INSTRUCTION MANUAL

For The

VAREC 6500 SERIES

SERVO LEVEL GAUGE

Document Number 33-09246

November, 1990

Installation, Operation, Maintenance and Troubleshooting

10800 Valley View Street, Cypress, CA 90630-5016 U.S.A.
Phone (714) 761-1300 Telex 4722044 Fax (714) 952-2701

Issued: November, 1990 - Original

Engineering Freeze Date: July 31, 1990

ACKNOWLEDGMENTS

Loctite is a registered trademark of Loctite Corp., Newington, CT

Teflon is a registered trademark of E. I. du Pont de Nemours Co. (Inc.), Wilmington, DE

Varec is a registered trademark of Whessoe Varec Inc.

All other trademarks are acknowledged.

Disclaimer of Warranties

The contract between the Seller and the Buyer states the entire obligation of the Seller. The contents of this instruction manual shall not become part of or modify any prior or existing agreement, commitment or relationship between the Seller and Buyer. There are no express or implied warranties set out in this instruction manual. The only warranties that apply are those in the existing contract between the Seller and Buyer.

Varec Series 6500 Servo Level Gauge has not been tested by Varec under all possible operational conditions, and Varec may not have all the data relative to your application. The information in this instruction manual is not all inclusive and does not and cannot take into account all unique situations. Consequently, the user should review this product literature in view of his/her application. If you have any further questions, please contact Varec for assistance.

Limitations of Seller's Liability

In the event that a court holds that this instruction manual created some new warranties, Seller's liability shall be limited to repair or replacement under the standard warranty clause. In no case shall the Seller's liability exceed that stated as Limitations of Remedy in the contract between the Seller and Buyer.

Use of parts that are not manufactured or supplied by Varec voids any Varec warranty and relieves Varec of any obligation to service the product under warranty. Varec recommends the use of only Varec manufactured or supplied parts to maintain or service Varec 6500 Series Servo Level Gauges.

Safety Precautions

READ AND UNDERSTAND THIS INSTRUCTION MANUAL BEFORE INSTALLING, OPERATING OR PERFORMING MAINTENANCE ON THE VAREC 6500 SERIES SERVO LEVEL GAUGE. FOLLOW ALL PRECAUTIONS AND WARNINGS NOTED HEREIN WHEN INSTALLING, OPERATING OR PERFORMING MAINTENANCE ON THIS EQUIPMENT.

READ AND UNDERSTAND STATIC AND LIGHTNING ELECTRICAL PROTECTION AND GROUNDING DESCRIBED IN API 2003. MAKE CERTAIN THAT THE TANK INSTALLATION, OPERATION, AND MAINTENANCE CONFORMS WITH THE PRACTICE SET FORTH THEREIN.

Safety Precaution Definitions

CAUTION
Damage to equipment may result if this precaution is disregarded.

WARNING

o Direct injury to personnel and/or damage to equipment may result if this precaution is not followed.

o Make certain that the tank is empty and not in service. Ensure that the tank has been leak and pressure tested as appropriate for the liquid to be stored. Observe appropriate safety precautions in flammable or hazardous liquid storage areas. Do not enter a tank that has contained hydrocarbons, vapors, or toxic materials, until a gas-free environment is certified. Carry breathing equipment when entering a tank where oxygen may be displaced by carbon dioxide, nitrogen or other gases. Wear safety glasses as appropriate. Use a hard hat.

o The mechanical connections between the guide cables, the float, the tape and the gaugehead provide a resistance to ground that is adequate for the safe electrical drain of electrostatic charges that may accumulate in the tank and the product. Worker activity and worker clothing may accumulate electrostatic charges on the body of a worker. Care should be used in flammable environments to avoid the hazard.

o This device is designed and manufactured to function as a precision tank level measuring device. It is not intended or recommended that this device be used for tank overfill or overflow protection. Refer to appropriate NFPA or API recommended practices that a high level limit switch separate from the tank gauging system be used.

This page left blank

Table of Contents

Section 1 - Introduction

Section 2 - Installation

Section 3 - Operation

Section 4 - Maintenance

Section 5 - Troubleshooting

Section 6 - Specifications and References

Appendix A - Servo Gauge Exploded View

Appendix B - Displacer Options

List of Illustrations

Figure

Tables

Section 1 - Introduction

USING THIS MANUAL

This manual is designed to assist the user with the installation, operation, maintenance and troubleshooting of the Varec 6500 Series Servo Level Gauge and is organized accordingly.

- Section 1 - Introduction
- Section 2 - Installation
- Section 3 - Operation
- Section 4 - Maintenance
- Section 5 - Troubleshooting
- Section 6 - Specifications and References

- Appendix A - Servo Gauge Exploded View
- Appendix B - Displacer Options

GETTING ACQUAINTED WITH THE SERVO LEVEL GAUGE

The Varec 6500 Series Servo Level Gauge is designed to provide optimum accuracy, reliability and safety in liquid level measurement. The gauge is applicable for use with all low, medium and high pressure storage tanks. It is of flameproof construction and is certified by the appropriate testing agencies in the United States, Canada and Europe. The measuring system, coupled with digital transmission of liquid level and temperature data, is acceptable for custody transfer, taxation and legal measurement worldwide.

The Varec 6500 Series Servo Level Gauge accurately measures a liquid level by maintaining a balance of physical forces acting on the displacer, the liquid level sensing element. When the liquid level in the tank is stationary, all opposing forces are balanced. When the liquid level changes, the gauge is activated by displacer movement until balance is restored.

The gauge indicates the product liquid level by means of a digital mechanical counter driven directly by the servo motor via a positive tooth belt. Level is displayed in English fractional or metric units of measure. These measurement units are factory established at the time of manufacture as follows:

- English units, feet and inches (1/16 inch minimum increment)
- Metric units, meters (0.001 meter or 1 mm minimum increment)

Operation

The liquid level sensing element, a small solid displacer, has a relative density considerably higher than the liquids being measured. It is suspended by a flexible measuring wire which is wrapped around a precision machined type 316 stainless steel grooved measuring drum. The measuring drum is magnetically coupled to the balance element which includes a balance spring, detection plate and slot initiator.

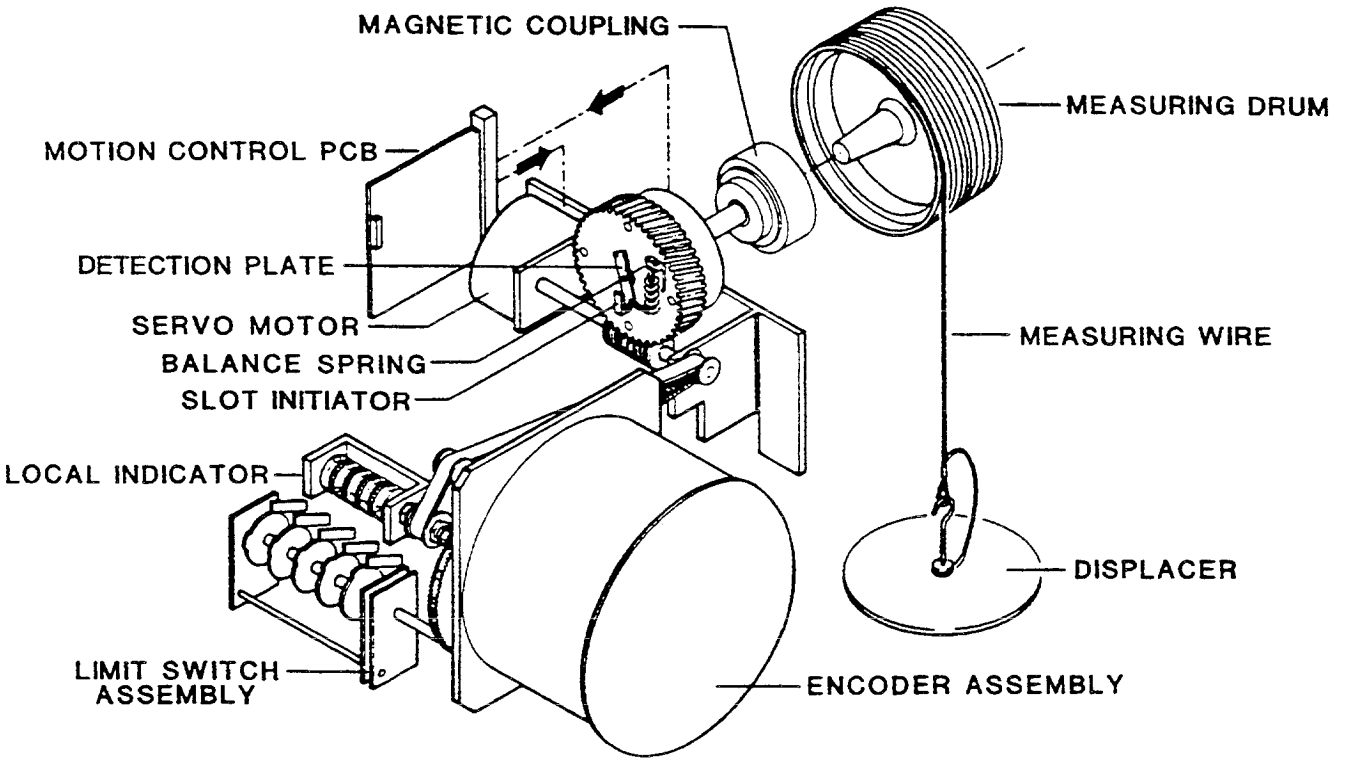


Figure 1-1 Servo Gauge Measuring Components

In an equilibrium condition, the weight of the displacer, partially immersed in the liquid, balances against the force of a balance spring. A rise or fall in the level of the product causes a change in buoyancy and movement of the detection plate in the slot initiator.

The relative position of the detection plate in the slot initiator affects the current output, detected as a voltage change in the motion control circuit. The bi-directional servo motor is activated and turns the measuring drum in the appropriate direction to raise or lower the displacer until balance is restored.

The servo motor also drives the mechanical digital counter, encoder and alarm switches. The mechanical digital counter displays the change in liquid level. It is mechanically linked to either a brush or optical type digital encoder or an analog encoder for remote liquid level data transmission. The five standard limit/level/alarm switches are activated when preset liquid level limits are reached. Two of the switches are required for displacer high/low limit settings. The other three switches should be set within the range of the high/low limit settings.

Construction

The Varec 6500 Series Servo Level Gauge is composed of two compartments:

- o drum housing compartment
- o servo/electronics compartment (with 24-terminal junction box)

The drum housing compartment cover is sealed with an O-ring and is dust and gas tight. Drum rotation is transferred to the explosion proof servo/electronics compartment by a magnetic coupling and shaft. The servo compartment cover is also sealed with an O-ring.

A mounting hub connects the drum and servo/electronics compartments, providing a flame proof path for the shaft entering the servo/electronics compartment.

Any condensation forming in the drum housing compartment returns into the tank.

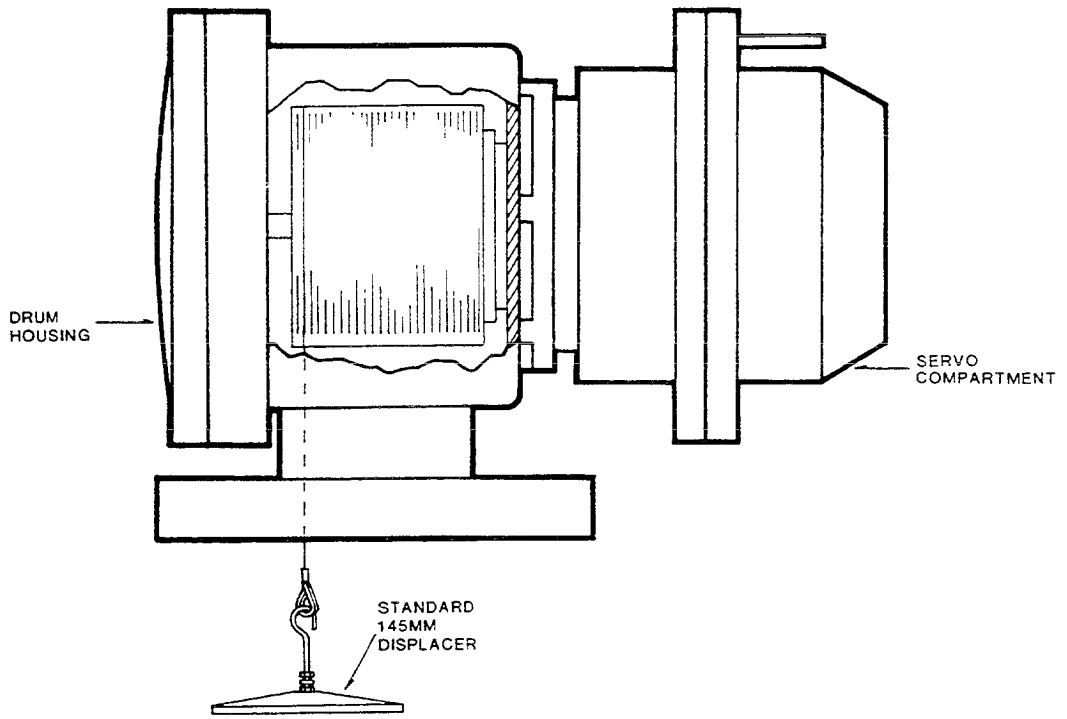


Figure 1-2 Servo Gauge Compartments

Section 2 - Installation

OVERVIEW

Proper operation and long term performance of the Varec 6500 Series Servo Level Gauge is dependent upon a high level of quality control during the installation process. If the quality of the installation is compromised, servo gauge accuracy and performance will most likely be degraded.

The position of the servo gauge must be as stable as possible with respect to a tank reference point. The selection of mounting components and location contribute significantly to servo gauge performance and repeatability.

Mounting Location

Selection of the servo gauge mounting location varies, depending upon tank type and size. Measurement inaccuracies can be caused by deformation of a tank bottom due to foundation and soil problems. Changes in the tank walls and roof can also occur due to the hydrostatic pressure of the liquid in the tank.

Cylindrical storage tanks generally offer adequate stable mounting at the first tank ring, usually stiffened near the bottom. In fixed roof tanks, the top ring is stiffened by the roof. In floating roof tanks, the top ring is stiffened by the wind girder. These locations should be used when installing a stilling well or a support for the top flange.

Measuring Wire Guidance

It is an absolute requirement that the measuring wire is always perpendicular or plumb. The currents in the liquid due to agitation or pumping operations can cause the displacer to drift, despite it being heavier than the liquid.

CAUTION
A stilling well provides an ideal guide for the displacer. It is recommended that this method be used if at all possible. If not, it is recommended that a guided displacer be used. The guided displacer has two eyes that ride fixed guide wires from the tank top to the tank bottom. The guide wires are held in place by a weighted element on the tank floor or are attached to the tank bottom.

Guide wires and a stilling well also discharge static electricity from the liquid near the displacer and are required for safe operation.

Stilling Well

Where practical, it is suggested that a stilling well be used in the tank. The stilling well provides a base for mounting the servo gauge. It also provides an accurate reference relative to the depth of the tank for use in calibration of the servo gauge.

The stilling well should be sized to accommodate the lateral movement of the displacer as it travels its full measuring range. The displacer must always have freedom of movement within the stilling well and should not touch the inside wall at any time.

Three diameter sizes of unguided displacers are available for use in a stilling well application. Table 2-1, Stilling Well Dimensions, lists each displacer diameter size and the minimum inside diameter of a stilling well tube that can be used with each displacer. Use of a larger stilling well tube would ensure the freedom of movement required for the displacer.

Table 2-1 Stilling Well Dimensions

Displacer Diameter	Stilling Well Inside Diameter
145 mm (5.7 inches)	250 mm (10 inches)
90 mm (3.5 inches)	200 mm (8 inches)
50 mm (2.0 inches)	150 mm (6 inches)

The stilling well must include slots or holes with a diameter of 25 mm (1.0 inch). The holes should be offset approximately 15 degrees from each other around the full circumference of the tube and be 300 mm (12 inches) apart over the full length of the stilling well tube. This venting allows for uniform product liquid density and movement within the stilling well. The inside of the stilling well tube must be free of burrs or any other obstructions that could impede the travel of the displacer or cause damage to the measuring wire. Refer to Figure 2-1, Fixed Roof Installation.

FIXED ROOF TANK INSTALLATION

Accurate liquid level measurement depends on the true perpendicular path of the measuring wire and displacer. With the requirement for servo gauges to be mounted on storage tanks, all new fixed roof tanks should be equipped with stilling wells, generally of a configuration as shown in Figure 2-1, Fixed Roof Installation. The optimum arrangement is obtained by securing the stilling well tube on the lower tank stop at the tank bottom level and centering or stabilizing the top end of the flange with three set screws. A flexible jacket should be used to seal the connection.

The inside diameter of the stilling well must be large enough to allow for the horizontal movement of the displacer as the measuring wire wraps and unwraps on the measuring drum. The inside of the stilling well tube must be free of burrs or any other obstructions that could impede the travel of the displacer or cause damage to the measuring wire.

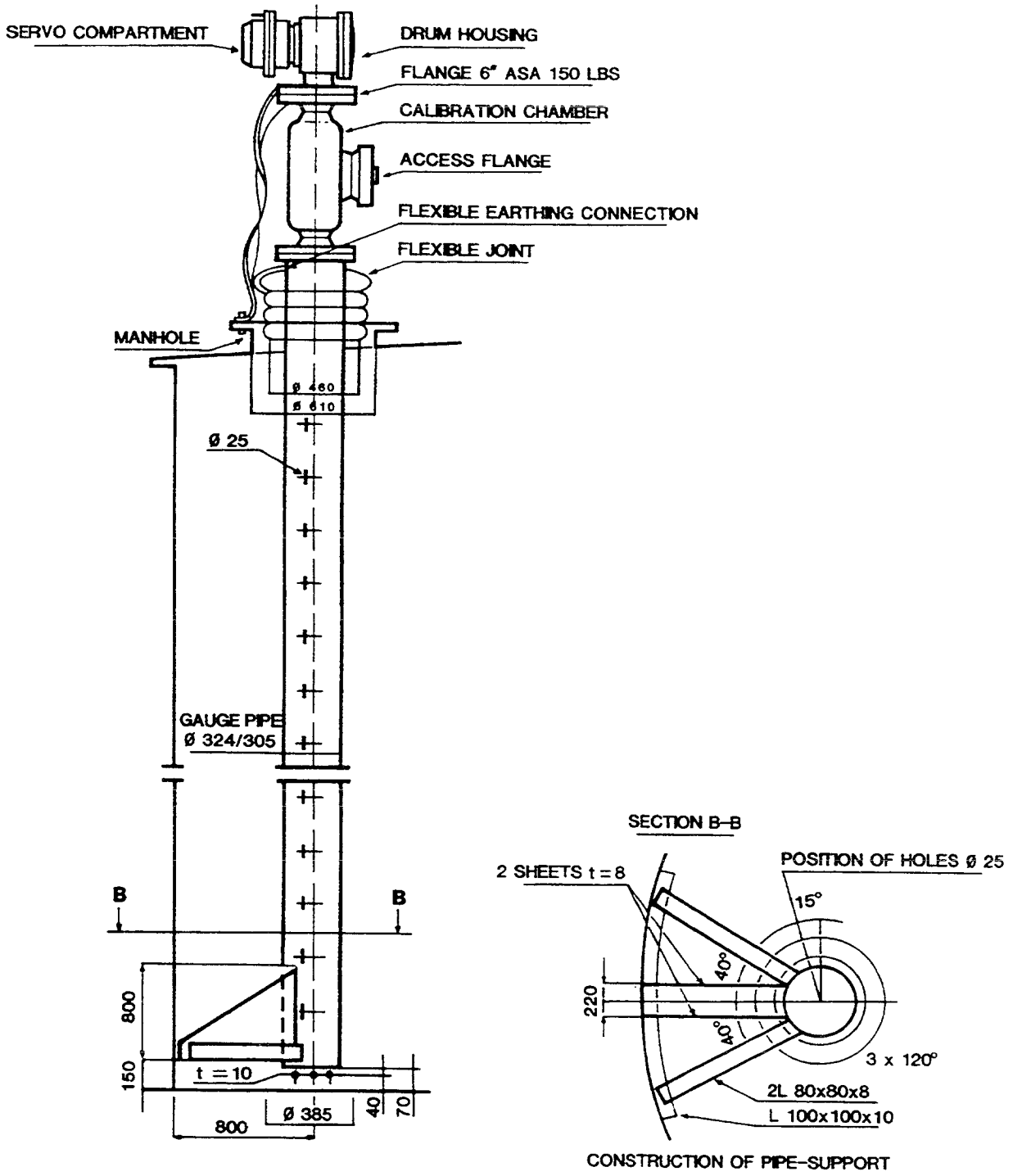


Figure 2-1 Fixed Roof Installation

FLOATING ROOF TANK INSTALLATION

For use on a floating roof tank, the servo gauge should be mounted directly over one of the gauging pipes. Fabricate the mounting structure to rigidly support the servo gauge so that it maintains its reference point. Refer to Figure 2-2, Floating Roof Installation. The gauging pipe in the roof should be covered with a light weight cap and Teflon guide sleeve. The cap should fit the gauging pipe loosely and not weigh more than 0.2 kg (7.0 oz). It should freely lift off the gauging pipe in the event of a power failure that allows the tank roof to lower. An adapter ring may be added to the gauging pipe to reduce the diameter of the cap. The adapter hole diameter should be at least 50 mm (2.0 inches) larger than the diameter of the displacer.

LOW PRESSURE APPLICATION

In atmospheric pressure applications utilizing a stilling well, it is recommended that a Varec 3910 Series Extension Nozzle be mounted between the top flange and the servo gauge. Use of the extension nozzle facilitates the initial calibration of the servo gauge, as well as service and regular maintenance.

The extension nozzle access flange and servo gauge drum housing cover should be aligned for access to components during calibration, service, and maintenance. The extension nozzle mounting flange and gasket should be aligned to ensure a clear path for displace travel.

HIGH PRESSURE APPLICATION

When the servo gauge is used in high pressure applications such as Butane or Propane storage, a six inch full-port ball valve is required between the stilling well and the servo gauge for isolation. It is recommended that a Varec 3950 Series Calibration Chamber with bleed and block valves be installed between the ball valve and the servo gauge to facilitate calibration, service and maintenance of the servo gauge. The calibration chamber allows raising the displacer above the isolation valve for calibration or maintenance without removing the servo gauge. Refer to Figure 2-3, High Pressure Installation.

The calibration chamber access flange and servo gauge drum housing cover should be aligned for access to components during calibration, service and maintenance. All flanges and gaskets should be aligned to ensure a clear path for displacer travel. The ball valve port must allow the displacer to move freely in and out of the tank.

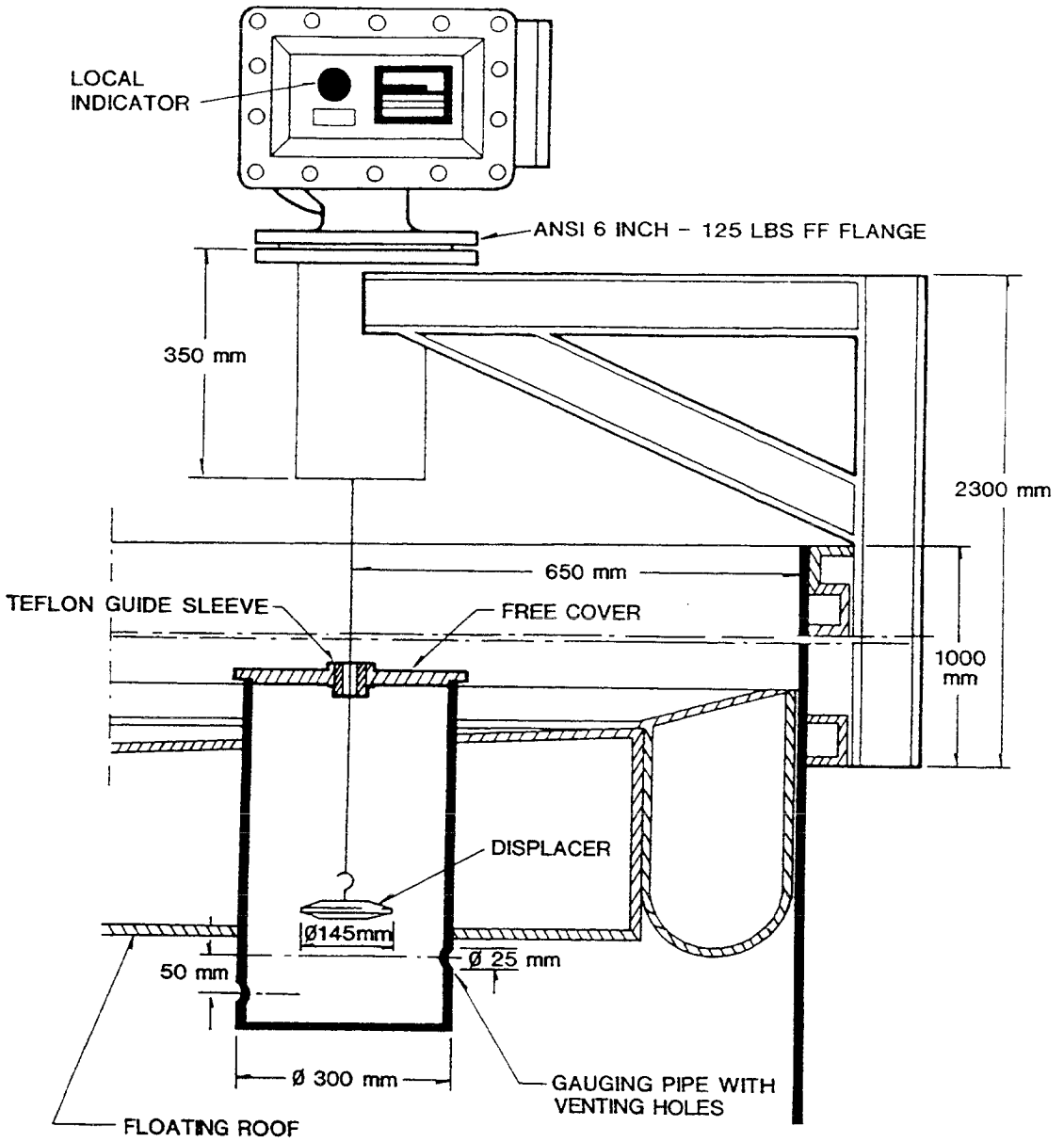


Figure 2-2 Floating Roof Installation

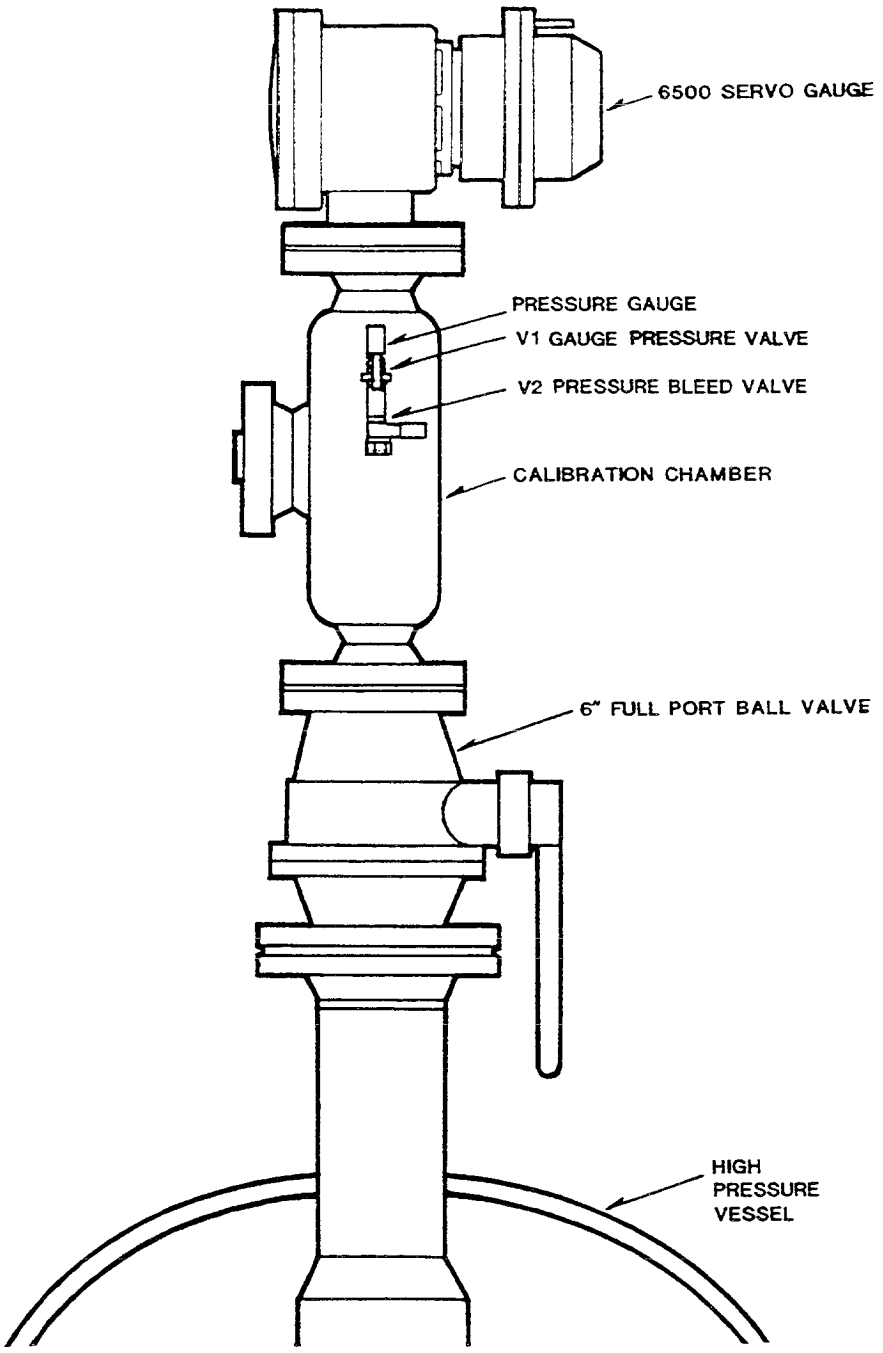


Figure 2-3 High Pressure Installation

MOUNTING THE SERVO GAUGE

The servo gauge is shipped in a foam filled 350 pound test carton. The foam is added to the carton in two stages with each stage separated by a plastic barrier. To remove the servo gauge, open the carton and remove the upper half of the foam filling.

1. Remove the barrier sheet.

2. Remove the plastic bucket holding the measuring drum assembly and displacer. Store the plastic bucket holding the measuring drum assembly and displacer in a secure location until ready to install the measuring drum assembly.

NOTE
The instruction manual and a metric hex key wrench set are also shipped in this location in the carton.

3. Remove the servo gauge in preparation for mounting on a tank.

Ensure that the servo gauge mounting components are properly installed and provide a rigid, fixed mounting and datum reference for the servo gauge.

1. Check the stilling well to verify that it is plumb and free of obstructions. The inside wall of the stilling well tube must be smooth and without burrs, welding slag, or any other obstruction that could impede the travel of the displacer.

2. With use of an extension nozzle, calibration chamber and/or ported ball valve, verify that the flange gasket is equal to or larger than the flange port to allow free travel of the displacer.

3. With use of a full ported ball valve, check the ball and port for alignment. Adjust the mechanical stops on the stem to ensure that the port is straight up and down when the valve is fully opened. The travel path of the displacer must be free and clear of any restrictions.

4. Verify that the access flange of the extension nozzle and/or calibration port of the calibration chamber are aligned and on the same side as the drum housing cover when the servo gauge is installed.

Mounting The Servo Gauge Without Extension Nozzle Or Calibration Chamber

When not using an extension nozzle or calibration chamber at installation time, the measuring drum must be installed in the servo gauge and the displacer attached to the end of the measuring wire before mounting the servo gauge. Refer to Figure 2-4, Measuring Drum Assembly.

1. Remove the drum housing cover and the drum end bearing support bracket.

2. Remove the measuring drum assembly and displacer from the plastic shipping container.

3. Two retaining clips are used to hold the measuring wire on the drum until the servo gauge is installed, calibrated and put into service. It is necessary to remove these clips to unspool sufficient wire to allow the displacer to be attached in the extension nozzle or the calibration chamber. Before removing the clips, ensure that the measuring wire is always under tension and that the measuring wire does not come out of the drum grooves. Remove the clips and unspool the measuring wire as required. Replace the two retaining clips.

CAUTION
Do not allow the measuring wire to become slack and unspool from the drum grooves. To avoid adversely affecting the service life and integrity of the servo gauge, do not twist, bend, or otherwise damage the measuring wire.

---

4. Place the measuring wire and hook in the drum housing. Place the measuring drum assembly, with the retaining clips attached, in the drum housing engaging the magnetic coupling and seating the drum bearing.

5. Attach the displacer to the hook on the measuring wire. With the displacer hanging free and tension on the measuring wire, the two retaining clips can be removed. Open the bent tab on the clip, push the clip in approximately 12 mm (0.5 inches) to disengage the tab at the other end. Lift the clip away from the drum and remove the clip from the housing. Install the drum end bearing support bracket.

NOTE
The servo gauge weight ranges from 85 lb (39 kg) to 175 lb (80 kg) depending on material of construction and pressure rating. Use appropriate tools and machinery when lifting these assemblies.

6. With the drum and displacer in place, lift the servo gauge high enough above the mounting flange to allow the displacer to clear. Align the servo gauge with the mounting flange and carefully lower it into place, allowing the displacer to settle into the pipe as the servo gauge comes to rest on the flange.

7. Check the alignment of the servo gauge flange connection and tighten the flange bolts evenly. The servo gauge is now ready for field wiring and calibration.

Mounting The Servo Gauge With Extension Nozzle Or Calibration Chamber

When installing the servo gauge using an extension nozzle or calibration chamber, the servo gauge should be mounted before installing the measuring drum assembly and displacer.

1. Mount the servo gauge on the flange with the drum housing and access flange of the extension nozzle or calibration chamber lined up together. Align the mating flanges and gaskets. Tighten all flange bolts evenly.

2. Remove the drum housing cover and the drum end bearing support bracket.

3. Remove the access cover from the extension nozzle or calibration chamber.

4. Remove the measuring drum assembly and displacer from the plastic shipping container.

5. Two retaining clips are used to hold the measuring wire on the drum until the servo gauge is installed, calibrated and put into service. It is necessary to remove these clips to unspool sufficient wire to allow the displacer to be attached in the extension nozzle or the calibration chamber. Before removing the clips, ensure that the measuring wire is always under tension and that the measuring wire does not come out of the drum grooves. Remove the clips and unspool the measuring wire as required. Replace the two retaining clips.

CAUTION
Do not allow the measuring wire to become slack and unspool from the drum grooves. To avoid adversely affecting the service life and integrity of the servo gauge, do not twist, bend, or otherwise damage the measuring wire.

---

6. Place the measuring wire and hook in the drum housing. Place the measuring drum assembly, with the retaining clips attached, in the drum housing engaging the magnetic coupling and seating the drum bearing.

7. The displacer is attached to the hook and measuring wire through the access flange of the extension nozzle or calibration chamber. Bring the hook and measuring wire out of the extension nozzle or calibration chamber, attach the displacer and place the measuring wire and displacer inside the extension nozzle or calibration chamber. Allow the displacer to hang freely.

8. With the displacer hanging freely and with tension on the measuring wire, the two retaining clips can be removed. Open the bent tab on the clip, push the clip in approximately 12 mm (0.5 inches) to disengage the tab at the other end. Lift the clip away from the drum and remove the clip from the housing.

9. This is a critical step. Install the drum end bearing support bracket and ensure that the drum can move freely. A small amount of play is acceptable. The servo gauge is now ready for field wiring and calibration.

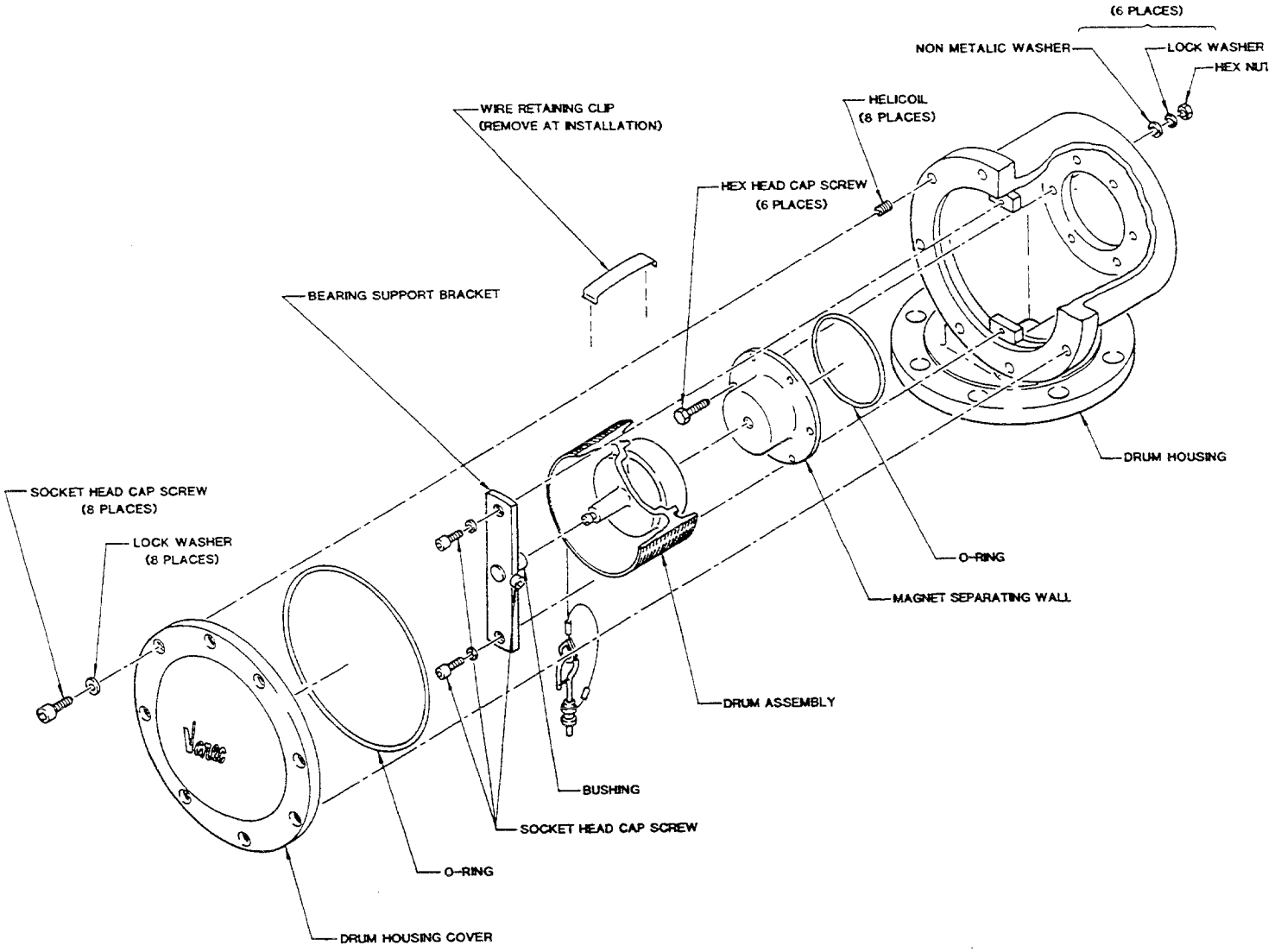


Figure 2-4 Measuring Drum Assembly

ELECTRICAL INSTALLATION AND INTERCONNECTS

Data acquired by use of the servo gauge is typically forwarded to a central location by the Varec data transmission system. Analog or digital transmission of data to a central receiver is available. Digital transmission is by Varec's 4-Wire 48-VDC Pulse Code mark/space communication bus, and may include level, temperature and status data. Analog transmission consists of a 4-20mA signal, proportional to product liquid level.

Junction Box Installation

The junction box for all terminations at the servo gauge is located on the right hand side of the servo/electronics housing.

Each servo gauge junction box includes two 3/4-inch NPT entries for conduit connectors. A minimum of six conductors is required for power input and digital data transmission. Additional conductors may be required for temperature, alarm function, etc. All conductors may be housed in a single cable or two multi-conductor cables may be used. All connections to the gauge should be made with shielded cable.

1. Remove the junction box cover and attach conduit to one or both 3/4-inch NPT entries. If only one entry is used, plug the other entry with a steel 3/4-inch NPT plug.

NOTE
The requirements of the conduit installation are in no way unique to the Varec data transmission system and should comply with the National Electric Code, Article 500, as well as all local codes and regulations.

2. Connect two conductors for 24 VAC. Connect four conductors for the Varec 4-Wire Digital Bus (B+, B-, M, S). Connect additional conductors as required.

3. Replace the junction box cover and screws. Tighten screws in sequence and to torque values as specified. Refer to Figure 2-5, Torque Specifications For Servo Gauge Cover Screws.

4. Check the earth ground on the servo gauge. A ground strap may be installed from the servo gauge flange bolt to earth ground if necessary.

For CENELEC (European Committee for Electrotechnical Standardization) certified servo gauges, connection to the servo gauge should be made by cable entries of a certified flameproof model or by threaded metal conduits. In this case, a stopping box with compound filling is to be placed at the entry to the servo gauge. The unused threaded holes are to be closed by installing certified threaded plugs with at least five threads engaged. The threads should be secured with Loctite 222 or equivalent.

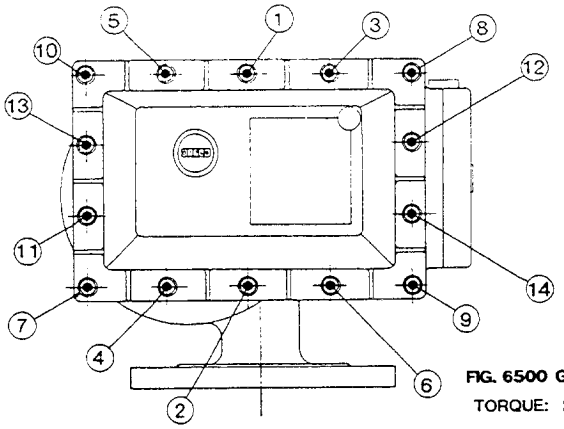
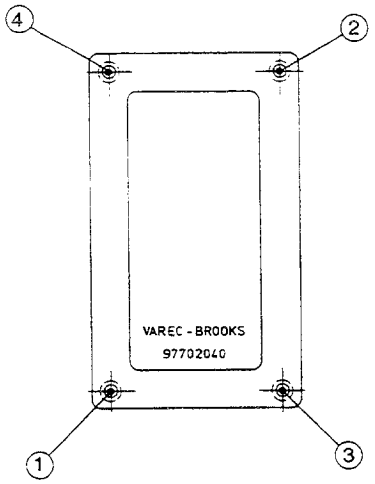


FIG. 6500 GAUGE COVER
TORQUE: 25-30 FT-LBS
(34-41 NT-M)
(TORQUE SEQUENCE AS SHOWN)



JUNCTION BOX COVER
TORQUE: 6-7 FT-LBS
(8-9.5 NT-M)
(TORQUE SEQUENCE AS SHOWN)

L C I E APPROVED VERSION
(PRODUCED PRIOR TO MAY 1986)

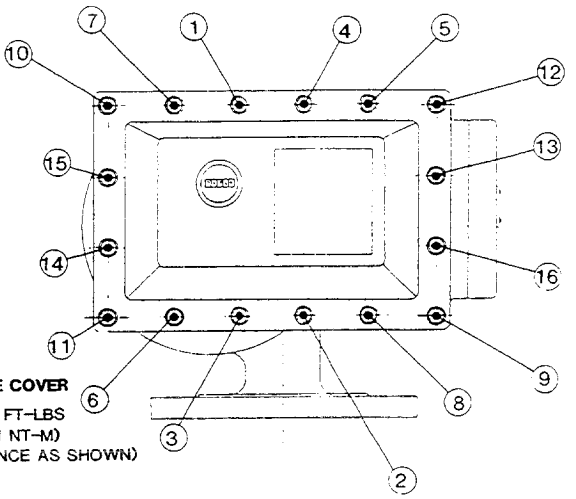
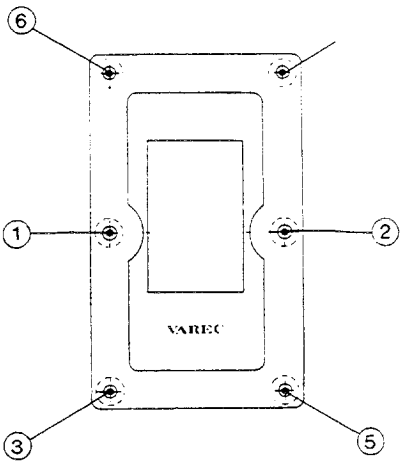


FIG. 6500 GAUGE COVER
TORQUE: 25-30 FT-LBS
(34-41 NT-M)
(TORQUE SEQUENCE AS SHOWN)

JUNCTION BOX COVER
TORQUE: 13-16 FT-LBS
(18-22 NT-M)
(TORQUE SEQUENCE AS SHOWN)



APPROVED VERSION

Figure 2-5 Torque Specifications For Servo Gauge Cover Screws

Servo Gauge Interconnect Wiring Diagrams

The wiring arrangement is dependent on the configuration as shown in Figure 2-6, Servo Gauge To Varec 9909 Averaging Bulb and Figure 2-7, Servo Gauge To Varec 8500 Spot Temperature Bulb. The interconnections and the number of conductors required are shown in the diagrams.

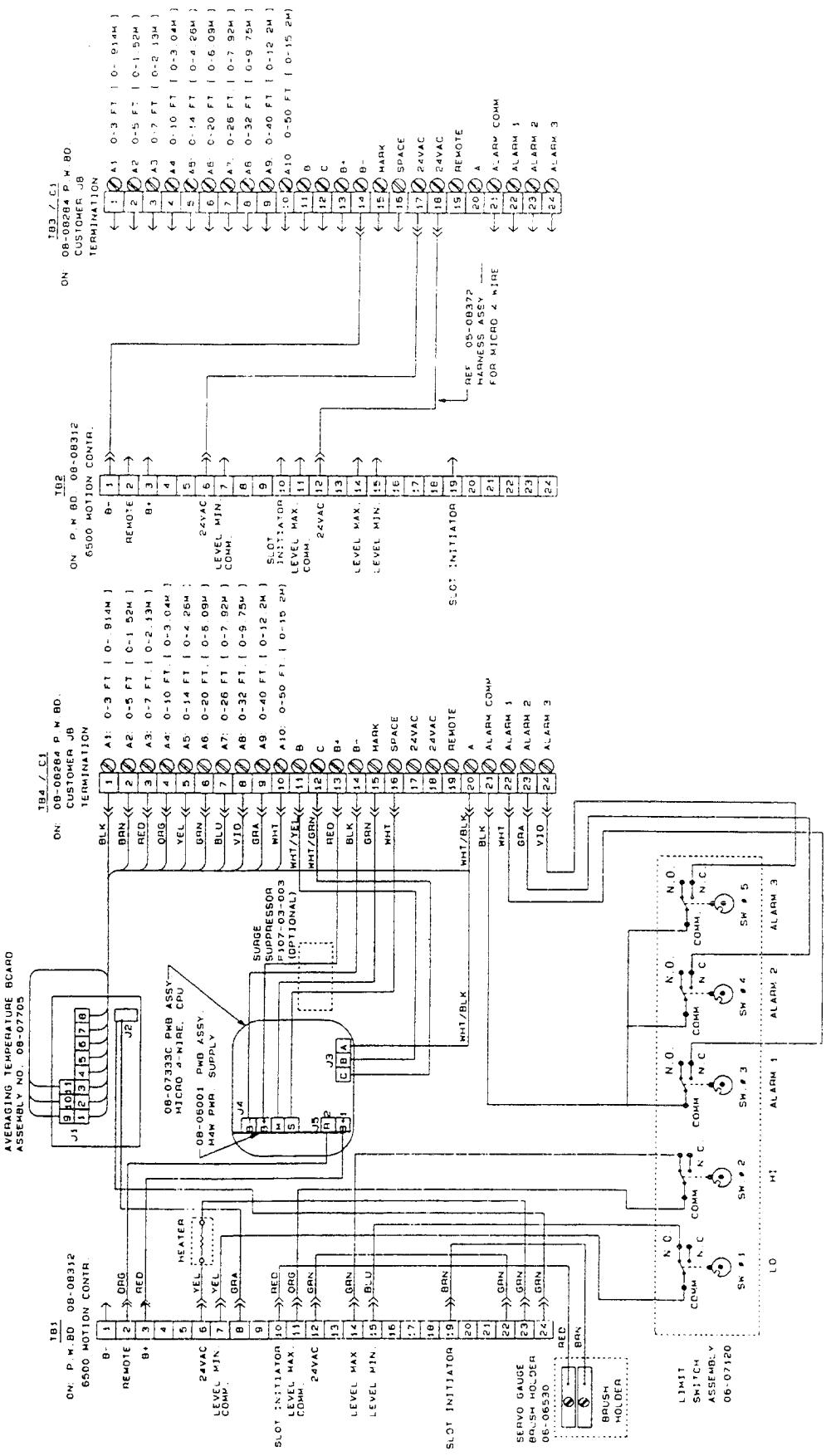


Figure 2-6 Servo Gauge To Varec 9909 Averaging Bulb

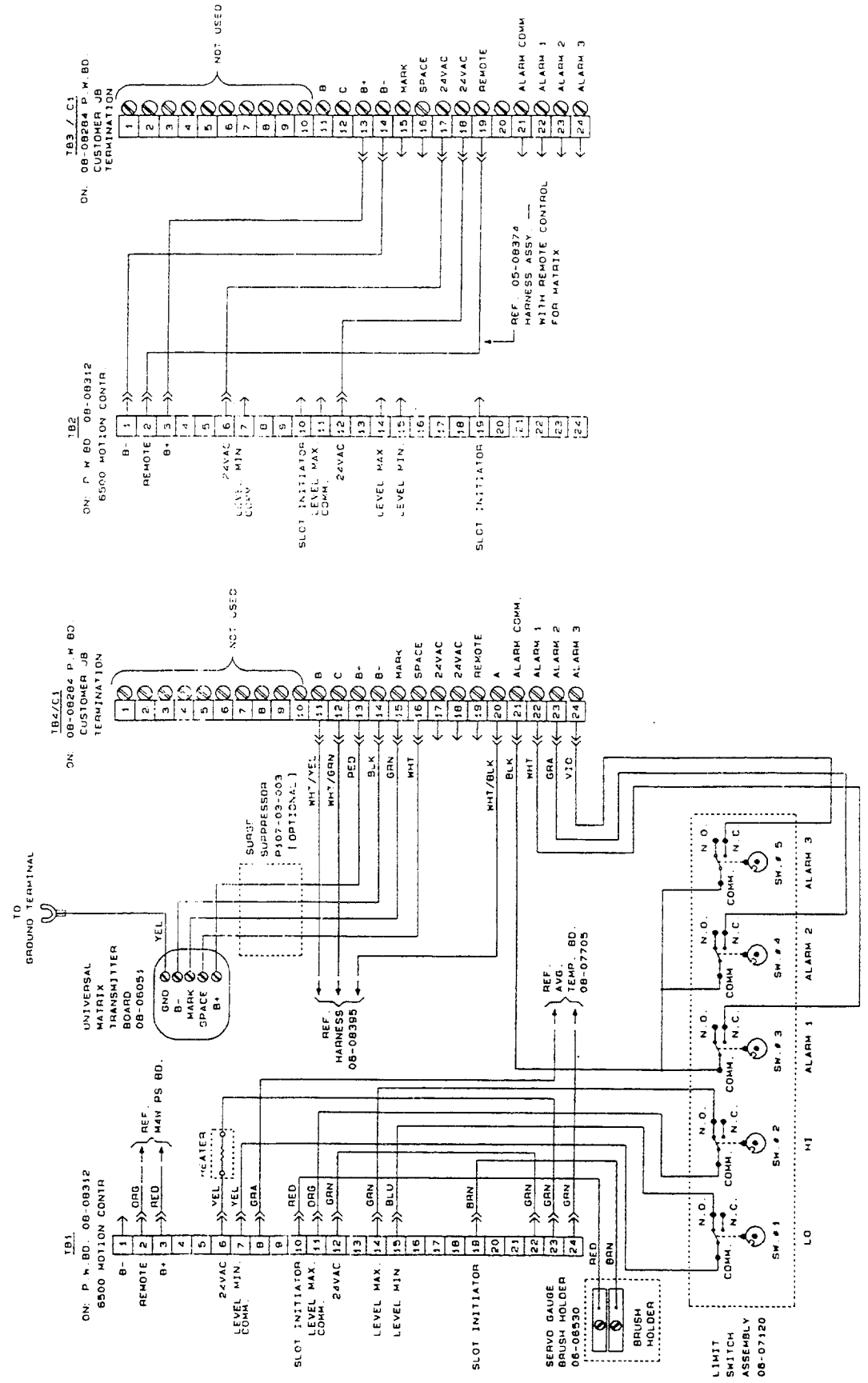


Figure 2-7 Servo Gauge To Varec 8500 Spot Temperature Bulb

Wire and Cable Installation

Standard methods for installing and testing the field wiring for a Varec data transmission system are provided for normally encountered conditions. The field wiring diagrams provided with this system shall be furnished to the general contractor and/or other parties responsible for the installation. They shall be used as a basis for the wire conductor count and the termination details of the system.

Lead Resistance

The lead resistance depends on the type of transmitter board:

- o universal matrix
- o 4-wire
- o current output

Universal Matrix Transmitter Board Lead Resistance

For all conductors, with the exception of AC power and temperature bulb leads, the resistance of each individual conductor between the liquid level transmitter and the receiver unit may not exceed 100 ohms.

For leads run from the receiver to both the liquid level transmitter and the temperature converter, the 100 ohm maximum resistance shall apply to the unit farthest from the receiver.

For the temperature averaging bulb leads, the resistance of each individual conductor between the temperature converter and the spot temperature bulbs or the liquid level transmitter shall not exceed 15 ohms. The resistance of the A and B leads between the temperature converter and the liquid level transmitter shall be the same +/- 0.1 ohms.

4-Wire Transmitter Board Lead Resistance

The maximum line resistance depends upon transmitter grouping and field wiring layout. Field communication wiring between the control room and the transmitters is critical and has significant impact on the reliability of the entire system. Grouping 6500 transmitters into "areas" of 25 or less and independently wiring their common bus back to the receiver, makes bus related failures (lightning strikes, wiring faults, or damaged transmitters) easier to isolate and have less impact on the entire system.

Transmitter grouping is readily implemented as Varec receiving equipment provides an independent wiring connection for groups of 32 transmitters or less. By limiting the number of transmitters in each "area" to 25 or less, thus limiting the maximum distance to 10,000 feet or less and limiting the maximum resistance on each of the four lines (B+, B-, Mark and Space) to 50 ohms or less, the maximum voltage drop limits are met.

CAUTION
If existing or proposed wiring cannot meet these limits, contact the Varec Systems Engineering department for specific system recommendations.

Current Output Transmitter Board Lead Resistance

It is necessary to compute the total circuit resistance to determine the correct gauge of field signal wire to use. The maximum allowable total loop resistance (the sum of the wire line and receiver load resistance) may be calculated with the aid of Figure 2-8, Current Output Transmitter Resistance/Voltage Chart.

CAUTION
If the resistance calculated with the aid of the chart (or mathematically) results in an indicated transmitter voltage below 15 VDC minimum, a wire with a larger diameter (smaller gauge) must be used.

The following two equations can be used to calculate maximum loop resistance (line and load):

NOTE
If the transmitter uses an internal on-board Varec power supply, the value of the power supply voltage entered into the equations is 30 VDC.

4-20 mA Current Output Range

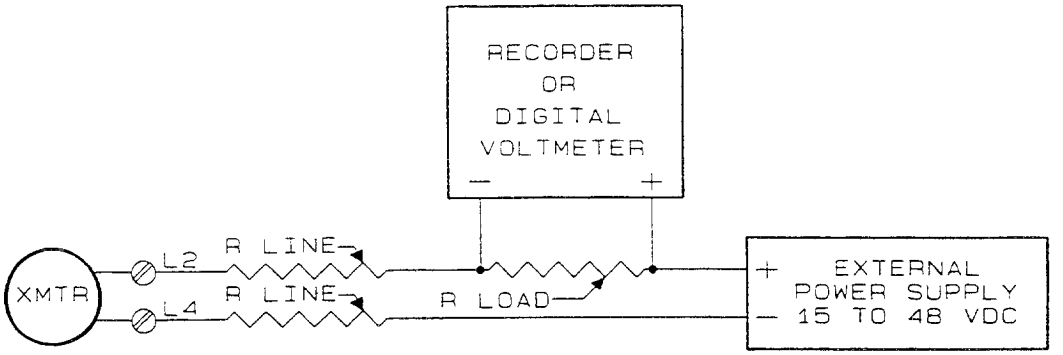
MAX RESISTANCE = 50 x (DC POWER SUPPLY VOLTAGE - 15)

10-50 mA Current Output Range

MAX RESISTANCE = 20 x (DC POWER SUPPLY VOLTAGE - 15)

Varec recommends that 22 gauge, or larger size wiring be used. Typical telephone wiring is 21 gauge or larger. Field conditions, as well as cost, affect the choice of wire.

Example:
Determine the minimum gauge of wire required to connect a transmitter (30 VDC, 4-20 mA range) located 3000 feet from the receiving device. The receiving device load is 100 ohms. From Figure 2-8, the maximum loop resistance is determined to be 600 ohms. According to wire data charts, 22 gauge wire has a resistance of 15.14 ohms per 1000 feet. Twice the wire run is 6000 feet, the total loop distance. The resistance is 96.04 ohms.



CURRENT OUTPUT TRANSMITTER POWER SUPPLY SCHEMATIC.
SHOWING R LINE AND R LOAD

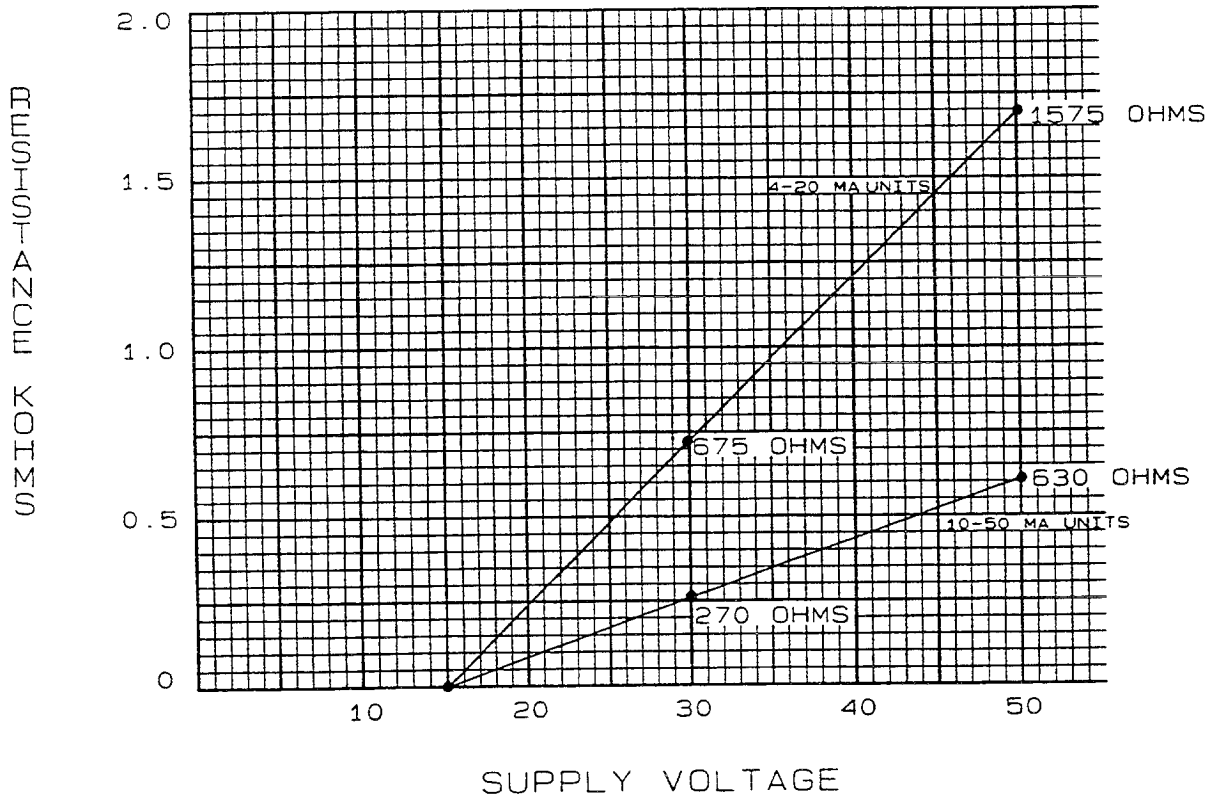


Figure 2-8 Current Output Transmitter Resistance/Voltage Chart

Insulation Resistance Test

The insulation resistance test should be conducted with all field wiring in place, all splices complete and with all leads disconnected from the servo gauge and receiver.

To ensure proper operation of the data transmission system, the insulation resistance must be maintained at a minimum of 1 meg ohm for the temperature bulb leads and 0.5 meg ohm for all other leads.

The insulation resistance measurement may be made with a 300 volt Megger or equivalent. The insulation resistance value should be measured between each pair of conductors in a cable run and between each conductor and ground.

Voltage Breakdown Test

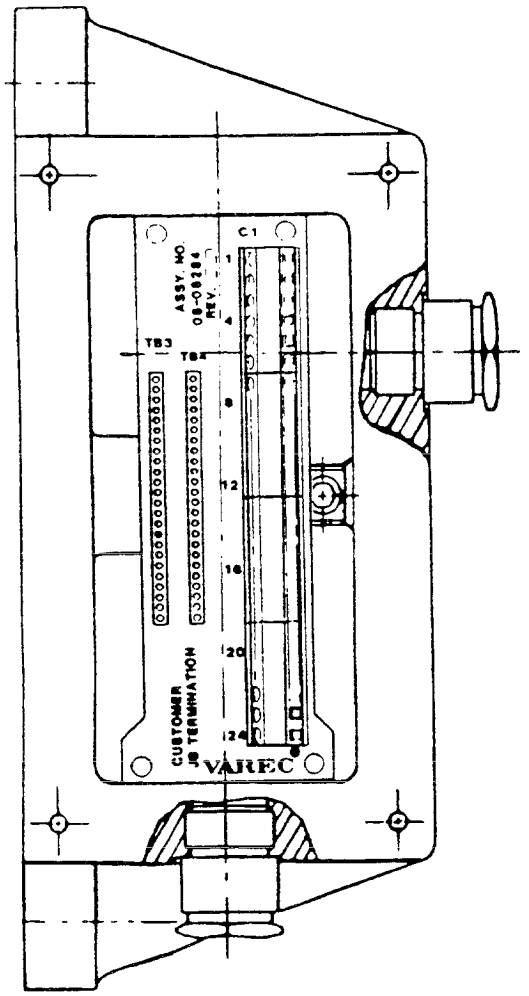
The voltage breakdown test should be conducted with all field wiring in place, all splices complete and with all leads disconnected from the servo gauge and receiver.

The field wiring installation, including terminal strips, should withstand a voltage breakdown test of a potential of 1500 volts applied for one second.

This test is conducted between each pair of conductors and between each conductor and ground.

Field Wiring Termination

Upon satisfactory completion of the insulation resistance test and the voltage breakdown test, the field wiring can be terminated at the servo gauge and data receiver in accordance with the field wiring diagrams furnished with the system. Refer to Figure 2-9, Electrical Termination.



SPOT RTD

1	NOT USED
2	
3	
4	
5	
6	
7	
8	
9	
10	
11	B
12	C
13	B+
14	B-
15	MARK/L4 (-)
16	SPACE/L2 (+)
17	24VAC
18	24VAC
19	REMOTE
20	A
21	ALARM COMM
22	ALARM 1
23	ALARM 2
24	

AVERAGING BULB/T FEATURE

1	A1: 0-3 FT. (0-.914M)
2	A2: 0-5 FT. (0-1.52M)
3	A3: 0-7 FT. (0-2.13M)
4	A4: 0-10 FT. (0-3.04M)
5	A5: 0-14 FT. (0-4.26M)
6	A6: 0-20 FT. (0-6.09M)
7	A7: 0-26 FT. (0-7.92M)
8	A8: 0-32 FT. (0-9.75M)
9	A9: 0-40 FT. (0-12.2M)
10	A10: 0-50 FT. (0-15.2M)
11	B (RTD CONV./PROBE TIE POINT)
12	C (CONVERTER/PROBE TIE POINT)
13	RAISE
14	RESET
15	L4 (-) CURRENT OUT RETURN
16	L2 (+) CURRENT OUT
17	24VAC
18	24VAC
19	B+ SOURCE
20	A (AVG. SW. COMMON)
21	ALARM COMM
22	ALARM 1
23	ALARM 2
24	B- RETURN

Figure 2-9 Electrical Termination

Section 3 - Operation

OVERVIEW

The basic operation of the Varec 6500 Series Servo Level Gauge is described in Section 1, Getting Acquainted With The Servo Level Gauge. This section describes the functional operation of the servo gauge in further detail. Refer to Figure 3-1, Servo System.

The Varec 6500 Series Servo Level Gauge consists of two functional components:

- o drum assembly
- o servo assembly

DRUM ASSEMBLY

The drum assembly monitors the product liquid level and signals the servo assembly when a level change occurs. A slight change in liquid level causes rotation of the shaft in the servo assembly. This initial movement is independent of servo control and is limited by a mechanical stop on the servo assembly. After this initial movement is detected, the servo motor is activated and turns the drum assembly. Rotation of the drum in the appropriate direction allows the displacer to follow the liquid surface until the liquid level is stationary and balance is restored.

The drum assembly consists of the following major components:

- o displacer
- o measuring wire
- o measuring drum and magnetic coupling

Displacers

The displacer normally rests partially immersed in the product, supported by the measuring wire, drum and servo assemblies. It is used to detect changes in the liquid level.

There are five standard displacers available for the servo gauge to accommodate different service and field installation requirements. The weight of all displacers, with hardware, is 280 g +/- 1.5 g (9.87 oz +/- 0.05 oz). Refer to Appendix B, Displacer Options.

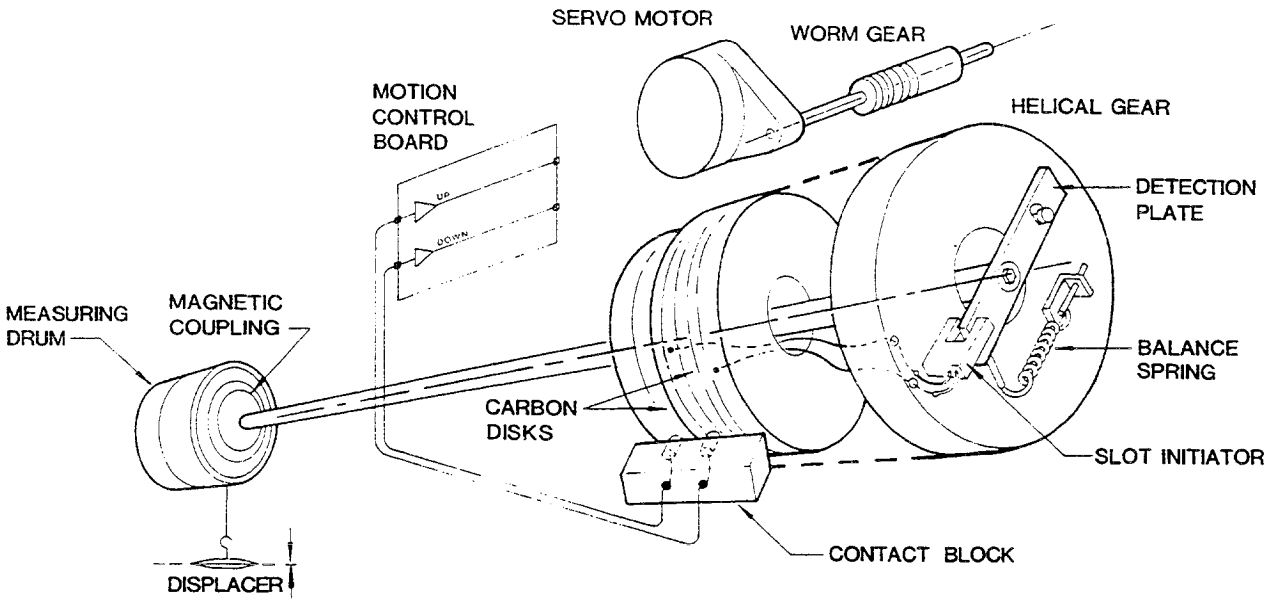


Figure 3-1 Servo System

Unguided Displacers

The four unguided displacers are for service within a stilling well or for applications where the product liquid level surface is relatively calm. The 145 mm (diameter) Teflon graphite displacer (10-inch stilling well) is normally used. The other diameter size and material displacers are available for smaller diameter stilling wells or product S.G. or viscosity requirements.

- o 145 mm Teflon graphite
- o 90 mm Teflon graphite
- o 50 mm Teflon graphite
- o 90 mm type 316 stainless steel

Guided Displacer

The guided displacer is for service when installation of a stilling well is not possible and product liquid surface is somewhat turbulent.

- o 145 mm Teflon graphite with guide eyes

Measuring Wire

The measuring wire is stranded 316 stainless steel with minimal thermal expansion. The measuring wire is spooled on the grooved measuring drum. Rotation of the drum raises or lowers the displacer by taking up or releasing the measuring wire.

Measuring Drum and Magnetic Coupler

The measuring drum is a precision machined component with a helical groove to hold the measuring wire. The drum diameter is calibrated to maintain the appropriate wire on/wire off length associated with the various gear ratios of the mechanical counter, encoder and alarm switch drive mechanism.

The drum is mounted on a stainless steel shaft with stainless steel ball bearings. The drum also supports the primary magnet of the magnetic coupling. A non-magnetic screen separates the primary magnet from the secondary magnet mounted on the shaft connected to the servo assembly.

SERVO ASSEMBLY

The servo assembly maintains the force balance condition of the servo gauge when the product liquid level is stationary. When a liquid level change occurs, the servo assembly detects the change and turns the drum assembly. Rotation of the drum in the appropriate direction allows the displacer to track the liquid surface and restore balance when the liquid is stationary.

The servo assembly mechanically drives the integral mechanical counter and electronic encoder for liquid level indication. In addition, it also drives the alarm switches. Refer to Figure 3-2, Servo Assembly.

The servo assembly consists of the following major components:

- o slot initiator, balance spring and detection plate
- o servo motor
- o motion control PCB
- o mechanical counter
- o encoder
- o alarm switches

Slot Initiator, Balance Spring and Detection Plate

The slot initiator produces magnetic lines of force on one side of an air gap. This magnetic force generates a current on the opposite side of the air gap. A detection plate, fixed to the measuring shaft, moves within the air gap of the slot initiator, changing the magnetic force proportional to its position within the gap. Movement of the detection plate produces the control current for the servo motor. Refer to Figure 3-1, Servo System.

The balance spring maintains a force balance on the servo gauge by compensating for the force differential caused by the weight or downward force of the displacer and the upward and buoyant force of the measured liquid. One end of the balance spring is attached to the detection plate, the other end to the helical gear. When the liquid level is changing, the balance spring recovers the balanced condition as the servo motor turns the helical gear and brings the slot initiator to a null position.

The detection plate is positioned in the slot of the slot initiator in the balanced condition. The slot initiator is supplied with 10 VDC by the motion control PCB. The voltage is transferred to the slot initiator by carbon rings and a contact block. The detection plate breaks the magnetic lines of force produced by the slot initiator. The current produced by the slot initiator varies between 1 mA and 7 mA, depending upon the location of the detection plate within the slot.

The change in current is detected as a voltage change across a series resistor on the motion control PCB input circuitry. This voltage is compared to two reference voltages. The up reference is 4.9 VDC while the down reference is 1.8 VDC. No up or down signal is produced within this voltage range. Refer to Figure 3-3, Servo Control.

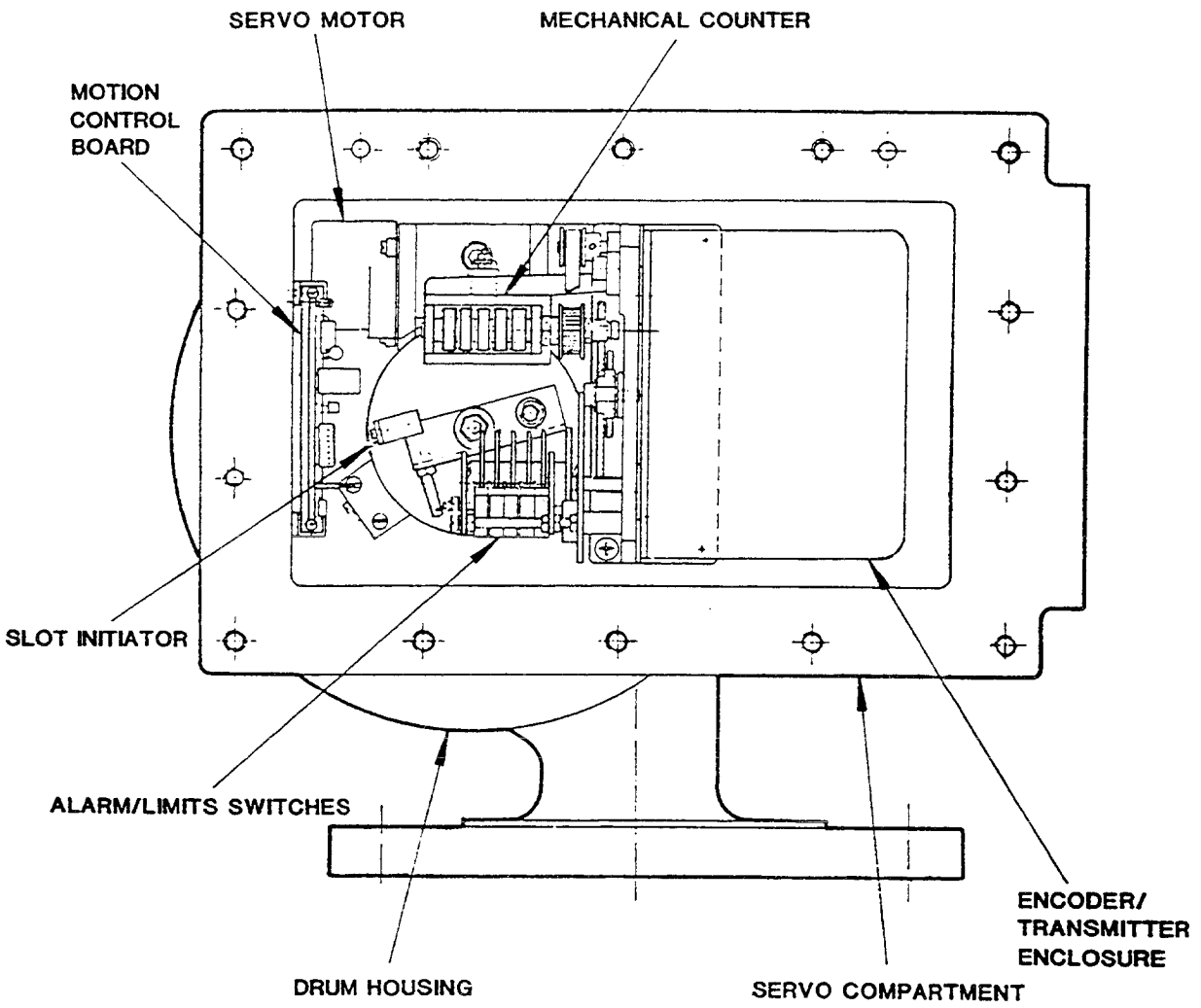


Figure 3-2 Servo Assembly

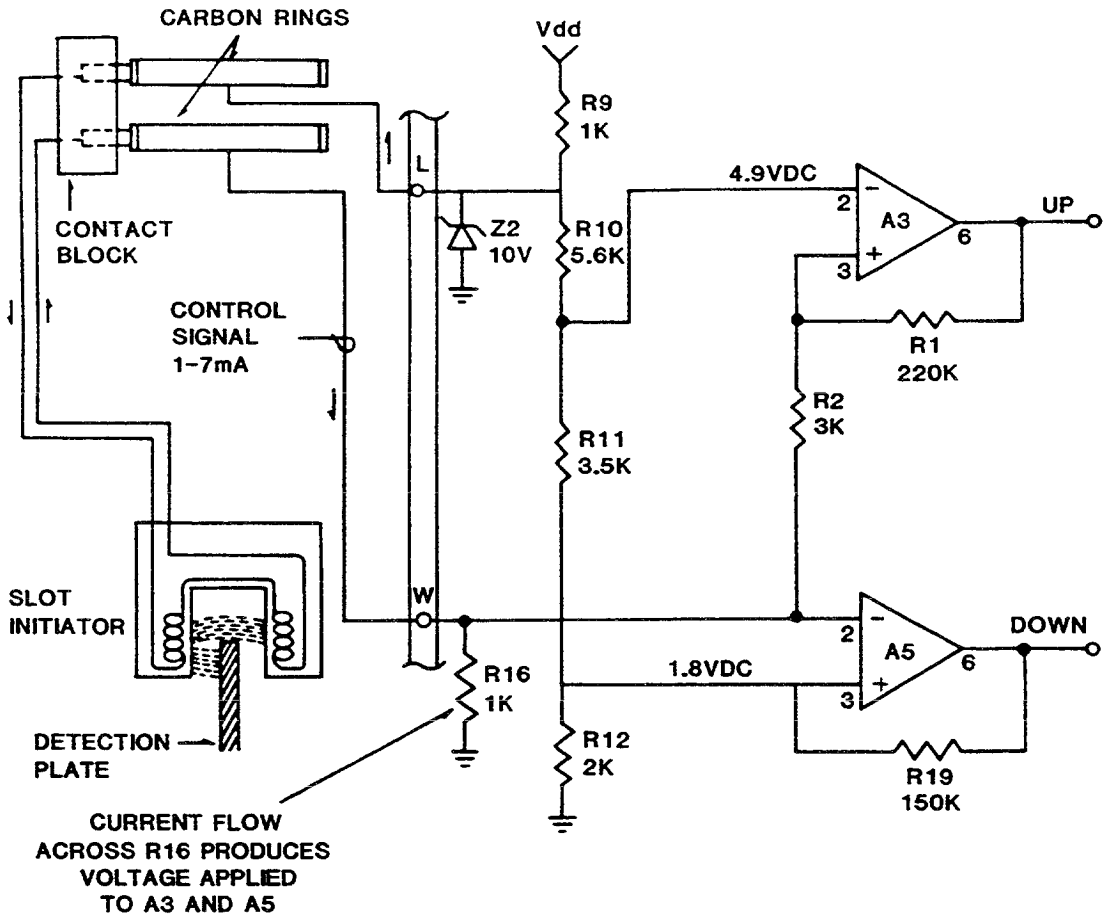


Figure 3-3 Servo Control

Falling Liquid Level

When the liquid level is lowered, the displacer movement turns the shaft in a clockwise direction, as viewed looking into the servo/electronics housing.

The detection plate moves against the balance spring. The initial rotation is limited by a pin in an elongated hole in the detection plate. The detection plate blocks the maximum lines of force produced in the slot initiator and changes the current to the motion control PCB, reducing the voltage to less than 1.8 VDC.

The servo motor starts and rotates the helical gear and measuring drum, slowly lowering the displacer until the liquid level is stationary. As balance is restored, the force against the balance spring is reduced and the detection plate moves out of the slot. The voltage increases to 1.8 VDC or more and the servo motor stops.

Rising Liquid Level

When the liquid level is raised, the displacer movement turns the shaft in a counter-clockwise direction, as viewed looking into the servo/electronics housing.

The detection plate moves with the balance spring and away from the slot initiator and changes the current to the motion control PCB, increasing the voltage to more than 4.9 VDC.

The servo motor starts and rotates the helical gear and measuring drum, maintaining tension on the measuring wire as the displacer rises. The measuring drum slowly raises the displacer until the liquid level is stationary. As balance is restored, the detection plate moves through the slot initiator. The voltage decreases to 4.9 VDC or less and the servo motor stops.

Servo Motor

The servo motor is a bi-directional motor with reduction gears. A 24 VAC, 50 or 60 Hz power supply drives the servo motor in either direction. The motion control PCB switches the servo motor on or off in either direction.

An adjustable time delay is used to prevent excessive switching of the servo motor. This delay is factory set at 6 seconds and is adjustable within a range of 2 to 15 seconds.

A latching relay on the motion control PCB provides the capability of operating the servo motor independent of the normal control input.

Motion Control PCB

The motion control PCB is a cable connector printed circuit board controlling the direction of rotation and operation of the servo motor. A 24 VAC, 50 or 60 Hz power supply to the board is used to power the servo motor. This power supply is rectified and regulated to supply 10 VDC to the slot initiator. The motion control PCB uses the slot initiator input to determine which direction the servo motor must turn, then switches the 24 VAC power to the appropriate winding.

The motion control PCB also receives 48 VDC raise signal from the B+, B- and remote lines. This signal activates a latching override relay on the circuit board, which turns on the servo motor and raises the displacer, overriding the normal control signal from the slot initiator.

The servo motor continues to raise the displacer until a 48 VDC reset signal is detected. The override relay is unlatched and control reverts back to the slot initiator signal. The servo motor reverses direction, lowering the displacer back to the liquid surface. A jumper on the board is used to set the control logic when the remote raise/reset feature is present.

Mechanical Counter

A 4-digit (English unit, fractional) or 5-digit (metric unit) mechanical counter is mounted within the gauge and is viewable through a site glass. The counter displays in feet or meters, depending upon the units selected.

The mechanical counter is driven by a positive-tooth belt from the servo motor shaft. Whenever the servo motor is activated and turns the measuring drum, the counter adds or subtracts its reading to conform to the product liquid level increase or decrease.

Encoders

Whenever the servo motor is active and turning the measuring drum, product liquid level information is encoded. The encoders are positioned by a positive-tooth belt from the servo motor shaft. The liquid level information is driven remotely by the respective digital or analog signal.

The servo gauge is equipped with one of three different types of encoders:

- Optical Digital (Fractional or Metric)
- Brush Digital (Fractional or Metric)
- Analog (4-20 mA output)

Optical Digital Encoder

The optical digital encoder assembly consists of:

- o two black metal disks with chemically etched Grey code pattern
- o disk rotation gears
- o LED array
- o photo-transistor array

The entire optical digital encoder assembly is housed in a metal enclosure mounted on the encoder mounting plate within the servo compartment. The metal enclosure protects the optical encoder from ambient light interference to the photo-transistor readings. The transmitter board is mounted to the outside of the metal enclosure.

The product liquid level information produced by the servo system is converted to an encoded Grey code message by means of the relative position of the two optical code disks read by the LEDs and photo-transistors. This signal is transmitted from the encoder to a central receiver over the Varec 48-VDC pulse code bus.

The liquid level information is transferred through an input shaft, mechanically coupled to the servo drive, that rotates the two optical code disks placed between the optical arrays and sets them at relative angular positions. One side of the optical arrays between which each code disk is placed consists of LED light sources and the other side, of photo-transistors.

As the code disks rotate, the solid, black part of each disk blocks the LED light source and turns off the photo-transistors. Only the cut-out area of each disk permits the light to pass, turning the photo transistors on or off in a sequence that represents the measured liquid level. This information is read by the transmitter board that produces the mark and space pulses sent to the central receiver.

Brush Digital Encoder

The brush digital encoder assembly consists of:

- o two disks of non-conducting material
- o conductive metal laminated with etched-out code pattern on one side of each disk
- o disk rotation gears
- o palladium alloy brush arrays

The product liquid level information produced by the servo system is converted to an electrical signal by means of the relative position of the two laminated code disks read by a set of palladium alloy brushes contacting the etched code pattern on each code disk. This signal is transmitted from the encoder to a central receiver.
The liquid level information is transferred through an input shaft, mechanically coupled to the servo drive, that rotates each of the two code disks in its own plane and changes the relative position of the disks to each other.

The code disks consist of a conducting metallic laminate on a non-conducting substrate. The code pattern is etched into the metal laminate. The contacting brushes either contact metal and are shorted to common, or touch the non-conductive surface and are open.

A change in the product liquid level changes the relative positions of the code disks, and the conductive and non-conductive parts of the code pattern contacted by the brushes. This information is read by the transmitter board that produces the mark and space pulses sent to the central receiver.

Analog Encoder

The analog encoder is a current output measuring device that encodes level information produced by the servo system as a voltage output which is converted to current output ranging from 4 to 20 mA for sending to a central receiver.

The current output is measured by a potentiometer mechanically coupled by a worm-gear arrangement to the servo drive shaft and electrically connected to the input of a current transmitter. As the drive shaft rotates, the potentiometer voltage varies. The transmitter, a linear integrated circuit, converts the voltage of the potentiometer to current that is transmitted to a central receiver.

Alarm Switches

Five SPDT cam-operated alarm switches are included in each servo gauge. All five alarm switches are on a common shaft and are driven by the same mechanism driving the mechanical counter and encoder.

Two alarm switches are dedicated to limiting the upward (high) and downward (low) movement of the displacer during operation of the servo gauge. These alarm switches can be set and changed at any time, either before or after the servo gauge is mounted in the field.

Three additional alarm switches can be used to trigger an audible or visible alarm or to control auxiliary equipment. These alarm switches are identical to the high/low limit switches and can also be changed at any time.

Remote Raise/Reset

The remote raise/reset signals override the normal control signals from the slot initiator to the motion control PCB. The remote raise/reset signals can originate from a Varec data transmission system or Varec 6603 Series Tank Data Receiver.

This feature can be used as a repeatability check on the servo gauge during normal operation or to raise and lower the displacer for maintenance and calibration.

CAUTION
The jumper on the motion control PCB must be in the A-B position when this feature is used, otherwise the gauge always drives in the up position.

When the raise signal is activated, the displacer continues its upward travel until a reset signal is manually initiated, the 24 VAC power is removed, or the high limit alarm switch opens.

Universal Matrix Pulse Code Transmitter Card

The universal matrix pulse code transmitter card receives power from a receiver that activates its transmit cycle. A fixed length pulse code message, containing product liquid level data, is transmitted back to the receiver. Power must then be turned off to the transmitter and then on again to initiate another transmit cycle.

Communication between the universal pulse code transmitter and a receiver is over four wires, identified as B+, B-, MARK and SPACE.

Pulse Code Format

To minimize transmission errors, all pulse code signals consist of marks (1) and spaces (0) and have the following standard characteristics:

o The number of pulses in a message is always constant for a specific type of transmitter and does not vary with the data.

o Only one code element (bit) changes between any two adjacent data increments. For example, only one mark (1) changes to a space (0) for a single digit change of data between:

29.98 feet	(001 1000 0000 0001) and
29.99 feet	(001 1000 0000 0000)

Similarly, when all four digits are involved, only one mark (1) changes to a space (0) for a change of data between:

29.99 feet	(011 1000 0000 0000) and
30.00 feet	(010 1000 0000 0000)

The code format is contained on two code disks. The first code disk is directly driven by the shaft from the level gauge. The second code disk is coupled to the first code disk with a geneva gear arrangement. The gearing is such that for a one-half rotation of the first disk, the geneva gear drives the second disk one increment. Two increments are equal to one foot of level change.

4-Wire Pulse Code Transmitter (1900) Card

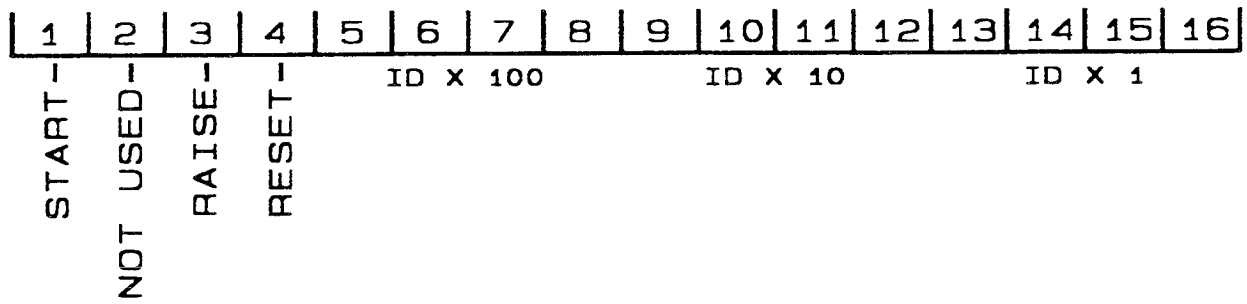
The Varec 4-Wire pulse code transmitter card is an addressable device which receives an identifying (ID) code that activates its transmit cycle. A fixed length pulse code message, containing transmitter ID code, level data, temperature data (if so configured), input switch status data and a parity bit is transmitted back to the receiver. Refer to Table 3-1, 1900 Transmitter - Function Jumper Positions (W2).

Communication between the 4-wire pulse code transmitter and a receiver is over four wires, identified as B+, B-, MARK and SPACE.

Code Structures

All transmission between the receiver and the transmitter is accomplished over a common pair of mark/space pulse code lines. A pulse is sensed as a low (line drops from +48 VDC to approximately 0 VDC) to indicate the presence of a mark or space.

The polling request signal from a receiver consists of a 16-bit pulse code message containing the ID of the particular transmitter to be polled. A mark pulse is considered to be a logical "one" and a space pulse a logical "zero". Refer to Figure 3-4, Polling Request Message.



Transmitter Interrogating Code Structure

Figure 3-4 Polling Request Message

Table 3-1 1900 Transmitter - Function Jumper Positions (W2)

Jumper	Position	Action
0	OFF	Always in the OFF position
1	OFF	Level only transmission
	ON	Level and temperature transmission
2	OFF	Level only transmission
	ON	Level and temperature transmission
3	OFF	Copper RTD
	ON	Platinum RTD
4	OFF	High speed transmission
	ON	Low speed transmission
5 (6 OFF)	OFF	Degrees Centigrade
	ON	Degrees Farenheit
5 (6 ON)	OFF	Gauging system interprets 18 bits of level message
	ON	Gauging system interprets 17 bits of level message
6	OFF	English encoder
	ON	Metric encoder
7	OFF	Normal operation
	ON	Test mode (A/D converter remains on continuously)

The start bit of the polling request message is always a mark pulse. The second bit is not used. The third bit provides the remote raise command to the servo gauge and the fourth bit provides the remote reset command to the servo gauge.

The ID code of the transmitter to be polled follows and consists of 12 BCD (Binary Coded Decimal) bits. Bits 5-8 contain the most significant digit of the transmitter ID (ID x 100), bits 9-12 contain the next most significant digit (ID x 10) and bits 13-16 contain the least significant digit (ID x 1).

The polling response message from the transmitter is either 40 or 56 bits in length, depending upon whether temperature reporting is included. Refer to Figure 3-5, Polling Response Message.

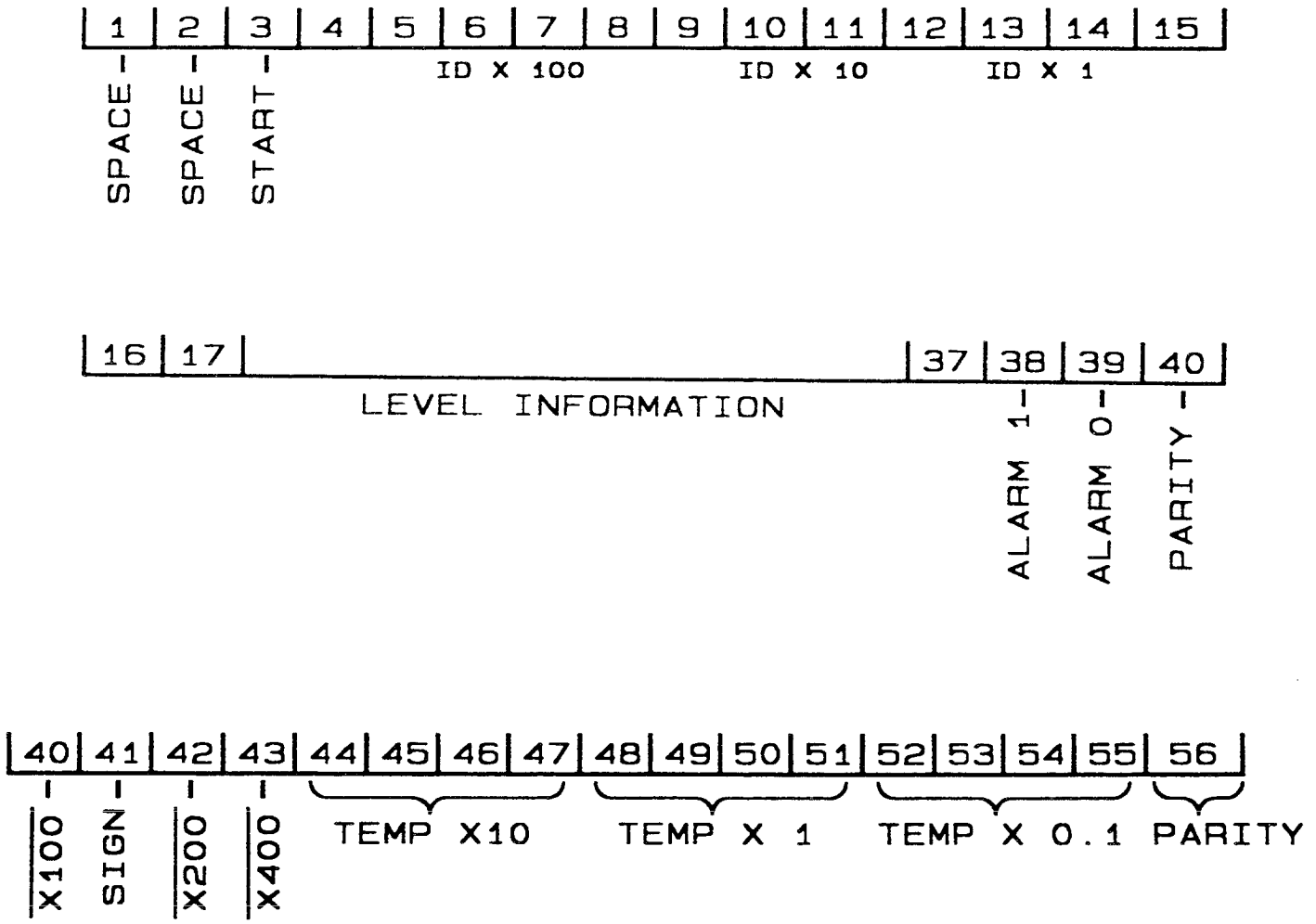


Figure 3-5 Polling Response Message

The start bit of the polling return message is always a mark pulse. The second and third bits are not used. The next 12 bits (bits 4-15) contain the ID code of the transmitter in the same format as it was received. Bit 16 is the first data bit and is always a space. Bits 17-37 contain the product liquid level data. Bits 38 and 39 are optionally used from external alarms, alarm 0 and alarm 1 (logical high qualified alarm). Any unused bits in the polling return message are transmitted as space pulses.

Bit 40 is the parity bit when the servo gauge returns level data only. Odd parity is used in the system. The parity bit is a one (mark) when the number of mark pulses in the message is even, and a zero (space) when the number of mark pulses is odd. In all cases, a valid 40-bit polling return message contains an odd number of ones (marks), including the parity bit.

When temperature information is also returned, bits 40-43 contain the x100 bit, the sign bit, the x200 bit and the x400 bit of the temperature. The sign bit indicates plus (+) when a one (mark) and minus (-) when a zero (space).

The next 12 bits (bits 44-55) contain the three BCD digits of the temperature. Bits 44-47 contain the TEMP x 10 digit, bits 48-51 contain the TEMP x 1 digit and bits 52-55 contain the TEMP x 0.1 digit. This BCD temperature value is affected by the multiplier bits defined above.

Bit 56 is the parity bit when the servo gauge also returns temperature data. It functions in the same manner as the parity bit (bit 40) in level only systems described above.

Current Output Transmitter (8200) Card

The current output transmitter card is positioned by the drive shaft assembly in the servo gauge head. A potentiometer is coupled by a worm gear arrangement to the drive shaft. As the drive shaft rotates, the potentiometer setting varies accordingly. The potentiometer is connected to the input of a current transmitter device , a linear integrated circuit used to convert voltage from a sensor to current. The current is then transmitted over two wires to the receiver or indicator.

The current output transmitter is normally configured to provide an increase in current output on a rising product liquid level. By reversing the connections (CW and CCW) on the potentiometer, the transmitter provides an increase in current output on a falling product liquid level.

This page left blank

Section 4 - Maintenance

OVERVIEW

The Varec 6500 Series Servo Level Gauge is designed and manufactured to provide accurate and reliable product liquid level measurement without regular maintenance. Due to the modular construction of the servo gauge, routine maintenance and necessary repairs can be quickly and safely accomplished.

It is recommended that all necessary maintenance and repairs be performed by a factory trained service engineer.

CAUTION
When performing maintenance or service of any kind on the servo gauge, follow all instructions relative to power on/off requirements.

If the servo/electronics cover or junction box cover is removed, follow all instructions relative to the tightening sequence and torque requirements when replacing the screws. Refer to Figure 2-5, Torque Specifications for Servo Gauge Cover Screws.

MECHANICAL

Maintenance of the mechanical components in the servo gauge should be limited to the displacer, measuring wire, measuring drum assembly and the drive belt for the mechanical counter and encoder.

Mechanical failure of the servo gauge is generally attributable to improper installation, requiring verification of the installation integrity. Refer to Section 2, Installation.

Displacer, Measuring Wire and Measuring Drum Assembly

The measuring wire can become damaged or broken a number of ways, including obstructions in the stilling well, flange connection, or isolation valve. The measuring drum assembly should be replaced by a qualified technician.

The respooling of a new measuring wire on an existing drum should be performed by a factory trained technician. If the measuring wire is broken, the displacer will most likely be abandoned in the tank and require replacement. Refer to Section 2, Installation.

Alarm Switches

Replacement of the alarm microswitch can be performed by a qualified technician. Refer to the calibration portion of this section.

ELECTRIC/ELECTRONIC

The electric/electronic portion of the servo gauge is mounted in the servo/electronic housing and consists of three modular assemblies:

- o motion control PCB
- o servo motor
- o encoder/transmitter

A malfunction in any of the three assemblies requires replacement of the entire assembly. Field repair or component replacement should not be attempted. The defective assembly should be returned to the factory for repair or replacement.

CAUTION
Maintenance or service of the following electric\electronic assemblies of the servo gauge requires that the 24 VAC power be turned off before removal of the servo\electronics housing cover is attempted.

Motion Control PCB

To replace the motion control PCB:

1. Unplug the small wire connector on top of the board.

2. Remove the defective board (grip the plastic handle and pull the board from its receptacle or unbolt the board from the housing and remove the two connectors).

3. Insert the new board (slide the board into the plug guides and push firmly from the outer edge until the board is seated in the receptacle or bolt the board to the housing and attach the two connectors).

4. Replace the small wire connector on top of the board.

The small wire connector connects the servo motor to the motion control PCB. The A/B/C link should also be checked when servicing the motion control PCB.

Servo Motor and Encoder/Transmitter Assemblies

The servo motor and encoder/transmitter assemblies are independently mounted on brackets with captive screws.

To replace either assembly:

1. Remove the counter/encoder/alarm switch drive belt.

2. Unplug the wire connector.

3. Unscrew the mounting bracket screws to remove the assembly.

4. Reverse the procedure to install the new assembly.

CALIBRATION

Calibration information is applicable to a new installation and start-up (commissioning) of a servo gauge, and calibration verification or re-calibration of the servo gauge during routine maintenance and service.

Free movement of the displacer is required for calibration. If there is any question regarding displacer movement, make the appropriate system inspection and correct any deficiencies prior to initiating the calibration procedure. Servo gauge accuracy is dependent upon the stability of the mounting and free movement of the displacer.

The mechanical counter and encoder must be set at the same value. If they are not the same, adjust the mechanical counter to match the encoder.

Calibration With Known Liquid Level

The following procedure may be used on low pressure and atmospheric tanks when a manual dip is possible. It is based on a known product liquid level or with the tank empty. The displacer is lowered to the liquid surface, or to the empty tank bottom, until the servo gauge is set to display the known liquid level.

CAUTION
The servo/electronics compartment should not be opened in hazardous areas with power applied to the servo gauge. Follow the precautionary label on the 6500 cover.

---

1. Apply 24 VAC power to the servo gauge. The suspended displacer signals the servo gauge motor to start and lower the displacer to a balance condition, either at the liquid surface or tank bottom, at which time the servo gauge motor stops.

2. Turn off the 24 VAC power to the servo gauge.

3. With the power off, remove the servo/electronics housing cover.

4. Loosen the tension adjustment on the mechanical counter drive belt and remove the belt from the counter drive sprocket.

5. Rotate the counter input shaft until the counter displays the known liquid level value.

The mechanical counter is now calibrated and ready to display the product liquid level. If the servo gauge is equipped with an optical or brush digital encoder, it is now also calibrated to transmit product liquid level data to a tankside receiver or system receiver.

NOTE
At this point, the high/low/limit alarm switches and optional additional alarm switches should be set. In addition, if the servo gauge is equipped with an analog encoder, the encoder should be zero and span calibrated before replacing the drive belt.

6. Verify that the mechanical counter displays the known product liquid level value.

7. Replace the drive belt on all three sprockets, set the belt tensioner arm to apply a *slight tension* on the drive belt, and tighten the mounting screw.

8. Replace the servo/electronics housing cover. Replace all screws and tighten the screws in sequence and torqued to the values specified in Figure 2-5, Torque Specifications for Servo Gauge Cover Screws.

9. Apply 24 VAC to the servo gauge.

The servo gauge is now ready for operation.

Calibration With Calibration Chamber and Isolation Ball Valve

The following procedure may be used on medium and high pressure tanks where manual dipping is not possible. It is based on a servo gauge installation with a calibration chamber and isolation valve (full-port ball valve). The displacer is manually lowered to rest on a calibration plate inserted into the calibration chamber. The mechanical counter is manually set to display a known reference value based on the relative position of the calibration plate and tank bottom. To display the actual product liquid level, the calibration plate is removed and the displacer is allowed to lower to the liquid level and balance condition. The counter then indicates the actual liquid level value.

CAUTION
The servo/electronics compartment should not be opened in hazardous areas with power applied to the servo gauge.

---

1. Pressure valve V1 (refer to Figure 4-1, Calibration Chamber) must be in the open position. If the pressure gauge indicates a pressure value, slowly open bleed valve V2 and allow the pressure to bleed to zero. Both valves, V1 and V2, must be in the open position throughout the calibration procedure. The isolation valve must be in the fully closed position.

2. If calibration is performed during start-up of the servo gauge, it is assumed the calibration chamber cover is already removed. For maintenance or service calibration, remove the blind flange cover, gasket, and calibration plate from the calibration chamber. Refer to Figure 4-2, Calibration Chamber With Calibration Plate.

3. Position the displacer in the upper portion of the calibration chamber. If calibration is performed during start-up of the servo gauge, manually turn the measuring drum to raise or lower the displacer. The measuring drum resists manual turning due to the magnetic coupling. Rotate the drum against the magnetic forces by gripping the drum firmly and rotating it in the required direction. During maintenance or service calibration, the displacer is raised with the manual raise feature of the servo gauge.

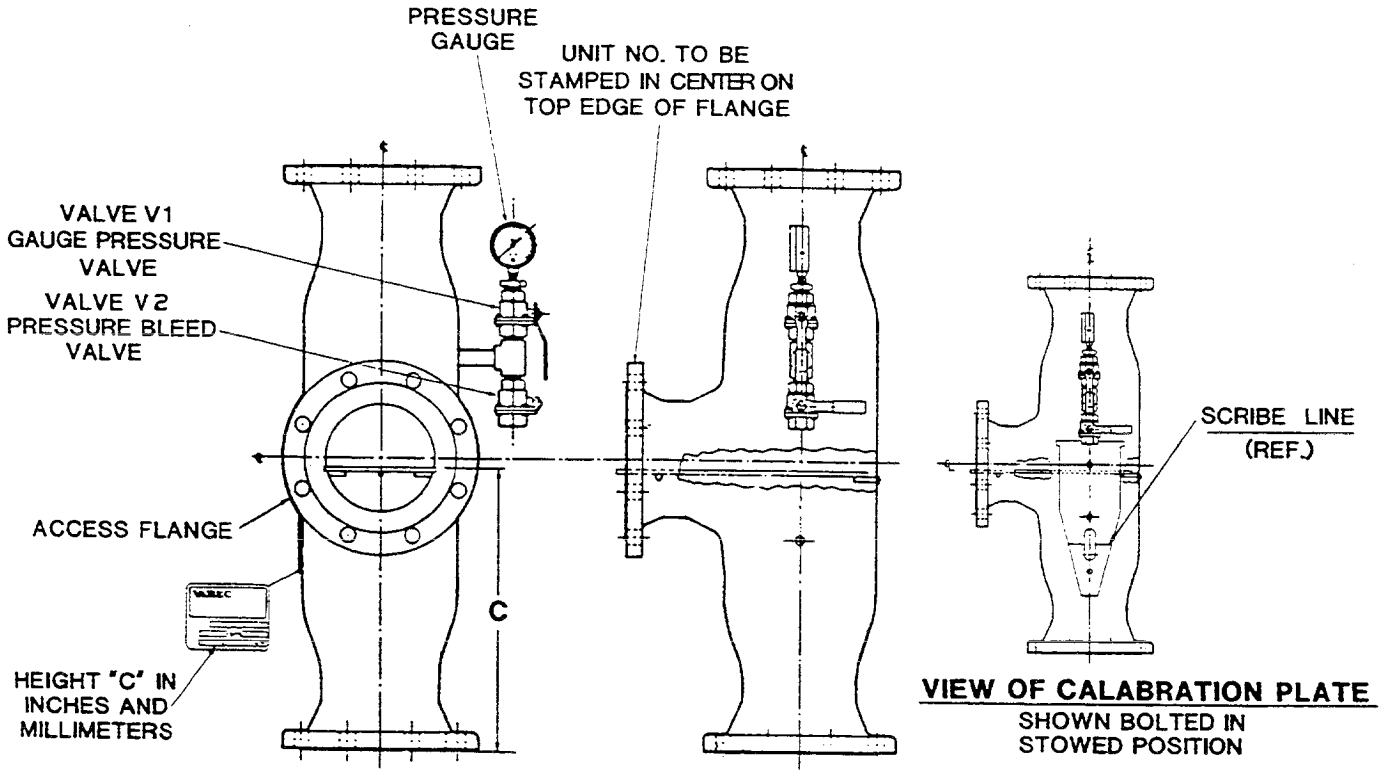


Figure 4-1 Calibration Chamber

4. Place the calibration plate, tapered end first, into the calibration chamber and rest it on the mounting pins. The displacer should be above the calibration plate.

5. Apply 24 VAC power to the servo gauge. The suspended displacer signals the servo gauge motor to start and lower the displacer to a balance condition, resting on the calibration plate, at which time the servo gauge motor stops.

6. Verify that the displacer is centered over the straight sides of the slot in the calibration plate.

NOTE
The distance from the calibration plate to the bottom of the tank must be known to complete the calibration procedure. This distance is dimension "D" in Figure 4-3, Calibration Point Determination. The following dimensions must be known to determine dimension "D":

- o Dimension "A" - Measured distance from the tank bottom to the stilling well or standpipe top flange face.

- o Dimension "B" - Flange to flange distance of the isolation valve

- o Dimension "C" - Calibration chamber bottom flange face to the top of the calibration plate. This dimension is stamped in the calibration chamber nameplate at the factory.

- o Dimension "H" - The immersion depth of the displacer. This varies slightly based on the specific gravity of the product and the displacer size. Refer to Figure 4.4, 4.5, or 4.6, Displacer Immersion Chart, to determine dimension "H" of the displacer in service on the servo gauge being calibrated.

- o Thickness of all flange gaskets at both isolation valve flanges.

Add dimensions "A", "B", "C", "H", and gasket thickness to determine dimension "D", to be manually set on the mechanical counter.

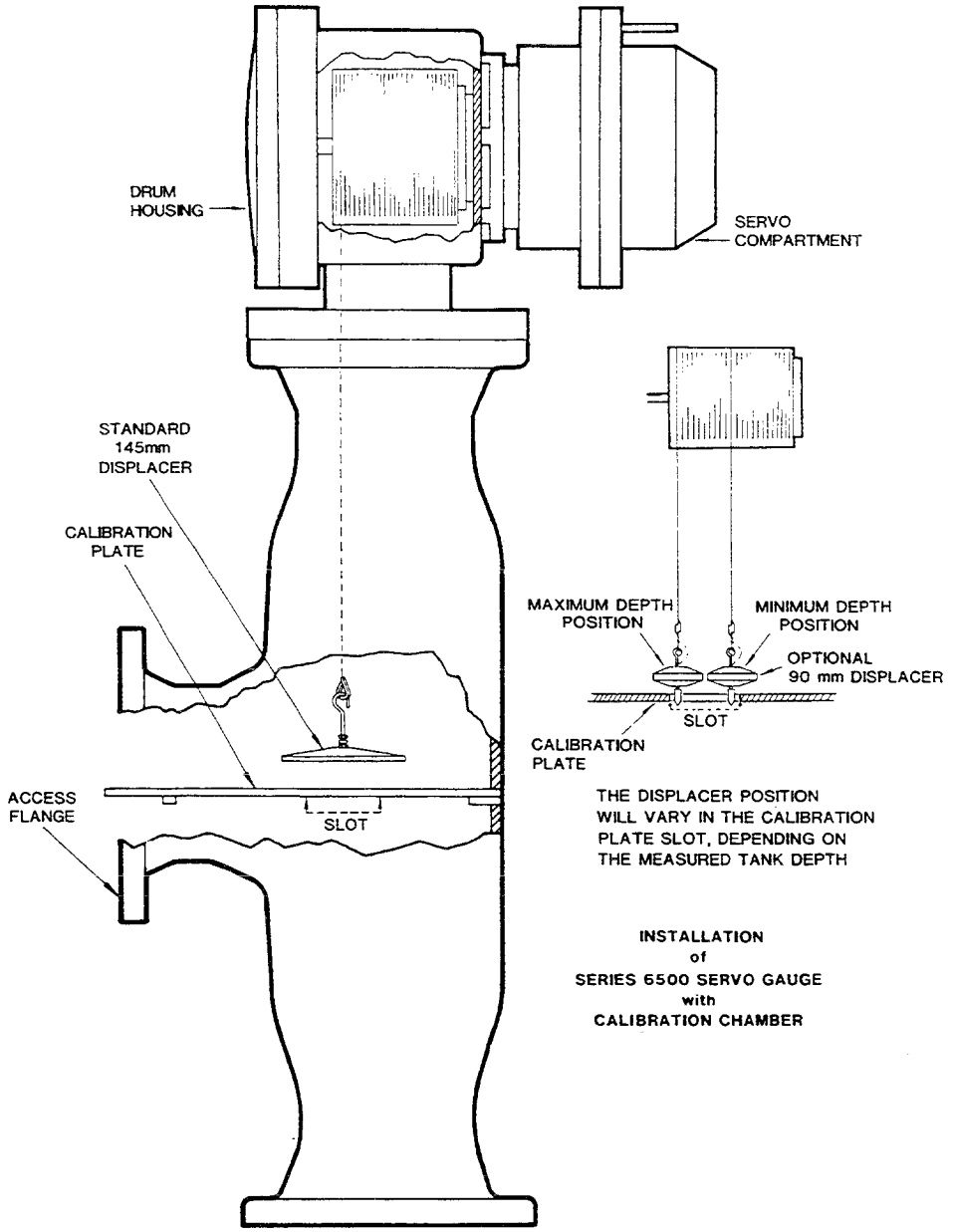


Figure 4-2 Calibration Chamber With Calibration Plate

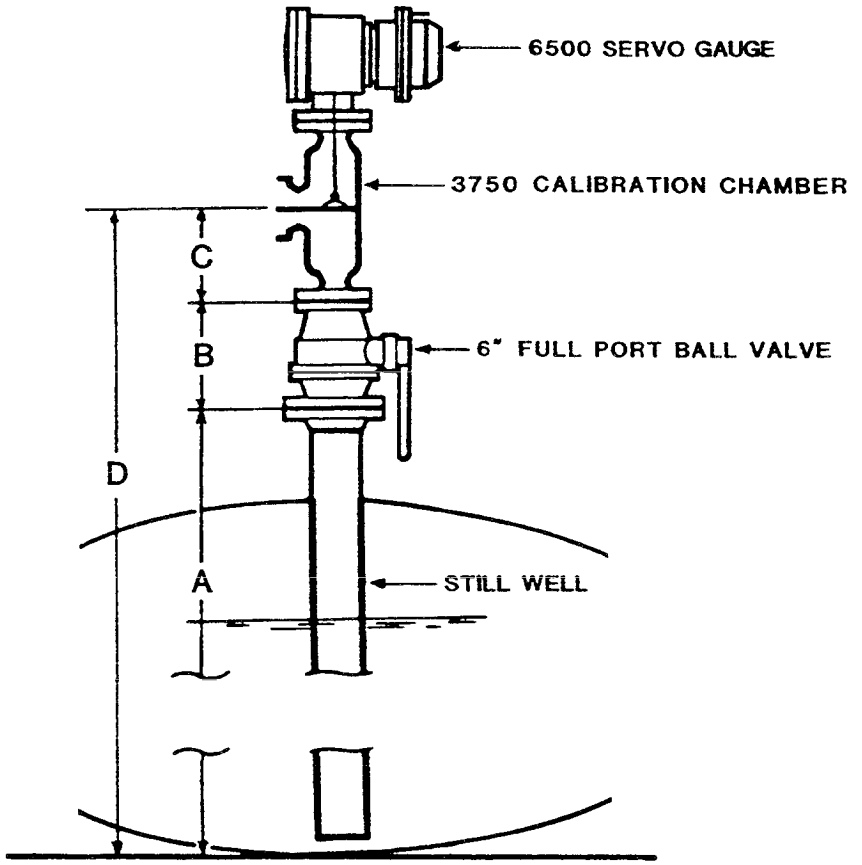


Figure 4-3 Calibration Point Determination

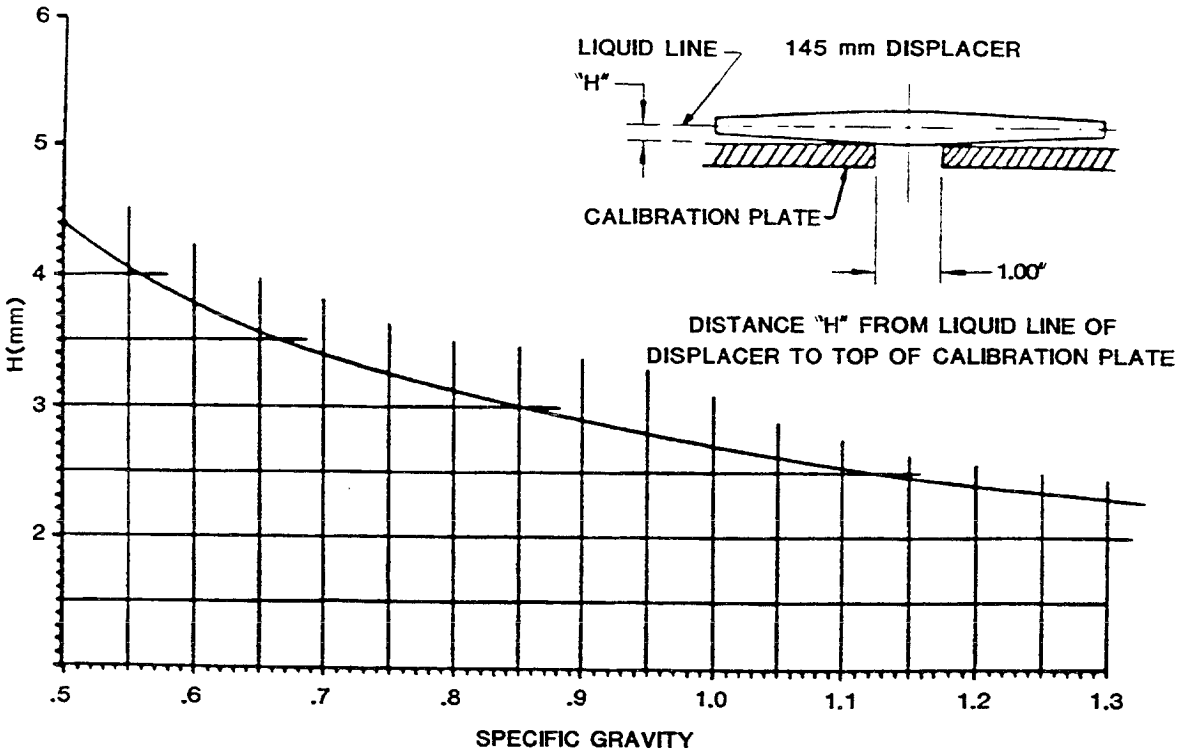


Figure 4-4 145 mm (5.7 in) Displacer Immersion Chart

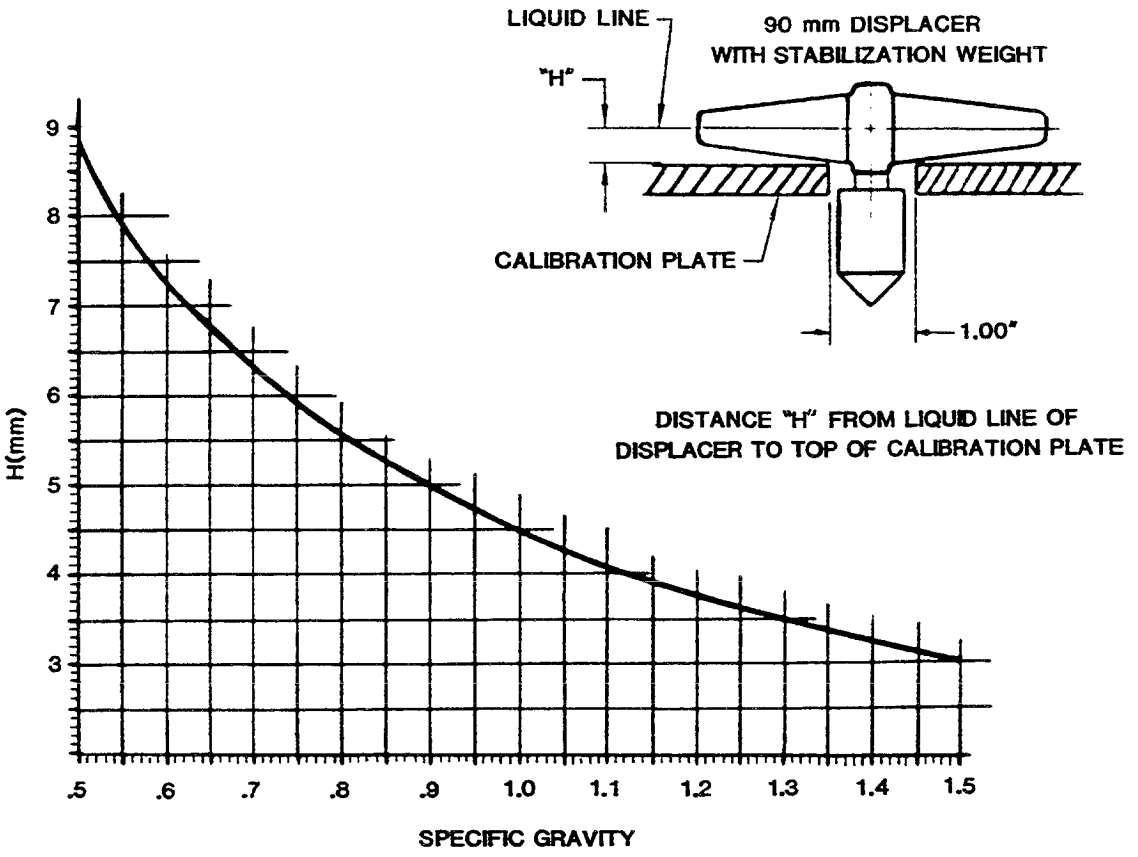


Figure 4-5 90 mm (3.5 in) Displacer Immersion Chart

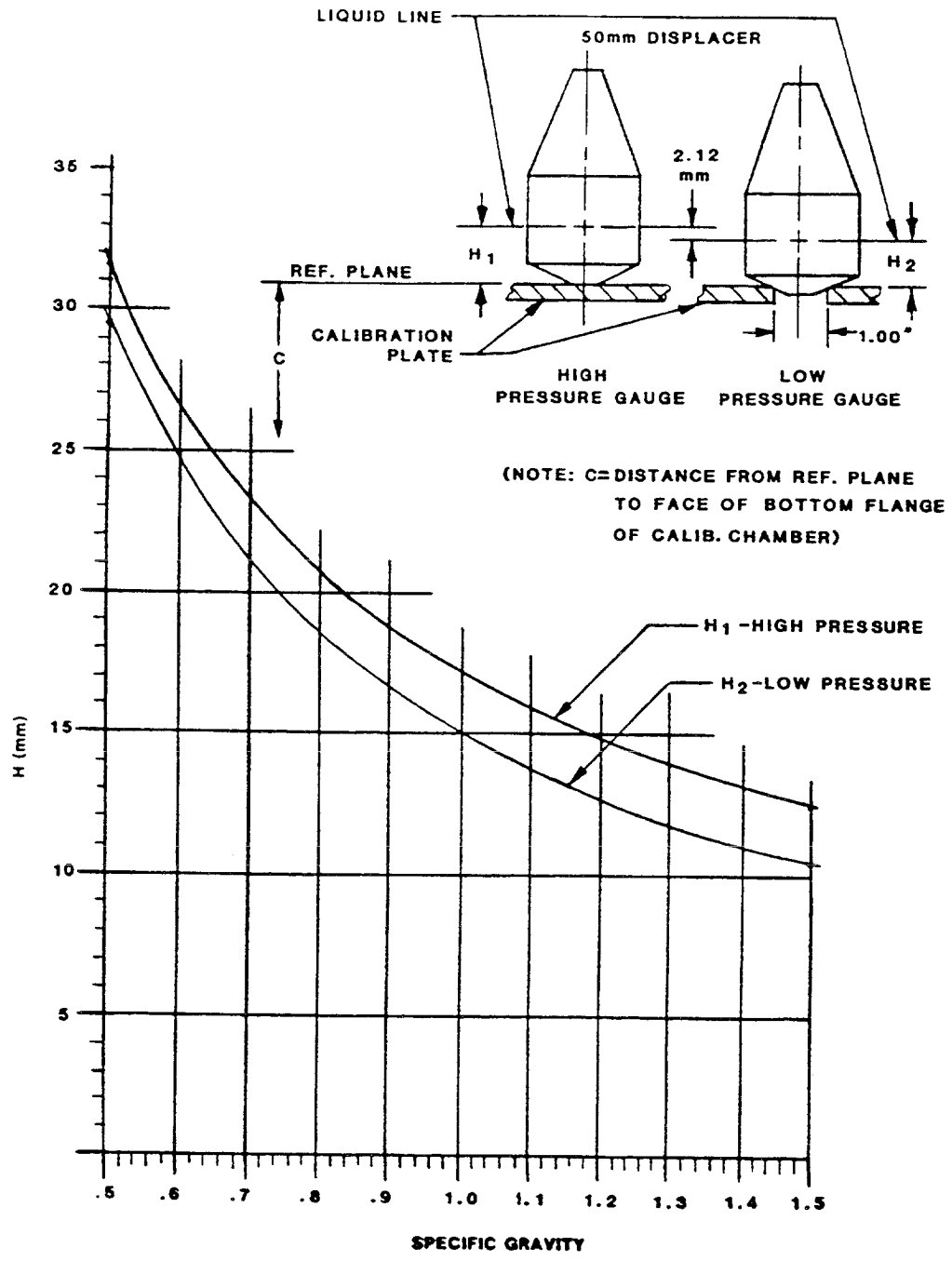


Figure 4-6 50 mm (2.0 in) Displacer Immersion Chart

The servo gauge is now ready to be calibrated with the calibration chamber.

1. Turn off the 24 VAC power to the servo gauge.

2. With the power off, remove the servo/electronics housing cover.

3. Loosen the tension adjustment on the mechanical counter drive belt and remove the belt from the counter drive sprocket.

4. Rotate the counter input shaft until the dimension "D" value is displayed.

The mechanical counter is now calibrated and ready for the displacer to be lowered to the liquid surface to display the product liquid level. If the servo gauge is equipped with an optical or brush digital encoder, it is now also calibrated to transmit product liquid level data to a tankside receiver or system receiver.

NOTE
At this point, the high/low/limit alarm switches and optional additional alarm switches should be set. In addition, if the servo gauge is equipped with an analog encoder, the encoder should be zero and span calibrated before replacing the drive belt.

5. Verify that the mechanical counter is set at the dimension "D" value.

6. Replace the drive belt on all three sprockets, set the belt tensioner arm to apply a slight tension on the drive belt, and tighten the mounting screw. Do not overtighten the drive belt. A small amount of play is desired.

7. Remove the calibration plate and mount the blind flange cover and gasket on the calibration chamber flange. (Attach the calibration plate to the outside of the calibration chamber for storage.)

8. Close the bleed valve V2. Leave the pressure valve V1 in the open position on the calibration chamber.

9. Replace the drum housing cover.

10. Replace the servo/electronics housing cover. Replace all screws and tighten the screws in sequence and torqued to the values specified in Figure 2-5, Torque Specifications for Servo Gauge Cover Screws.

11. Slowly open the isolation valve (full-port ball valve) to the full open position. The tank pressure will fill the calibration chamber and measuring drum housing. Ensure that there is no leakage at any gasketed connection.

12. Apply 24 VAC to the servo gauge. The suspended displacer signals the servo gauge motor to start and lower the displacer to a balance condition at the surface of the product being measured, at which time the servo gauge motor stops.

The servo gauge is now ready for operation.

Setting the Cam-Operated Switches

The servo level gauge has five cam-operated microswitches that are coupled to the mechanical counter drive mechanism. Two of these switches are dedicated to high and low liquid level limit settings. The other three switches can be used to trigger audible or visual alarms, or to control on/off discrete equipment. The cam-operated switches can be set before or after the servo gauge is field mounted and can be changed at any time.

High and Low Limit Switches

The cam-operated high and low limit switches are used to limit the upward (raise) and downward (lower) travel of the displacer during normal operation of the servo gauge.

CAUTION
The high limit switch must be set to prevent the displacer from being reeled up into the measuring drum housing, as this will cause damage to the instrument.

The cams are secured with set screws to a shaft that rotates proportionately to displacer travel. The counter drive belt must be removed to set the high and low limits. Refer to Figure 4-7, Mechanical Drive Assembly.

1. Loosen the tension adjustment on the mechanical counter drive belt and remove the belt from the counter drive sprocket.

2. Rotate the counter input shaft until the low limit value is displayed on the counter. Rotate the cam until the microswitch arm drops into the detent on the cam. Tighten the set screw.

3. Rotate the counter input shaft until the high limit value is displayed on the counter. Rotate the other cam until the microswitch arm drops into the detent on the cam. Tighten the set screw.

4. Verify that the counter displays the known liquid level value (calibration with known liquid level) or the value of dimension "D" (calibration with a calibration chamber). If the counter is not displaying the correct level, it must be manually adjusted by loosening tension on the drive belt and turning the counter shaft.

5. Replace the drive belt on all three sprockets, set the belt tensioner arm to apply a slight tension on the drive belt and tighten the mounting screw.

Optional Alarm Switches

The optional alarm switches are set in the same manner as the high/low limit switches. They can be set to any value within the range of the high/low limit switches.

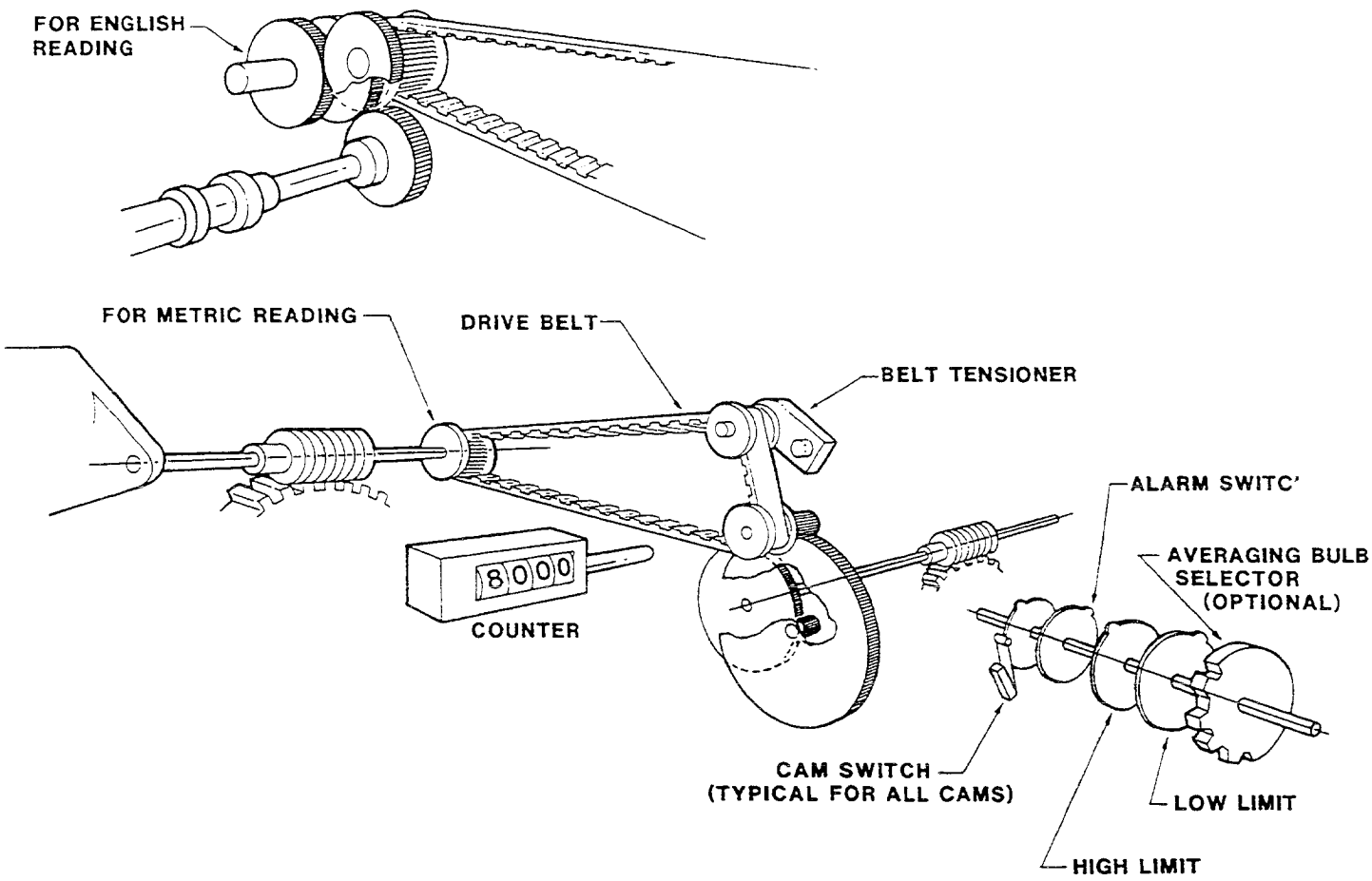


Figure 4-7 Mechanical Drive Assembly

Servo Motor Time Delay

The time delay preventing excessively fast switching of the servo motor is factory set at six seconds. If desired, this delay can be adjusted from a minimum of two seconds to a maximum of 15 seconds. The adjustment is made by turning potentiometer P-1 on the motion control PCB.

Encoders

The servo gauge is equipped with one of three different types of encoders:

- o optical digital
- o brush digital
- o analog

Optical Digital Encoder

The optical digital encoder is calibrated at the factory and does not require calibration in the field. Refer to Figure 4-8, Optical Encoder Assembly.

Brush Digital Encoder

The brush digital encoder is calibrated by phasing the code disks at the factory and during normal service should not require calibration in the field. Refer to Figure 4-9, Brush Encoder Assembly.

Code disk phasing refers to the angular relationship between the code patterns on the two disks, at the point where the second code disk is advanced, and the relationship of the code disk sensors.

1. If the Geneva gear has been disengaged from the code disk, loosen the post bracket assembly.

2. Set the second code disk on 40 feet in reference to the scribe mark on the back plate and the number 40 on the second code disk.

NOTE
For metric encoders, use the 10 meter point for phasing.

3. Using the dial, set the first code disk on "1" in reference to the scribe mark.

4. Engage the Geneva gear with the lock disk gear and the second code disk gear. Note that the transmitter must be set on 40 feet and 1 inch. Secure the post bracket assembly by tightening the two screws. This operation aligns the code patterns between the two disks.

5. Rotate the input shaft and check for smooth operation. If the unit binds, or is hard to turn, loosen the post bracket assembly and reset, allowing a little more play between the first and second code disks. The play can be checked at any point except for the changeover point.

6. Check for excessive play. The second code disk should move no more than one quarter tooth with respect to a fixed reference.

7. Rotate the input shaft slowly between 39 feet, 11.5 inches and 40 feet, 0.5 inches. Observe the second track from the bottom. Check to see that the code disk as related to the brush moves an equal distance on either side of the conducting and non-conducting pattern.

8. Rotate the input shaft to each side of the changeover point. Check each side to see that the second finger does not move from the conducting to the non-conducting pattern when the second code disk is moved with your finger.

9. Reassemble the transmitter. Connect the transmitter to a receiver and check the changeover point every 10 feet from 0 to 70 feet.

Analog Encoder

The analog encoder should be calibrated when installed in the field. Refer to Figure 4-10, Analog Encoder Assembly.

The following equipment is required:

- o voltmeter, Newport Digital Model 2000 A2, A3, D2, or equivalent
- o 100 ohm 0.1% resistor
- o Helipot Model 5617 1K Ohm 0.1% potentiometer

The reference voltage for the analog encoder is adjusted at the factory and, under normal circumstances, need not be recalibrated in the field.

To adjust for reference voltage:

1. Install R10 on the transmitter board, if it was not previously installed. Refer to Section 2, Installation (Current Output Transmitter Board Lead Resistance).

2. Connect the 1K Ohm potentiometer. Refer to Figure 4-11, 4-20 mA Transmitter Board Schematic.

3. Connect the positive lead of the digital voltmeter to R1 at point A and the negative lead to point B. Refer to Figure 4-12, 4-20 mA Transmitter Board Assembly.

4. Adjust the onboard potentiometer until the digital voltmeter indicates 4.3 V.

To adjust for zero:

1. Replace the readout device with a 100 Ohm resistor.

2. Connect the digital voltmeter across the 100 Ohm resistor.

3. Remove the cover from the transmitter assembly.

4. Disengage the driveshaft by loosening the screw on the shaft coupling.

5. Using the knob on top of the shaft, rotate the shaft drive until the digital voltmeter reads approximately 400 mV.

6. Adjust P2 (zero adjustment potentiometer) until it reads 400 mV.

To adjust for span:

1. Rotate the shaft drive until a 2 V reading is reached.

2. Adjust P3 (span adjustment potentiometer) until a reading of 2 V is reached.

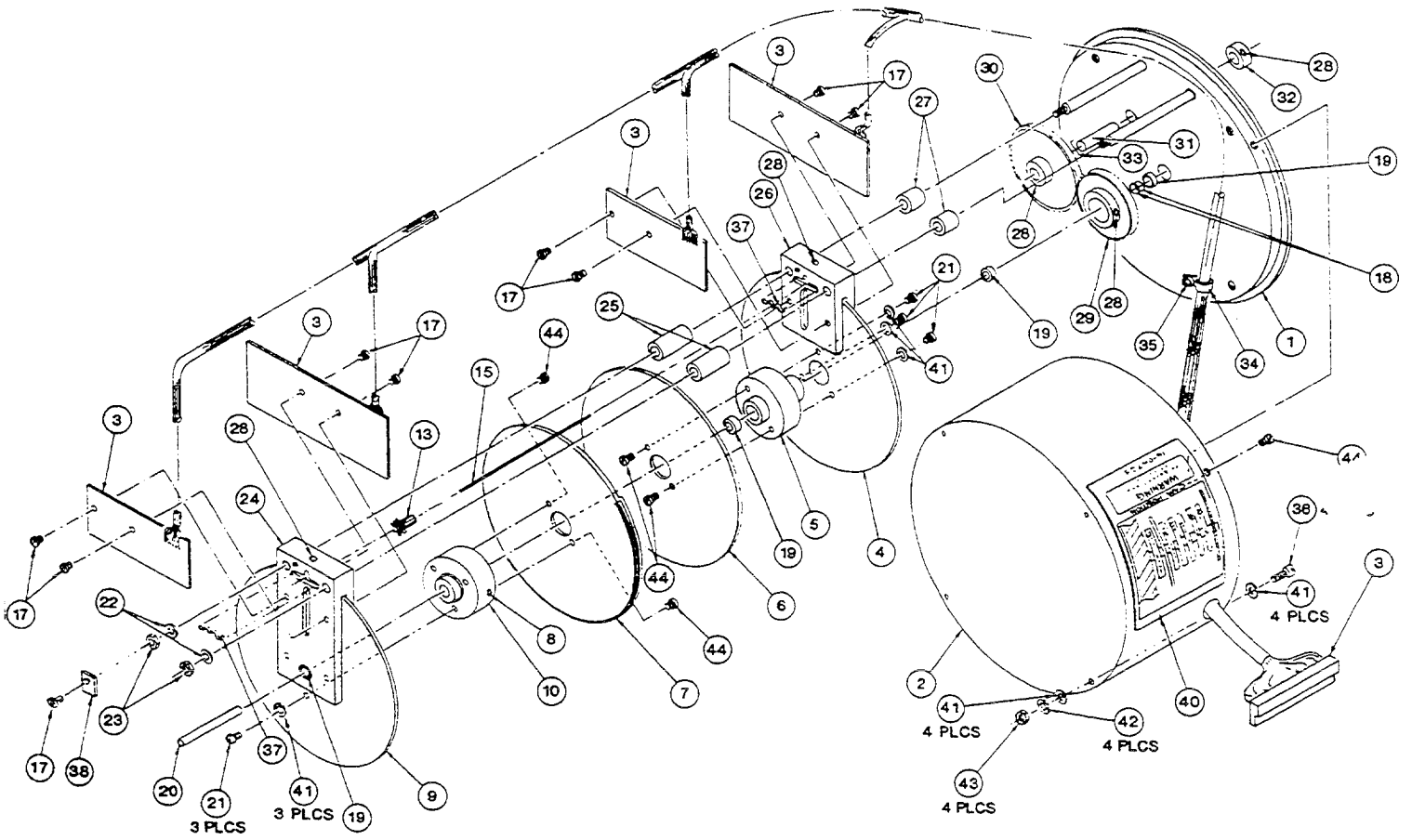


Figure 4-8 Optical Encoder Assembly (Page 1 of 2)

ITEM	DESCRIPTION	PART NO.
	Optical Encoder, Metric	06-06577D-1 Rev.FF
1	Mounting Plate	
2	Cover	
3	Harness Assembly (metric)	
	Harness Assembly (English)	
4	Optical Code Disk (meters)	
	Optical Code Disk (feet)	
5	Code Disk Hub, Bottom	
6	Gear Assembly	
7	Lock Disk/Geneva Gear Support	
8	Socket-End Set Screw	
9	Optical Code Disk (metric)	
	Optical Code Disk (English)	
10	Code Disk Hub, Top	
11	Deleted by E.O.	
12	Deleted by E.O.	
13	Geneva Gear w/Keeper	
14	Deleted by E.O.	
15	Geneva Gear Shaft	
16	Previously deleted	
17	Slotted Cylinder Head Screw (9)	
18	Shim Washers (8)	
19	Bearings (4)	
20	Encoder Shaft	
21	Socket Button Head Screws (6)	
22	Split Lockwashers (6)	
23	Hex Nuts (6)	
24	Previously deleted	
25	Encoder Spacers, Top (2)	
26	Previously Deleted	
27	Encoder Spacers, Bottom (2)	
28	Socket-end Set Screws (4)	
29	Brass Gear (metric)	
	Brass Gear (English)	
30	Brass Gear (metric)	
	Brass Gear (English)	
31	Alarm Shaft	
32	Alarm Shaft Retainer	
33	Nylon Bushing, Thompson	
34	Cable Clamp	
35	Cylinder Head Screw	
36	Slotted Cylinder Head Screws (4)	
37	Leaf Springs, Adjust Geneva Gear (2)	
38	Leaf Spring Retainer	
39	Threadlocker adhesive (Locktite 222, or equal)	
40	Label, Limit Switch	
41	Washers, Flat, M3 (14)	
42	Washers, Splitlock, M3 (4)	
43	Hex Nut M3, (4)	
44	Slotted Cylinder Head Screws, M3 (7)	

Figure 4-8 Optical Encoder Assembly (Page 2 of 2)

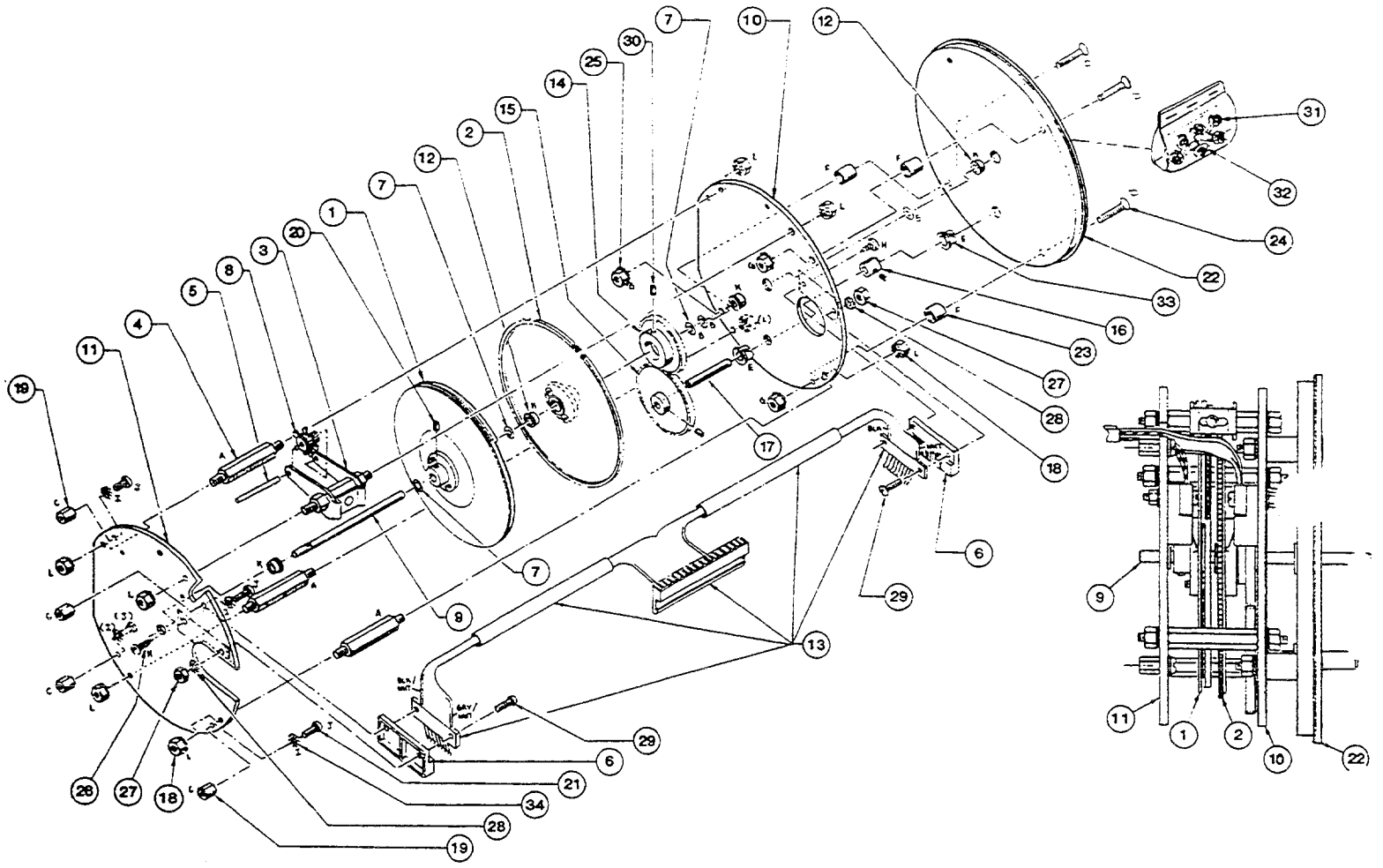


Figure 4-9 Brush Encoder Assembly (Page 1 of 2)

Item No.	Part No.	Description	Qty Per
1	D5414-1	Code and Lock Disk Assembly (English)	1
	D5414-2	Code and Lock Disk Assembly (metric)	1
	D5414-3	Code and Lock Disk Assembly (decimal)	1
2	D5415-1	Code Disk and Gear Assembly (English)	1
	D5415-1	Code Disk and Gear Assembly (decimal)	1
	D5415-2	Code Disk and Gear Assembly (metric)	1
3	B12121	Post Bracket Assy	1
4	B12122-003	Post Dynel	3
5	B12126	Geneva Gear Shaft	1
6	B12127	Brush Block Spacer	2
7	B12128-005	Shim Washer	5
8	B12138-2	Geneva Gear	1
9	02-06116	Center Shaft	1
10	15-06114	Front Chassis	1
11	D5275	Back Chassis	1
12	P2-13	Bearing	5
13	BME11686	Harness Assembly (metric)	1
	BME11253	Harness Assembly (English & decimal)	1
14	02-06444	Gear (metric)	1
	02-06115	Gear (English & decimal)	1
15	02-06492	Brass Gear (metric)	1
	02-06494	Brass Gear (English & decimal)	1
16	02-06445	Collar	1
17	02-06117	Alarm Shaft	1
18	P31-942	Hex Nut Washer Assembly	8
19	B8173-2	Hex Standoff	4
20	P31-982	Set Screw	1
21	P031-01-1620	Round-Head Machine Screw	4
22	02-06446	Mounting Plate	1
23	02-06598	Short Encoder Spacer	4
24	P31-882	Flat Head Screw	3
25	P31-943	Hex Nut Washer Assembly	3
26	P031-08-1641	Self-Tapping Panhead Screw	2
27	P31-984	Hex Nut	2
28	P31-909	Washer	2
29	P31-1510	Button-Head Machine Screw	2
30	P031-49-4	Socket-End Set Screw	1
31	P031-85-25	Socket-Head Cap Screw	4
32	P031-42-5	Split Lockwasher	4
33	P102-21-045	Thompson Nylon Bushing	3
34	P31-921	External Lockwasher No.6	4

Figure 4-9 Brush Encoder Assembly (Page 2 of 2)

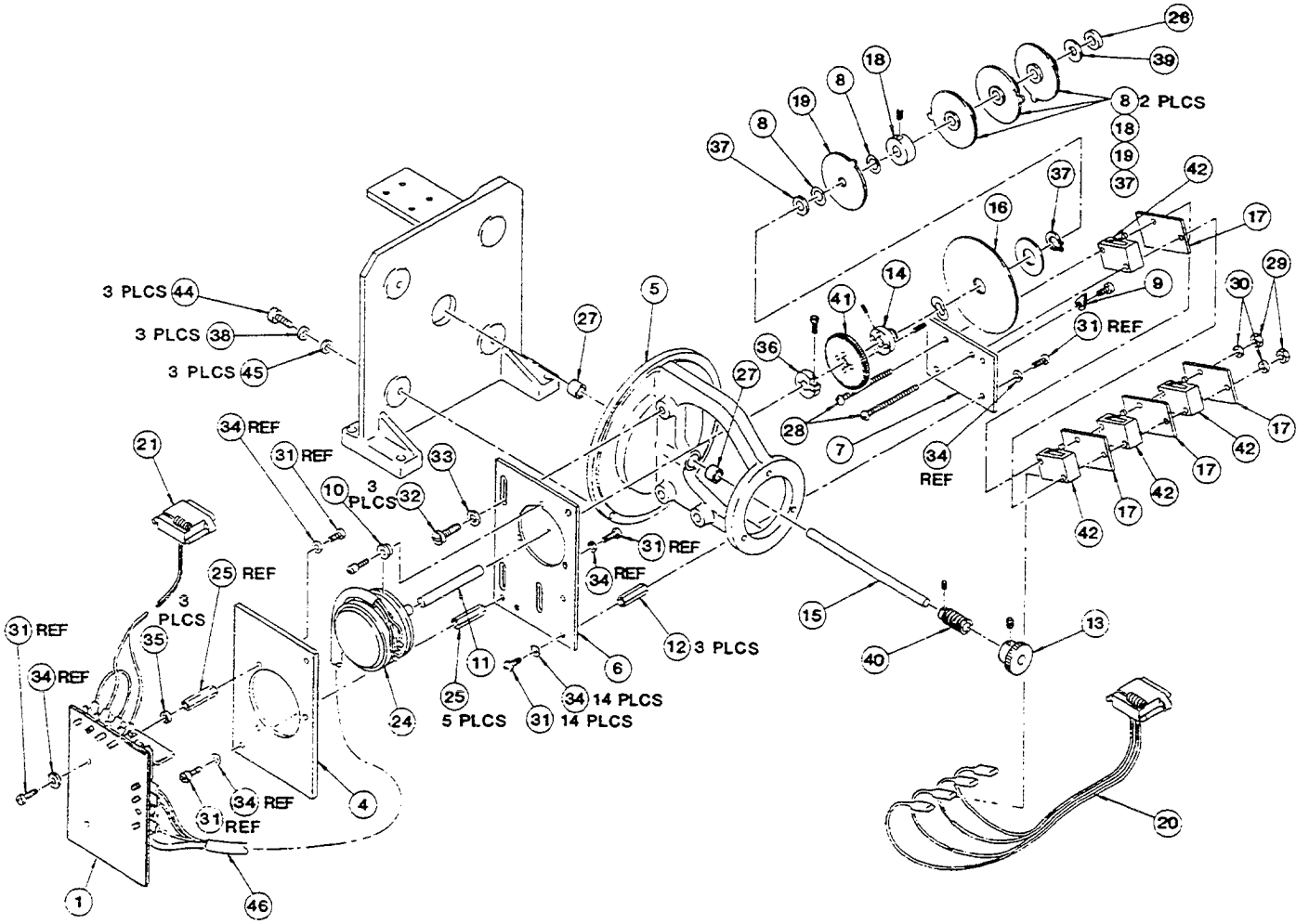


Figure 4-10 Analog Encoder Assembly (Page 1 of 2)

Item No.	Part No.	Description	Qty Per
1	BMC190-00	Power Supply Transmitter Board	1
4	02-03970	Transmitter Board Mounting Plate	1
5	02-03972	Current Output Transmitter Casting	1
6	02-03971	Potentiometer Mounting Plate	1
7	B15912-001	Switch Mounting Plate	1
8	B12128-005	Shim Washer	8
9	B15927-099	Dial Pointer	1
10	B15928	Cleat	3
11	B4758-25	Input Shaft	1
12	B8173-12	Hex Standoff	3
13	B19000	Field Adjust Gear Knob	1
14	B15925-001	Hub	1
15	B15915-005	Shaft	1
16	B15936	Dial	1
17	B15913-068	Insulator	4
18	B12230-001A	Limit Switch Hub	4
19	B12231-003	Limit Switch Cam Dynel	4
20	06-04109	Switches Cable Assembly	1
21	06-03987	Analog Cable Assembly	1
24	P45-54	Potentiometer	1
25	P102-21-006	Standoff	5
26	P10-37	Grip Ring	1
27	P2-13	Bearing	2
28	P31-1389	Pan-Head Screw	2
29	P31-719	Hex Nut	2
30	P31-908	Flat Washer	2
31	P31-822	Pan-Head Screw	14
32	P31-957	Pan-Head Machine Screw	3
33	P31-912	Flat Washer	3
34	P31-910	Flat Washer	14
35	P102-25-005	Fiber Washer	3
36	P25-85	Clamp	1
37	P10-29	Grip Ring	4
38	P31-393	Spring Washer	3
39	P31-917	Washer	1
40	P25-73	Worm Gear	1
41	P25-79	Worm Wheel	1
42	P47-81	Micro Switch	4
44	P31-838	Pan-Head Machine Screw	3
45	P31-911	Flat Washer	3
46	D6898	Cable Assembly	1

Figure 4-10 Analog Encoder Assembly (Page 2 of 2)

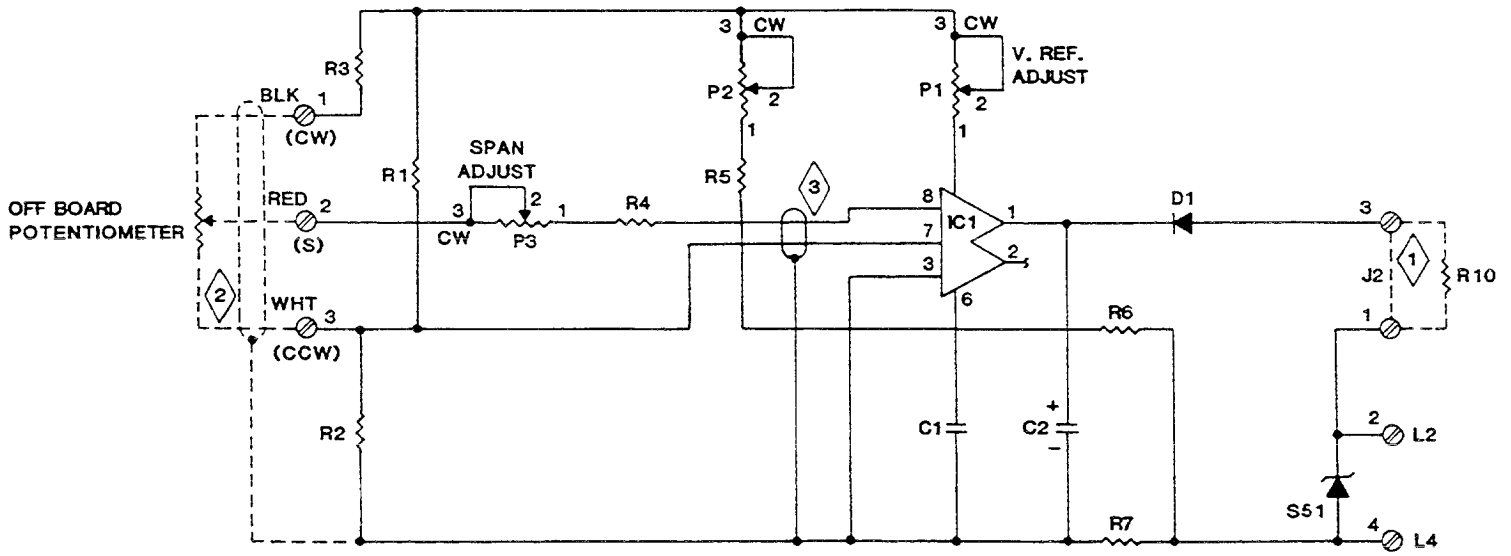
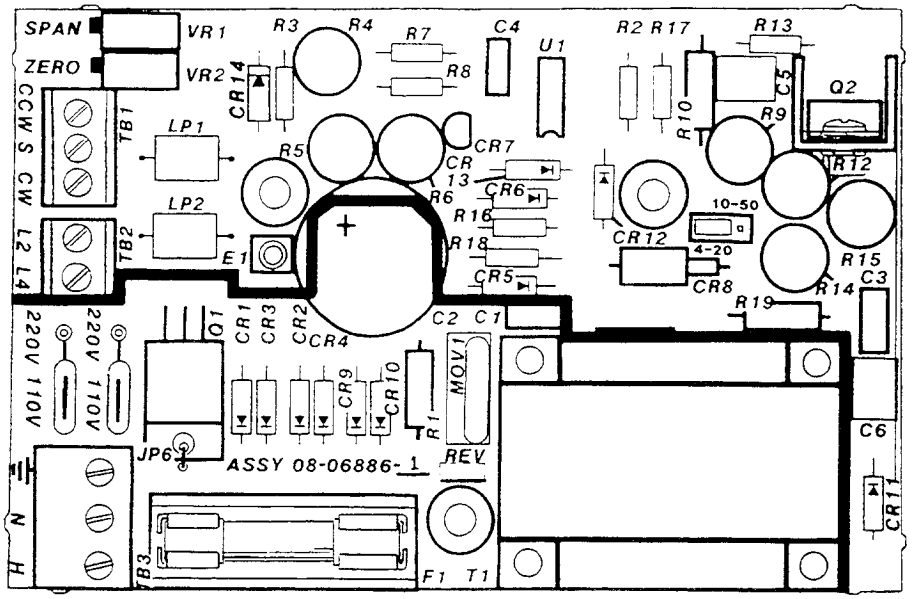
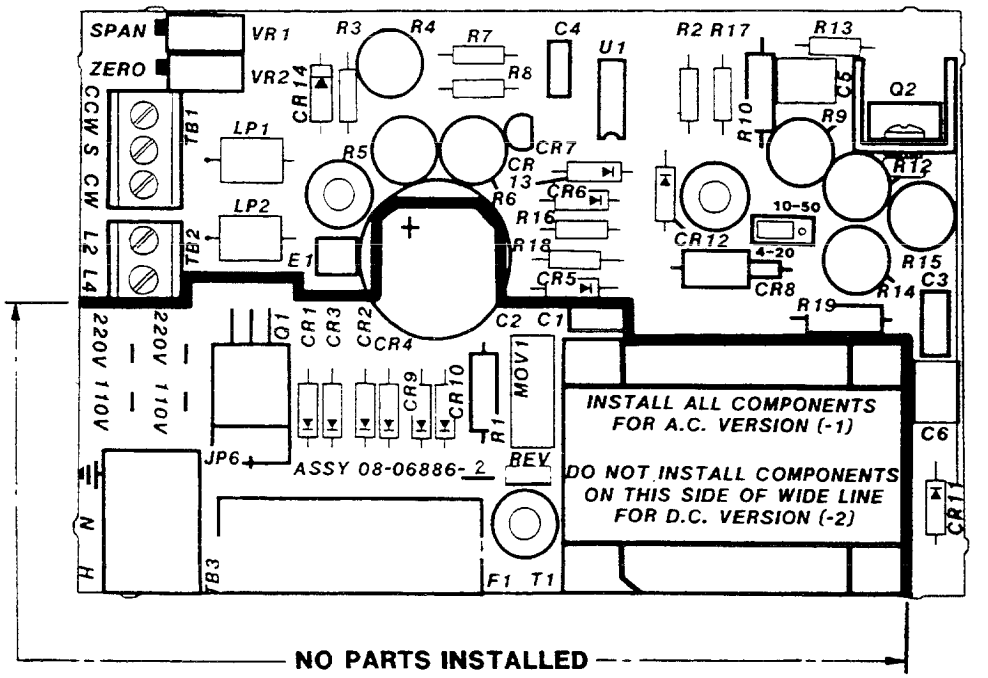


Figure 4-11 4-20 mA Transmitter Board Schematic



A.C. VERSION (-1)



D.C. VERSION (-2)

Figure 4-12 4-20 mA Transmitter Board Assembly

This page left blank

Section 5 - Troubleshooting

TROUBLESHOOTING THE SERVO LEVEL GAUGE

Friction is a common problem affecting servo gauge accuracy. Certain liquids produce corrosion in the mechanism. Periodic inspection and maintenance, provided through a Varec/Rosemount service contract, can prevent problems from occurring by cleaning, lubrication and replacement of worn parts.

NOTE
If a Varec 6603 Series Tank Data Receiver is used in conjunction with the 6500 servo gauge, the tank data receiver displays error codes indicating data transmission faults from the servo gauge. Refer to the 6603 tank data receiver manuals for additional information.

It is recommended that all troubleshooting and repairs be performed by a factory trained service technician.

Troubleshooting Guide

The following list of problem symptoms and possible causes is intended to provide a general view of servo gauge failure indications.

Symptom
Servo motor does not respond to a change in liquid level.

Possible Causes
- o Loss of 24 VAC power supply
- o Faulty motion control PCB circuitry
- o Servo motor failure
- o High/low limit switches open
- o Broken measuring wire

Symptom
Servo motor responds to a liquid level change but the mechanical counter and the remote indication displayed at the central receiver does not change.

Possible Cause
Broken or loose drive belt

Symptom
Servo motor and mechanical counter respond to a liquid level change but the remote indication displayed at the central receiver does not change.

Possible Causes
- o Faulty field communication wiring
- o Loss of B+ (48 VDC) supply
- o Faulty encoder/transmitter circuitry
- o Central receiver not polling the servo gauge

Symptom
Servo motor continually drives in the up direction.

Possible Causes
o Jumper on the motion control PCB is not in the A-B position when the remote raise/reset feature is present
o Component failure on the motion control PCB

Startup Guide

The following startup procedures are intended for use at installation of the servo gauge, following repair of the servo gauge, or for troubleshooting the servo gauge.

1. Inspect all wire connections on connector C1.

   Refer to Figure 2-9, Electrical Termination, and ensure that the proper wires are connected to the designated terminals. Check for frayed or broken wires and ensure that 24 VAC is supplied to the servo gauge.

   Move the servo gauge to a proper location to repair any wiring problems.

2. Ensure that all mechanical parts move freely.

   Check the measuring drum for movement. Check the detection plate and spring assembly, and the mechanical counter and worm gear. All components must move freely.

   Adjust as necessary.

3. Apply 24 VAC to the servo gauge.

   The displacer signals the servo motor to start and lower the displacer to a balance condition, either at the liquid level surface or the tank bottom. The servo motor stops.
   If no response, check the 24 VAC power to the servo gauge. The problem could also be any of the following:

   - o faulty motion control PCB
   - o faulty servo motor
   - o high/low limit switch open
   - o measuring wire broken

4. Compare the servo gauge reading with a known liquid level in the tank.

   If the servo gauge reading does not coincide with the known liquid level, the servo gauge is out of calibration. Skip the next step if the servo gauge provides a proper level reading.

5. Calibrate the servo gauge. Refer to Section 4, Calibration With Known Liquid Level or Calibration With Calibration Chamber and Isolation Valve. Refer to Section 4, Encoders, for transmitter calibration.

If unable to calibrate, inspect the gear assembly, mechanical counter assembly and the motion control PCB. Inspect the belt tension.

If unable to set a high/low limit/alarm switch or an optional alarm switch, check the wiring and cam position. Ensure that the set screw is tight.

This page left blank

Section 6 - Specifications and References

RECOMMENDED SPARE PARTS

The modern design of the Varec 6500 Series Servo Level Gauge dictates that only a minimum number of spare parts be inventoried. It is not required to stock a quantity of spare parts equal to the number of servo gauges and tanks in a given field. Review the service history for quantity requirements.

Varec stocks a complete line of spare parts and assemblies for the servo gauge. Shipment can be made on an as required basis. A repair/exchange program is also available. Contact the Varec product service support group for further details.

Note the product material requirement and any size restriction requirement when specifying a displacer and measuring wire.

The following spare parts may be stocked:

Description	Varec Part Number
Measuring Wire, 38 m (125 ft.) Spool	
316 S.S.	02-08345
Hastelloy-C	P108-05-004
Invar Alloy	Consult Factory
Measuring Wire Crimp, 316 S.S.	P004-02-001
Drive Belt	
English, Fractional	02-06593
Metric	02-06592
Motion Control PCB	
Plug-In	
60 Hz	08-06565-1
50 Hz	08-06565-2
Bolt-In	
60 Hz	08-08312-1
50 Hz	08-08312-2
Displacer	
145 mm (5.7 in), Teflon/Graphite	06-07262
145 mm (5.7 in), Teflon/Graphite, Guided	06-05648
90 mm (3.5 in), Teflon/Graphite	06-05755
90 mm (3.5 in), 316 S.S.	06-07192
50 mm (2.0 in), Teflon/Graphite	06-05498

MAJOR SYSTEM ASSEMBLIES AND COMPONENTS

The list of major servo system assemblies and components are primarily for user reference. Varec does not feel that these items need be stocked as spares.

Description	Varec Part Number
Counter Sub Assembly	
English, Fractional	06-06578
Metric	05-08245
Drum Hsg O-Ring Set	
Viton	05-06460
Teflon	05-06461
Motor Mounting Plate Assembly	
English, Fractional	06-08123
Metric	06-08131
Encoder Mounting Plate Assembly	
English, Fractional	06-06575-2
Metric	06-06575-1
Encoder	
Optical	
English, Fractional	06-06577D-2
Metric	06-06577D-1
Brush	
English, Fractional	06-06354-2
Metric	06-06354
Analog	
English	
0-12.5 ft	06-05766
0-25.0 ft	06-05767
0-50.0 ft	06-05584
0-100.0 ft	06-05583
Metric	
0-3.75 m	06-05768
0-7.5 m	06-05769
0-15.0 m	06-05770
0-24.0 m	06-05885
Universal Matrix Commutator Board Intl D Shell	08-06051
Universal Matrix Commutator Board U.S. 24 Pin	08-03833
17 to 24 Bit Adapter Cable	06-06665
Matrix Harness	05-07319

Description	Varec Part Number
Motion Control PCB	
Plug-In	
60 Hz	08-06565-1
50 Hz	08-06565-2
Bolt-In	
60 Hz	08-08312-1
50 Hz	08-08312-2
Micro 4-Wire	
Board Set	06-07335
Adapter Board	08-07245
Harness	23-05946
Encoder Assembly (Micro 4-Wire Electronics, Encoder, Encoder Mounting Plate, 5 Switches)	
Optical	
English, Fractional	06-07318-2
Metric	06-07318-1
Brush	
English, Fractional	06-07318-4
Metric	06-07318-3
Encoder Assembly (Universal Matrix Electronics, Encoder, Encoder Mounting Plate, 5 Switches)	
Optical	
English, Fractional	06-07317-2
Metric	06-07317-1
Brush	
English, Fractional	06-07317-4
Metric	06-07317-3
Limit Switch Assembly	
High and Low	06-07120-0
2 Switches	06-07120-2
3 Switches	06-07120-3
4 Switches	06-07120-4
2 Switches (> 20 m)	06-07120-6
Average Temperature Selection Switch	15-06669
Worm Gear Assembly	06-08125
Drum Housing Cover Screw (8 required per unit)	P031-88-30

Description	Varec Part Number
Servo/Electronics Housing Cover Screw	
FM or CENELEC approved gauge (16/unit)	P031-88-35
Junction Box Cover Screw	
FM or CENELEC approved gauge (6/unit)	P031-87-40
316 S.S. Measuring Drum Assembly	
w/ 316 S.S. Wire	06-07199
w/ Hastelloy Wire	06-07199-1
w/ Invar Alloy Wire	06-07199-2

MODEL OPTIONS

The following servo gauge model options are available:

65 Servo Gauge

Code	**Accuracy Approval**
0	Standard Accuracy
1	Future Approval

Code	**Explosion Proof Approval**
0	No Approval
1	Factory Mutual (FM)
3	CENELEC/Iniex
4	Future Approval

Code	**Encoder/Electronics**
01	English, Fractional, Brush/Matrix, 0-80 ft nominal
02	English, Fractional, Brush/4-Wire, 0-80 ft nominal
03	English, Fractional, Optical/Matrix, 0-80 ft nominal
04	English, Fractional, Optical/4-Wire, 0-80 ft nominal
05	Metric, Brush/Matrix, 0-20 m
06	Metric, Brush/4-Wire, 0-20 m
07	Metric, Brush/4-Wire, 0-30 m
08	Metric, Optical/Matrix, 0-20 m
09	Metric, Optical/4-Wire, 0-20 m
10	Metric, Optical/4-Wire, 0-30 m
13	English, 4-20 mA Current Output, 0-50 ft
17	Metric, 4-20 mA Current Output, 0-15 m

Code	**Drum Housing Material and Flange Connection**
0	Cast Aluminum, 6 inch, 125# ANSI FF
1	Carbon Steel, 6 inch, 150# ANSI RF
2	Carbon Steel, 6 inch, 300# ANSI RF
3	316 S.S., 6 inch, 150# ANSI RF
4	316 S.S., 6 inch, 300# ANSI RF

Code	**Measuring Wire**
0	316 S.S. Braided Cable
1	Hastelloy C Wire
2	Invar Alloy 36 Wire

Code	**Displacer**
0	145 mm (5.7 in) Teflon Graphite
1	145 mm (5.7 in) Teflon Graphite, Guided

Code	Displacer
2	90 mm (3.5 in) Teflon Graphite
3	90 mm (3.5 in) 316 S.S.
4	50 mm (2.0 in) Teflon Graphite

Code	Options
0	None
1	Teflon O-Rings
2	Raise/Reset Switch
3	Surge Protector
4	Raise/Reset Switch, Surge Protector, Teflon O-Rings
5	Averaging Temperature "T" Feature

Example:

65 0 1 02 0 0 0 0

Where:

65 = Servo Gauge
0 = Accuracy Approval; Standard Accuracy
1 = Explosion Proof Approval; Factory Mutual (FM)
02 = Encoder/Electronics; English, Fractional, Brush/4-Wire, 0-80 ft nominal
0 = Drum Housing Material; Cast Aluminum, 6 inch, 125# ANSI FF
0 = Measuring Wire; 316 S.S. Braided Cable
0 = Displacer; 145 mm (5.7 in) Teflon Graphite
0 = Options; None

SPECIFICATIONS AND PHYSICAL CHARACTERISTICS

Specifications

Measuring Range:
English Fractional, Standard, 0-80 ft (0-24.4 m)
Metric Fractional, Standard, 0-20 m (0-65.6 ft)
Metric Fractional, Optional, 0-30 m (0-98.4 ft)

Accuracy:
English: +/- (0.02 + 0.0013 L) in
Metric: +/- (0.5 + 0.11 L) mm
Where L is the distance in meters or feet between the actual liquid level and the original servo gauge calibration reference height.

Sensitivity:
0.5 mm (0.02 in) Change in Level

Repeatability:
0.5 mm (0.02 in)

Static Error for Change in Relative Density of 100 kg/cubic m (6.24 lb/cubic ft):
0.5 mm (0.02 in)

Response Delay for Wave Integration:
Preset at 6 seconds (adjustable 2-15 seconds)

Displacer Following Level Speed:
400 mm/minute (1.3 ft/minute)

Displacer Weight:
280 g +/- 1.5 g (9.87 oz +/- 0.05 oz)

Power Requirements:
24 VAC +/- 10 % (50 Hz or 60 Hz)

Power Consumption:
16 VA

Service Conditions

Operating Temperature Range:
-20° C to +80° C (-5° F to +175° F)

Operating Humidity Range:
5 to 95 % Relative Humidity, Non Condensing

Operating Product Specific Gravity Range:
0.5 to 1.2

Operating Pressure Ranges:
Low/Medium Pressure
125 psi tested at 200 psi (8.8 kg/cm^2 tested at 14 kg/cm^2)
High Pressure:
300 psi tested at 450 psi (21 kg/cm^2 tested at 32 kg/cm^2)

Certification

Flame Proof/Explosion Proof Certification:
Factory Mutual (FM) - File No. 1G3A5.AF/ON1A3.AE
CENELEC/Iniex - File No. 86.103.516

Materials of Construction

Servo/Electronics Housing and Cover:
Cast Aluminum

Drum Housing and Cover:
Cast Aluminum - Standard
Carbon Steel - Optional for Medium and High Pressure
316 S.S. - Optional for Medium and High Pressure

Measuring Drum:
316 S.S.

Measuring Wire:
316 S.S. Stranded Wire - Standard
Hastelloy-C - Optional
Invar Alloy - Optional

Flange Connection:
Cast Aluminum, 6 inch, 125# ANSI FF
Carbon Steel, 6 inch, 150# ANSI RF
Carbon Steel, 6 inch, 300# ANSI RF
316 S.S., 6 inch, 150# ANSI RF
316 S.S., 6 inch, 300# ANSI RF

Displacer:
145 mm (5.7 in) Teflon Graphite
145 mm (5.7 in) Teflon Graphite, Guided
90 mm (3.5 in) Teflon Graphite
90 mm (3.5 in) 316 S.S.
50 mm (2.0 in) Teflon Graphite

Alarm Switches

High/Low Limit Displacer Travel Switches:
Two switches dedicated to high/low displacer travel.

Alarm/Signal Switches:
Three switches rated at:
0.3 A at 125 VDC, 0.15 A at 250 VDC and/or 1.0 A at 125 or 250 VDC for resistive loads only.

Dimensions and Weights

Servo Gauge Dimensions:

Height	13.8 in (350 mm)
Width	16.5 in (420 mm)
Depth	20.5 in (520 mm)

Servo Gauge Weight:

Low Pressure	85 lb (39 kg)
Medium Pressure	160 lb (73 kg)
High Pressure	175 lb (80 kg)

Encoder Options and Data Transmission

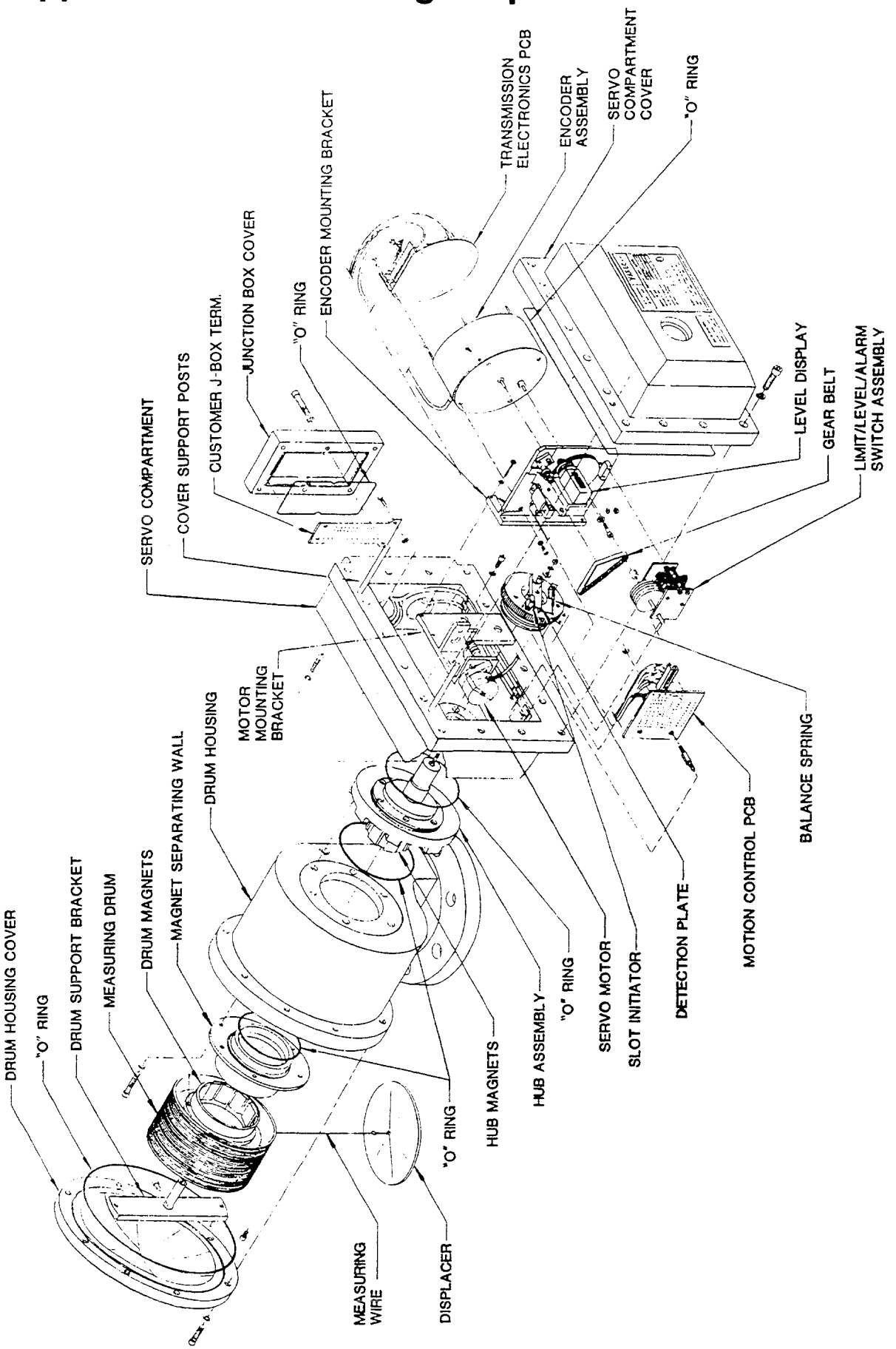
Encoder Options:

- Brush Type, Digital, Metric, 0-20 m in 0.001 m increments
- Brush Type, Digital, Metric, 0-24 m in 0.001 m increments
- Brush Type, Digital, English, Fractional, 0-80 ft in 1/16 inch increments
- Optical Type, Digital, Metric, 0-20 m in 0.001 m increments
- Optical Type, Digital, Metric, 0-24 m in 0.001 m increments
- Optical Type, Digital, English, Fractional, 0-80 ft in 1/16 inch increments
- 4-20 mA Current Output Type - Various Ranges

Data Transmission:

- Matrix Selectable - 16, 17 or 24 bits
- 4-Wire Addressable
  - Level only - 40 bits
  - Level and Temperature - 56 bits
- Current Output - 4-20 mA (24 to 48 VDC by user)

Appendix A - Servo Gauge Exploded View

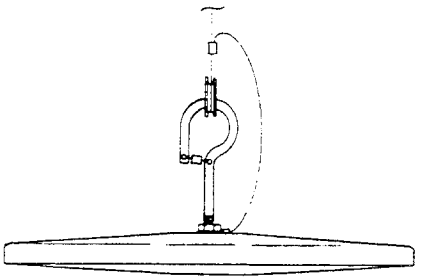


Servo Gauge Exploded View

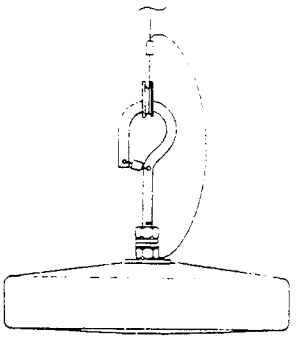
This page left blank

NOTES

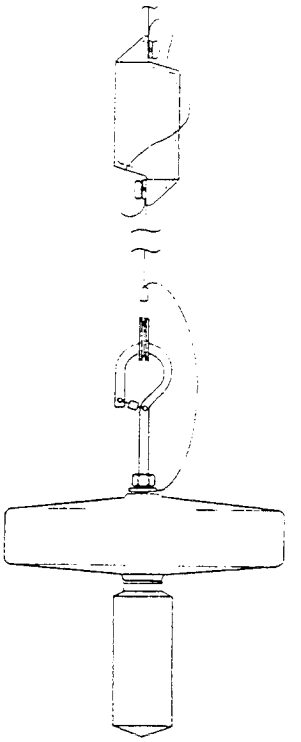
Appendix B - Displacer Options



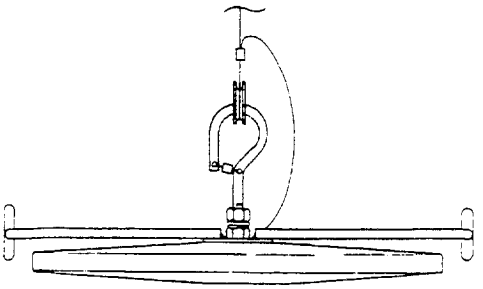
145 mm TEFLON/GRAPHITE
PART NO. 06-07262



90 mm TEFLON/GRAPHITE
PART NO. 06-05755

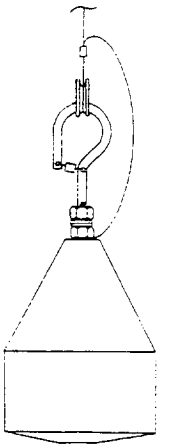


90 mm TYPE 316 STAINLESS STEEL
PART NO. 06-07192
NOTE: MAX TANK PRESSURE 50 PSI



145 mm TEFLON/GRAPHITE WITH GUIDES
PART NO. 06-05648

WEIGHT OF ALL DISPLACERS IS 278.5-281.5 GRAMS (9.82-9.92 oz)



50 mm TEFLON/GRAPHITE
PART NO. 06-05498

WEIGHT OF ALL DISPLACERS IS 278.5-281.5 GRAMS(9.82-9.92 oz)