CHAPTER 2

HYDRAULICS

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2.0 SCALES, SYSTEMS AND TROUBLE-SHOOTING

2.1 INTRODUCTION

Today the hydraulic load cell is used in many varied weighing applications, involving scales and systems. The principle of operation is as follows:

In Figure 2.1, a frictionless piston operates on a thin film of hydraulic fluid in a cylinder to convert weight or force into hydraulic pressure. This pressure can be transmitted directly to hydraulically operated readout devices. By using penumatic or electronic transducers, many more readout capabilities are added.

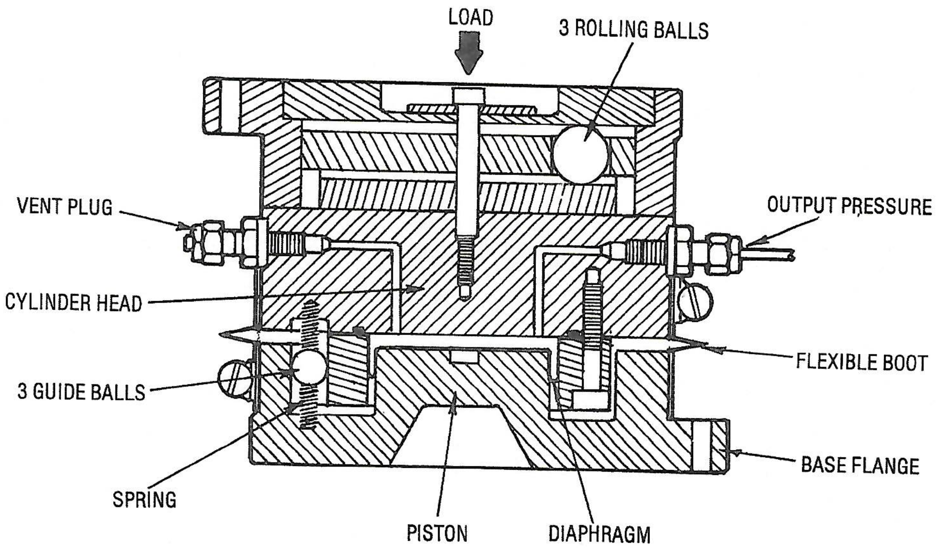


Figure 2.1. Cross Section; Hydraulic Load Cell

Hydraulic load cell weighing systems operate in either of two arrangements: single cell or multi-cell (these can be in compression or tension). The single cell uses an indicator for local readout. The multi-cell arrangement consists of systems having two or more cells. Their output can be fed into a hydraulic load totalizer, illustrated in Figure 2.2. Output of the totalizer is fed either to a hydraulic readout device or transduced into a pneumatic or electronic signal for transmission to remotely-located readout devices. Single cell output can be similarly transduced and transmitted.

It has been assumed, mistakenly, that hydraulic load cells are used only for the higher weight and force measurement ranges. Not so; they are readily available for applications requiring capacities of 100 lbs. or less. Also, hydraulic load cells are used in H44 applications. Linearity to 1 part in 10,000 has been demonstrated.

Where explosion-proof weighing equipment is required, the hydraulic load cell can be the basis for an intrinsically safe weighing system. It has no electric circuits. The signal can be read on a simple Bourdon gauge indicator or pressure-actuated recorder. The recorder chart drive can be spring-wound or powered by a pneumatic motor. These instruments contain no electrical circuits. For remote signal transmission, hydraulic cells in explosive environments may be connected to pneumatic transmitters. Where remote electrical transmission is required, the cells may be in the hazardous area and then be connected to electrical transmitters located outside the hazardous area. If electrical transmitters must be in the hazardous area, they are available in Underwriters Approved explosion-proof enclosures.

The hydraulic load cell can handle vibrating loads, especially if the vibration is irregular in both magnitude and frequency. The cell has no loose parts, no wear points, nothing that will shake it to pieces. The deflection of the cell is extremely small (a few thousandths) so that its natural frequency is very high... usually above the frequency of any

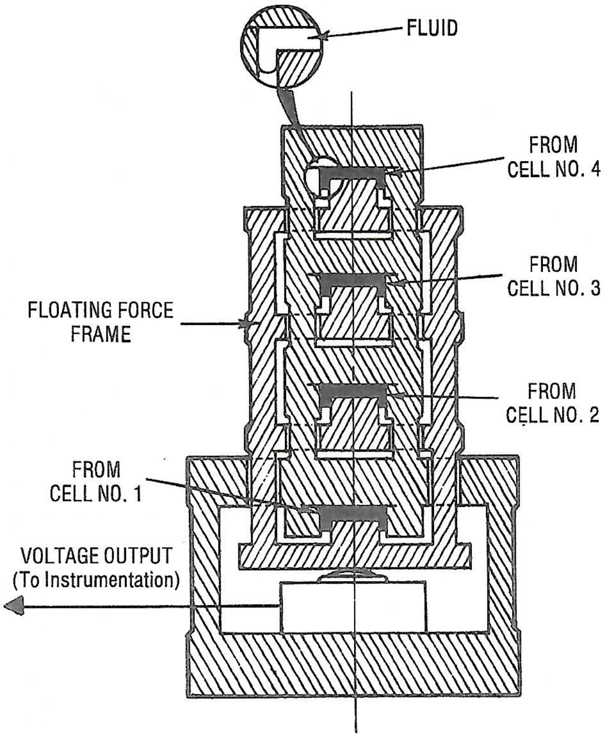


Figure 2.2. Hydraulic Load Totalizer

disturbing vibrations. In addition, the hydraulic fluid further dampens out the vibrations, allowing a smooth signal to be transmitted.

An unusual and valuable characteristic of the hydraulic load cell is its immunity to damage by lightning and to readout variations from radio frequency currents. Also, the cell can function under water with no apparent deterioration in performance.

Other advantages stem from the construction of the cell; no moving parts, total enclosure, and piston-in-cylinder force absorption. All of these features combine to give the cell high sustained accuracy, sensitivity, and stability, even under severe conditions of shock, vibration, moisture, corrosion and dust.

Many engineers in industry use hydraulic load cells directly to handle a process weighing or force measuring assignment. Their small size and compactness makes them suited to this purpose. Additionally, these cells are used in scales of various kinds and sizes as the weight sensing element instead of levers and beams.

Hydraulic load cells have had an increasingly greater role to play in weighing and force measurement of all kinds, especially where environmental stresses made conventional weighing equipment impractical. Typical Hydraulic Load Cells are illustrated in Figure 2.3.

2.2 DESCRIPTION

The Load Cell Systems depicted are hydraulically operated and require no external power source. They are available in two, three, and four load cell setups and come with 8-1/2, 12 or 18 inch dial indicators. They are designed to operate in the temperature range of -50°F (-45.5°C) to 150°F (65.5°C) with hydraulic hose lengths up to 100 feet. Accuracy of Hydraulic load cell systems is generally ±0.2 of 1% of full scale capacity.

The Hydraulic load cell system consists of three basic components: an indicator, two or more hydraulic hose assemblies and two or more hydraulic load cells.

2.3 INDICATOR

The indicator provides a dial faceplate, calibrated in pounds, tons or kilograms, as specified. The indicator has a damper for each load cell input to the indicator to smooth pointer sensitivity and to adjust the pointers response to the operator's preference. Also included on each indicator is a dial adjust gear, which rotates the dial to make necessary tare adjustments.

2.4 LOAD CELL

The load cell transmits a no-lag, linear load indication signal to the indicator by transforming the applied load to a hydraulic signal. This is accomplished by a diaphragm sensing element held in place by the load cell housing. All load cells are compression measurement devices. With the addition of auxiliary hardware it has the capability of measuring tension loads with extreme accuracy as illustrated in Figure 2.4.

2.5 HYDRAULIC HOSE

Two types of hydraulic hose are used, depending upon the capacity of the system. The standard hydraulic hose comes with 1/4 NPT hose connections. Quick disconnect couplings are recommended where installation or

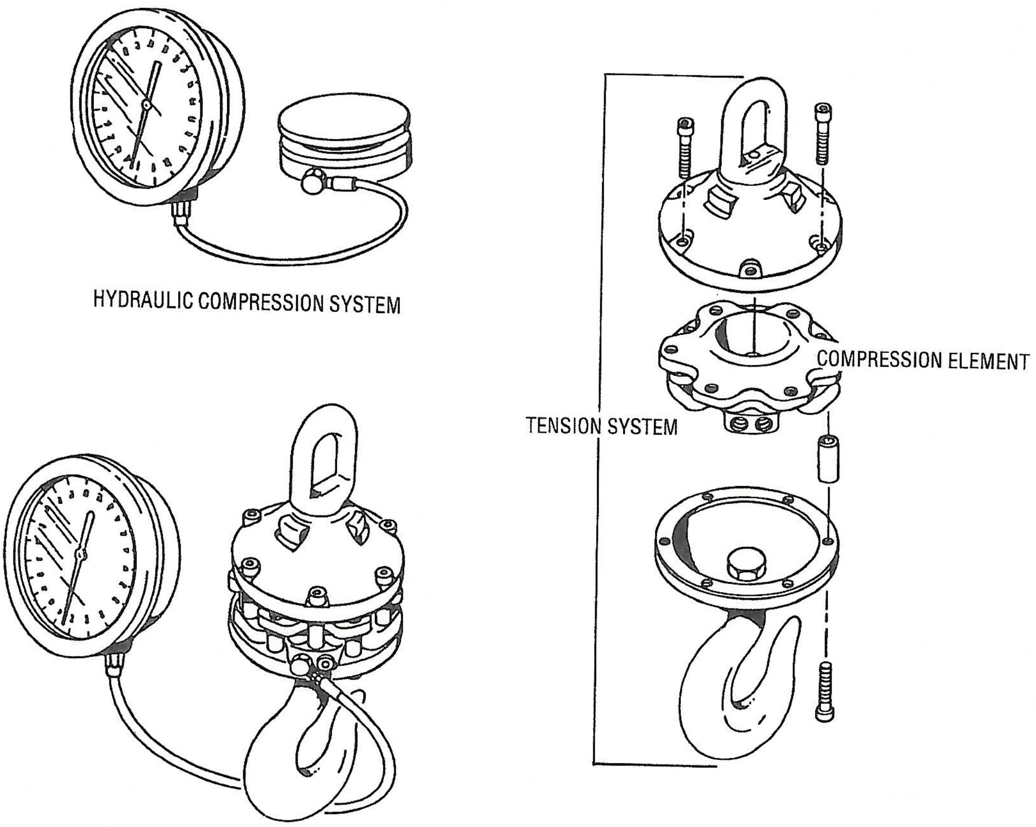


Figure 2.3. Typical Hydraulic Load Cells

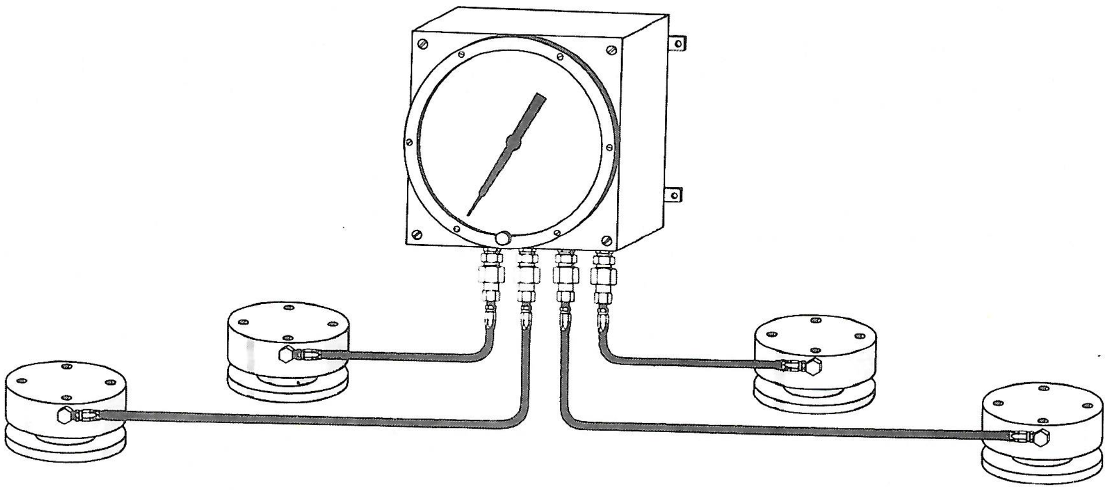


Figure 2.4. Typical Hydraulic Load Cells System

frequent disconnecting of the hose from the load cell or indicator is required. The hydraulic hose will come in maximum lenghts of 50 feet in a single unit and couplings will be used where extended lengths are needed to meet job requirements.

a. The 3/16 inch diameter hose is of single wire braid construction and rubber covered. The use of this hose is recommended with all systems, using 4.0 to 16.1 square inch load cells.

b. The 1/4 inch diameter hose is of double wire braid construction and rubber covered. The use of this hose is recommended with all systems, using 25.0 to 200.0 square inch load cells.

2.6 QUICK DISCONNECTS

Disconnects are recommended where disconnection of the hose from the load cell or indicator is required. The female half of the disconnect is usually installed on the hose while the male half is installed on the damping chamber to facilitate connection. Additionally, disconnects may be used in-line to separate two hoses. Disconnect halves are supplied with protective covers to preclude entry of contaminants into system when components are disconnected.

2.7 TUBING

Copper or stainless steel tubing may be used to supplement the hydraulic hose for fixed applications or where the indicator is mounted at extreme distances from the load cell. It can also be used for rigidity and transmission line protection.

2.8 ATTACHING AND SUPPORT HARDWARE

The following are all necessary to facilitate installation and maintenance:

a. Check Valve - Usually installed on the load cell and is used to replenish the hydraulic fluid in the system. In some cases the check valve may be located elsewhere in the system.

b. Hand Pump - Used for field loading the system with hydraulic fluid, connects to the check valve.

2.9 INSTALLATION AND OPERATION

2.10 INSTALLATION

2.11 PRE-INSTALLATION

The pre-installation procedure consists primarily of insuring that either the Tension or Compression System is the correct system to be installed. The following must be checked:

a. Determine that indicator dial is calibrated in the units of measurement (pounds, tons, or kilograms) compatible with what will be measured.

b. Determine that disconnect O-rings (if supplied with system) are not damaged.

c. Determine that load cell capacity is suitable for the intended application.

d. Determine that the load cell and hydraulic hose is located in a position to move freely, taking into account any obstructions that may interfere with the load to be measured. Also, determine that the hydraulic hose is of sufficient length for routing from the indicator to the load cell.

e. Verify condition of hose disconnects and fittings to insure that they will not leak hydraulic fluid when mated.

2.12 SYSTEM INSTALLATION

2.13 LOAD CELL INSTALLATION

The load cell may be mounted in any attitude, depending on application requirement. The Tension Cell should be installed in such a manner that when a load is applied, the components mating with the eye nuts, hooks, padeyes, etc. bear at the center of these attachments. The Compression Cells should be installed in such a manner that the mating surfaces are within 1° to 2° of parallel. The load plate (piston) and retainer ring (cylinder) should not be eccentric greater than 1/16 inch. Eccentricity or excessive out of parallel loading may produce an indication error and induce premature failure of the diaphragm.

CAUTION

The load cell does not support torsional loading of any significance. Torsional loads will cause the diaphragm to rotate over the pressure plate, resulting in premature failure. In applications where twisting is encountered, a swiveling device must be used to relieve the load cell from torsional loads. Some versions of the tension load cell are available with anti-rotation configuration.

2.14. COMPRESSION LOAD CELL IN A LEVER APPLICATION

When an A Compression System is to be used with a lever (i.e., specified as 3:1, 2:1 or other lever ratio), the lever length and position of the weight must be precisely measured to maintain accuracy. If, for example, a 2:1 ratio system is desired the weight must be applied to the lever at the midpoint between the load cell and the lever pivot point (fulcrum). Any deviation from this arrangement will result in faulty weight indication as illustrated in Figure 2.5.

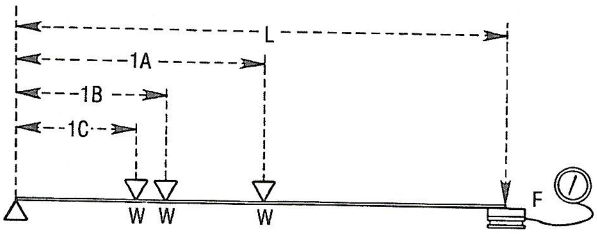


Figure 2.5. Load Cell/Lever Application

Figure 2.5 illustrates a 2:1 ratio lever arrangement; note that while the load cell receives half of the applied weight, the indicator shows all of it. Changing the position of the weight along the lever will change the indication; closer to the load cell will increase the error in a plus direction (reads fast) while further from the load cell will increase the error in a minus direction (reads slow). For final span adjustment, change the length of the lever slightly by moving the load cell closer to, or further from, the pivot point. When the span has been adjusted, bolt the lever to the load cell to prevent accidental shifting. Requirements for a successful lever installation include:

a. Lever secured to pivot point (free to rotate vertically) and load cell to prevent accidental shifting. Distance (L. figure 2.5) to be precisely measured.

b. Load center of gravity positioned directly over predetermined location on lever to maintain ratio of system.

c. Lever must be sufficiently sturdy to prevent introduction of a bending moment with attendant indication error.

d. System must be level within 1/4 bubble on a carpenters level, or equivalent.

2.15 INDICATOR INSTALLATION

Select location for the indicator that provides convenient visual access to the operator.

CAUTION

The indicator is a precision instrument and must be handled with extreme care.

2.16 HOSE/COUPLINGS INSTALLATION

When installing the hose and couplings, lay out the hose so that it will not be cut, crushed, or otherwise damaged. Tie the hose to the structure where possible.

CAUTION

Do not pull hose taut. This will put excessive tension on the end connections and might cause them to blow off under pressure.

For installations where frequent disconnecting of the hose from the load cell or gauge is necessary, self-sealing, quick-disconnect couplings, as shown in Figure 2.2 must be used. These couplings allow the load cell system to be quickly and conveniently separated with a negligible loss of fluid. To recouple it is very important that the "O" ring on the female half of the coupling is carefully started in male half to prevent cutting "O" ring resulting in a connection that leaks.

CAUTION

Self-sealing couplings must be carefully protected when disconnected to prevent dust or foreign particles from becoming lodged in or around the poppet. If the coupling is to be left disconnected for any length of time, covers must immediately be placed on both male and female halves. Never drag couplings on the ground.

2.17 POST-INSTALLATION CHECKOUT

After system installation, check to insure that it is operating properly.

a. Exercise the system, using a known weight of at least 25 percent of full scale capacity several times. This is to flex the diaphragm in the load cell.

b. Remove weight from load cell.

c. Turn tare adjust knob to rotate dial indicator to zero.

d. Check load cell to see that it is free of all encumbrances.

2.18 SYSTEM OPERATION

The load indicating system is automatic, but two adjustments of the load cell system indicator are necessary prior to initial use of the system.

2.19 LOAD POINTER ZERO ADJUSTMENT

a. Apply a load not exceeding 75% of full scale capacity.

b. Remove load.

NOTE

When reading the indicator, maintain a direct and perpendicular line of sight between the eye and pointer in order to eliminate the possibility of parallax error.

c. Adjust zero adjust knob until indicator pointer reads zero with all tare loads acting on load cell.

2.20 POINTER DAMPING ADJUSTMENT

The damper is located on the top, bottom or side of the indicator case and has a tee handle or slotted stem projecting from the damper block.

a. Fully engage damper, push stem in and turn clockwise to closed position.

b. Open damper by turning stem counterclockwise two complete revolutions.

c. If pointer is too sensitive, turn stem clockwise 1/4 to 1/2 revolution.

d. If pointer is sluggish, turn damper stem counterclockwise 1/4 to 1/2 revolution.

e. Recheck sensitivity and repeat step c or d, as applicable, until desired sensitivity is reached.

2.21 SYSTEM ACCURACY CHECK

System accuracy is such that the indicated load should not differ from actual load more than ±0.2% of full scale. Use a series of known loads to check the systems accuracy.

2.22 SYSTEM WEIGHT TEST

To insure accuracy of the load indicator system, a load test should be performed at 6-month intervals and at initial test at system installation.

2.23 WEIGHT TEST

NOTE

Test weights should have a minimum accuracy of ±0.1%.

a. Assemble necessary equipment to perform test:

1. Test weights on the order of 15, 35 and 75 percent of the total capacity of the system, accurate to ±0.1%.

2. Rigging or equipment required to hoist test weights. If weight of rigging or lift equipment is to be included in test, its weight must also be known to ±0.1%.

b. Apply test weights and tabulate indicator readings.

c. Repeat step b to ensure repeatability.

2.24 VOLUME CHAMBER

Some models of hydraulic Load Cell systems include a calibration volume chamber. On systems so equipped the following procedures should be followed to make minor corrections to the fluid load for system accuracy correction as illustrated in Figure 2.6.

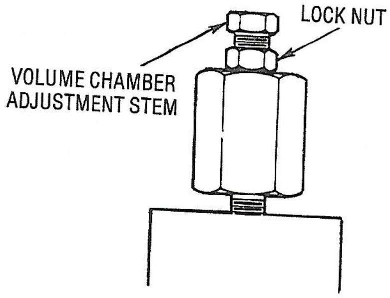


Figure 2.6. Volume Chamber Adjustment

a. If scale reading is too high:

1. Loosen lock nut.

2. Apply a full scale capacity load or as near full scale capacity load as is available.

3. Turn volume chamber adjust stem counterclockwise until scale reads correct weight being applied to scale.

4. Remove test weight being applied to scale.

5. Re-zero scale at tare load.

6. Apply test weight to scale.

7. If the scale still reads high, repeat step b thru e until scale checks at zero and the test weight being used.

8. Tighten lock nut.

b. If scale reading is too low:

1. Loosen lock nut.

2. Apply a full scale capacity load or as near full scale capacity load as is available.

3. Turn volume chamber adjust stem clockwise until scale reads correct weight being applied to scale.

4. Remove test weight being applied to scale.

5. Re-zero scale at tare load.

6. Apply test weight to scale.

7. If the scale still reads low, repeat step b thru e until scale checks at zero and the test weight being used.

8. Tighten lock nut.

2.25 MAINTENANCE AND TROUBLE-SHOOTING

2.26 MAINTENANCE

2.27 GENERAL

The Hydraulic Load Cell requires no maintenance. However, general operating practices should include:

a. Cleaning indicator glass on an "as necessary" basis. This can be accomplished by using any commercially available glass cleaning solution and a clean, soft, lint-free cloth.

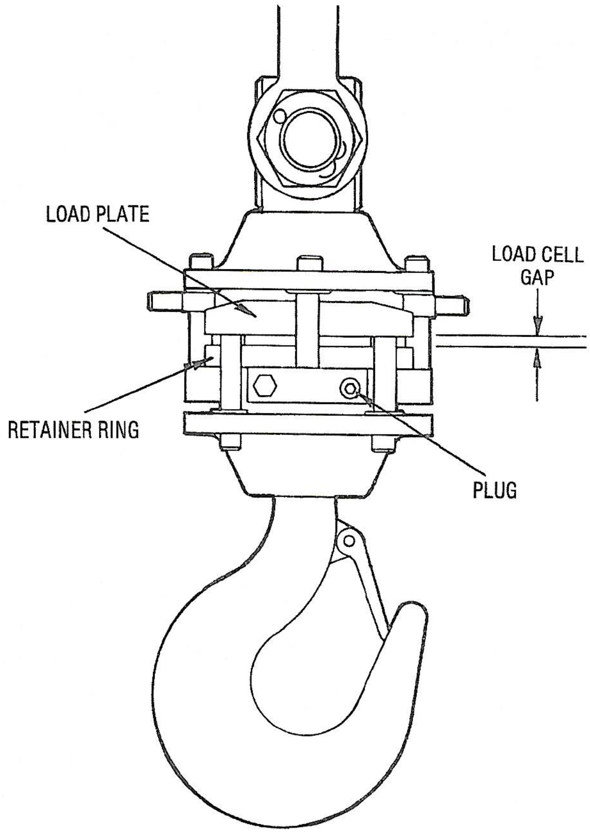
b. Visual inspection of the system prior to use. Pay particular attention to the integrity of fittings and connections (no fluid leakage). Check load cell gap and ascertain that the load cell is free of obstructions.

2.28 TROUBLESHOOTING

If during operation indication of system malfunction is observed (no load indication and/or sluggish, erratic or erroneous indication), see figure 2.7 and check load cell in conjunction with table 2.1 for tabulation of probable causes and their corrective actions.

2.29 LOAD CELL GAP

The load cell gap is the distance measured between the load plate and the load cell retaining ring. The gap will vary from one load cell to another due to configurational makeup. The nominal gap is stamped on the load cell pipe plug at the completion of system calibration at the factory. This information can be used as a quick reference when a malfunction is suspected in the system, or when hydraulic fluid is added or reduced, and as a comparative check against actual weight calibration. The load cell must be exercised several times before this measurement is made.



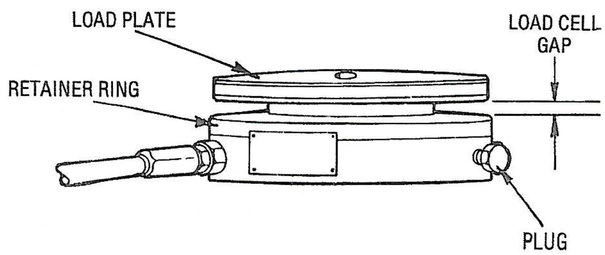


Figure 2.7. Load Cell Gap and Plug Location

2.30 REPAIR

2.31 COMPONENT REPAIR

DISCONNECT O-RING REPLACEMENT. If the O-ring in the female half of the disconnect becomes damaged during mating, or other cause, it must be replaced to preserve the integrity of the system as illustrated in Figure 2.8.

a. Remove damaged O-ring from the female half of the disconnect.

b. Clean O-ring groove thoroughly.

c. Lubricate (using silicone, or equivalent) and install new O-ring.

d. Disconnect is ready to be returned to service.

2.32 GAUGE DISASSEMBLY

Following is the breakdown, in disassembly sequence, of a typical 12-inch gauge. Other sizes contain the same parts, but they may be in different locations from those in the 12-inch gauge. Figure 2.9 illustrates a typical Hydraulic Gauge, Exploded View.

NOTE

Although the gauges are precision type gauges, all of the parts are locked in position against shock or vibration. It is suggested that gauge be left until last when troubleshooting a system. The psi for full scale calibration is stamped on the tag at the back of the gauge.

a. Remove screws (2) from case ring (3).

b. Remove case ring (3), glass (4), and gasket (5).

c. Remove pointer (6), external Truarc retaining ring (7), and dial (8).

d. Remove two screws (9), two lock washers (20), and hub and bridge assembly (11).

e. Remove sleeve connector with nut (12) and copper tubing (13).

f. Remove screw (14), lockwasher (15), flat washer (26), and tube stop (17).

g. Remove linkage assembly (18).

h. Remove two screws (19), tab lockwasher (20), and movement assembly (21).

i. Remove three screws (22), three lock washers (23), and tube socket and tip assembly (24).

Table 2.1. Malfunction Isolation

MALFUNCTION	PROBABLE CAUSE	CORRECTIVE ACTION
Load Indication Too High	Improper zero (tare) setting	Adjust zero set (tare)
	System charge overload	Reduce (bleed system) hydraulic charge
Load Indication Too Low	Improper zero (tare) setting	Adjust zero set (tare)
	Insufficient system charge	Charge system
	Loose and leaking hose connection	Tighten hose connection
	Leaking disconnect assembly (in-line or at indicator)	Replace O-ring in female half of disconnect
	Obstruction in hydraulic hose	Replace or clean hose
	Hydraulic hose crimped	Straighten hydraulic hose and eliminate tight bends, etc.
Erratic or Sluggish Indication	Insufficient system charge	Charge system
	Incorrect damper setting	Correct damper setting
	Obstruction in hose	Replace or clean hose
	Hydraulic hose crimped	Straighten hydraulic hose, eliminate tight bends, etc.
No Indication	Dampers closed	Correct damper setting
	Load cell/cells dry (No hydraulic fluid)	Check load cell gap and charge system
	Hydraulic hose crimped	Straighten hydraulic hose, eliminate tight bends
	Obstruction in hose	Replace or clean hose

Table 2.2. Tension/Compression Load Cell Gap

TENSION LOAD CELL GAP		
EFFECTIVE AREA IN.^{2}	NOMINAL IN.	GAP m m
4.02	.38	10
6.44	.44	11
16.10	.31	8
36.77	.62	16
50.00	.75	19
60.00	.75	19
100.00	.75	19

COMPRESSION LOAD CELL GAP		
EFFECTIVE AREA IN.^{2}	NOMINAL IN.	GAP m m
4.02	.38	10
6.44	.44	11
8.00	.38	10
12.00	.44	11
16.10	.44	11
25.00	.50	13
36.77	.62	16
50.00	.75	19
60.00	.75	19
100.00	.75	19

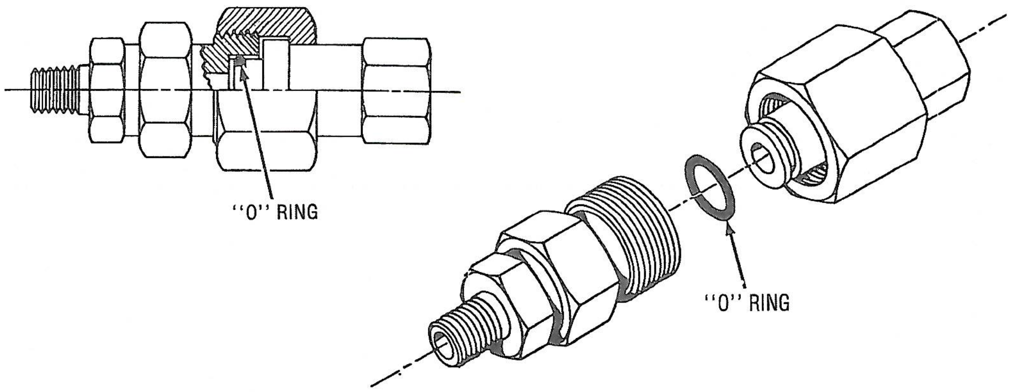


Figure 2.8. "O" Ring Replacement

j. Remove tip bleed plug (25), four screws (26), and pipe plug (27).

k. Remove stem nut (28), damper stem (29), and O-ring (30).

l. Remove setscrew (31) and dial adjust assembly (32).

m. Remove three cap screws (33) and damper body (34) from case (35).

2.33 GAUGE CALIBRATION PROCEDURE

Pull pointer (6) using a pointer puller. Remove snap ring (7) with snap ring pliers and remove gauge dial (8). With screwdriver or long nose pliers, gently bend tabs on tab lock washer (20) and loosen movement mounting screws (19) with a 1/4" socket wrench. Also loosen three tube mounting screws (22) and two bridge mounting screws (9). Install calibration dial on bridge hub and lock in place with snap ring (7). Push dial to bottom of gauge case leaving approximately 1/32" clearance between dial and bottom of gauge case and dial clearance should be equidistant at 90 and 270. Then tighten bridge mounting screws (9). Next center movement pinion in center of bridge (11) by means of centering buttons. The centering buttons are consecutively .001 larger in O. D. to accommodate different bridge I. D. With correct centering button in place tighten movement mounting screws (19), lock tabs (20) and tighten tube mounting screws (22). The movement pinion is now centered to the dial increment circle.

a. Apply half the total gauge psi, and

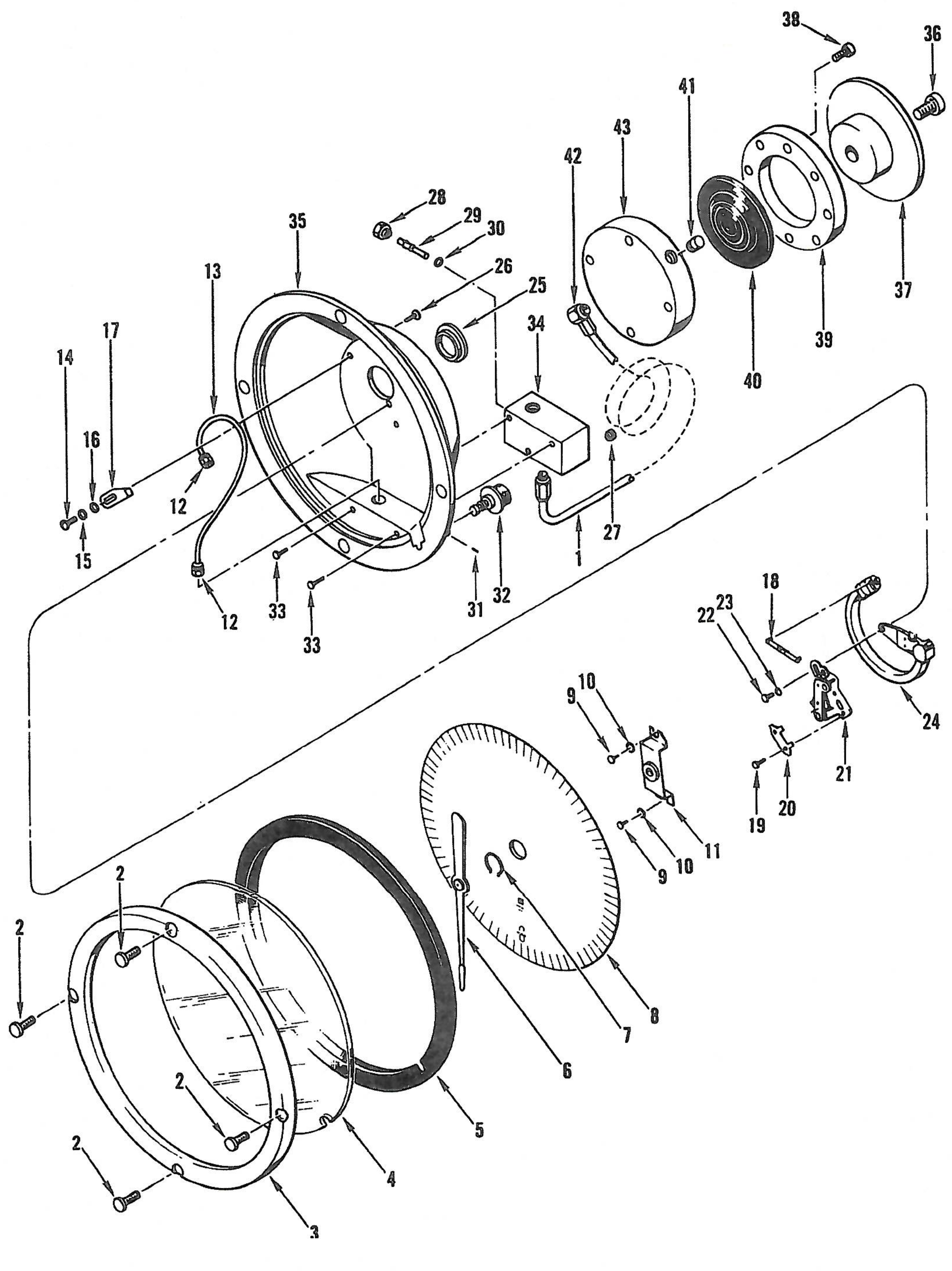


Figure 2.9. Hydraulic Gauge; Exploded View

b. Set pointer on 180° on calibrating dial.

c. Let gauge down to zero psi and pointer should read zero or 1 increment minus (to the right) of zero.

1. If pointer returns beyond zero (to the right) more than 1 increment, gauge is too fast. Loosen linkage screw on movement quadrant and move linkage (18) away from quadrant pivot shaft (toward tail end of quadrant). (Small adjustments are advisable). Moving linkage (18) away from quadrant pivot shaft slows pointer travel and moving linkage (18) toward quadrant pivot shaft speeds up pointer travel. Tighten linkage screw and repeat steps a., b., and c., until pointer reads 180° with half gauge psi applied and zero or 1 increment minus (to the right) at zero psi.

d. Next apply total gauge psi and pointer should read 360° or 1 increment plus (to the left).

1. If pointer travels beyond 360° more than 1 increment, gauge is too fast. Loosen two linkage screw nuts with 5/32" socket wrench that bolts two sections of linkage together and spread linkage apart slightly. Lengthening linkage slows pointer travel and shortening linkage speeds up pointer travel. Tighten linkage screws and repeat steps a., b., and c., until first half of gauge is in calibration then repeat step d. Using this procedure in this sequence gauge will be in calibration or in balance. If gauge at steps c. and d. checks at one increment minus and one increment plus, respectively, gauge is said to be in balance. Gauge may be brought to correct reading by tightening micro adjust screw on quadrant.

CAUTION

Hold teeth end of quadrant when tightening this adjustment - tighten 1/6 turn at a time - and NEVER loosen this adjustment. This adjustment is only used to slow down pointer travel, never to increase travel speed.

This adjustment acts as a wedge on quadrant tail. After each micro adjustment repeat steps a., b., c., and d. until gauge is in calibration.

Remove pointer (6) and calibration dial, and install load dial (8). At zero psi set pointer (6) at zero on dial (8). Apply 1/4 total psi and pointer (6) should read 90° then apply 3/4 total psi and gauge should read 270°. If pointer (6) reads plus at 90° and minus at 270°, the error can be corrected by a dial shift. Remove pointer (6) and load dial (8) and install calibration dial. With a straight edge and a sharp pencil or scriber mark case (35) at the four quadrants starting at dial zero, 90°, 180° and 270°. Next loosen two bridge screws (9) and push dial and bridge (11) up keeping dial zero and 180° mark on vertical marks on case (35). This is an adjustment of the horizontal marks only. Care should be taken to keep dial in same vertical position. Then lock bridge screws (9). Remove calibration dial and install load dial (8) and stake pointer (6) on zero at zero psi. Care should be taken in staking on pointer (6) as movement pinion shaft is ball bearing mounted. A light stake sufficient to hold pointer (6) on tapered end of shaft is all that is required.

Gauge should now be in calibration and after installing glass (4), rubber and door bezil (3), ready for operation.

NOTE

An additional calibration adjustment aid is the tube tip slot. Generally the linkage (18) is locked somewhere near the center of the tube tip. By moving the linkage (18) outboard on the tube tip, faster pointer (6) speed results, and moving the linkage (18) inboard on the tube tip slows down the action.

2.34 GAUGE DAMPER SEAL REPLACEMENT

Following are instructions for replacing "O"-ring (30) on the damper stem (29) illustrated in Figure 2.9.

a. Unscrew damper stem nut (28) and damper stem (29) from damper body (34).

b. Remove old or damaged "O"-ring (30).

c. Lubricate new "O"-ring with grease or vaseline. Slip "O"-ring over screwdriver end of stem (29), working it up and over shoulder into groove.

d. Reinstall damper stem nut (28) and damper stem (29) on damper body (34).

CAUTION

Use extreme care when inserting the damper stem (29) into the damper body (34) to prevent scarring of the "O"-ring (30).

2.35 LUBRICATION

During reassembly or replacement procedures, apply lubricants as follows: (refer to Figure 2.9).

a. Grease or vaseline to "O"-ring (30).

2.36 REASSEMBLY

Reassemble the load cell system in reverse order of disassembly, noting the following.

a. During reassembly, refer to repair or replacement and lubrication instructions contained in this manual.

b. Apply Loctite sealant to cap screw (36 and 38) threads prior to installation.

c. Torque linkage assembly (18) screws and nuts to 3 inch-pounds.

2.37 CHARGING AND BLEEDING SYSTEM

The hydraulic system can be successfully and adequately charged without special loader by following these instructions.

a. Lay the complete load cell on its side with the street elbow (42) hole up. Install and tighten pipe plug (41) or replace pipe plug (41) with F-53 check valve.

b. Slowly pour hydraulic fluid into street elbow (42) hole while gently rocking cell and working load plate (37) slightly. When cell chamber is full only fluid will be seen at street elbow (42) hole.

c. Replace and cap temporarily street elbow (42).

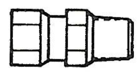
d. Attach hose to gauge. Lay gauge on the floor and raise up open end of hose until hose is straight with no bends or low places between open end of hose and gauge. Pour hydraulic fluid into open end of hose until full. Temporarily cap hose and return to gauge level.

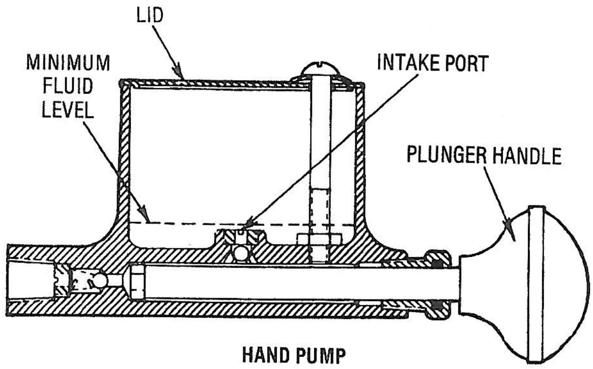
e. Both the cell and the gauge hose assembly are now full of fluid with a minute quantity or no air in system. Hold hose at capped end and twist anti-clockwise about 4 or 5 turns. Remove cap from street elbow (42) and remove cap from hose. Attach hose to street elbow (42). Since the cell is full of fluid it will remain so while removing cap from street elbow (42). and attaching hose, if it is left in position a. and load plate is not moved.

f. The complete system is now overloaded slightly with fluid, and step o. of Fluid Addition to System may be performed.

2.38 FLUID ADDITION TO SYSTEM

The system is loaded in the field with a hand pump and connections as follows: (as illustrated in Figure 2.10).


SWIVEL CONNECTOR



HAND PUMP

Figure 2.10. Typical Hand Pump & Connection

a. Lay the complete load cell on its side with the pipe plug (41) up. Remove pipe plug (41).

b. Slowly pour hydraulic fluid into pipe plug (41) hole while gently rocking cell and working load plate (37) slightly. When cell chamber is full only fluid will be seen at pipe plug (41) hole.

c. Install check valve.

NOTE

Generally step b. will slightly overload the system with fluid and step o. can now be performed. However, if system is bled too much or is low on fluid, steps d. through p. may be used.

d. Remove pipe cap from load cell check valve.

e. Connect hand pump to check valve, leaving connector nut loose.

f. Slide hand pump lid to one side and fill pump bowl with (red) hydraulic fluid.

g. Operate hand pump plunger until all air in pump cylinder is expelled.

NOTE

The pump must be lower than the bleed point and there must be no sharp bends in the hose to act as air traps.

h. Tighten swivel connector nut and load the system.

NOTE

Do not allow fluid level in pump bowl to drop below approximately half of bowl. This will allow air to be pumped into the system.

i. Load system until gauge indicates approximately 5% load.

j. Leaving pump installed, loosen pipe plug (27) at gauge damper and bleed air.

k. When all air bubbles cease to appear, tighten pipe plug (27) and operate hand pump until gauge again indicates 5% load.

l. Remove tip bleed plug (25) from gauge case and loosen small setscrew on bourdon tube tip. Allow air to escape till bubbles cease; then tighten set screw and replace tip bleed plug.

CAUTION

Do not torque tube tip when tightening set screw in tip. Also place rag or tissue under tube tip to keep fluid from contaminating movement or inside of gauge case.

m. If gauge indicates less than 5% load, pump additional fluid to 5% load indication.

n. Disconnect hand pump and replace check valve cap.

NOTE

If system is air free the cell stroke will be very small from zero to full capacity of system. The exact amount of cell stroke cannot be given as it depends on elasticity of the hose and the travel of the bourdon tube (24).

o. Use a series of known loads to calibrate system. Bleed system at pipe plug (27) at damper until all-point calibration is within specified tolerances.

p. Leave check valve installed.

NOTE

Periodically inspect load cell clearance for proper spacing.

2.39 HYDRAULIC FLUID REDUCTION

Occasionally it may be necessary to reduce the quantity of hydraulic fluid in the system to achieve accuracy.

a. Remove all weight from load cells.

b. Zero pointer.

c. Apply full scale weight to system.

d. If readings are fast, the load cells must be bled. If the indicated reading at full scale is 1,000 pounds fast on a 100,000 pound system, consisting of four load cells, then you must determine how much to bleed each load cell. To determine this, divide the number of load cells into the error.

Example:

$$\frac{\text{Pounds Error}}{\text{Number of load cells}} = \frac{1000}{4} =$$

250 pounds

The error for each load cell is 250 pounds. When bleeding the system, you must bleed twice that of the error. Therefore, each cell will be bled 500 pounds. Then the indicated reading at full scale will be 99,000 pounds.

e. On completion of step d. remove weight from load cells, then apply weight. Repeat several times to exercise the diaphragm to the reduction of fluid in the system.

f. Remove weight and zero pointer.

g. Apply full scale load, if indicated reading is still fast repeat steps a thru e. If indicated reading is within tolerance, perform system weight test to insure accuracy of 25, 50, 75 and 100 percent of full scale.

2.40 LOAD CELL DISASSEMBLY

Following is the breakdown, in disassembly sequence of a typical load cell assembly. Various attachments and sizes may cause the load cells to differ somewhat in configuration. Refer to Figure 2.9.

a. Remove cap screw (36).

b. Lift out load plate (37).

c. Remove cap screws (38).

d. Separate retainer ring (39), diaphragm (40) and casing (43).

e. Remove pipe plug (41) and street elbow (42) from casing (43).

2.41 CLEANING

Wash all parts with detergent. Dry parts thoroughly with a clean, lint-free cloth, or moisture-free compressed air. Use only a dry, soft, clean cloth to clean gauge window.

2.42 INSPECTION

Inspect all parts for cracks, breaks, corrosion, scoring, and other obvious damage. Check that all threads are clean and undamaged and that all ports and passages are clean and unobstructed.

2.43 REPAIR OR REPLACEMENT (Refer to Figure 2.9.)

2.44 GENERAL

Following are general instructions concerning repair or replacement.

a. Polish out minor scoring on non-sealing surfaces of metallic parts with crocus abrasive cloth (for steel parts), or aluminum oxide abrasive cloth (for aluminum, aluminum alloy, or brass parts). Reclean polished parts in accordance with instructions contained under "Cleaning".

b. Replace any parts damaged beyond minor repair, or not meeting inspection requirements.

c. Each time the system is disassembled for repair, replace "O"-ring (30) and diaphragm (40).

2.45 DIAPHRAGM REPLACEMENT (Refer to Figure 2.9.)

Perform steps a. through e. of load cell "Disassembly" paragraph to remove old or damaged diaphragm (40). Place diaphragm (40) in casing (43). Place retainer ring (39) over diaphragm (40) and line up holes of casing (43) and retainer ring (39). Start all cap screws (38) tighten cap screws (38) a few turns at a time, alternating screws across from each other, making four or five passes around before screws are tight. When subassembly of casing (43), diaphragm (40) and retainer ring (39) are properly reassembled, casing (43) and retainer ring (39) will be together metal to metal on circumference. Place load plate (37) in diaphragm (40) and lock in place with cap screw (36).