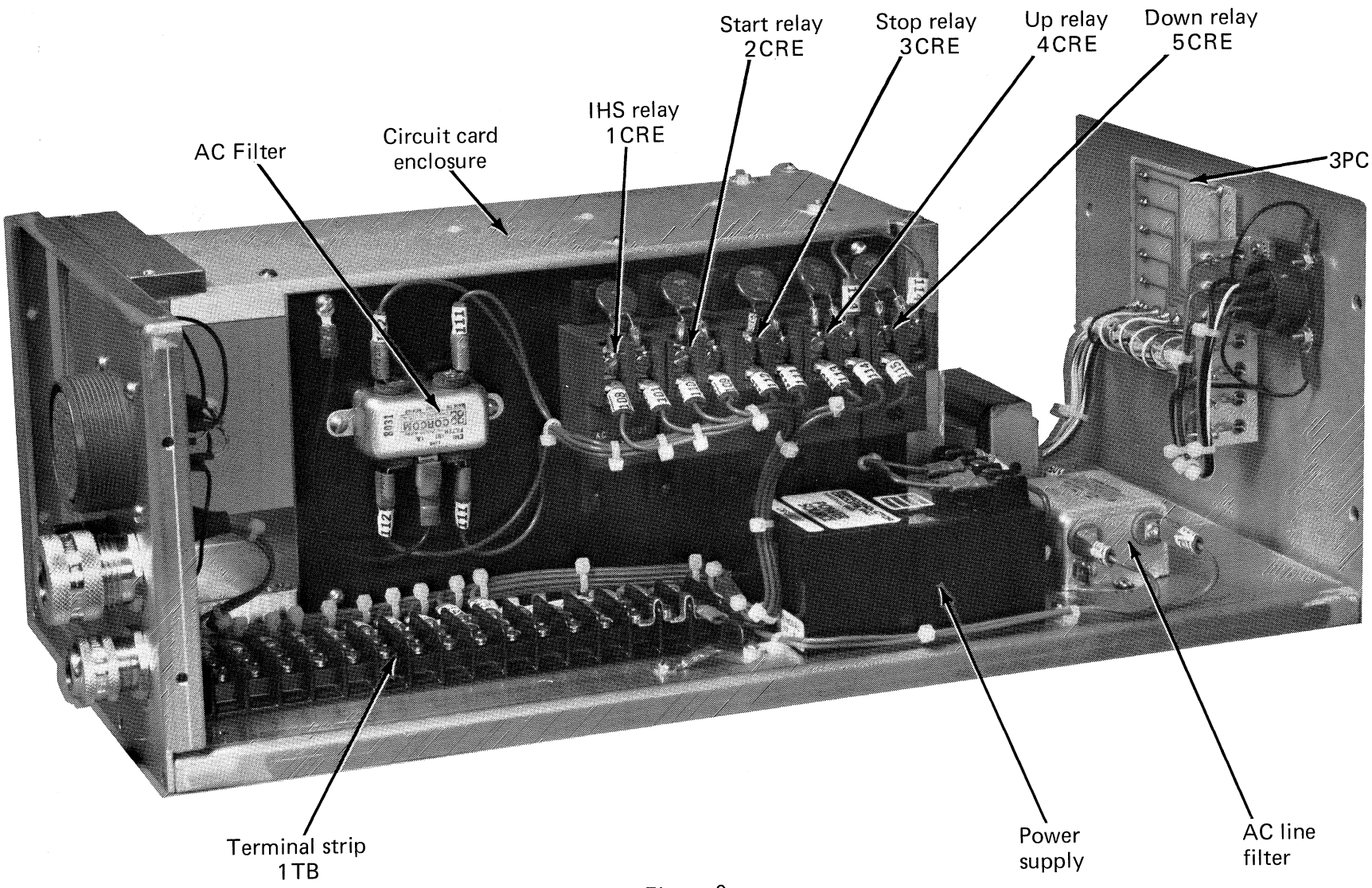


Figure 9

THC-1/RVC CONTROL MODULE

Interior View

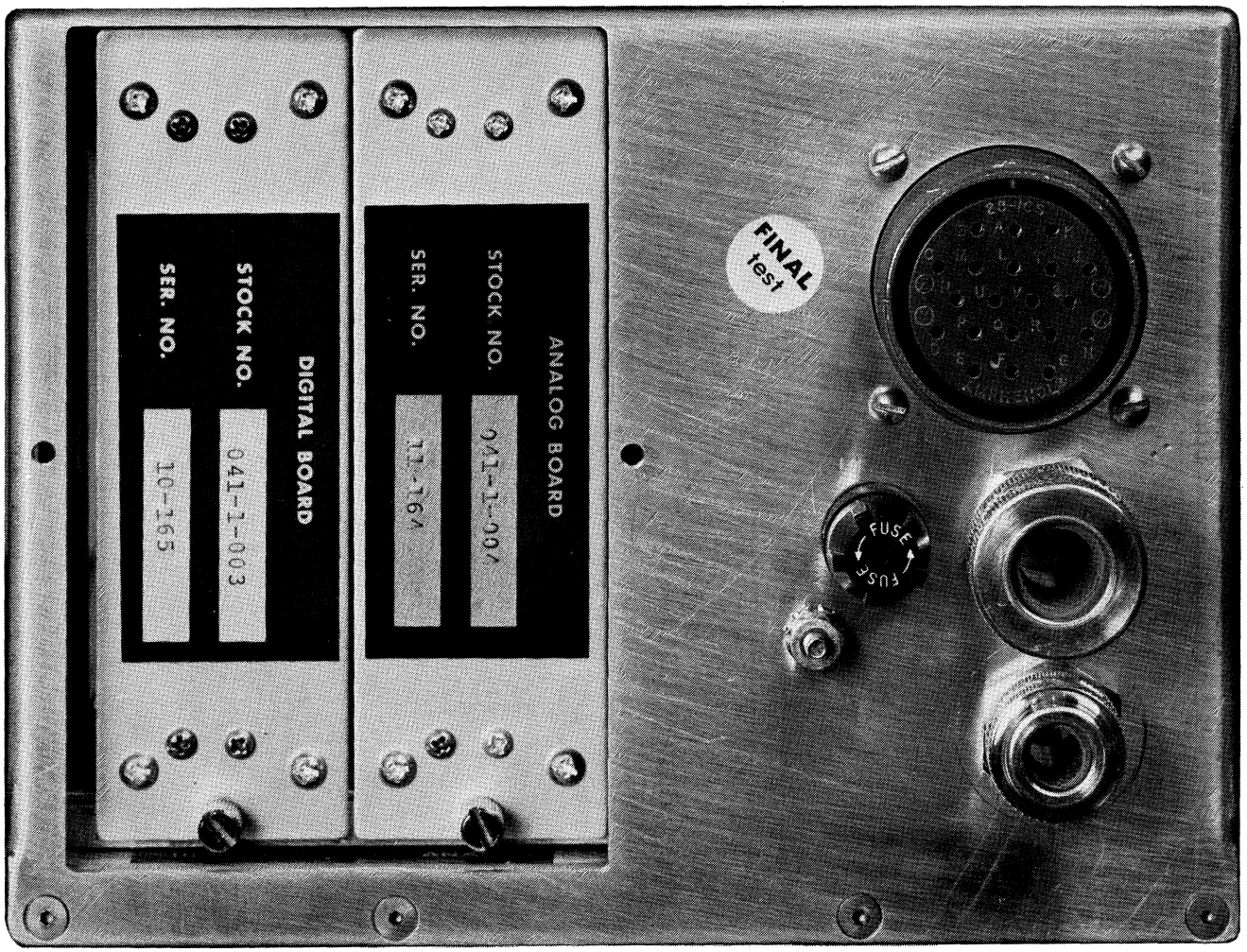


Figure 10

THC-1/RVC CONTROL MODULE - Rear View

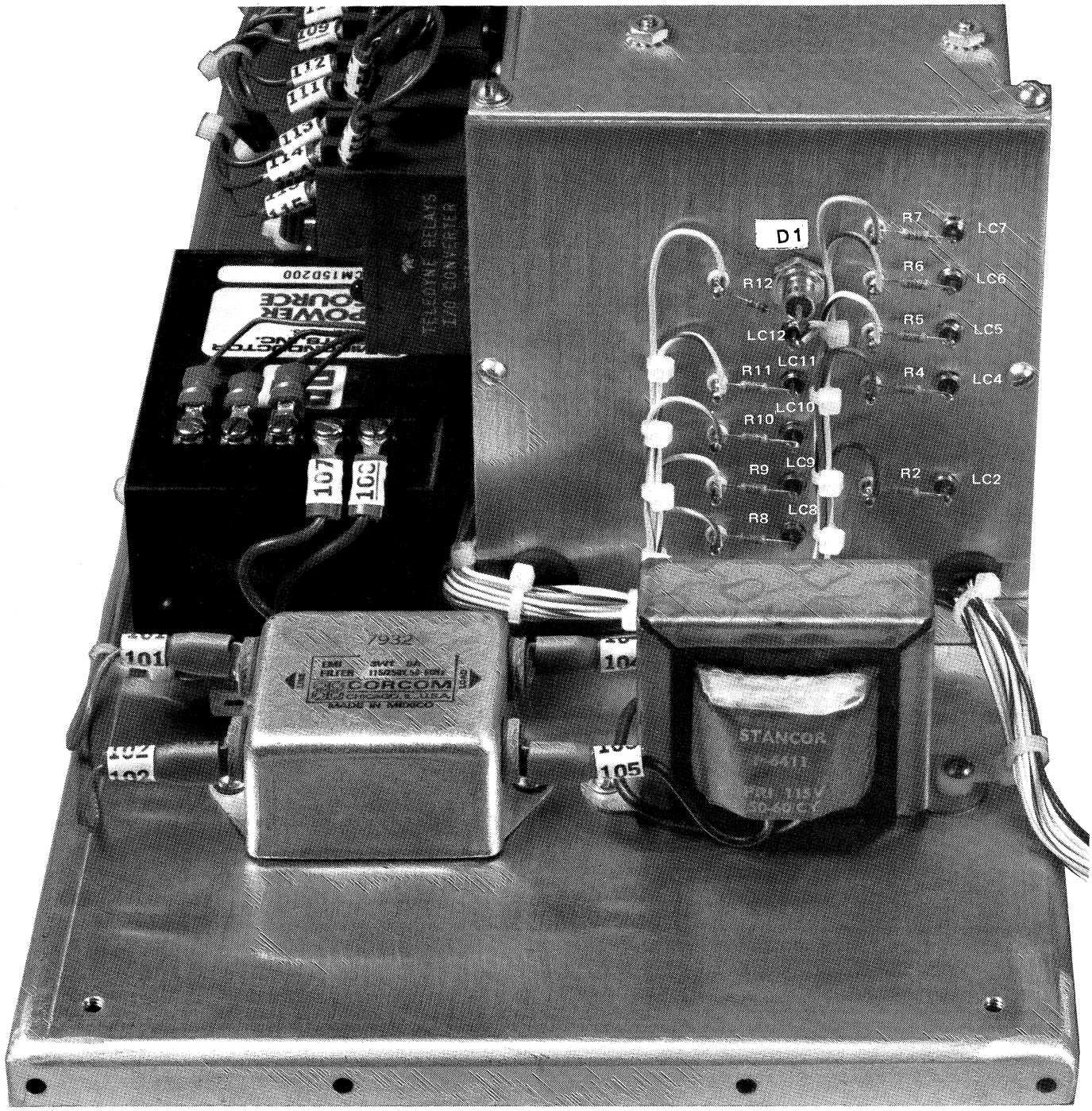


Figure 11

THC-1/RVC CONTROL MODULE
CARD ENCLOSURE DETAIL

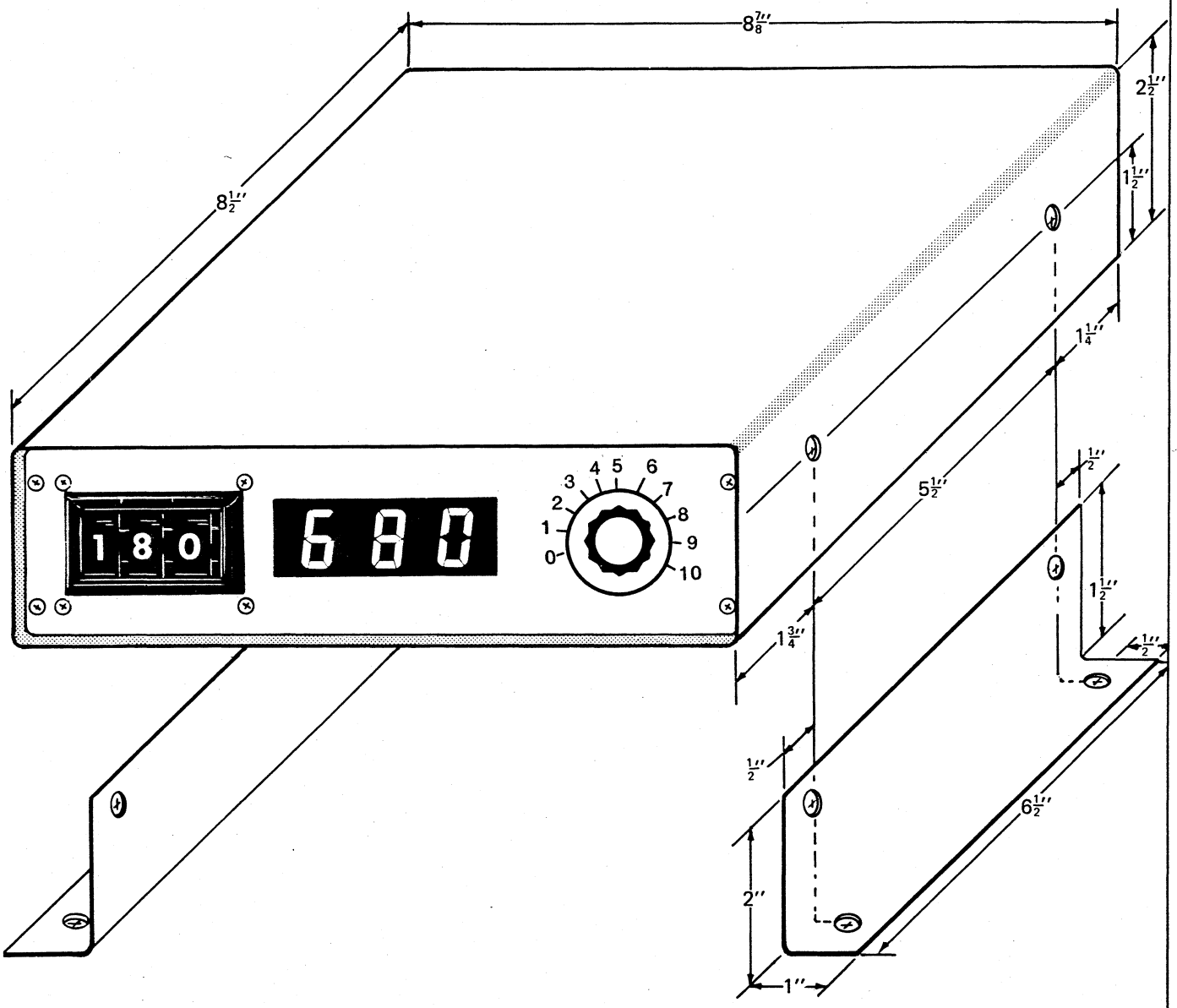


Figure 12.

Control Station Mounting Detail

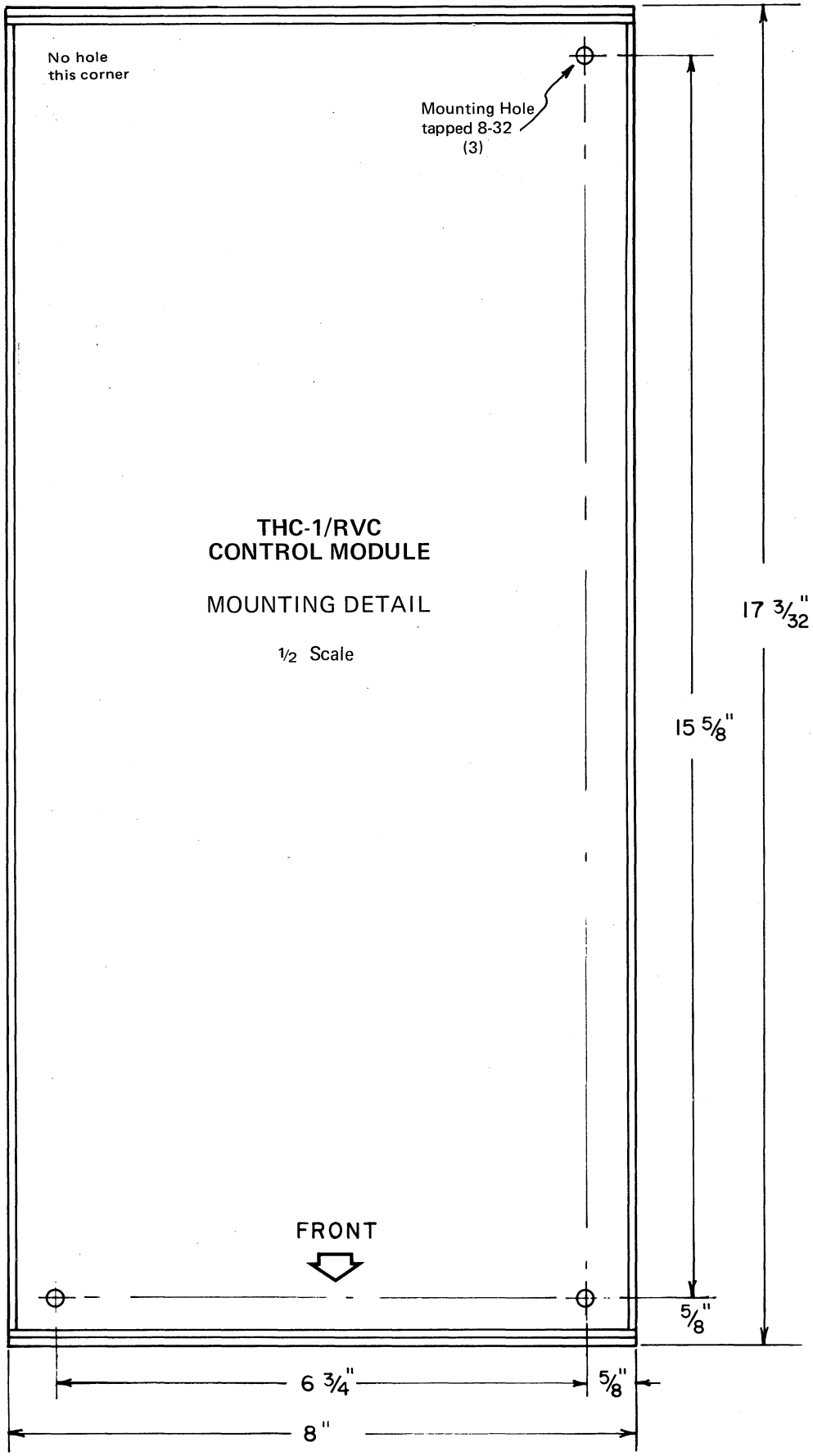

No hole
this corner
Mounting Hole
tapped 8-32
(3)
THC-1/RVC
CONTROL MODULE
MOUNTING DETAIL
1/2 Scale
17 3/32"
15 5/8"
FRONT
5/8"
6 3/4"
5/8"
8"

Figure 13

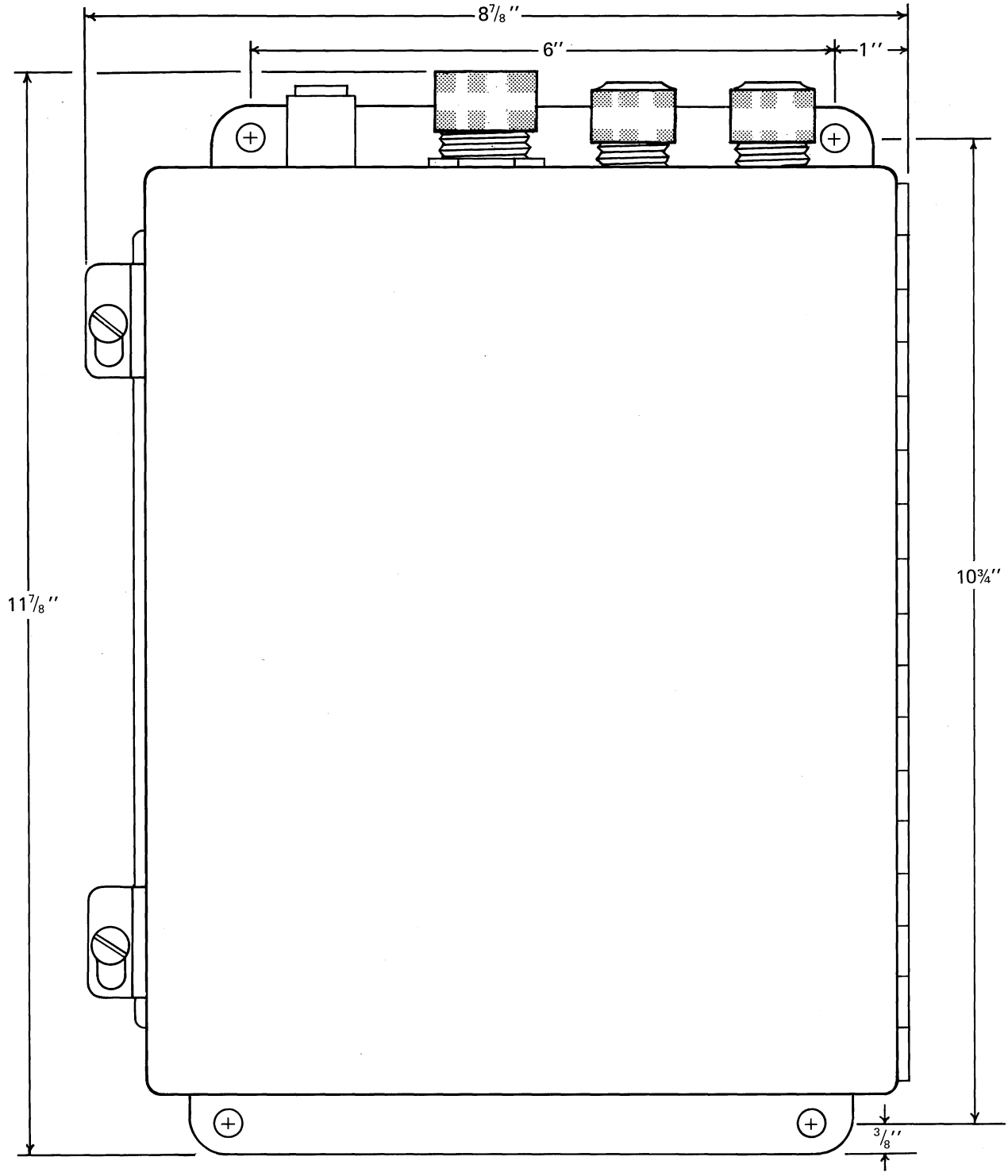


Figure 14
Manual Transmitter Mounting Detail

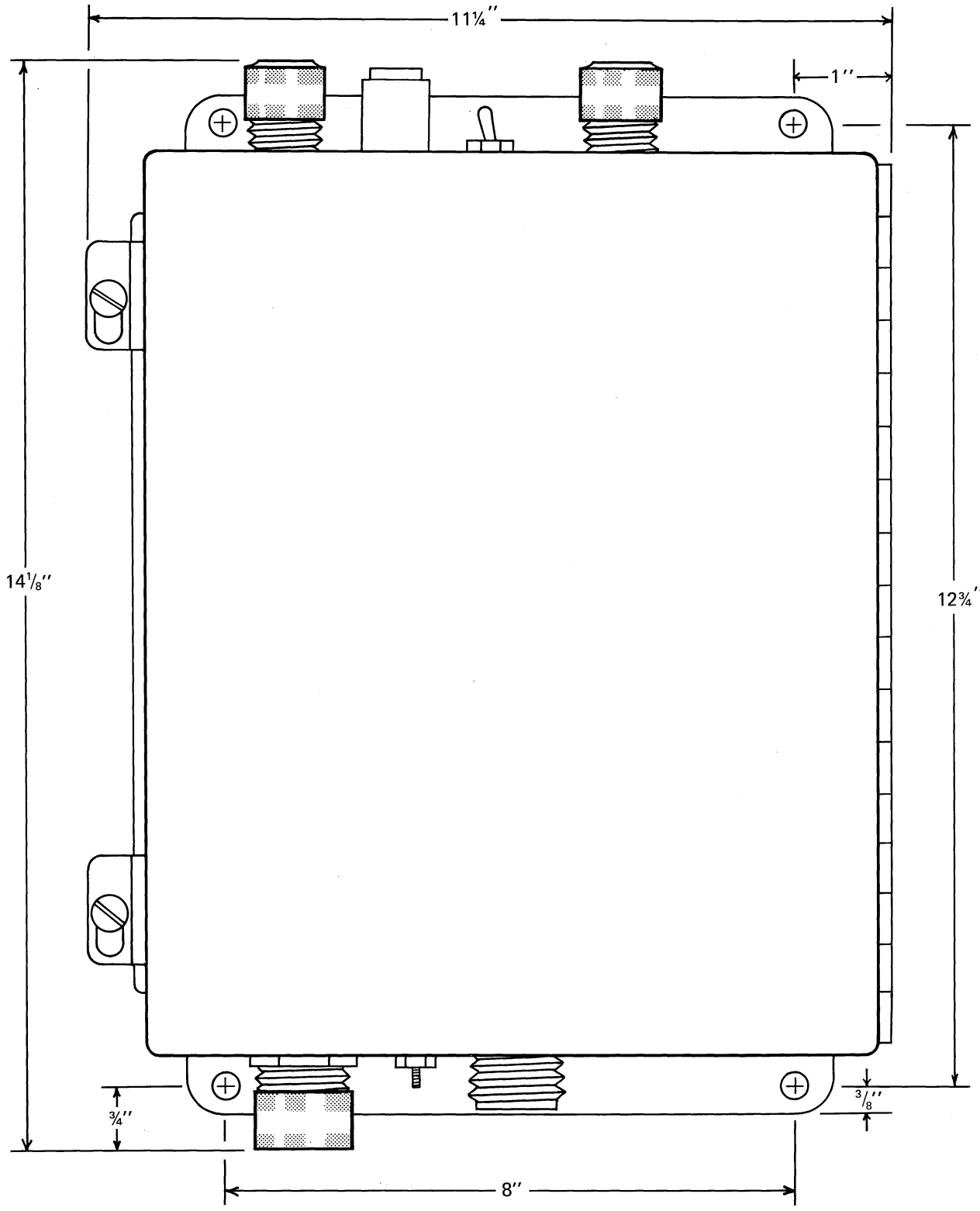


Figure 15
Programmable Current Transmitter Mounting Detail

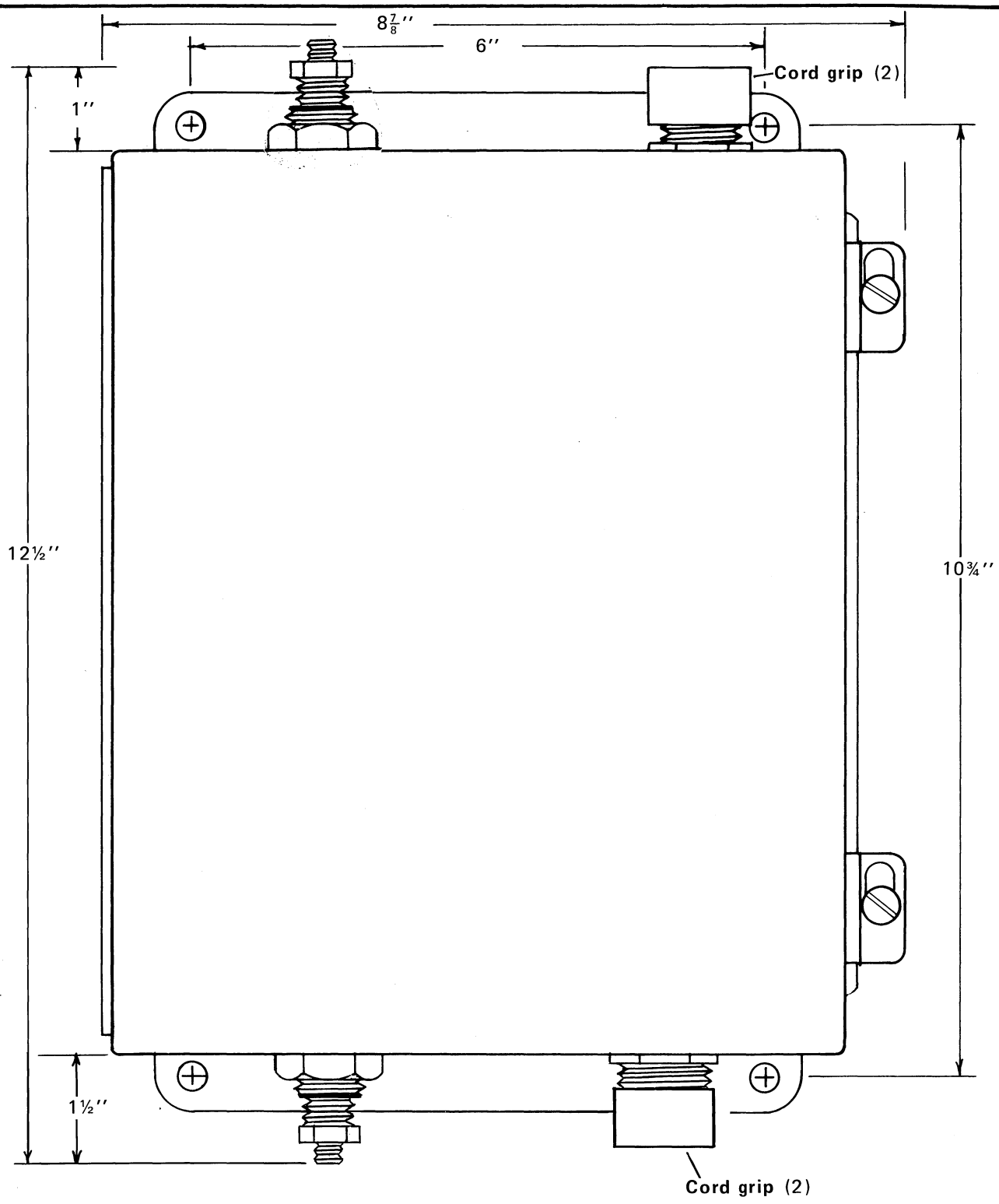


Figure 16
Initial Height Sensor

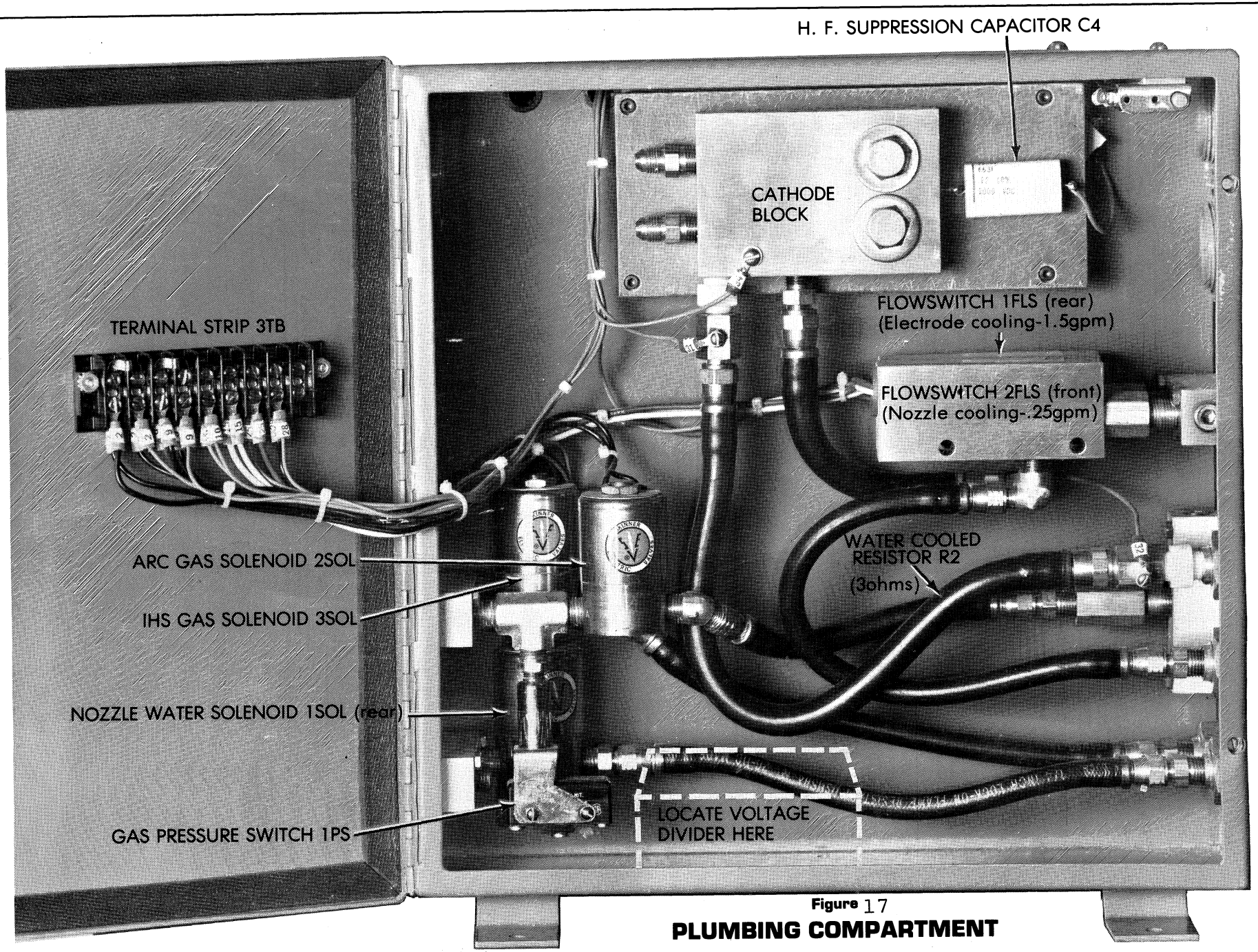


Figure 17

PLUMBING COMPARTMENT

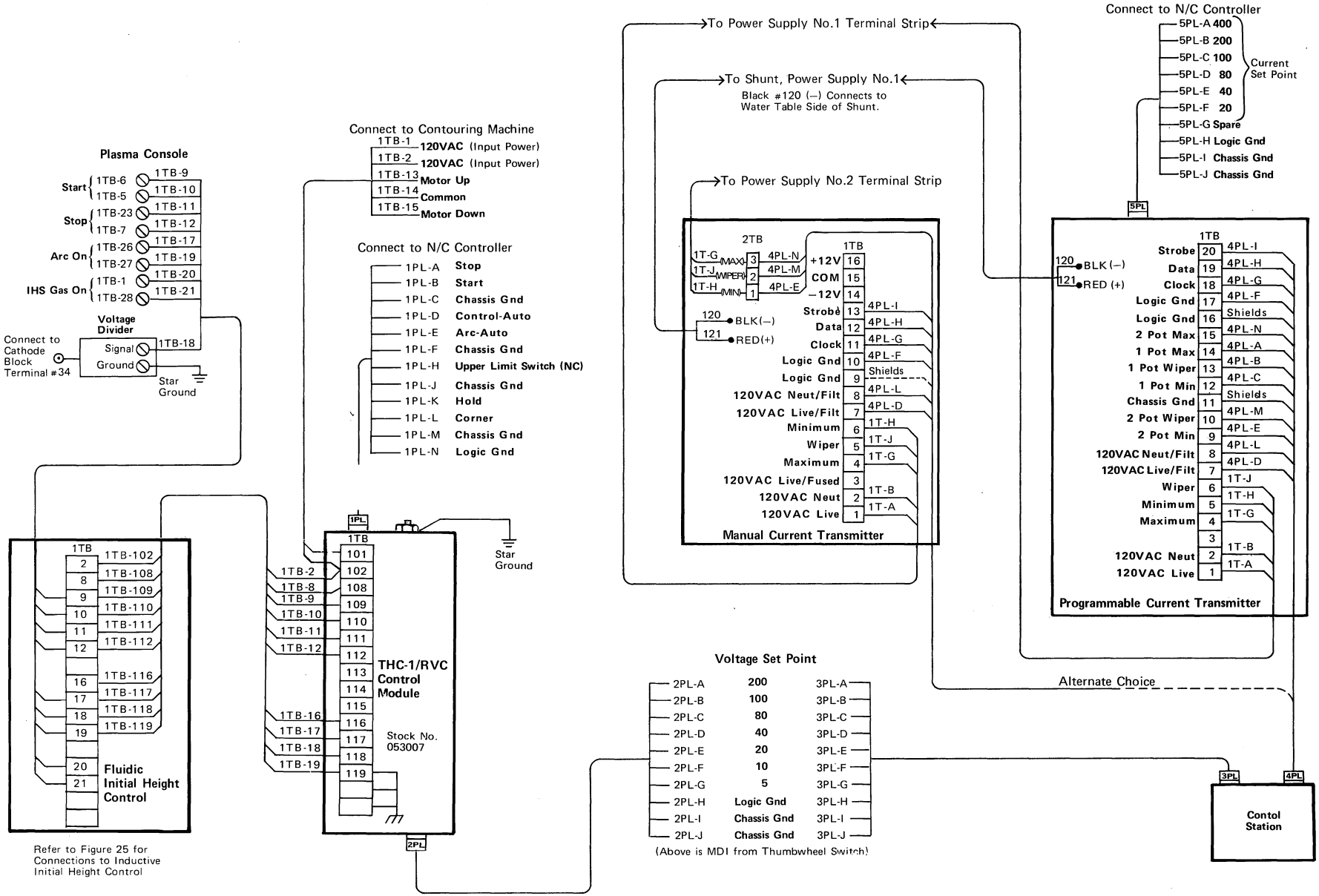


Figure 18. THC-1/RVC Interconnection Diagram

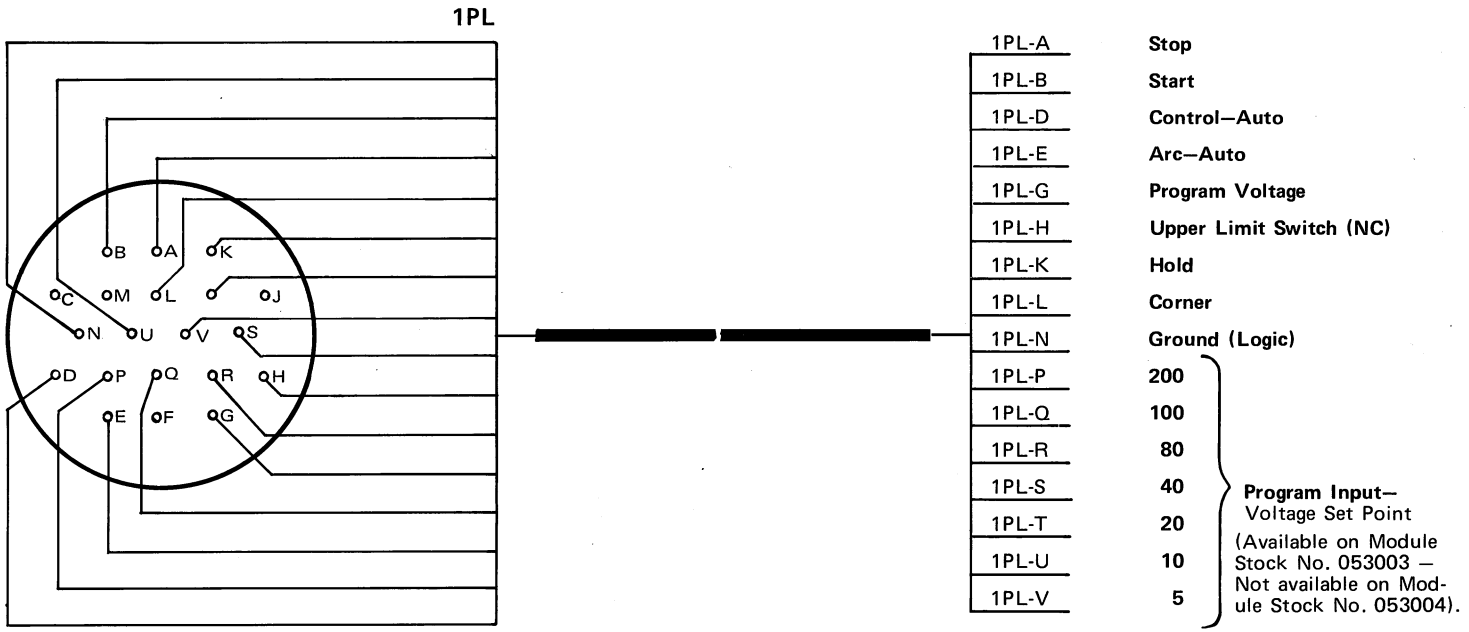


Figure 19

Cable Assembly for Machine Interface using THC-1 Control Module Stock Nos. 053003 & 053004

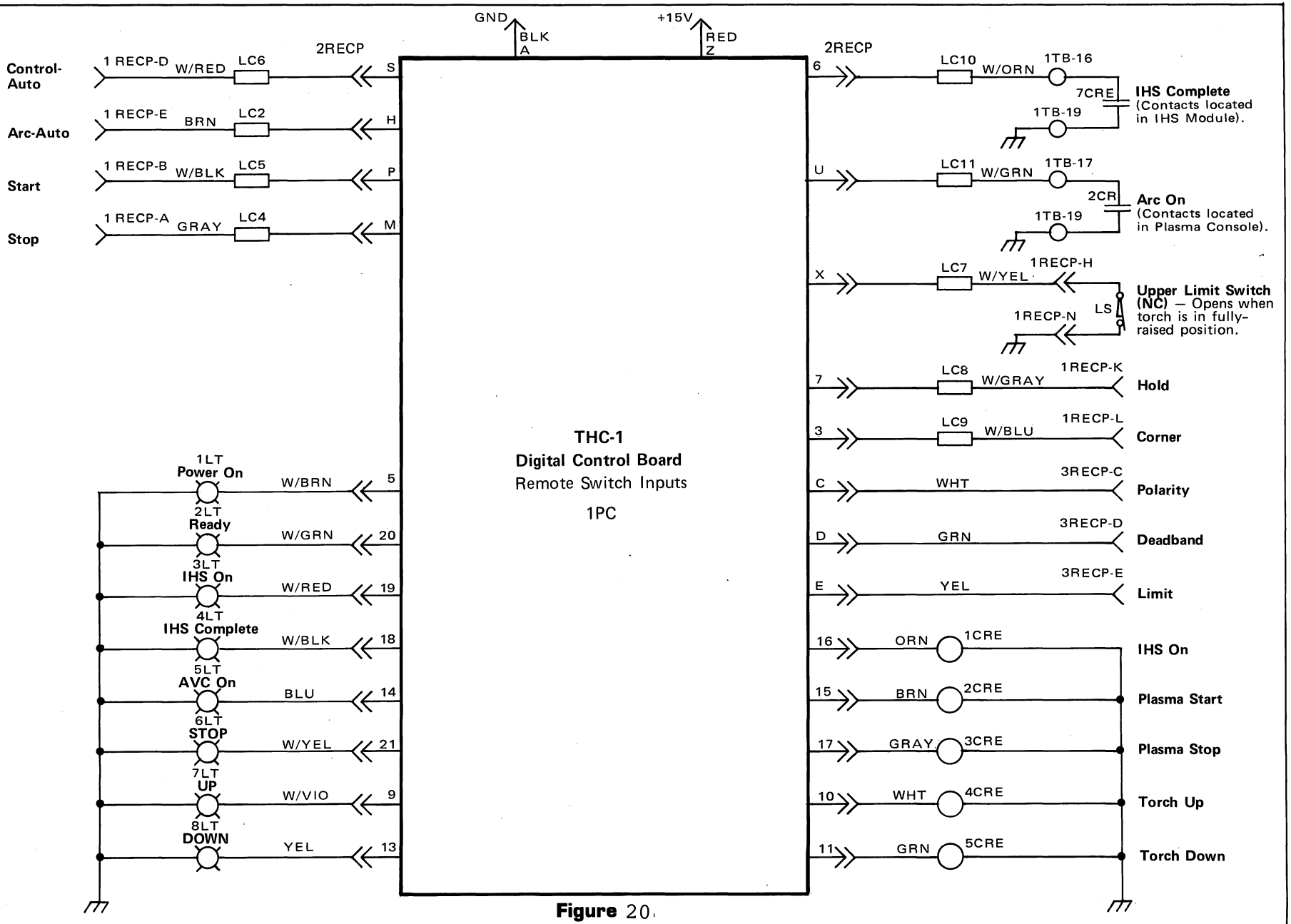


Figure 20.

THC-1 Digital Control Board — Remote Switch Input/Output

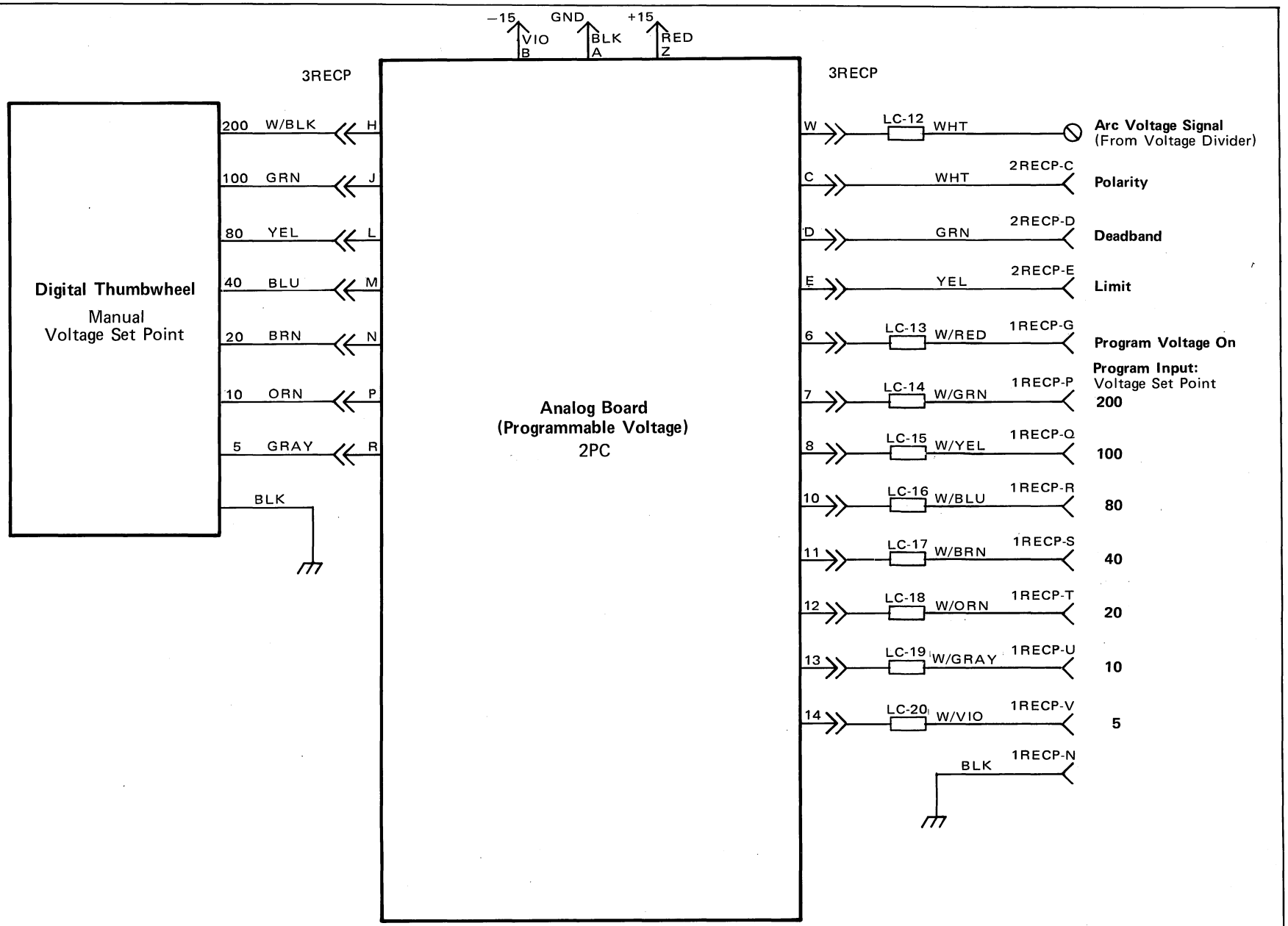


Figure 21

THC-1 Analog Board — Programmable Voltage Input/Output

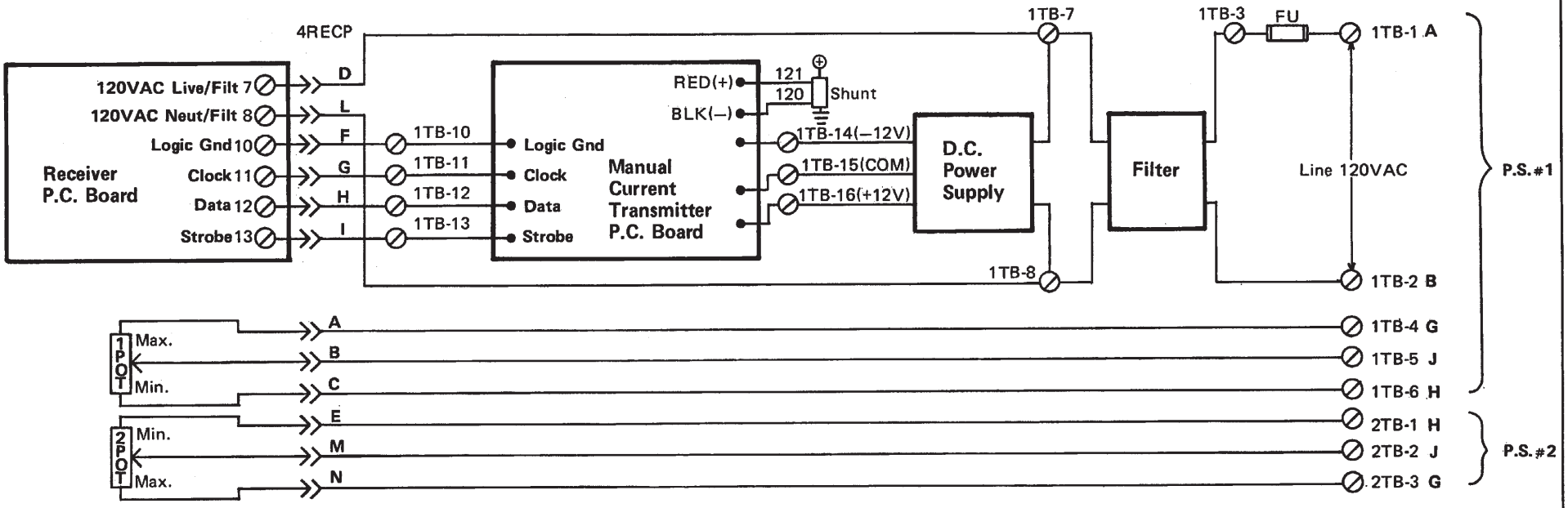


Figure 22. Schematic, Manual Current Control

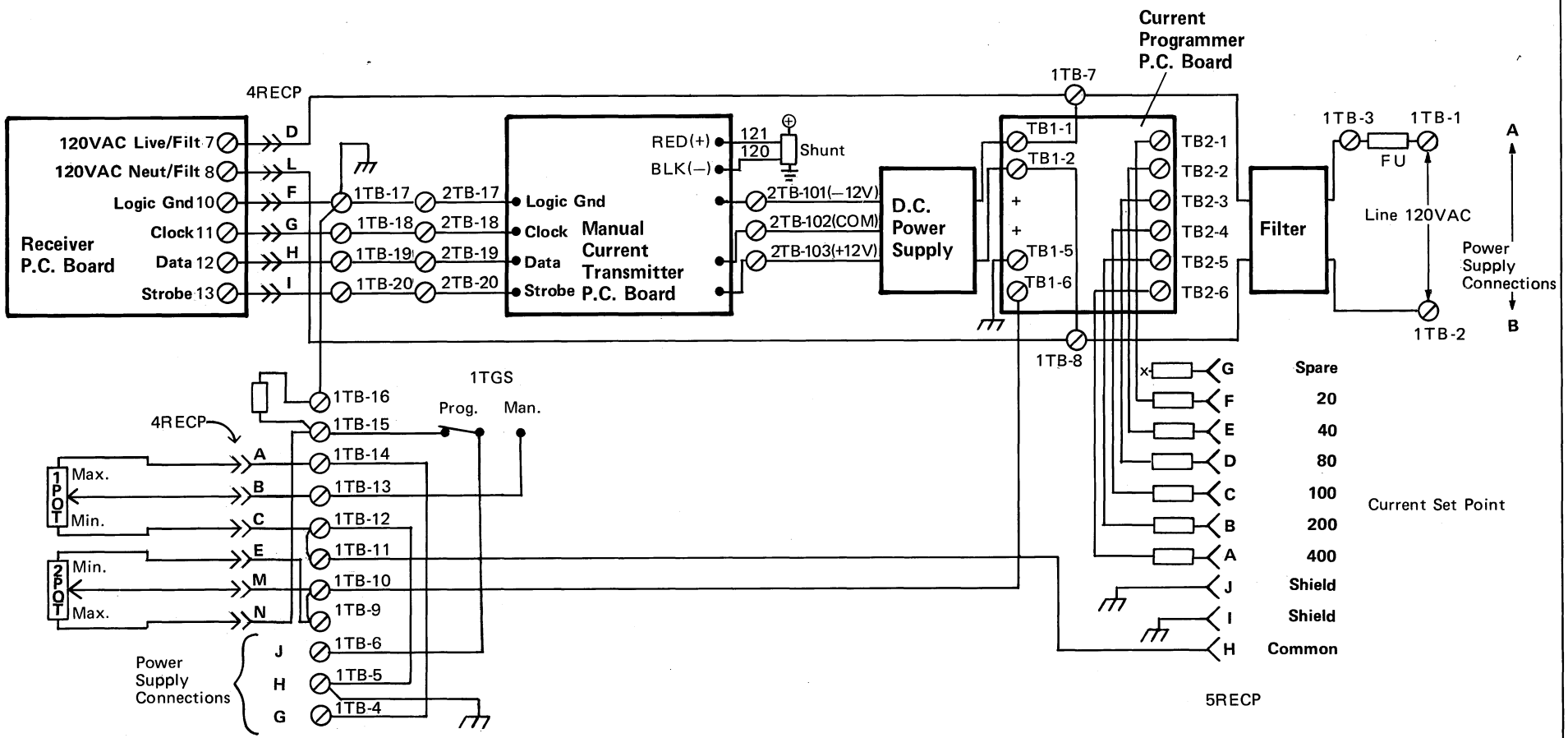


Figure 23. Schematic, Programmable Current Control

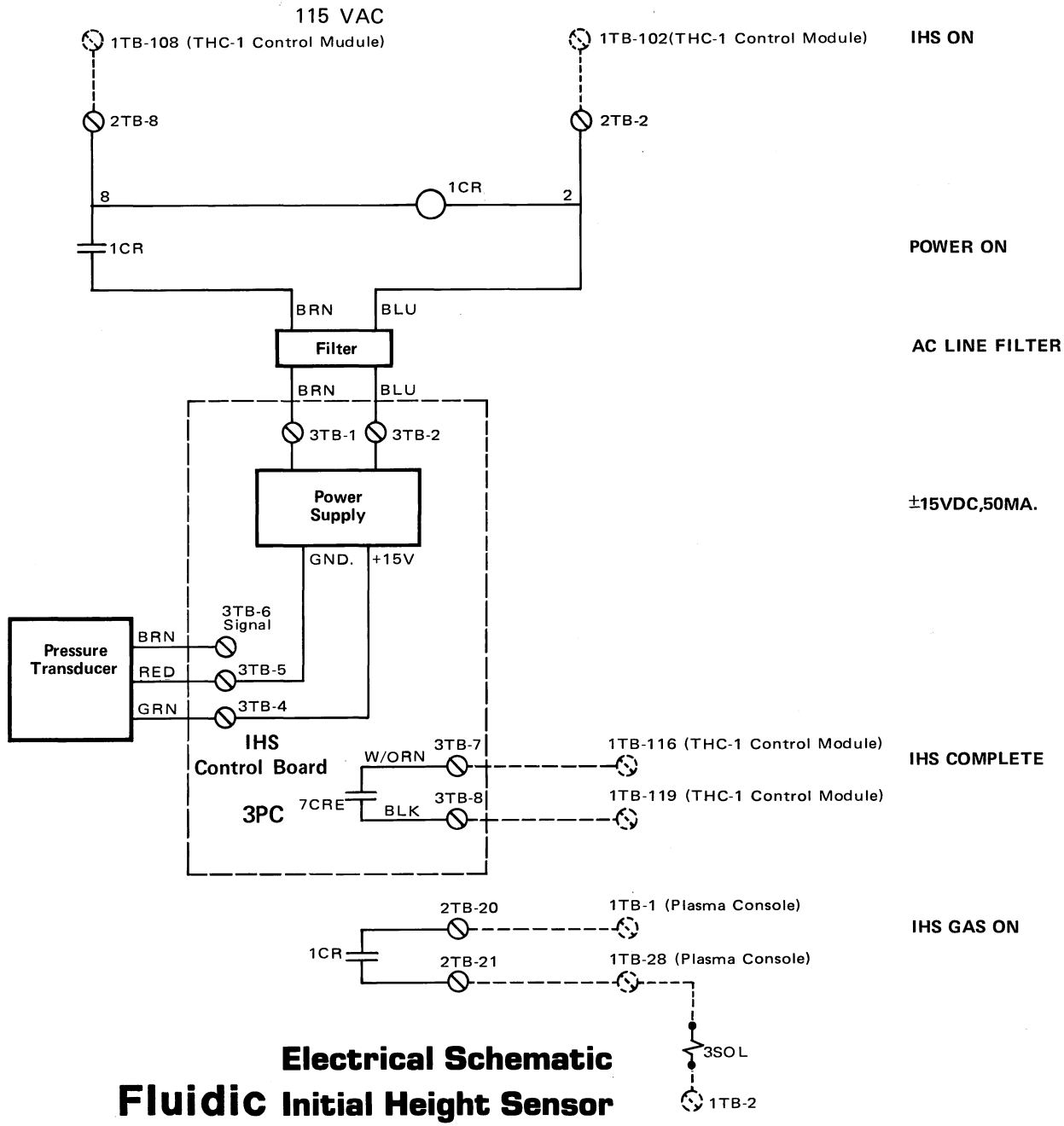


Figure 24 **Electrical Schematic**
Fluidic Initial Height Sensor

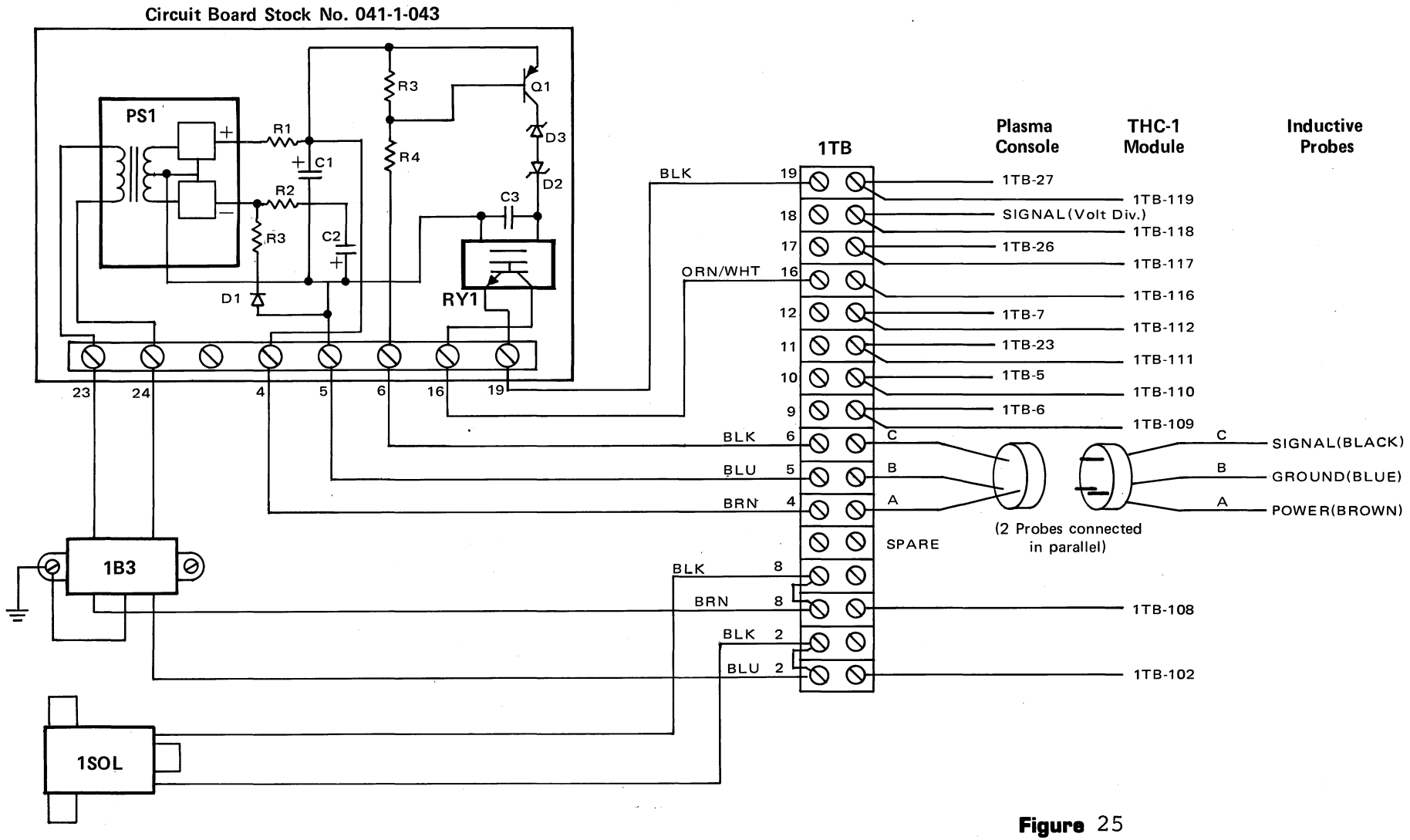
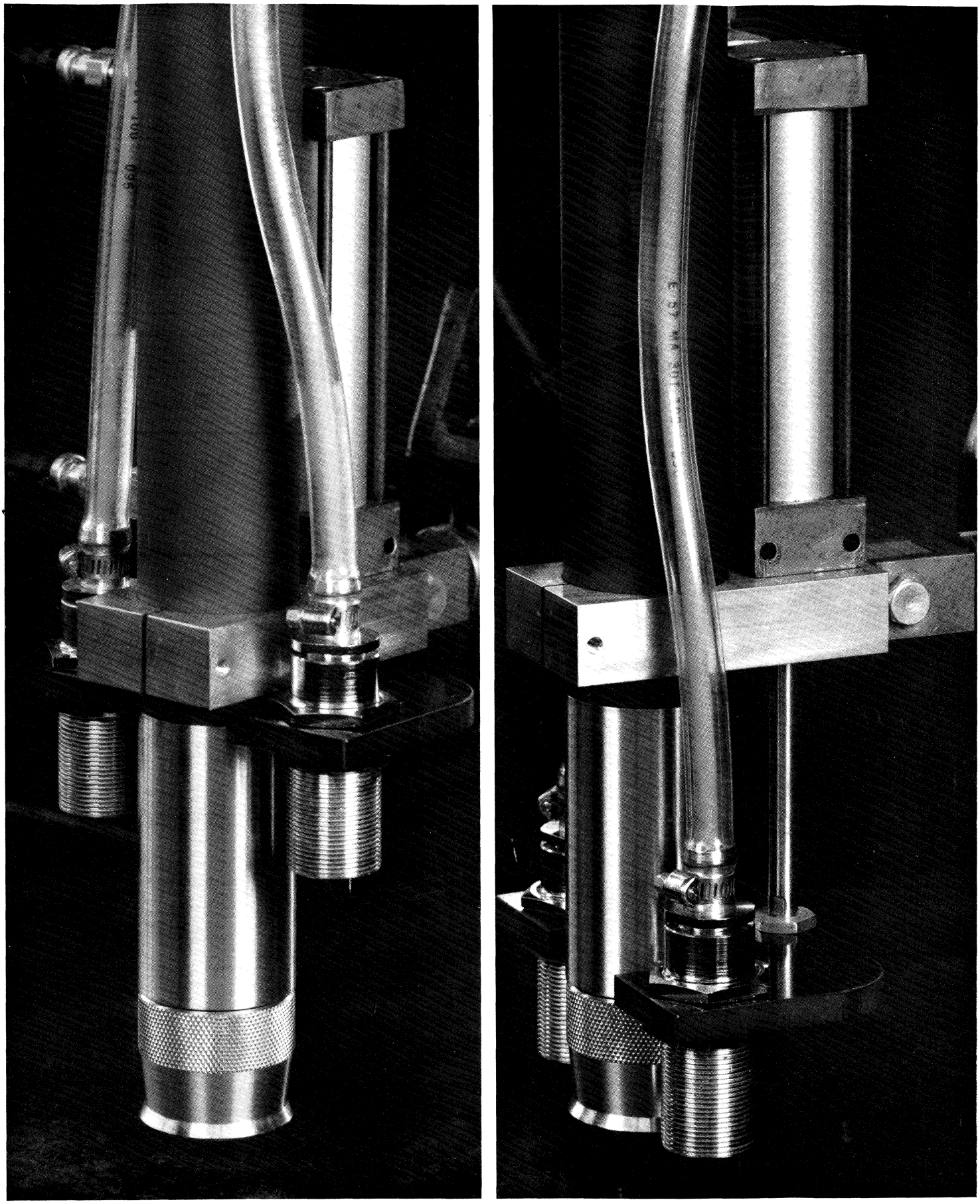


Figure 25

Interconnection Schematic Inductive Initial Height Sensor for Underwater Cutting



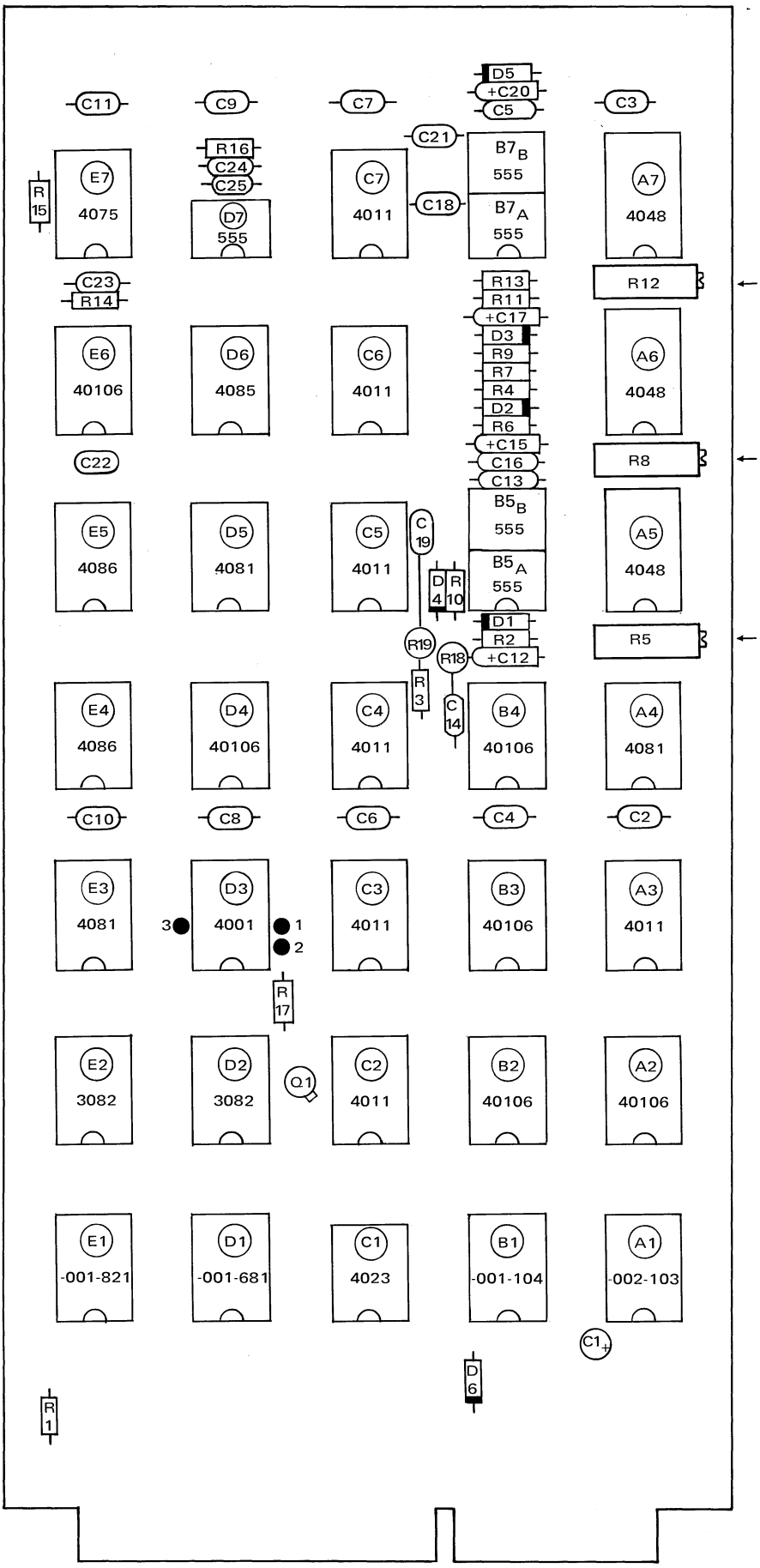
Probes Retracted **Probes Extended**

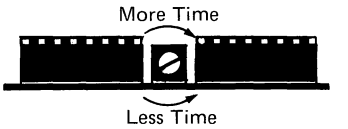
Figure 26

Inductive Probe Assembly for Underwater Cutting

HYPERTHERM, Inc.

THC-1 DIGITAL REV O
COMPONENT LOCATOR





● 1. Test Point - IHS Delay
● 2. Test Point - IHS Up
● 3. Test Point - Arc on Delay

CONTACT ASSIGNMENT			
22	+15 Volts	+15 Volts	Z
21	Stop LED		Y
20	Ready LED	Upper Limit Switch N.O.	X
19	IHS LED		W
18	IHS Complete LED		V
17	Stop Relay	Arc N.O.	U
16	IHS ON Relay		T
15	Start Relay	Control Auto/ Man. N.O.	S
14	AVC LED		R
13	Down LED	Start N.O.	P
12			N
11	Down Relay	Stop N.O.	M
10	Up Relay		L
9	Up LED	Man. Up N.O.	K
8			J
7	Hold N.O.	Arc Start A/M N.O.	H
6	IHS Complete N.O.	Man. Down N.O.	F
5	Power ON LED	Limit	E
4		Dead Band	D
3	Corner N.O.	Polarity	C
2			B
1	GND.	GND.	A

31 October, 1977

Figure 27

SECTION 11 REPLACEMENT PARTS LIST

PARTS LIST - CONTROL STATION
PARTS LIST - CONTROL MODULE STOCK NO. 053007
PARTS LIST - MISCELLANEOUS RELATED PARTS
PARTS LIST - MANUAL TRANSMITTER
PARTS LIST - PROGRAMMABLE TRANSMITTER
PARTS LIST - FLUIDIC IHS MODULE
PARTS LIST - INDUCTIVE IHS MODULE
PARTS LIST - INDUCTIVE PROBE ASSEMBLY

PARTS LIST STOCK NO. 053010 CONTROL STATION, THC-1/RVC.

	ITEM NO.	QUANTITY	SYMBOL	STOCK NO.	DESCRIPTION
	1	1		001095	ENCLOSURE, RVC REC W/POT
	2	1		001096	PANEL, FRONT, RVC REC W/POT
	3	1		001097	PANEL, REAR, RVC REC W/POT
	4	1		002104	(LENS) PANEL, AMBER, 2x3½
	5	1		004079	SPACER, POT,RVC REC DCM REC
	6	1	TWS	005052	SWITCH, THUMBWHEEL EEC
§	7	1	3RECP	008087	RECEPTACLE, 14 PIN M
	8	1		008099	KNOB
*	9	1	4RECP	008119	RECEPTACLE, 10 PIN M
	10	1	1POT/2POT	009311	POTENTIOMETER,DUAL,1KOHM/SEC
	11	1	2PC	041027	PC BD ASSY DCM REC/RVC REC

PARTS LIST STOCK NO. 053007 CONTROL MODULE, THC-1/RVC.

ITEM NO.	QUANTITY	SYMBOL	STOCK NO.	DESCRIPTION
1	1		001027	COVER, CONTROL MODULE THC
2	1		001032	COVER, REAR ACCESS THC-1
3	2		008072	THUMBSCREW
4	1	AC FILTER	009040	FILTER, AC, 3 AMP 3W1
5	1	TRAN	014003	TRANSFMR ISO 15VA 115 IN/OUT
6	1	CARD ENCLOSURE	029025	PC CARD CAGE SA, THC-1 RS/RVC
7	1		029053	WIRING HARNESS SA,THC-1/RVC
8	1	1PC	041003	PC BD ASSY DIGITAL THC-1
9	1	2PC	041005	PC BD ASSY ANALOG THC-1
10	1		041011	POWER SOURCE, THC-1/THC-2

SELECTED REPLACEMENT PARTS INCLUDED IN ASSEMBLIES LISTED ABOVE

ITEM NO.	QUANTITY	SYMBOL	STOCK NO.	DESCRIPTION
2	5(sets)		003046	BRACKET, RELAY MTG
* 3	1	1RECP	008032	RECEPTACLE, 20 PIN F
§ 4	1	2RECP	008118	RECEPTACLE, 10 PIN F
5	2	2,3 RECP	008065	SOCKET, PC BOARD
6	1		008068	FUSE HOLDER, DCM,PCC,THC-1&2
7	1	FU	008069	FUSE, 3/8A-SB, 313,375
8	10		008113	TERMINAL, RELAY (Gold Pins)
9	8	LT	009306	DIODE, SIL, LED, RED
10	1	D1	009034	DIODE, ZENER 15V
11	13	LC	009035	FILTER, ERIE
12	1	R12	009484	RESISTOR, 390 OHM, $\frac{1}{4}$W, 5%
13	2	4,5 DAS	009038	VARISTOR, MOV, 250V
14	3	1,2,3, DAS	009039	VARISTOR, MOV, 175V
** 15	5	1,2,3,4,5 CRE	003044	RELAY,I/O CONVERTER AC 673-6H (Red body)

* Mating plug for this receptacle is S/N 008086 PLUG, 14 PIN M (MS 3106B 20-27P)

§ Mating plug for this receptacle is S/N 008116 PLUG, 10 PIN M (MS 3106B 18-1P)

** When a DC Torch Lifter Motor is used, 4 CRE and 5 CRE should be replaced with Stock No. 003045 RELAY, I/O CONVERTER DC 673-22 (Blue body)

PARTS LIST STOCK NO. 053014 CONTROL MODULE, THC-1/RVC.(PROG. VOLT.)

ITEM NO.	QUANTITY	SYMBOL	STOCK NO.	DESCRIPTION
1	1		001027	COVER, CONTROL MODULE THC
2	1		001032	COVER, REAR ACCESS THC-1
3	2		008072	THUMBSCREW
4	1	AC FILTER	009040	FILTER, AC, 3 AMP 3W1
5	1	TRAN	014003	TRANSFMR ISO 15VA 115 IN/OUT
6	1	CARD ENCLOSURE	029042	PC CARD CAGE SA, THC-1/ PV/RS
7	1		029035	WIRING HARNESS SA,THC-1/PV/RS
8	1	1PC	041003	PC BD ASSY DIGITAL THC-1
9	1	2PC	041005	PC BD ASSY ANALOG THC-1
10	1		041011	POWER SOURCE, THC-1/THC-2

SELECTED REPLACEMENT PARTS INCLUDED IN ASSEMBLIES LISTED ABOVE

ITEM NO.	QUANTITY	SYMBOL	STOCK NO.	DESCRIPTION
2	5(sets)		003046	BRACKET, RELAY MTG
* 3	1	1RECP	008032	RECEPTACLE, 20 PIN F
§ 4	1	2RECP	008118	RECEPTACLE, 10 PIN F
5	2	2,3 RECP	008065	SOCKET, PC BOARD
6	1		008068	FUSE HOLDER, DCM,PCC,THC-1&2
7	1	FU	008069	FUSE, 3/8A-SB, 313,375
8	10		008113	TERMINAL, RELAY (Gold Pins)
9	8	LT	009306	DIODE, SIL, LED, RED
10	1	D1	009034	DIODE, ZENER 15V
11	13	LC	009035	FILTER, ERIE
12	1	R12	009484	RESISTOR, 390 OHM, $\frac{1}{4}$W, 5%
13	2	4,5 DAS	009038	VARISTOR, MOV, 250V
14	3	1,2,3, DAS	009039	VARISTOR, MOV, 175V
** 15	5	1,2,3,4,5 CRE	003044	RELAY,I/O CONVERTER AC 673-6H (Red body)

* Mating plug for this receptacle is S/N 008086 PLUG, 14 PIN M (MS 3106B 20-27P)

§ Mating plug for this receptacle is S/N 008116 PLUG, 10 PIN M (MS 3106B 18-1P)

** When a DC Torch Lifter Motor is used, 4 CRE and 5 CRE should be replaced with Stock No. 003045 RELAY, I/O CONVERTER DC 673-22 (Blue body)

ITEM NO.	QUANTITY	SYMBOL	STOCK NO.	DESCRIPTION
1	1		041007	VOLTAGE DIVIDER, THC-1/THC-2
2	1		041009	EXTENDER,PC BD,ANALOG,THC-1
3	1		041010	EXTENDER,PC BD,DIGITAL,THC-1

Items 2 and 3 are optional. Item 1 is supplied with each THC-1 package.

PARTS LIST STOCK NO. 054002 MANUAL TRANSMITTER

ITEM NO.	QUANTITY	SYMBOL	STOCK NO.	DESCRIPTION
1	1		002069	ENCLOSURE
2	1		002070	PANEL
3	1		008068	FUSEHOLDER
4	1		008069	FUSE, 3/8 AMP., SLO-BLO
5	2		008070	RELIEF, STRAIN
6	1		008073	STRIP, TERMINAL (16)
7	4		008110	SPACER
8	1		008114	SOCKET, POWER SOURCE
9	1		009045	FILTER, LINE, 1B1
10	1		041028	ASSEMBLY, P.C. BOARD, CURRENT-TRANSMITTER
11	1	041029	POWER SOURCE	

PARTS LIST STOCK NO. 054008 TRANSMITTER, PROGRAMMABLE CURRENT CONTROL

ITEM NO.	QUANTITY	IDENT	STOCK NO.	DESCRIPTION
1	1		002097	ENCLOSURE
2	1		002098	PANEL
3	1		004071	PANEL, FILTER, BLANK
4	1	1TGS	005044	TOGGLE SWITCH
5	7		008066	TERMINAL, TFE
6	1		008068	FUSEHOLDER
7	2	FU	008069	FUSE, 3/8 AMP., SLO-BLO
8	2	1SR	008070	RELIEF, STRAIN (Small)
9	1	2SR	008071	RELIEF, STRAIN (Large)
10	1		008114	SOCKET, POWER SUPPLY
11	1	5RECP	008118	RECEPTACLE, 10 PIN, FEMALE (MS3102A18-1S)
12	1		008133	STRIP, TERMINAL (20)
13	1		008134	STRIP, TERMINAL (8)
14	1		008136	FUSEHOLDER
15	8	R2	009036	RESISTOR, 2K OHM, 1%
16	1	FILTER	009045	FILTER
17	1	R3	009119	RESISTOR, 470 OHM, 1% (RN60D)
18	1	R1	009163	RESISTOR, 10K OHM, 1% w/(2)RA333 RING TERMINALS
19	1		027023	TOOL, POT TRIMMER
20	1	2PC	041028	P.C. BOARD ASSEMBLY, CURRENT TRANSMITTER
21	1	PS	041029	SOURCE, POWER
22	1	1PC	041041	P.C. BOARD ASSEMBLY, CURRENT PROGRAMMER

PARTS LIST STOCK NO. 053013 FLUIDIC IHS MODULE

ITEM NO.	QUANTITY	SYMBOL	STOCK NO.	DESCRIPTION
1	1		002047	ENCL., CONTROL MODULE IHS
2	1		002048	PANEL, IHS
3	1	1CR	003034	RELAY, 120VAC 4PDT MINI
4	1		003035	SOCKET, RELAY, MINI
5	2		008071	STRAIN RELIEF, ½ x.375 -.500
6	1	2TB	008073	TERMINAL STRIP (16)
7	1		009041	FILTER, AC, 1 AMP 1B3
8	1		024088	HOSE ASSY, IHS HI PRESS, 2.5'
9	1		029046	TEE SA, IHS MOD/169 CONS
10	1	1PC	041049	PC BD ASSY IHS-REV 4
11	1		043006	TRANSDUCER ASSY IHS REV 4

PARTS LIST STOCK NO. 053012 INDUCTIVE IHS MODULE

ITEM NO.	QUANTITY	SYMBOL	STOCK NO.	DESCRIPTION
1	1		002095	ENCL., CONTROL MODULE UW-IHS
2	1		002096	PANEL, UW-IHS
3	1		006021	VALVE, SOL 75 PSI ¼ NPTF
4	2		008070	STRAIN RELIEF, ½ x .312-.375
5	2		008071	STRAIN RELIEF, ½ x .375-.500
6	1		008073	TERMINAL STRIP (16)
7	2		008095	JUMPER, TERMINAL
8	1	FIL	009041	FILTER, AC, 1 AMP 1B3
9	2		015001	ADAPTER, BULKHEAD, ¼ NPTF
10	4		015005	ADAPTER, ¼ NPT x #4
11	2		015006	SWIVEL, #4
12	1		015100	ADAPTER, ¼ NPT x #4 POLY
13	1		015502	NIPPLE, ¼ x CLOSE
14	1		024038	HOSE ASSY, #4 x 7"
15	1		041043	PC BD ASSY UW-IHS

PARTS LIST STOCK NO. 029044 INDUCTIVE PROBE ASSEMBLY .

ITEM NO.	QUANTITY	SYMBOL	STOCK NO.	DESCRIPTION
1	1		004082	BRACKET, IND SENSOR, UW-IHS
2	1		004083	BRACKET, TORCH MTG, UW-IHS
3	2		004085	NUT, INSULATING, IND SENSOR
4	2		005074	SENSOR, INDUCTIVE UW-IHS
5	2		008144	PLUG, 3 PIN F
6	2		008145	PLUG, 3 PIN M
7	1		015005	ADAPTER, $\frac{1}{4}$ NPT x #4
8	1		027024	CYLINDER, AIR, IND SENSOR
9	6 ft (1.8m)		046023	TUBING, 3/8" (9.5mm) ID TYGON