Go-Power Systems

"The Measure of Performance"

OPERATION, INSTALLATION, SERVICE and REPAIR of

REMOTE INSTRUMENT CONSOLE MODELS C-11, C-11-1, and C-11-2

1419 Upfield Drive,
Carrollton, Texas 75006

(972) 446-2046
(800) 527-0883

TABLE OF CONTENTS

SECTION I

OPERATION

1-1. PURPOSE AND DESCRIPTION.

1-2. This manual provides information necessary for the installation, operation, and maintenance of the Models C-11 and C-11-1 (formerly DR) Instrument Consoles. This equipment is manufactured by Go-Power Systems, Palo Alto, California.

1-3. SCOPE. This manual is divided into six sections. Section I describes the operation of the C-11 and C-11-1 instrument consoles. Section II provides information necessary for the proper installation of the console. Section III contains information for maintenance and repair of the console. Section IV provides the troubleshooting procedures for the system. Section V contains the circuit diagrams, including a comprehensive point-to-point wire list. Section VI is the illustrated parts breakdown (exploded view) of the console, that will provide the user or repair technician with an easy-to-understand method of locating and identifying parts referenced in other sections of this manual.

1-4. USE OF NOTES, CAUTIONS, AND WARNINGS. Inserts in the text are used to emphasize important and critical instructions. The meaning and importance of each is noted below. It is imperative that these inserts be read and thoroughly understood before performing any procedure described in this manual. In all cases, the insert will precede the procedure or condition to which it applies.

NOTE

An operating procedure, condition, etc., which it is essential to highlight.

CAUTION

An operating procedure, practice, etc., which, if not strictly observed, could result in damage to, or the destruction of, equipment.

WARNING

An operating procedure, practice, etc., which if not correctly followed, could result in severe personal injury.

1-5. PRINCIPLE OF OPERATION. The models C-11 and C-11-1 remote instrument consoles are desk-height units that contain complete instrumentation and controls for use with all engine dynamometers manufactured by Go-Power Systems. These consoles are equipped with an engine overspeed cutoff system that can be preset to any desired maximum RPM. This overspeed system will automatically shutdown the engine under test when the maximum RPM level is reached; thus preventing engine runaway.

1-6. These consoles are designed to precisely measure dynamometer system and engine operating parameters, monitor engine temperatures and pressures, and contain positive engine operating and overspeed controls. The major difference between the C-11 and C-11-1 consoles is that the C-11-1 console contains instrumentation designed for measuring performance of industrial gas, diesel, and diesel truck engines; while the C-11 console contains instrumentation for automotive and certain marine-type engines.

Table 1-1. C-11 and C-11-1 Console Instruments

COMMON NAME	DESCRIPTION	
Torque Meter (C-11) (C-11-1) (C-11-2)	Range: Accuracy: Repeatability:	0 to 750 lb-ft 0 to 1200/1500 lb-ft 0 to 2000 lb-ft ±0.3% f.s. ±0.05% f.s.
Tachometer (C-11) (C-11) (C-11-1) (C-11-2)	Ranges (RPM): Accuracy:	0 to 1000, 0 to 3000, 0 to 6000, and 0 to 10, 000 0 to 2500, 0 to 4000 ±0.5% f. s. ±0.2% f. s.
Temperature Meter	Ranges (°F):	0 to 100 x 1°, 100 to 200 x 5°, 200 to 400 x 5°, 400 to 600 x 5°, and 0 to 2000 x 5°
Oil Pressure (Standard) (Optional)	Ranges (psi):	0 to 100, ±2% f.s. 0 to 150, ±2% f.s.
Fuel Pressure (C-11) (C-11-1)	Ranges (psi):	0 to 10, ±2% f.s. 0 to 150, ±2% f.s.
Vacuum (C-11 only)	Range (Hg):	0 to 30-in., ±0.5-in.
Hourmeter (C-11-1 only)	Elapsed test time resetable counter (999.99 hrs)	
Oil Temperature	Ranges (°F)	100° to 325°, ±2% f.s.
Water Temperature	Ranges (°F)	100° to 250°, ±2% f.s.

Table 1-2. Special Tools Required

DESCRIPTION	USE
Audio Signal Generator (0 to 10 kHz)	Calibration and Troubleshooting circuit card assemblies
Frequency Counter (1V RMS)	Calibration and Troubleshooting circuit card assemblies
Digital Voltmeter (optional) (0 to 19.99 VDC)	Calibration and Troubleshooting circuit card assemblies
Soldering iron	Checking and securing all electrical connections
Screwdriver, 6 in. cresent wrench, and 1/8 in. Allen wrench	Potentiometer adjustments, control panel knobs and dials

1-12. OPERATING THE INSTRUMENT CONSOLES. To operate the instrument consoles, proceed as follows:

1. Check the engine for water, oil, exhaust system and fuel. Make sure no wires or lines are against the exhaust or near the fan.

2. Connect the engine battery. If the console lights go on, push the console IGNITION button to turn lights off.

3. Set load control value to zero, turn on the water supply to the console fully, and check for leaks.

4. Plug the console into 117 VAC.

5. Push the IGNITION button on the console, and the following should occur:

   (a) The Ignition light should go on.

   (b) If overspeed comes on, reset overspeed.

   (c) The gauge lights should be on.

   (d) The oil pressure warning light should be on if it has been wired.

   (e) The hot water warning light should be off, even if it has been wired.

   (f) The start and overspeed lights should be off.

   (g) The fuel pump light could be either on or off.

6. If the fuel pump light is off, push the button, and the light should come on. (Not required if a mechanical fuel pump is being used.)

7. Control the throttle while holding the start button down, until the engine starts. Now check the following:

   (a) Engine oil pressure

   (b) Fuel pressure

   (c) Tachometer

8. To use the overspeed set control:

   (a) Set the numbers on the dial to the desired maximum RPM for the engine; for example, 620 on the dial stands for 6200 RPM. When the engine exceeds 6200 RPM, the engine power switch will shut off and the red overspeed light will come on. The engine will stay shut down until restarted.

   (b) To restart the engine, push the power button to turn it off, and then push it again to turn the engine power on. Now restart the engine and continue the test.

   (c) To override the overspeed circuit, simply hold the red overspeed button down. The engine will not activate the overspeed circuit, as long as this button is held down, even if the overspeed RPM is exceeded.

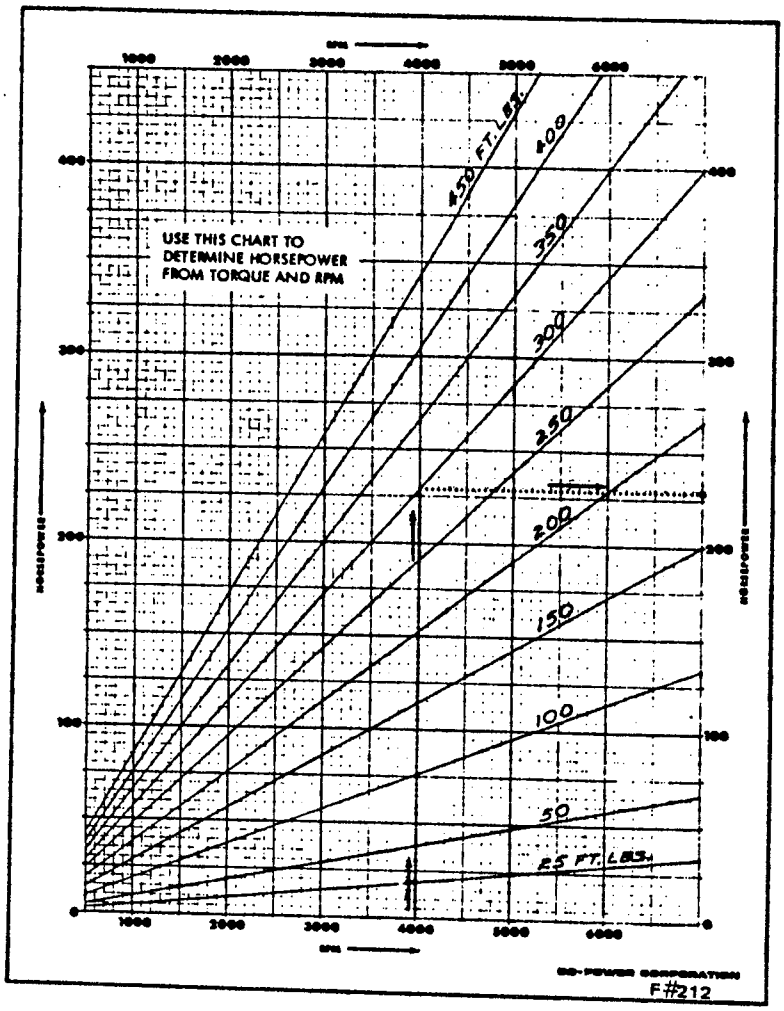


Figure 1-1. Chart for Determining Horsepower from Torque and RPM, Gas Engines

1-20. TEST DATA COLLECTION AND ANALYSIS.

NOTE

Engine performance is affected significantly by the atmospheric conditions at the time of the test. (Refer to Go-Power Manual F#209.) To ensure the greatest accuracy, it is desirable to record the barometric pressure, and wet and dry bulb air temperatures, also at the time of the test. This information can frequently be obtained from the local airport, if you do not have your own instrumentation. Once this data is known, the atmospheric correction factor can be determined.

1-21. ENGINE ANALYSIS DATA SHEET. The data sheet, Figure 1-3, may be used to record test data on any engine operating between 1000 and 5500 RPM. The dynamometer load should be adjusted to obtain the desired RPM, for instance 4000 RPM, and then the torque should be recorded in the space provided in line 2 under 4000 RPM.

1-22. If the Go-Power M-5000 Air-flow-Fuel-flow system is also used, the air-meter and fuel-flow meter reading should also be recorded on lines 3 and 4 below the correct RPM. From this data, all the factors shown on the data sheet can be calculated. Lines 5 and 6 are left blank for other appropriate test data such as spark advance, oil temperature, oil pressure, engine vacuum, or water temperature.

ENGINE ANALYSIS DATA SHEET

Engine Manufacturer _____ Model _____ Test Date _____
Engine Type _____ Bore _____ Serial No. _____
Engine Displacement _____ Ignition Advance _____ Stroke _____
Fuel Type _____ Specific Gravity _____
Oil Type _____ Fuel/Oil Ratio (2-cycle) _____
Air Temperature _____ °F Barometric Pressure _____ Inches of Mercury
Wet Bulb Air Temperature _____ °F
Correction Factor for Horsepower _____
Test Observers _____

1. ENGINE RPM	1000	1500	2000	2500	3000	3500	4000	4500	5000	5500
2. TORQUE (LBS.-FT.)										
3. AIR METER (IN./H_2O)										
4. FUEL METER										
5.										
6.										
7. HORSEPOWER										
8. CORR. HORSEPOWER										
9. AIR FLOW (LBS./HR.)										
10. CORR. AIR FLOW										
11. FUEL FLOW (LBS./HR.)										
12. AIR/FUEL RATIO										
13. SPECIFIC FUEL CONSP.										
14. VOLUMETRIC EFF. (%)										
15. BMEP (PSI)										
16. THERMAL EFF. (%)										

F#210

GP-1003

Figure 1-3. Engine Analysis Data Sheet

SECTION II

INSTALLATION

2-1. GENERAL.

2-2. This section contains the instructions for both the initial installation of the console and setup procedures for engine tests. These procedures will vary slightly for the C-11 and C-11-1 consoles. However, the differences in setting up the C-11-1 console for tests are inherently obvious to the users of diesel engines and, therefore, only those procedures generally required in both applications are described here.

2-11. The instruments in this unit are sensitive to vibration, so it is advised that the console be mounted outside the operating environment of the engine. If the floor is subject to transmitted vibrations, the table should be placed on material to dampen out vibrations. All cables and lines to the dynamometer and engine should be routed in a channel in the floor or hung overhead in order to keep them out of the way. The throttle cable must be routed direct to the engine.

2-4. POWER REQUIREMENTS.

2-5. ELECTRICAL SYSTEM. The consoles require a power line supply voltage of 117 VAC, 60 Hz, for the console instruments. The power source should be within four feet of the rear of the console.

2-6. WATER SUPPLY. The water supply requirements will vary slightly depending upon the specific dynamometer to be used. However, most engines use approximately 2.66 gallons of water per horsepower hour. The pressure requirement is nominal and city water line pressure is usually adequate. Refer to manual supplied with dynamometer for specific water requirements.

2-7. CONSOLE CONTROLS. The function of the electrical controls used in the consoles is described in Table 2-1.

2-8. ENGINE AND CONSOLE CONNECTIONS.

2-9. LOAD CONTROL AND THROTTLE CONNECTIONS. The water supply hoses are connected to the load control valve (on the right side panel of the console) through a notched opening in the bottom panel of the console. Installation of the water supply hoses is described in paragraph 2-10, steps 1 through 4. The throttle control lever (on the left side panel of the console), will hold the engine throttle at any setting from 0 to 100% during engine tests. A flexible steel cable and housing is supplied with each console to connect the engine carburetor lever to the console throttle control lever. The inner cable must be connected to the carburetor throttle lever and the outer housing clamped to the engine (see Figure 2-1). Cable clamp mounts are provided with the Go-Power dynamometer. A mount must be installed on those engines not already so equipped. The other end of the throttle is installed through an opening in the rear panel, is locked into position by a cable clip (also mounted on the rear panel), and is connected to the console throttle lever and housing clamp. (See Figure 6-5.) The carburetor lever travel is different on each type of carburetor but the throttle control cable can be adjusted to compensate for this difference. After connecting the throttle cable to the carburetor and instrument consoles, as shown in Figure 2-1 and described in paragraph 2-10 (steps 5 and 6), adjust the cable by following the adjustment procedures beginning with step 7.

2-10. The following procedures are for the initial installation, or replacement, of water supply hoses or the throttle cable in the console.

Load Control:

1. Carefully set the console face down on the table and remove the screws retaining the bottom panel of the console.

2. Install the nonfitted end of the load control inlet hose onto one side of the load control valve (see Figure 6-3).

3. Install the nonfitted end of the load control outlet line (dynamometer inlet supply line) onto the other side of the load control valve.

4. Install and tighten hose clamps on both hoses. (Proceed to step 11 below, if only installing water supply hoses).

Throttle Control Adjustment:

5. Route the throttle cable through the hole in rear panel and connect the throttle cable and swivel to the throttle control adjustment arm.

6. Lock the arm of the housing clip (on the rear panel) in position over the throttle cable.

7. Adjust the throttle cable connector, on the throttle lever clamp, until the carburetor lever is just beginning to move at 20% throttle.

8. Tighten the housing clamp and slowly rotate the throttle lever to 100% while watching the carburetor lever. Do not force. If the carburetor reaches a wide open position before the throttle handle reaches 100% open, shorten the stroke by sliding the cable connector up the throttle control lever clamp. If the carburetor does not reach a wide open position when the throttle lever reaches 100% open, lengthen the stroke by sliding the cable connector down on the throttle control lever clamp.

9. Repeat the above procedures until the throttle lever reads 20% at idle and 100% at wide open throttle.

10. It is desirable to reduce carburetor return spring tension to the lowest level that will close the throttle repeatably.

11. After adjusting throttle cable, replace bottom panel and screws. Thread water hoses through opening in table top and set console into position in table top.

2-11. NONADJUSTABLE CONSOLE INSTRUMENTS. (See paragraph 2-12 for step-by-step connecting instructions.) The fuel pressure, oil pressure, and vacuum guages are bourdon type. The fuel and oil pressure guages are connected to the engine by a 1/4-inch diameter nylon hose with quick disconnect fittings on one end, and 1/8-NPT pipe fittings on the other end. The vacuum guage uses a 3/16 plastic line with a quick disconnect fitting on one end. The oil and water temperature guages are the vapor type and are connected to the engine by flexible metal tubes. (These tubes cannot be disconnected from the gauges, and therefore, require reasonable care to prolong the useful life of these instruments.)

WARNING

It is imperative that electrical, fuel, and oil lines be routed away from the exhaust manifold and muffler system. The engine test stand frame provides a convenient means to support these lines in the area of the test engine.

2-13. ELECTRICAL INSTRUMENTS AND ENGINE WIRING. The instrument console is equipped with overspeed reset, fuel pump, ignition, and starter pushbutton switches. These switches control the engine and panel controls, and light when the electrical system is on. Physically, the switches are connected to the engine via a wiring cable to the remote panel on the engine test stand. The temperature meter is also connected to the remote panel via a cable. Additional cables are available so that multiple setups can be performed if desired. Figures 2-2 and 2-3 are simplified wiring diagrams for connecting engine electrical systems to the remote panel. The remote panel is equipped with twelve temperature probe jacks which facilitate easy connection of the temperature measurement probes to the desired measurement locations; i.e., exhaust ports, head temperature, inlet fuel temperature, etc. To make console and engine wiring connections, proceed as follows:

Instrument Console/Remote Panel Connections:

1. Mount the remote panel permanently onto the engine stand near the front of the engine.

CAUTION

Care must be exercised in mating sockets and connectors to ensure that the socket pins are not bent or broken. Mismating these connectors can severely damage the console instruments.

It is especially important that the larger diameter cable be connected to the ENGINE INPUT and the smaller diameter cable be connected to the TEMPERATURE METER.

2. Connect the male socket end of the larger cable into the rear panel socket marked ENGINE INPUT.

3. Connect the female socket end of the larger cable into the remote panel socket marked ENGINE INPUT.

4. Connect the female socket end of the smaller cable into the rear panel socket marked TEMPERATURE METER.

5. Connect the male socket end of the smaller cable into the remote panel socket marked TEMPERATURE METER.

6. Connect the male socket end of the tachometer cable into the rear panel socket marked TACHOMETER.

7. Connect the other end of the tachometer cable to the connector on the dynamometer. (Refer to Section III, paragraph 3-8, for calibration of the tachometer.)

8. If used, the digital counter is connected to the rear panel via the socket marked DIGITAL PANEL OUTPUT.

Remote Panel/Engine Connections:

CAUTION

When wiring the engine, do not connect the hot side of the battery until ready for testing.

1. There are two methods to connect the engine to the remote panel. For quick tests on 12 VDC engines only, plug the four-wire cable into the plug on the panel and connect the four alligator clips to the points marked on the wires.

GND — connect to the grounded side of the engine or battery.

BAT — connect to the hot side of the battery (Positive +).

START — connect to the starter solenoid terminal on the starter or starter relay.

COIL — connect to the ignition coil resistor wire, or to the engine PT pump or fuel control system.

2. A special hook-up wire, Delco-Remy No. 1967344, is needed for engines equipped with alternators. This hook-up wire contains a one-way diode and a resistor to ensure proper functioning of the engine alternator and to allow the power button to turn off the engine. Without the diode in the circuit, the engine could continue to run on the electrical power supplied by the alternator. This wire can easily be damaged if improperly installed. Do not use it on generator equipped engines.

3. For longer tests or for a neater installation, the engine and engine accessories should be wired to the terminal strip on the back of the remote panel. The following list shows the proper connection points for a 12 VDC engine electrical system with a coil or magneto. Special provisions must be made for other voltage systems such as 6V, 24V, or 48 VDC.

Terminal Strip Wiring

1. To ignition ballast resistor, coil, PT pump or fuel control system.
2. Accessory Connection.
3. To electric fuel pump (use relay if over 5 amps*).
4. To low oil pressure switch.
5. To hot water sensor switch.
6. To ground.
7.
8. Magneto kill. Eight automatically connected to seven when power switch is off and to nine
9. when power switch is on.
10. Overspeed accessory switch. Eleven is automatically connected to ten until overspeed is
11. reached. When overspeed is reached, eleven automatically connects to twelve. Wire auto-
12. matic fuel shut-off, throttle shut-off, or alarm through here.
13. To starter solenoid or relay.
14. Not used.
15. To 12 VDC battery hot side.

*If the electric fuel pump used draws more than 5 amps, a relay must be used. Use a horn relay or a Potter-Brumfield part no. PR3DY with a no. 35D013 cover. This relay will handle up to 25 amps, and is available from most electronic supply houses.

SECTION III

MAINTENANCE AND REPAIR

3-1. GENERAL.

3-2. The C-11 and C-11-1 instrument consoles were designed for extensive use and should be relatively trouble free. Replacement of damaged components, rather than repair, is recommended in those instances involving accidental instrument damage (gauges, switches, instrument faces, etc.). Common parts, such as fuel and vacuum lines, power cords, and hoses should be handled in accordance with good shop maintenance standards. Except for the instruments listed in the following paragraphs, the panel gauges are factory set and are not adjustable.

3-3. INSTRUMENT CALIBRATION.

3-4. TORQUE METER. Each Go-Power dynamometer has a torque calibration arm designed for use with that particular model. Each torque calibration arm has the effective weight stamped on it. Except the DT-1000. The torque calibration arm should be attached to the dynamometer as outlined in the manual supplied for that unit. The method of adjusting the torque meter varies slightly, depending upon which dynamometer is to be operated. Generally, however, the method of calibration is the same. A basket of appropriate weight should be constructed for the torque range to be tested.

NOTE

The arm should be as close as possible to horizontal to ensure the greatest accuracy.

3-5. To check calibration, add "effective weight" of the calibration arm to twice the combined weight of the basket and weights. For example, if the effective weight of the arm was 4.4 lbs., and the weight of the basket was 12 lbs., then with additional weight of 25 lbs., the formula would be $4.4 + 2(12 + 25) = a$ gauge reading of 78.4 lbs. For the best results, average two readings taken with the same weight. The first, or ascending, reading should be taken after lifting up the arm and releasing it slowly. The second, or decending, reading should be taken after pressing down on the arm and releasing it slowly.

3-6. At any point in its range, the torque gauge should correspond to the test weight within 1/2% of full scale following the procedures outlined above. If not, adjust the torque gauge by turning the large chromed knob in front of unit, which turns face of gauge. If gauge is still inaccurate after this adjustment, refer to gauge calibration section of Appendix A.

3-7. TEMPERATURE METER. The temperature meter is a 100 microamp meter that is adjustable only by trimpot adjustment on the printed circuit card. This meter is set at the factory before shipment and normally will not require adjustment. However, if the meter should be found to be inaccurate, the following paragraph lists the adjustment procedures. Calibration plugs are available from Go-Power. The letter stamped on the thermistor probe must be specified when ordering these plugs.

WARNING

Hazardous voltages are contained in this equipment. Servicing and adjustments to console instruments should be performed only by a qualified electronics technician.

3-8. To calibrate the temperature meter on the consoles, proceed as follows:

6. Move the position selector switch to no. 2 position and adjust potentiometer RA2 (500Ω) to full scale reading. Return the position selector switch to no. 1 position and recheck the low reading (readjust if required). Put the position selector switch back to no. 2 position and recheck the full scale reading (readjust if required).

7. With the position selector switch still in the no. 2 position, adjust RF3 (1000Ω) to 100°F reading on the 100°F to 200°F scale.

8. Move the position switch selector to no. 3 position and adjust RB3 (500Ω) to full scale reading.

9. Recheck the 100°F and 200°F reading by switching the position selector switch to no. 2 position for 100°F and no. 3 for 200°F (readjust if necessary).

10. With the position selector switch in no. 3 position, move temperature range switch to 200° to 400°F position. Adjust potentiometer RB4 (200Ω) to low reading on 200°F scale to 400°F. Shift position selector switch to no. 4 and adjust RF4 (50Ω) to full scale reading. Recheck (readjust if necessary) as outlined previously.

11. Move temperature range switch to 400°F to 600°F position with the position selector switch in no. 4 position. Adjust RB5 (100Ω) to 400°F (on 400°F to 600°F scale). Put position selector switch to no. 5, and adjust RF5 (50Ω) to full scale. Recheck and readjust if necessary.

3-9. If it is suspected that the circuit card is faulty it should be returned to the factory for replacement.

3-10. TACHOMETER. The tachometer range meter is a 1 ma meter that is calibrated only by trimpot adjustments on the printed circuit card (see Figure 3-2).

3-11. To calibrate the tachometer range meter, proceed as follows:

1. Plug audio frequency generator into tachometer input.

2. Remove rear cover.

3. Plug console into 117 VAC power source.

4. Press ignition pushbutton switch (leave audio generator off) and reset overspeed switch.

5. Adjust meter to zero with trimpot on card.

6. Turn tachometer range switch to 10,000 RPM range, 4,000 RPM on C-11-1.

7. Set audio frequency generator to 10 kHz at 20 volts rms and turn on and check with digital counter, 4 kHz on C-11-1.

8. Adjust tachometer to full scale reading.

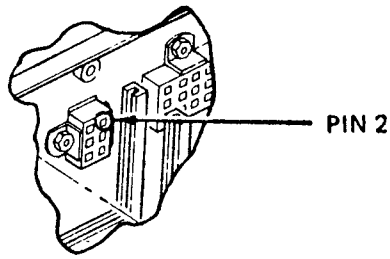
9. Set overspeed digidial to 999,400 on C-11-1.

10. Adjust audio frequency generator to 9990 RPM,4000 RPM on C-11-1.

11. Adjust overspeed trimpot until unit trips and overspeed light comes on. Repeat several times until sure of adjustment.

3-12. POWER SUPPLY. The power supply circuit card (see Figure 3-3) is adjusted using a voltmeter as follows:

1. Connect negative of voltmeter lead to chassis ground and positive lead to pin 2 of digital tachometer connector (on rear panel) and adjust trimpot to +15V, ±0.2V.



2. With negative lead still connected to chassis ground, connect positive lead to pin 4 of digital tachometer connector and adjust second trimpot to -15V, ±0.2V.

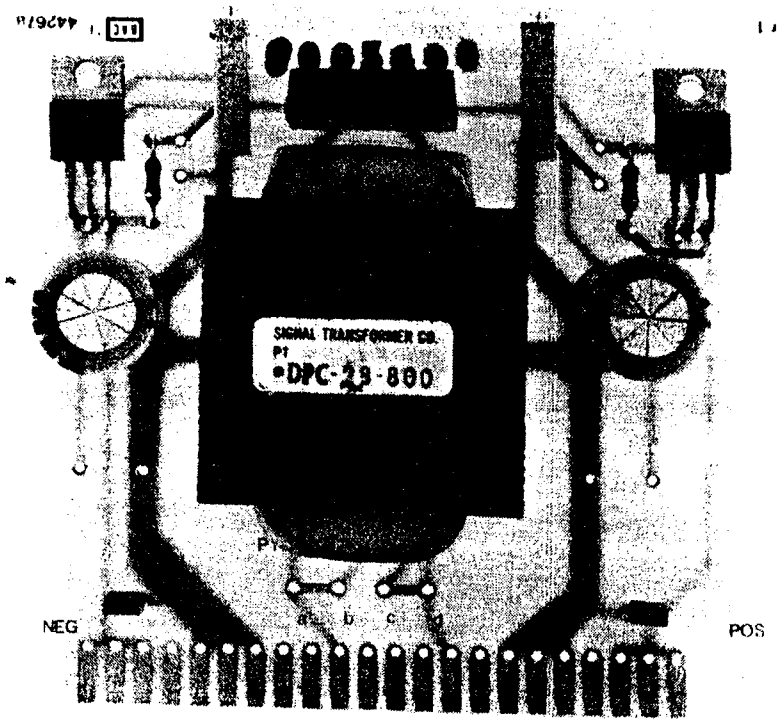


Figure 3-3. Regulated Power Supply Circuit Card Assembly

3-13. LAMPS AND FUSES.

3-14. To replace panel lamps, simply remove lens cover and press lamp to one side of socket and remove. To replace lamp, simply press into socket. The fuse holders are located on the rear console panel. When replacing the fuses, ensure that the replacement fuse is the proper rating.

SECTION IV

TROUBLESHOOTING

4-1. INTRODUCTION.

4-2. Each instrument console is thoroughly adjusted and tested before shipment to ensure the best possible performance and accuracy. However, under some operating conditions, certain problems could occur while conducting engine tests which would detrimentally effect either dynamometer operation or cause errors in test results. Table 4-1 below provides a comprehensive list of symptoms, their probable cause, and suggested remedies to each of the potential problems described. The number in parenthesis () indicates the location of the referenced part in the illustrated parts breakdown, Section VI.

Table 4-1. Troubleshooting the C-11 and C-11-1 Instrument Consoles

SYMPTOM	PROBABLE CAUSE	REMEDY
Tachometer		
Tachometer does not work	Console not connected to power source	Plug into 117V ac power source
	Ignition switch off	Push ON
	Blown fuse	Check/replace with fuse of same rating
	Faulty tachometer cable	Check for opens or shorts
	Faulty magnetic pickup on dynamometer	Check with ohmmeter (approx 200Ω)
	Improper clearance on magnetic pickup on dynamometer	Check/adjust to 0.005 in. on dynamometer
	Loose circuit cards	Check/reset tight into connectors
	Faulty tachometer circuit card	Replace circuit card
	Faulty power supply circuit card	Check output at connector ±15V dc and replace as required (see paragraph 3-12.)
	Faulty tachometer switch	Replace switch (6-4-28)
	Faulty tachometer meter	Replace meter (6-4-26)
Tachometer reading steady but inaccurate	Improper clearance on magnetic pickup on dynamometer	Check/adjust to 0.005 in. on dynamometer
	Out of calibration	Check calibration (see paragraph 3-10.)
	Faulty power supply circuit card	Check output at connector ±15V dc and replace as required (see paragraph 3-12.)
	Faulty tachometer circuit card	Replace circuit card

Table 4-1. Troubleshooting the C-11 and C-11-1 Instrument Consoles (continued)

SYMPTOM	PROBABLE CAUSE	REMEDY
Temperature Meter		
Temperature meter does not work	Console not connected to power source	Plug into 117 vac power source
	Blown fuse	Check and replace
	Faulty power supply circuit card	Check output at connector ± 15 vdc and replace as required (see paragraph 3-12)
	Ignition switch off	Push ON
	Faulty cable or connectors	Check/replace as required
	Faulty probes	Replace
	Faulty temperature meter circuit card	Check (see paragraph 3-7) replace as required
	Faulty temperature meter	Replace meter
Temperature meter inaccurate	Dirty connectors	Clean and reconnect
	False reading (misplaced probes)	Check probe placement (see T2100 instructions)
	Misadjustment of meter	Check calibration (see paragraph 3-7)
	Faulty power supply circuit card	Check/replace as required
	Faulty cables or connectors	Check/replace as required
	Faulty probes	Check/replace as required
	Faulty temperature meter	Check/replace as required
	Faulty temperature meter switch	Check/replace as required
	Faulty temperature meter circuit card	Check (see paragraph 3-7) replace as required
Controls		
Ignition switch does not work or works improperly	Blown fuse	Check/replace as required
	Battery disconnected	Clean and connect terminals
	Console not connected to power source	Plug into 117 vac power source

SECTION V

CIRCUIT DIAGRAMS

5-1. INTRODUCTION.

5-2. This section contains the circuit diagrams for the C-11 and C-11-1 consoles. Electrically, both units are identical except for the additional 117VAC hour meter wires (C-11-1) and, therefore, no distinction between the two is made in this section.

5-3. Servicing of the electrical components should be accomplished only by a qualified electronics technician. If a fault is found in a printed circuit card, it is recommended that the circuit card be returned to the factory for repair or replacement.

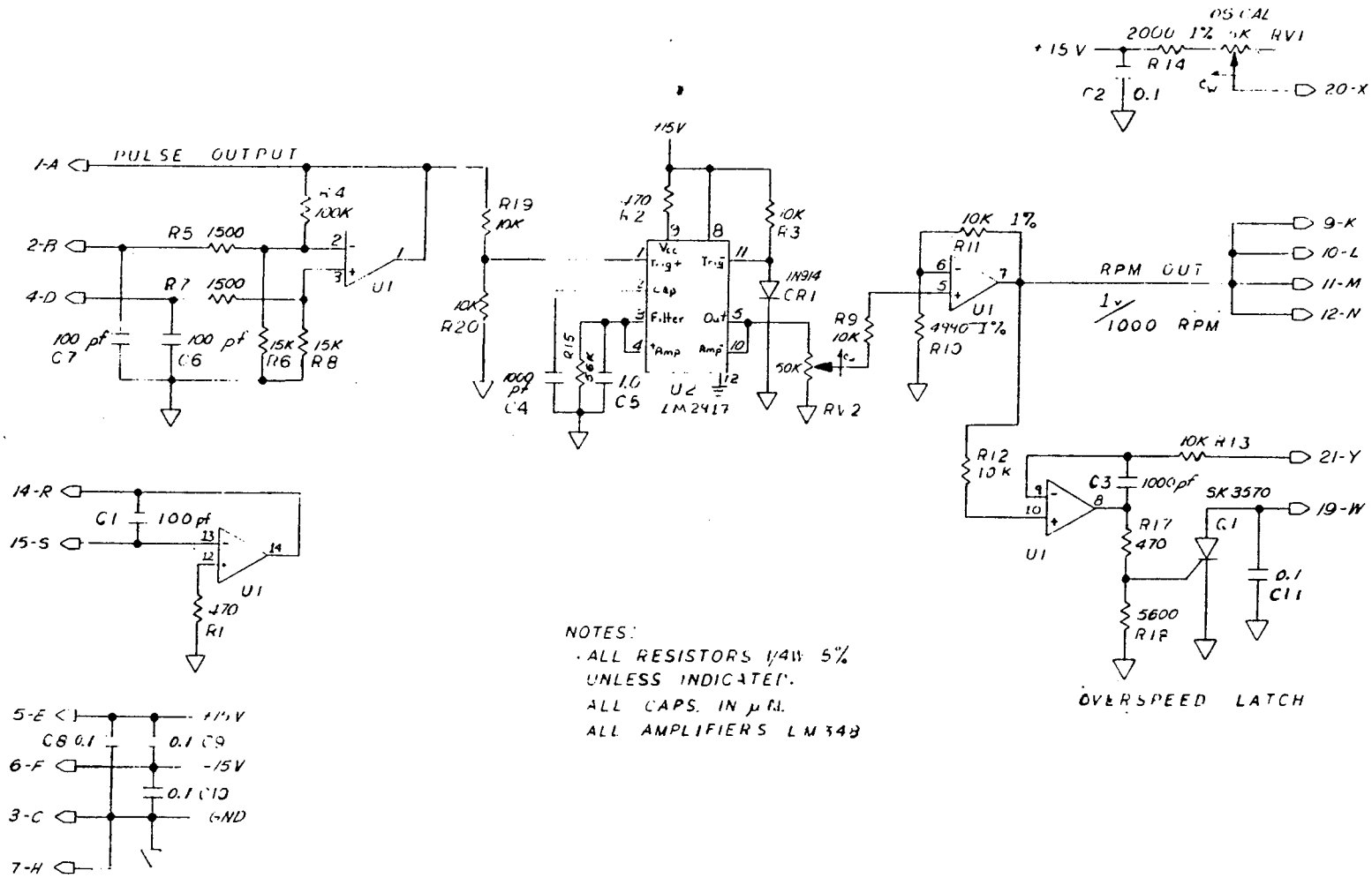


Figure 5-2. Tachometer Circuit Card Assembly, Schematic Diagram

SECTION VI

ILLUSTRATED PARTS BREAKDOWN

6-1. GENERAL.

6-2. This illustrated parts breakdown is divided into two parts. Part 1 is the Group Assembly Parts List and part 2 is the Numerical Parts List. This section, when used in conjunction with other sections of this manual, provide the user or repair technician with an easy-to-understand method of locating and identifying all components of the DR console.

6-3. GROUP ASSEMBLY PARTS LIST. The group assembly parts list is presented in disassembly sequence for each subassembly. The illustrations are keyed, by means of an index number, to the related parts list, and specifically identifies each part in the illustration. Parts listed without index numbers are not illustrated and, in most cases, are accessories listed only for identification to a particular subassembly.

6-4. Figure and Index Number. The figure and index number column provides the figure numbers and index numbers that are used to key a part or assembly listed in the parts list to its appearance in the illustration.

6-5. Part Number. The part number column lists the manufacturer's part number. This number should be referenced when ordering replacement parts for the C-11 or C-11-1 console. When the part number column contains the entry COML, the part described is a common use part available from most hardware or auto parts stores.

6-6. Description. This column provides the common name of the part and any identifying characteristics.

6-7. Quantity Per Article. This column lists the number of parts required in the assembly illustrated. The notation Ref, is the assembly being described.

6-8. Use On Code. An entry "-1" in this column identifies a part that is used only in the C-11-1 console and replaces the part listed which immediately precedes it.

FIG. & INDEX	PART NO.	DESCRIPTION	QTY PER ART	USE ON MODEL
6-1	44100	CONSOLE, Remote Instrument (C-11, C-11-1, or C-11-2)	Ref	
-1	COML	SCREW, 10-32	8	
-2	44105	COVER, Bottom	1	
-3	COML	SCREW, 10-32	8	
-4	44106	COVER, Rear	13	
	COML	NUT, 10-32 Kep	4	
-5	44107	COVER, Top	1	
-6	44102-1	PANEL, Left Side (See Fig. 6-2 for detail breakdown)	1	
-7	44102-2	PANEL, Right Side (See Fig. 6-3 for detail breakdown)	1	
-8	44108	PANEL, Front, control assembly (See Fig. 6-4 for detail breakdown)	1	
-9	44129	PANEL, Rear (See Fig. 6-5 for detail breakdown)	1	
-10	44143	PANEL, Remote (See Fig. 6-6 for detail breakdown)	1	
		NONILLUSTRATED PARTS		
	42022	ASSEMBLY, Thermistor	4	
	42037	ASSEMBLY, Extender Cable	12	
	42039	THERMOCOUPLES	8	
	44128	LINE, Torque	1	
	44147	TABLE, Desk Assembly	1	
	44152	CHAIR (Optional)	1	
	44154	HOSE, Supply	1	
	44158	CABLE, Engine Input	1	
	44159	CABLE, Temperature Meter Assembly	1	
	45115	CABLE, Tachometer Input	1	
	44162	CABLE, Throttle	1	
	44164	SWITCH, Water Temperature	1	
	44165	SWITCH, Oil Pressure	1	
	44167	LINE, Vacuum	1	
	44168	LINE, Fuel Pressure	1	
		LINE, Oil Pressure	1	
	43183	CABLE, Remote Panel Plug	1	
	44300	HOSE, Inlet (C-11)	1	
	44301	HOSE, Inlet (C-11-1)	1	
		HOSE, Inlet (C-11-2)		

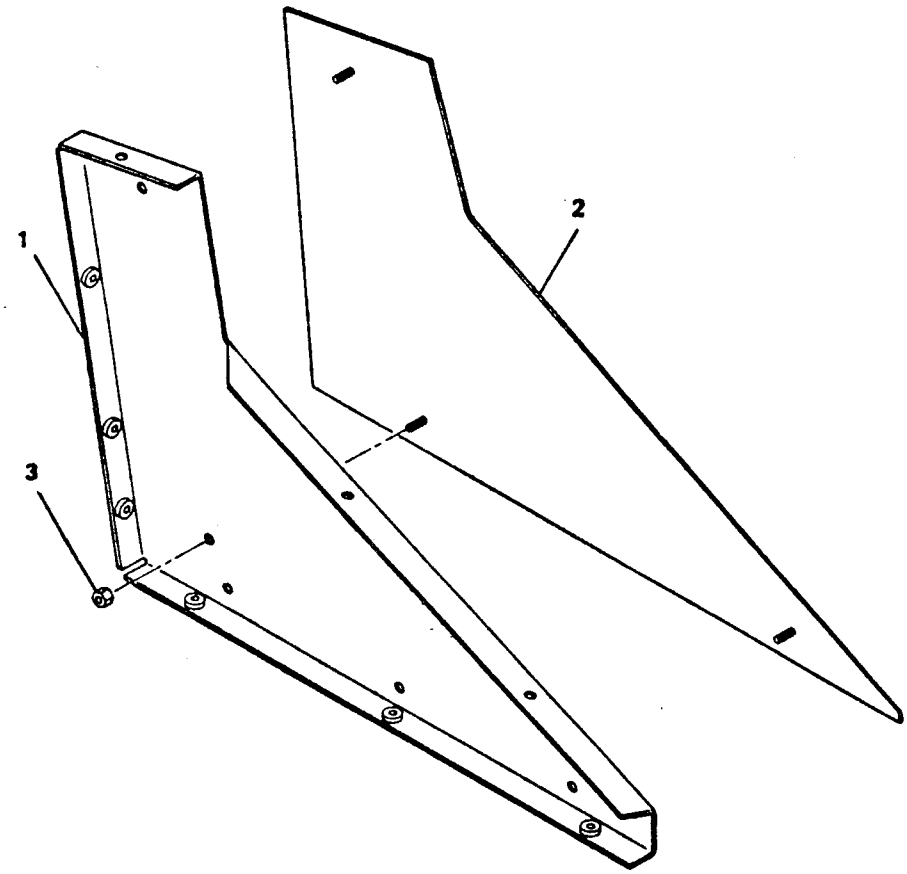


Figure 6-3. Right Side Console Panel Assembly

FIG. & INDEX	PART NO.	DESCRIPTION	QTY PER ART	USE ON MODEL
6-3	44102	PANEL, Right Side Console Assembly	Ref	
-1	44102-2	PANEL, Right Side	1	
-2	44103-2	COVER, Right Side	1	
-3	COML	NUT, Panel, 10-32 Kep	3	

FIG. & INDEX	PART NO.	DESCRIPTION	QTY PER ART	USE ON MODEL
6-4	44108	PANEL, Front Console Assembly	Ref	
-1	43350	METER, Oil Pressure	1	
	43350-4	METER, Oil Pressure, (Option 0-150 psi)	1	
	43350-3	METER, Oil Pressure, 0-100 psi	1	-1
		BRACKET, (Attaching part for meter)	1	
		LOCKNUT, (Attaching part for meter)	2	
-2	43350-6	METER, Fuel Pressure	1	
	43350-10	METER, Fuel Pressure, (Option 0-150 psi)	1	-1
		BRACKET, (Attaching part for meter)	1	
		LOCKNUT, (Attaching part for meter)	2	
-3	43350-5	METER, Vacuum, (C-11 only)	1	
		BRACKET, (Attaching part for meter)	1	
		LOCKNUT, (Attaching part for meter)	2	
	45133	HOURMETER, (C-11-1 only)	1	-1
	45137	CLAMP, (Part for 45133)	1	-1
	45138	COVER, (Part for 45133)	1	-1
		BRACKET, (Attaching part for meter)	1	-1
		LOCKNUT, (Attaching part for meter)	2	-1
-4	44120-1	SWITCH, Overspeed Control Set (Digidial)	1	
-5	44121	POTENTIOMETER, 10K Ohm Helipot	1	
		NUT, (Attaching part supplied with 44254)	1	
-6	44113	METER, Oil Temperature, assembly (C-11)	1	
	44113-1	METER, Oil Temperature, assembly (C-11-1)	1	-1
		BRACKET, (Attaching part for meter)	1	
		LOCKNUT, (Attaching part for meter)	2	
-7	44111	METER, Water Temperature, assembly (C-11)	1	
	44111	METER, Water Temperature, assembly (C-11-1)	1	-1
		BRACKET, (Attaching part for meter)	1	
		LOCKNUT, (Attaching part for meter)	2	
-8	44123	INDICATOR	2	
-9	COML	LAMP	6	
-10	44124-2	LENS, Low Oil Pressure	1	
-11	44124-6	LENS, Water Hot	1	
-12	44109	GAUGE, Torque, lb-ft	1	
	45132-2	GAUGE, Torque, lb-ft	1	-1
	44109-1	GAUGE, Torque, metric (specified option)	1	
		FITTING, Elbow, (Attaching part for gauge)	1	
		FITTING, Adapter, (Attaching part for gauge)	1	
		FITTING, Torque gauge (Attaching part for gauge)	1	
		NUT, Wing, 1/4-20, (Attaching part for torque gauge)	1	
-13	43175	SWITCH, Assembly, console controls (STARTER)	2	
-14	44124-4	LENS, Overspeed Reset	1	
-15	44124-5	LENS, Starter	1	
-16	43174	SWITCH, Fuel Pump	1	

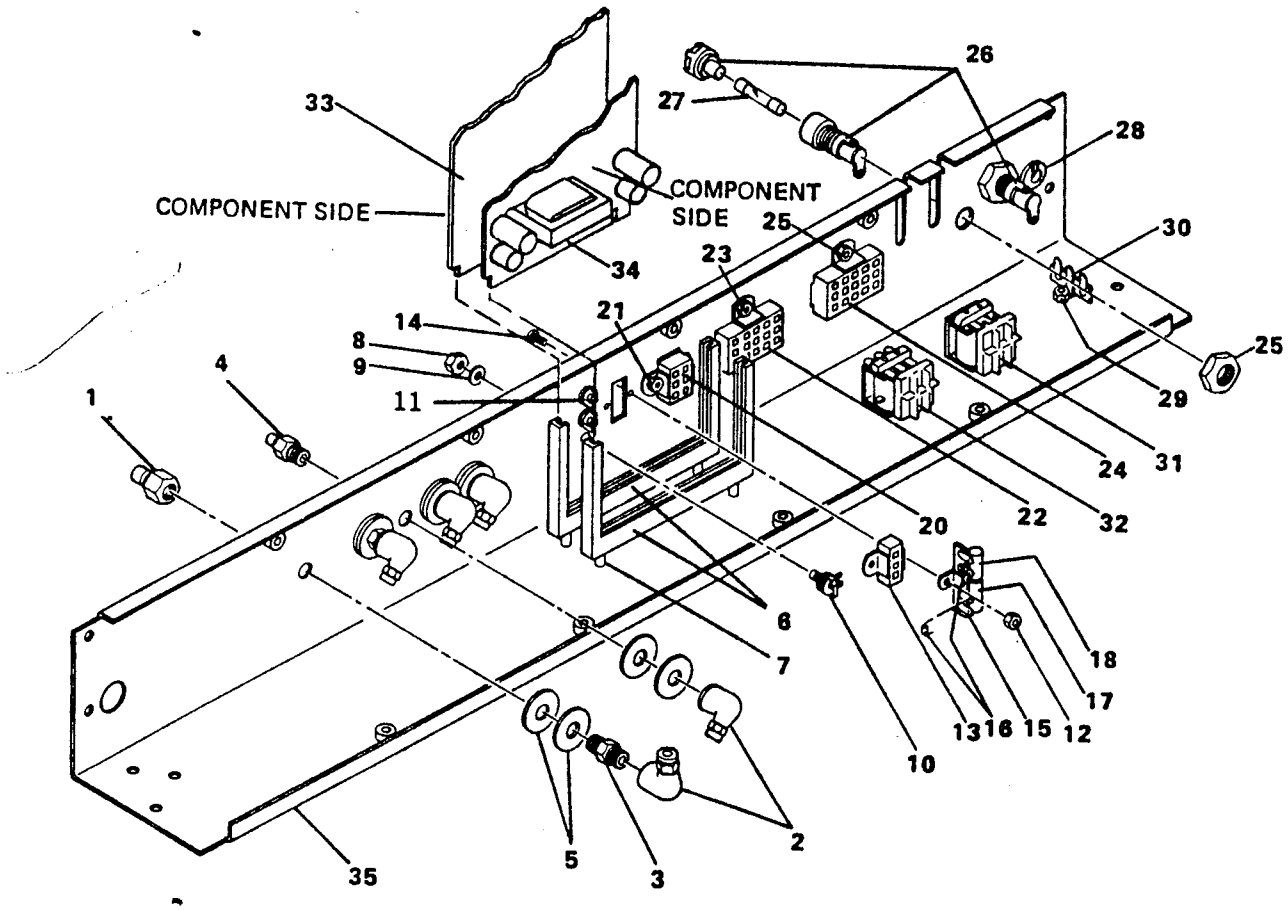


Figure 6-5. Rear Console Panel Assembly

FIG. & INDEX	PART NO.	DESCRIPTION	QTY PER ART	USE ON MODEL
6-5	44129	PANEL, Rear, console assembly	Ref	
	44126	BLOCK, Throttle Swivel (Not Illustrated)	1	
	44127	CLIP, Throttle Cable (Not Illustrated)	1	
	44163	SWIVEL, Throttle Cable (Not Illustrated)	1	
-1	43192-1	FITTING, Quick Disconnect, female	2	
-2	41058	FITTING, Elbow, 90°, female	5	
-3	43173	FITTING, 2-Way, male, 1/8 NPT Hex	2	
-4	43191-1	FITTING, Quick Disconnect, male	3	
-5	COML	WASHER, Flat, 3/8 in.	10	
-6	44182	CONNECTOR, Printed Circuit Card	2	
-7	44196	STANDOFF, 1/4 x 1/2 in.	4	
	COML	SCREW, Panhead, 4-40 x 3/4	4	
-8	COML	NUT, (Attaching part furnished with 42021)	1	
-9	COML	WASHER, (Attaching part furnished with 42021	1	
-10	42021	SWITCH, Pushbutton	1	
-11	42041	JACK, Extension Cable	2	

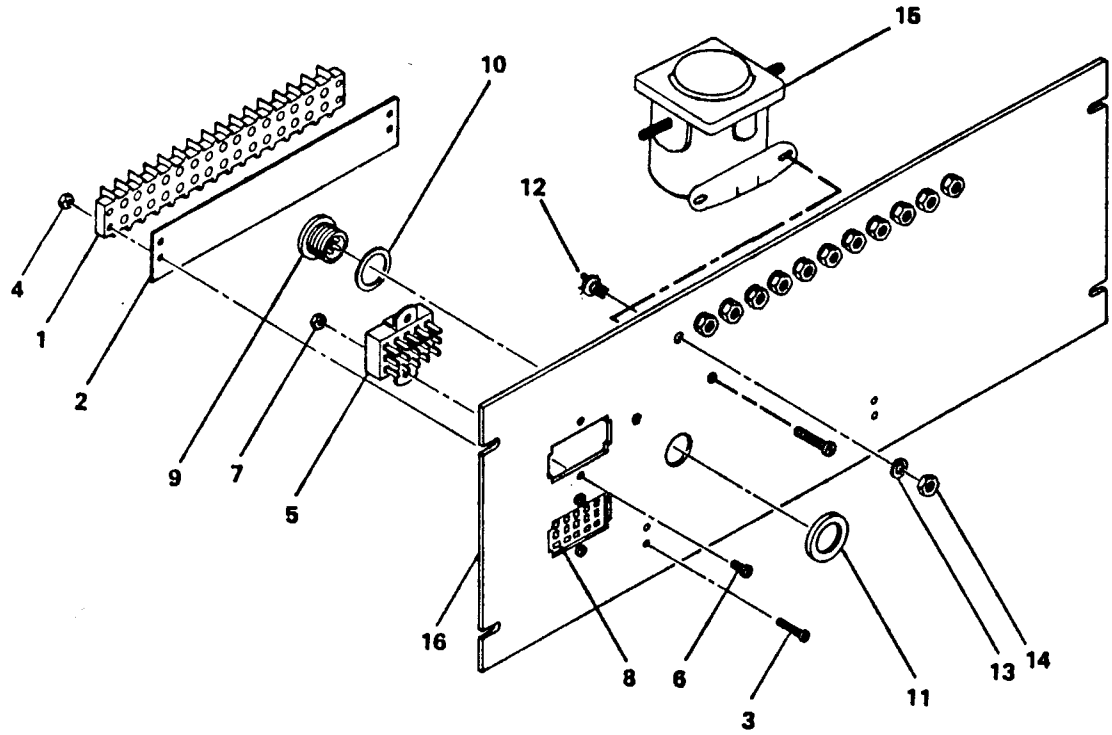


Figure 6-6. Remote Panel Assembly

FIG. & INDEX	PART NO.	DESCRIPTION	QTY PER ART	USE ON MODEL
6-6	44143	ASSEMBLY, Remote Panel	Ref	
-1	44207	STRIP, Barrier (CJ141-15)	1	
-2	44208	STRIP, Marker (CJMS141-15)	1	
-3	COML	SCREW, 6-32 x 5/8	4	
-4	COML	NUT, 6-32 Kep	4	
-5	44198	CONNECTOR	1	
-6	COML	SCREW, 6-32 x 1/4	2	
-7	COML	NUT, 6-32	2	
-8	44197	CONNECTOR	1	
	COML	SCREW, 6-32 x 1/4	2	
	COML	NUT, 6-32	2	
-9	43179	PLUG, Console	1	
-10		WASHER (Attaching part furnished with 43179)	1	
-11		NUT (Attaching part furnished with 43179)	1	
-12	42041	JACK	12	
-13		WASHER (Attaching part furnished with 42041)	12	
-14		NUT (Attaching part furnished with 42041)	12	
-15	44145	SOLENOID	1	
-16	44144	PANEL, Remote	1	

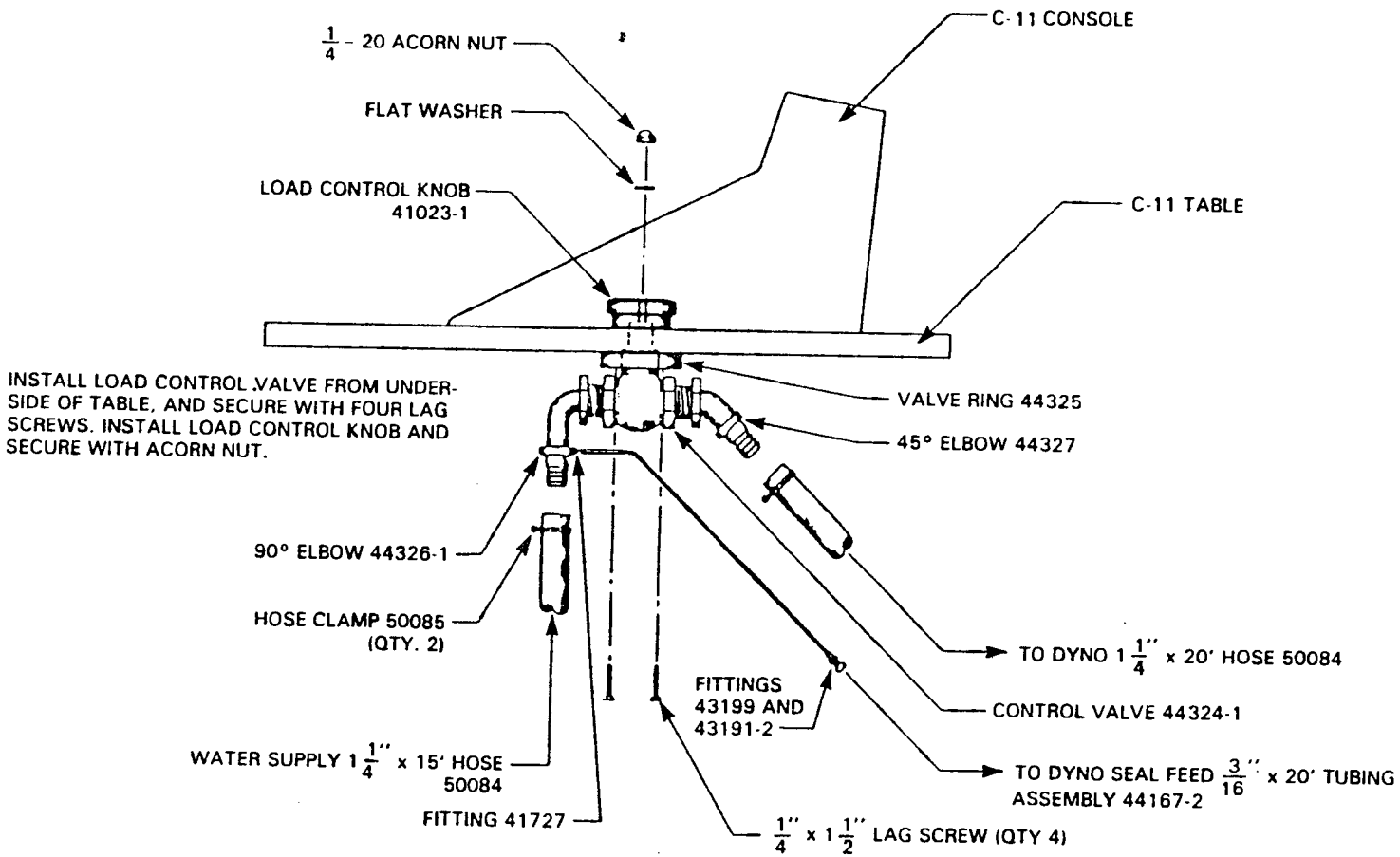
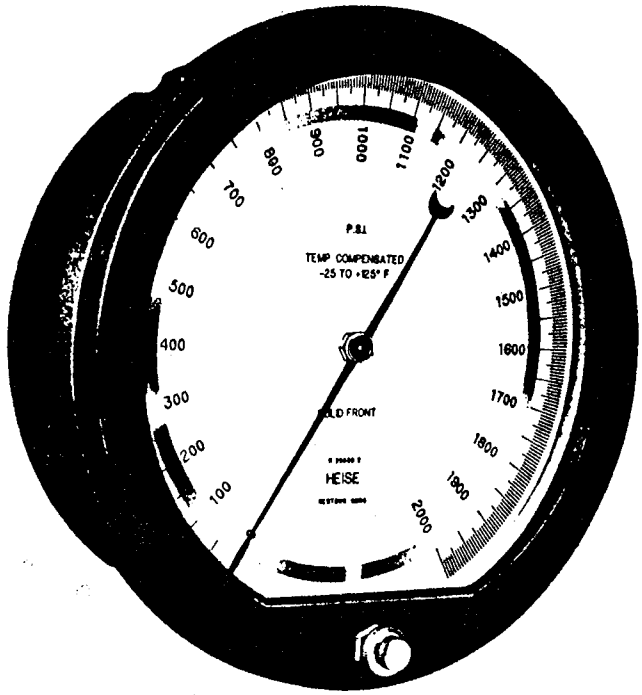


Figure 6-8. Typical Valve Installation, C-11-2.

APPENDIX A

DESCRIPTION OF BOURDON TUBE GAUGE

The Bourdon Tube Gauge is a pressure indicating instrument operated by the effect of internal pressure on a tube which is oval in cross section and is bent into a circular arc. Pressure within the tube tends to straighten it. The motion of the free end of the Bourdon tube is transmitted by a linkage and calibrated to indicate the pressure on a graduated dial.



Model CM

THE HEISE BOURDON TUBE GAUGE

The Heise Laboratories specialize in the manufacture of precision pressure gauges based on the principle of the Bourdon tube. Scientific design of the tube section and other significant features and scrupulous adherence to high quality in manufacturing methods make the Heise Gauge a superior instrument for applications where accuracy is paramount. The Heise Gauge is accurate to 0.1% of full scale, including the effect of hysteresis.

END PIECE ASSEMBLY

The end piece assembly is pivotally mounted on the free end of the Bourdon tube. It comprises a quadrant and clamp arrangement to permit adjustment of its angular position, and a quadrant slide upon which the connecting link is pivoted. It is used to establish the angular relationship of the connecting link and the sector slide which controls linearity in the pointer movement.

CONNECTING LINK

The Connecting Link transmits motion from the end piece assembly to sector slide.

SECTOR SLIDE

The Sector Slide is mounted on the gear sector. It permits adjustment of the ratio of pointer travel to Bourdon Tube motion by altering the multiplication through the "Micro-Slide" adjustment. This adjustment controls the pointer travel or range of the gauge.

CHECK FOR HYSTERESIS

1. Connect the gauge to the dead weight tester in a vertical operating position.
   (1.1) If the gauge has been drained, fully or partially, air may be entrapped in the Bourdon tube and this trapped air must be removed through the bleeder valve to insure positive, accurate response.
   (1.2) If the gauge has been used with and contains mercury, care should be taken to avoid contamination of brass tubing and fittings on the tester.
   (1.3) Gauges used in pneumatic systems should, of course, be cleaned of oil, water, or similar entrapped matter before use.
2. Set the pointer to zero using the dial adjustment.
3. Applying the pressure slowly, load the gauge to one-half scale pressure and record the reading.
4. Load to full scale pressure, release to one-half scale pressure and compare the reading.
5. If the second reading is higher than the first it may be caused by either hysteresis or friction. With dead weight still at one-half load, tap the gauge gently. If the pointer returns to substantially the original one-half load reading, the difference in readings was caused by friction. If the amount of tap is not excessive it might be considered satisfactory for use. It is normal procedure to tap an instrument to observe its sensitivity. If the tap is excessive, it is usually remedied by cleaning the mechanism with solvent such as ether, carbon tetrachloride, Freon, etc.

   If after tapping the gauge the pointer still reads higher than the first reading, the cause is hysteresis. Increased hysteresis effect may be brought about by crystalization of the Bourdon tube due to excessive cycling. A similar condition may result from exposure to excessively high pressure causing a partial fracture of the tube. A new tube is the only remedy for these conditions and it should be installed at our plant.

CHECK CALIBRATION

In order to properly check and adjust the calibration of a precision gauge, a reliable standard of reference is required. Care should be taken in the selection of a dead weight tester since the resulting operation can be no more accurate than the standard on which it is based.

6. Load the gauge to 20 known pressures equally spaced within the range of the gauge and record the readings.
7. If the error exceeds the amount permissible for the intended service, follow recalibration procedure.

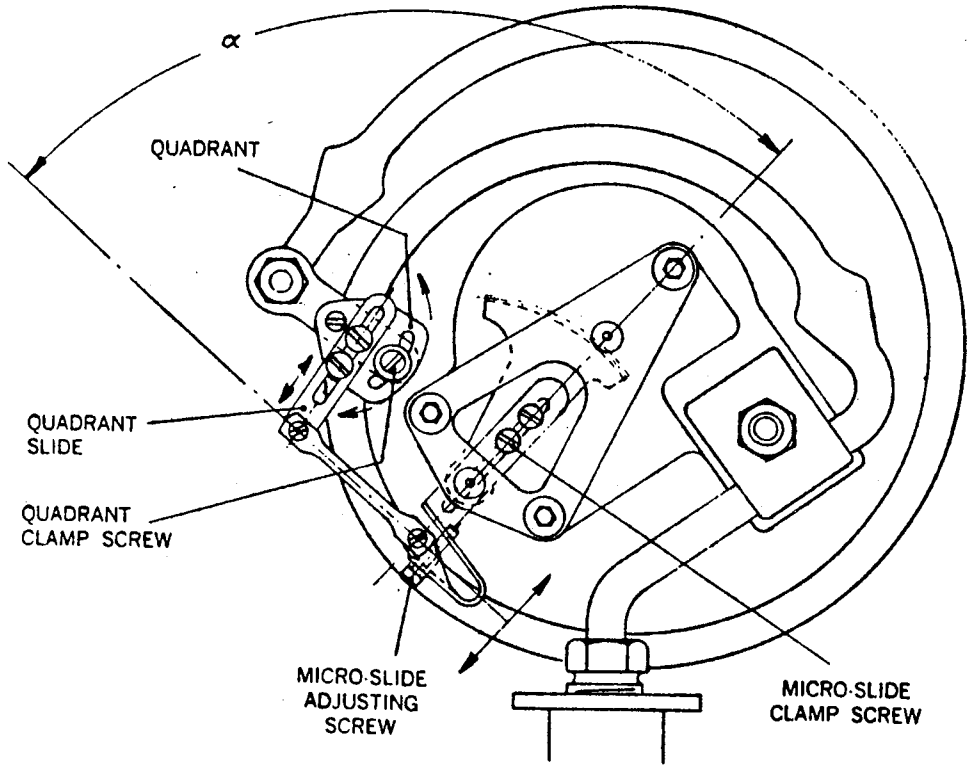
RECALIBRATION PROCEDURE

8. The Bourdon tube must be completely free of entrapped gas or, if tested with gas, must be free of any liquid.
9. Load the gauge to full scale pressure and return to zero.
10. Adjust the pointer to zero with the dial centered.
11. Load the gauge to one-half scale pressure and record the reading.
12. Load the gauge to full scale pressure and observe that reading. If linearity is normal, the reading at full scale pressure should be double the reading at one-half scale pressure so as to produce a straight line relationship.

    If the readings are not linear, recalibration procedure as follows is indicated:

    The first adjustment is to "straight line" the gauge. That is to make the readings linear or proportional to the load. At this point the actual value of the readings at any given load is secondary. Once linearity has been established range adjustment to bring the full scale reading into agreement with the full scale load will complete the calibration.

Model "CM"



Linearity Adjustment

1. If reading at full scale pres sure is greater than twic the reading at one-half pres sure, decrease angle α.
2. If reading at full scale pres sure is less than twice th reading at one-half pressure increase angle α.

Range Adjustment

3. When Pointer indicates greater than dead weight tester at applied full scale pressure, adjust the Micro-Slide screw counter clockwise.
4. When Pointer indicates less than dead weight tester at applied full scale pressure, adjust the Micro-Slide screw clockwise