Pressurements

# USER'S MANUAL

# M3800 & M3820

# M3800 & M3820

# HIGH PRESSURE DEADWEIGHT TESTER

# USER'S MANUAL

Manufactured by;

GE RUSKA

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# REVISION NOTICE

| RELEASE NUMBER | REVISION | DATE OF REVISION | DESCRIPTION |
|---|---|---|---|
| PMAN-121-1D01 | A | 01/07/03 | Original release. |
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## WARNING

PRESSURIZED VESSELS AND ASSOCIATED EQUIPMENT ARE POTENTIALLY DANGEROUS. THE APPARATUS DESCRIBED IN THIS MANUAL SHOULD BE OPERATED ONLY BY PERSONNEL TRAINED IN PROCEDURES THAT WILL ASSURE SAFETY TO THEMSELVES, TO OTHERS, AND TO THE EQUIPMENT.

# INDEX

## HIGH PRESSURE DEADWEIGHT TESTER
## MODEL M3800 & M3820

# USERS HANDBOOK
# HIGH PRESSURE DEADWEIGHT TESTER
# MODEL M3800 & M3820

## 1.0 GENERAL INFORMATION

Deadweight Testers are the primary standard for pressure measurement. Utilising the well-proven Piston/Gauge system, consisting of a vertically mounted precision lapped Piston and Cylinder assembly, accurately calibrated weight masses (FORCE) are loaded on the Piston (AREA) which rises freely within its Cylinder. These Weights balance the upward force created by the pressure within the system.

$$\text{PRESSURE} = \frac{\text{FORCE}}{\text{AREA}}$$

Each Weight is marked with the Tester serial number and the pressure measured when placed on a correctly spinning and floating Piston. The total pressure measured is the summation of the Weights plus the Piston Weight Carrier.

The Deadweight Tester has been calibrated to the Gravity, Temperature and Air Density stated on the Certificate. Equations and factors are given on the Certificate to adjust for any variations in these environmental conditions. *

**Gravity** varies greatly with geographic location and so will the Deadweight Tester reading. Due to the significant change in gravity throughout the world (0.5%), ensure that the Tester has either been manufactured to your local gravity of that you have applied the correction from the calibrated gravity.

Example:

Deadweight Tester calibrated gravity : 980.665 cm/s$^2$
(980.665 cm/s$^2$ is the International Standard Gravity)
Gravity at site : 981.235 cm/s$^2$
Indicated Pressure : 250 psi

$$\text{True Pressure} = \frac{981.235}{980.665} \times 250$$

$$= 1.0005812 \times 250$$

$$= \mathbf{250.1453\ psi}$$

**Temperature** and Air Density variations are less significant than Gravity. Variations should be corrected for when maximum accuracy is required.
Temperature variation example:

| | | |
|---|---|---|
| Deadweight Tester calibrated temperature: | | 20 °C |
| Operating temperature | : | 24 °C |
| Percentage change per °C | : | 0.0011% |
| Indicated Pressure | : | 250 psi |

$$\text{True Pressure} = 250 + (20 - 24) \times \frac{0.0011}{100} \times 250$$

$$= 250 - \frac{0.0044}{100} \times 250$$

$$= 250 - 0.011$$

$$= \mathbf{249.989\ psi}$$

If more than one correction is being applied then the subsequent corrections will use the resultant of the previous correction. The corrections should be applied in the following order:-

1. Temperature
2. Head of Fluid
3. Gravity
4. Air density

To ensure that accuracy is maintained, the Piston and Weights must be kept clean and undamaged.

* See Ancillary Equipment, S700 Software, PDP 101, Section 10, Page 10.

## 2.0 SUPPLIED AS STANDARD EQUIPMENT WITH EACH INSTRUMENT:

Calibrated Weight Set in wooden cases.
Certificate of Overall Accuracy.
Certificate of Piston Effective Area.
Computer print-out of Weight masses.
Female Adaptors: 1/2" & 3/4" BSP.
Spare Seals (6 & 33).
Piston Lubricating Oil - Specification: Our reference ST55
Oil supplied - Shell Tellus 22
Compatible oils - Esso Nuto H22
- Mobil Velocite No.10

## 3.0 SET UP FROM NEW

See Figure 5, Page 5.

3.1 Carefully unpack the instrument and associated components.

3.2 Place Triangle (13) onto Foot Supports (17).

3.3 Connect pipe to the bottom of the column, do not over tighten.

3.4 Fill Reservoir (64) with correct operating fluid, close Valve (27), and pump Handpump (57) until fluid appears at the 'O' ring in the top of the column.

3.5 Clean and assemble piston cylinder unit as per Sections 9.2, 9.3, & 9.4.

3.6 Carefully place Carrier Tube (11) over piston. Ensure Piston Cap (3) locates and centres in the top of the carrier tube.

## 4.0 PREPARATION

See Figure 5, Page 5.

4.1 Place the Deadweight Tester on a flat, stable surface.

4.2 Fit Spokes to Hub on the front of the Tester.

4.3 Level the triangular Base Plate using the three Adjustable Feet (14) to the Spirit Level (19) mounted in the Base Plate. Secure the Feet using Lock Screws (16).

4.4 Close Valve (27).

4.5 Fit instrument to be tested to Test Station (31).

4.5.1 Screw the appropriate Adaptor (74) fully onto the instrument to be tested.

4.5.2 Screw assembly down ANTI-CLOCKWISE onto the Test Station.
Note: The internal thread in the lower half of the Adaptor is LEFT-HANDED
Ensure that the bottom face of the instrument to be tested
contacts the Lens Ring (33) on the Test Station.

4.5.3 To adjust position to face forward. Hold the Adaptor and unscrew the instrument to be tested ANTI-CLOCKWISE so that it faces forward. Hold the instrument to be tested steady whilst turning the Adaptor ANTI-CLOCKWISE until it pulls down onto the Lens Ring *.

4.5.4 Tighten fully to ensure a good seal.

IMPORTANT: ENSURE THAT ANY INSTRUMENT FITTED TO THE TEST STATION IS INTERNALLY CLEAN.

* The lens ring may distort with use, replace as required.

## 5.0 PRIMING

5.1 Open Valve (27) one turn anti-clockwise and screw Capstan (24) fully in.
5.2 Pump twice.
5.3 * Close Valve and screw Capstan FULLY OUT.
5.4 Open Valve and screw Capstan FULLY IN.

**Note:** During this operation bubbles may appear in the Reservoir (64), as trapped air is expelled.
For large volume instruments repeat steps 5.3 and 5.4 until no further bubbles appear.

5.5 With Valve open, screw Capstan FULLY OUT and close Valve. The Tester is now ready for use.

***WARNING:**
Screwing the Capstan (24) out with Valve (27) closed will generate 0.5 bar/15 inHg vacuum. If the instrument under test is vacuum sensitive, leave Valve open during operation 5.3.

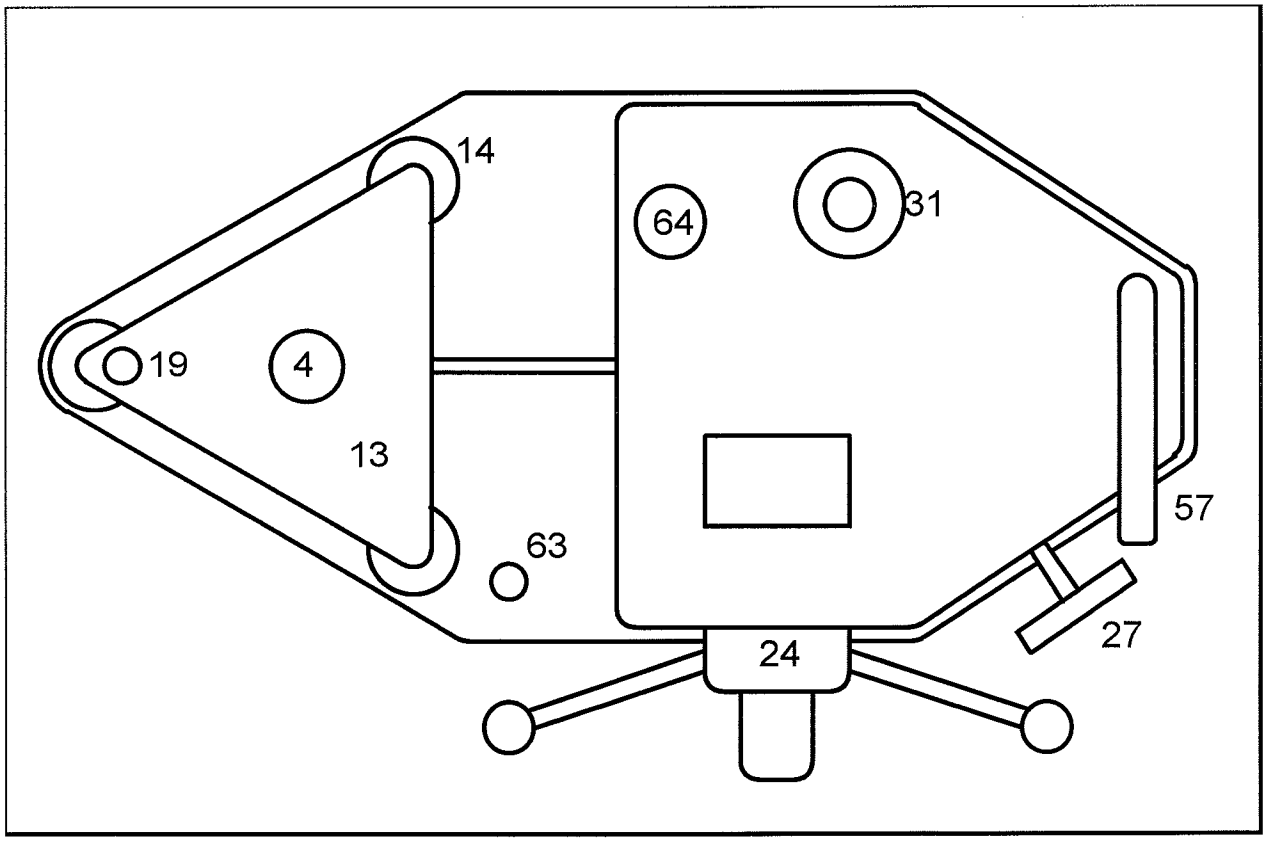



FIGURE 5.0

## 6.0 OPERATION

6.1 Select required weights * and stack onto the Piston Weight Carrier (11).
(* Fractional Weights: smaller increments are available).
The pressure measured is the sum of the weights plus the Piston Weight Carrier.

6.2 Use the Handpump (57) to generate the initial pressure up to 1000 psi/70 bar, for higher pressure screw the Capstan (24) in. When the Piston rises, ensure the bottom face of the lowest weight is level with the groove, midway in the recessed area on the Indicator Rod (63). See Figure 6.2.

6.3 Rotate the weight stack clockwise.
**DO NOT ROTATE WEIGHTS WHEN THE PISTON IS AGAINST THE TOP OR BOTTOM STOP.**

6.4 Observe the reading of the instrument under test.

6.5 For the next higher calibration point, repeat 6.1 above.

6.6 To measure reducing pressures, remove the necessary weights, and screw the Capstan out so that the weight stack floats at the correct height, then rotate clockwise.

6.7 Depressurise by screwing Capstan FULLY OUT.

6.8 Any pressure remaining in the system can now be released by SLOWLY opening Valve (27).
**NEVER RELEASE SYSTEM PRESSURE WITHOUT SCREWING CAPSTAN FULLY OUT FIRST.**

6.9 Remove weight stack.

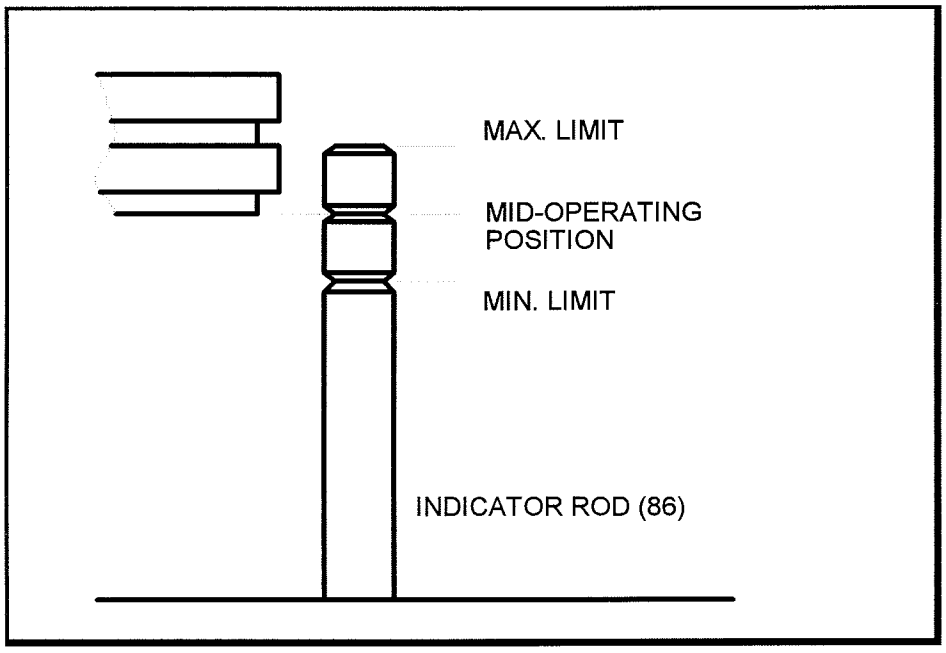



FIGURE 6.2

## 7.0 CALIBRATION IN DIFFERENT PRESSURE UNITS

Conversion Weights can be supplied to measure the existing range in any other pressure unit. The Conversion Weight set is supplied with a special Converting Weight (marked 'CONV') which is placed on the Piston Weight Carrier. This increases the Piston Weight Carrier mass so that it now measures the value stated on this Weight, in the new pressure unit. The Conversion Weight set can now be used in the same way as the Standard Weight set.

Alternative option see S700 Software, PDP 101, Section 10, Page .....

## 8.0 STORAGE AND TRANSPORTATION

8.1 With Test Station (31) plugged, open Valve (27) and screw Capstan (24) fully in. Close Valve.
8.2 Disassemble Spokes (25) from Capstan (24) and Pump Handle (58) from Pump Arm (57).
8.3 Carefully remove carrier tube and piston.
8.4 Fluid can remain in the Reservoir (64) during transportation, providing that the Tester remains horizontal.
8.5 Disconnect pipe under the column and remove triangular base.
8.6 Carefully pack all individual components, ensuring the piston cannot be damaged.
8.7 Stack ALL the appropriate weights into the wooden Weight Boxes (75) not illustrated). Ensure packing pieces are located so the hinged lid clamps the weights firmly in position when closed.

## 9.0 PISTON CARE

The Piston and Cylinder Assembly is the most critical and sensitive part of the Tester. To maintain accuracy, the Piston must always slide freely in the Cylinder

Note: Ensure system is depressurised before attempting Piston removal, by SLOWLY opening Valve (27).

9.1 PISTON REMOVAL

9.1.1 Remove Weight Carrier assembly (11).

9.1.2 Unscrew Piston Nut B (2), and carefully lift out Piston Assembly (4).
If Nut is tight, a locating hole is provided in the side for insertion of a 'C' Spanner, or similar Tommy Bar.

9.1.3 Unscrew Piston Nut A (1), taking care not to allow the Cylinder to fall.
If Nut is tight, a 'C' Spanner, or similar Tommy Bar can be used in the Oil Bleed Hole.

9.1.4 Separate Cylinder and Piston Nut A.

9.2 PISTON CLEANING

9.2.1 Use 'non-fluffing', non-abrasive, lint-free tissue or absorbent cloth. Hold the Piston Assembly (4) by the Piston Cap (3), and rub the tissue back and forth along its length.

9.2.2 To remove all traces of contamination, the Piston must be immersed in a non-filming solvent such as Trichloroethylene or Isopropanol.

9.2.3 Using a NEW tissue, clean the Piston as before, pressing hard between thumb and forefinger along the Piston's length.

9.2.4 Place Piston carefully on a NEW tissue where it will not become dirty or damaged whilst the Cylinder (5) is cleaned.
IMPORTANT: NEVER TOUCH THE WORKING AREA OF A CLEAN PISTON WITH BARE FINGERS - THE NATURAL OIL IN YOUR SKIN CAN CAUSE THE PISTON AND CYLINDER ASSEMBLY TO STICK

9.3 CYLINDER CLEANING

9.3.1 Wipe excess fluid from the outside surfaces of the Cylinder (5).

9.3.2 Roll a tissue into a tapered rod of appropriate size. Force the tissue through the Cylinder bore by rotating. Ensure the tissue is tight so that dirt is removed. Repeat, inserting a NEW tissue from the opposite end

9.3.3 To remove all traces of contamination the Cylinder must be immersed in a suitable solvent.

9.3.4 After removal from the solvent, using a NEW tissue, repeat the cleaning process in 9.3.2

9.4 PISTON RE-ASSEMBLY

GENERAL: The Piston must be carefully introduced into its Cylinder
If both parts are aligned and correctly cleaned, the Piston will slide freely into the Cylinder
NEVER FORCE THE PISTON INTO ITS CYLINDER OR DAMAGE MAY RESULT

9.4.1 Place Cylinder (5) on top of Column (10) with the register upwards, ensuring that the 'O' Ring (6) is clean and undamaged.

9.4.2 Replace Piston Nut A, and screw down securely.

9.4.3 Ensure that Bearing Assembly (7) and Thrust Washers (8) are located correctly.

9.4.4 Close Valve (27), and gently use the Priming Pump (57) to raise the oil level in the system until it reaches the top of the Cylinder.

9.4.5 Holding the Piston Assembly by the Piston Cap (3), carefully introduce the end of the Piston into the top of the Cylinder and push gently through.
**NEVER FORCE THE PISTON INTO ITS CYLINDER OR DAMAGE MAY RESULT.**
If resistance is felt, introduce more fluid. If resistance continues, then re-clean either Piston, Cylinder or both.
If, after repeated cleaning, the Piston still will not slide freely within the Cylinder, then permanent damage may have occurred. In which case the complete assembly will need to be replaced or returned for evaluation.

9.4.6 Replace Piston Nut B (2) and screw down securely.

9.4.7 Replace Weight Carrier Assembly (11), ensuring that it locates correctly on the top of the Piston Cap

## 10.0 ANCILLARY EQUIPMENT

If you require further information on any of the following equipment, please contact your local agent.

### S700 CALIBRATION SOFTWARE

DOS based calibration software designed specifically for Deadweight Testers. This software has been developed as a flexible working tool which assists the user with pressure measured calibrations.

The program corrects for variables such as:-

- Gravity
- Temperature
- Air Density
- Head of oil or gas
- Surface tension and buoyancy
- Piston effective area and distortion coefficients

The user friendly menu driven software generates hardcopy calibration reports and provides a historic database.

### PDP 101 PRESSURE DATA PROCESSOR

To reduce human errors and greatly shorten calibration time, the PDP 101 stores and calculates calibration results for direct printing or computer transfer. It enables you to use your Deadweight Tester in 10 different pressure units without the need for additional sets of Conversion Weights or complicated calculations. Changes in Gravity and Temperature can be simply keyed in.

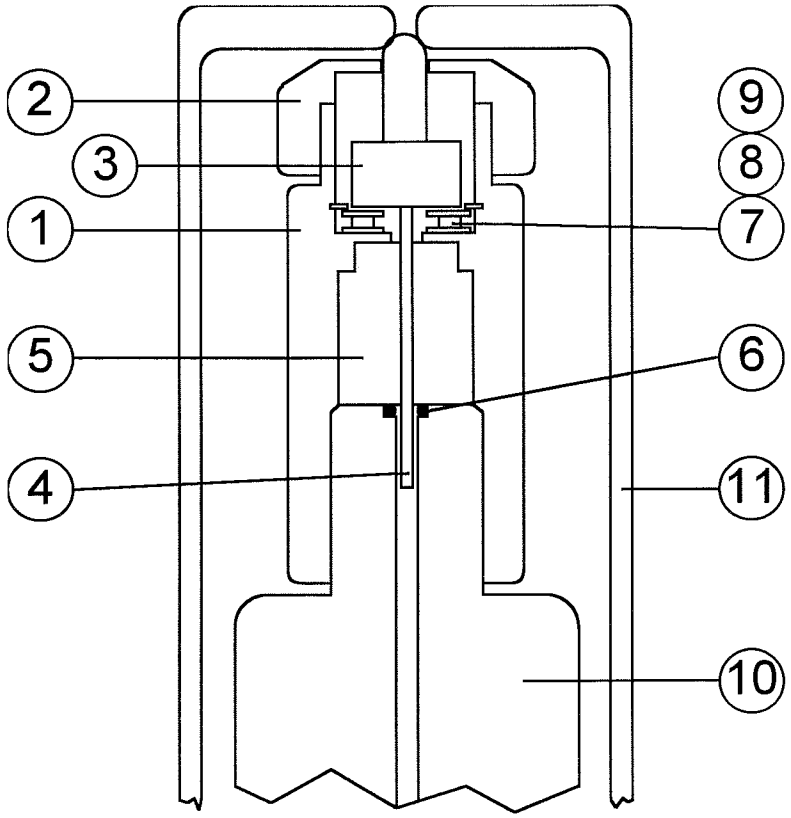
### T4600 POINTER REMOVER/PUNCH

To remove and refit the pointer of a Pressure Gauge. This two-in-one tool has a spring-loaded plunger to quickly and consistently refit the pointer.

## 11.0 GENERAL ARRANGEMENT DRAWINGS & PARTS LIST

| ITEM | PART | DESCRIPTION |
|---|---|---|
| 1 | D3813 | PISTON NUT A |
| 2 | D3814 | PISTON NUT B |
| 3 | D3815 | PISTON CAP |
| 4 | D4101 | PISTON |
| 5 | D3824 | CYLINDER |
| 6 | B3823 | 'O' RING |
| 7 | B3825 | BEARING ASSEMBLY |
| 8 | B3826 | THRUST WASHER |
| 9 | B3827 | RETAINING CLIP |
| 10 | D3816 | COLUMN |
| 11 | D3836 | CARRIER TUBE |
| 12 | D3821 | CARRIER RING |
| 13 | D3837 | TRIANGULAR BASE PLATE |
| 14 | D1048 | FOOT |
| 15 | D1046W | STUD |
| 16 | D7026 | LOCK SCREW |
| 17 | D3817 | FOOT STAND |
| 18 | B7042 | SCREW |
| 19 | B1045 | SPIRIT LEVEL |
| 20 | B3838 | SCREW |
| 21 | D3819 | BASE PLATE |
| 22 | D3818 | HOUSING |
| 23 | B3839 | SCREW |
| 24 | B3828 | RAM SCREW |
| 25 | B3829 | SPOKE |
| 26 | B3830 | SCREW |
| 27 | B3831 | VALVE |
| 28 | B3832 | SCREW |
| 29 | B3833 | NYLOK NUT |
| 30 | B3834 | NYLOK NUT |
| 31 | D3810 | TEST STATION |
| 32 | B3835 | SCREW |
| 33 | D3928 | LENS RING |
| 34 | B3840 | FERRULE |
| 35 | D3842 | PIPE |
| 36 | B3841 | COUPLING NUT |
| 37 | B3843 | HP NON-RETURN VALVE |
| 38 | D3812 | PUMP BLOCK |
| 39 | B2414 | LP NON-RETURN VALVE |
| 40 | D4720 | CONNECTOR |
| 41 | B1033 | BONDED SEAL |
| 42 | B1806 | FEMALE COUPLING |
| 43 | B1805 | MALE COUPLING |
| 44 | B1804 | NYLON PIPE |
| 45 | B1054 | BARREL SEAL |
| 46 | D3847 | PUMP BARREL |

| ITEM | PART | DESCRIPTION |
|---|---|---|
| 47 | D1023 | LOCKNUT |
| 48 | D1019A | UNION NUT |
| 49 | D4703 | BEARING |
| 50 | D3848 | SHAFT |
| 51 | D3849 | RAMBLER |
| 52 | B2809 | RAMBLER SEAL |
| 53 | B2810 | ANTI-EXTRUSION RING |
| 54 | B2420 | LOCKNUT |
| 55 | B2407 | CLEVIS |
| 56 | B2407A | CLEVIS PIN |
| 57 | D2406 | PUMP ARM |
| 58 | B2405 | PUMP HANDLE |
| 59 | D2455 | PIVOT LINK |
| 60 | D4718 | PIVOT PIN |
| 61 | D2418 | EYEBOLT |
| 62 | B2412 | LOCKNUT |
| 63 | D3822 | INDICATOR ROD |
| 64 | D3844 | RESERVOIR |
| 65 | B1808 | SCREW |
| 66 | D3845 | RESERVOIR SUPPORT |
| 67 | B1822 | SCREW |
| 68 | B1025 | FIBRE SEAL |
| 69 | D1809 | RESERVOIR BUNG |
| 70 | B1069 | 'O' RING |
| 71 | D1910W | NUT/OLIVE COUPLING |
| 72 | B1033 | BONDED SEAL |
| 73 | B3846 | LOCKNUT |
| 74 | D3850 | GAUGE ADAPTOR |
| 75 | D3851 | WEIGHT BOX |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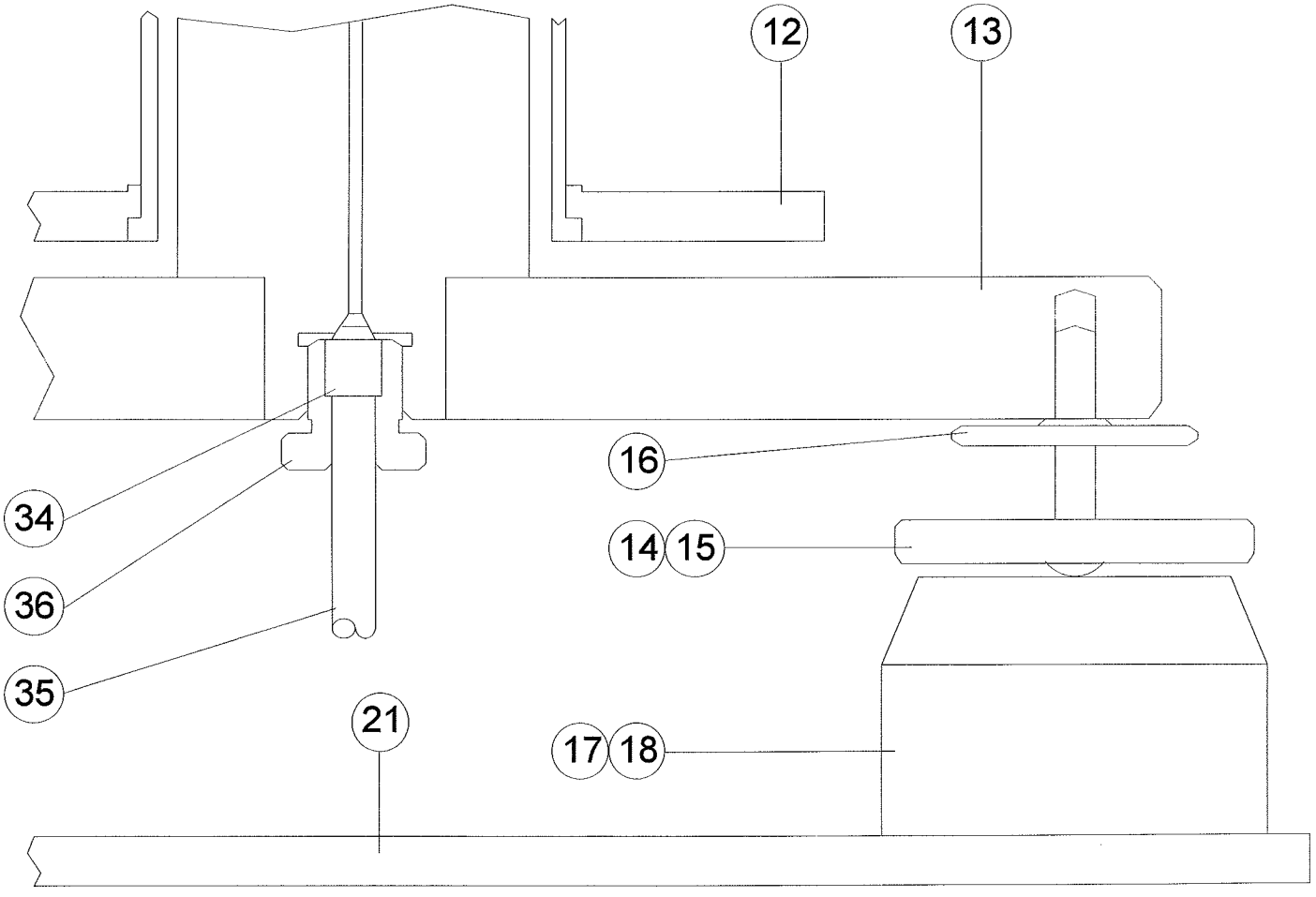
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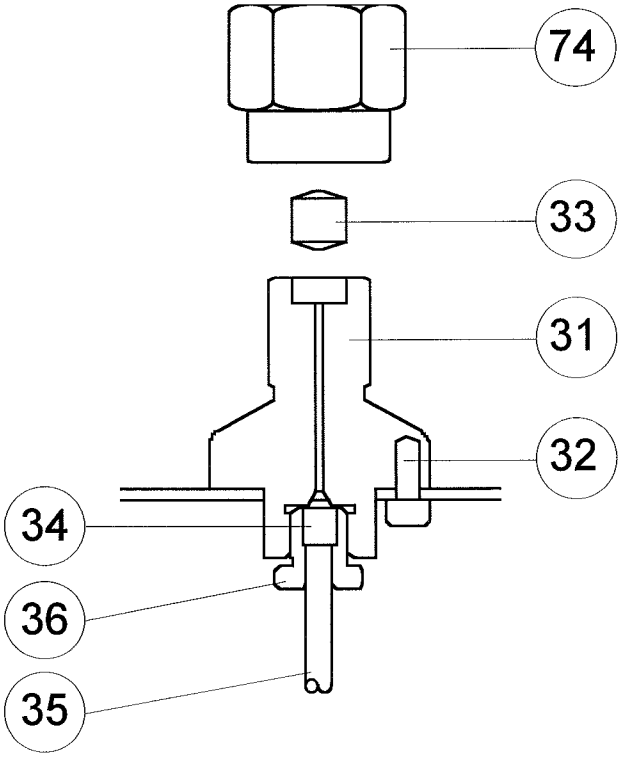
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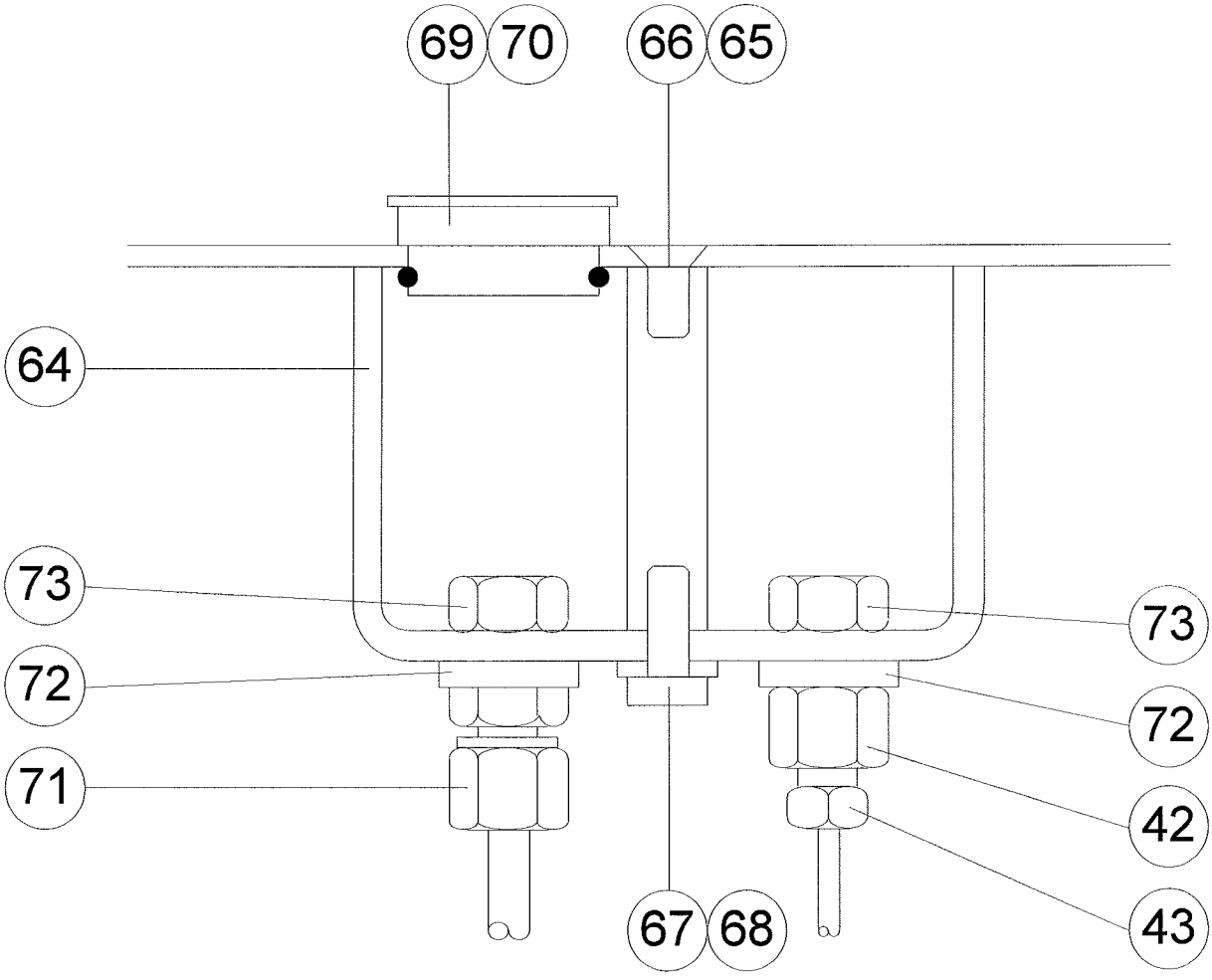
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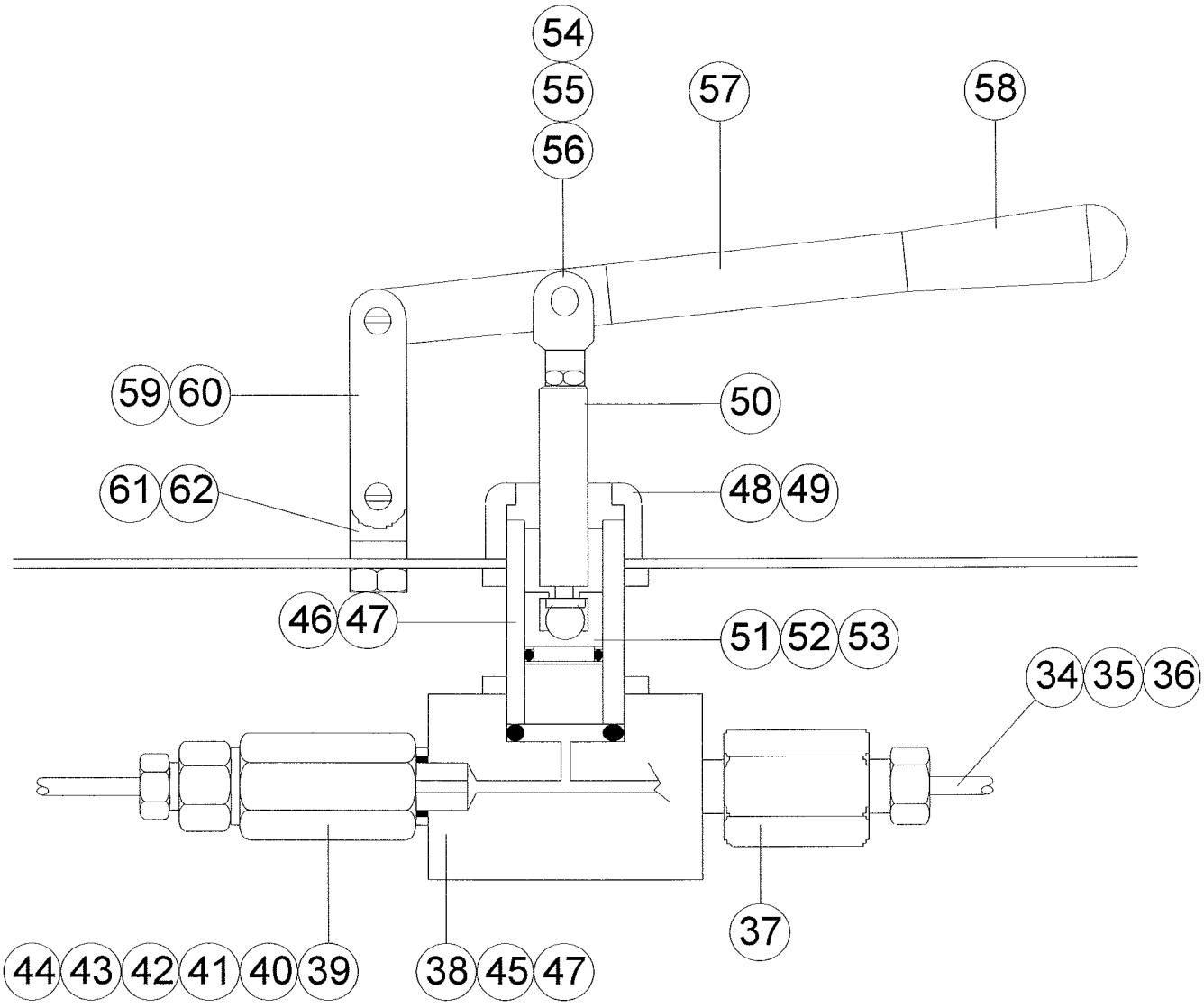
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## 12.0 FAULT FINDING

12.1 POOR PISTON SPIN/SENSITIVITY

IF PISTON IS NOT FREE, DO NOT ROTATE AS DAMAGE MAY OCCUR, DISMANTLE AND CLEAN - SEE SECTION 9, PAGE 8.

12.1.1 Remove the Weight Carrier Assembly.

12.1.2 Holding the Piston Cap (3), lift gently up and down. The Piston (4) should slide freely within its Cylinder (5), if any resistance or a 'gritty' sensation is detected, then it must be cleaned (See Section 9, Page 8).

12.1.2 If spin/sensitivity of a cleaned Piston deteriorates quickly then it is likely that the operating oil within the Deadweight Tester system is contaminated. This must be drained out, the system cleaned and re-primed with clean oil, see Section 5, Page 5.

12.2 SYSTEM WILL NOT PRIME

12.2.1 Check Valve (27) is closed.

12.2.2 Check there is sufficient fluid in the Reservoir (64).

12.2.3 Check for damaged/missing/dirty Lens Ring (33) in Test Station (31).

12.2.4 Check that the face of the instrument under test is contacting the Lens Ring (33), and that it is not scored or dented.

12.3 SYSTEM WILL NOT PRESSURISE

12.3.1 Check that Valve (27) is closed.

12.3.2 Check for missing/damaged/dirty Lens Ring (33) in Test Station (31).

12.3.3 Check that the face of the instrument under test is contacting the Lens Ring (33), and the face is not dented or scored.

12.3.4 Check Piston Seal (6) is undamaged.

12.3.5 Check that instrument under test is not leaking.

12.3.6 Check system for leaks by looking for drips at joints whilst continually pressurising. Replace Seal/Part, ensuring that sealing faces are clean and undamaged when re-assembling.

12.4 HAND-PUMP MALFUNCTION

12.4.1 Check 12.3

12.4.2a If pumping generates no pressure, then the Inlet Non-Return Valve (39) has probably failed.

12.4.2b This should be disassembled and inspected for dirt or damage to valve seat and Seal. After inspection, clean all parts thoroughly, replace as required and re-assemble correctly.

12.4.3 If the system pressurises and depressurises in conjunction with the downward and upward strokes of the Pump (57), then the Outlet Non-Return Valve (37) has failed completely. Inspect as per 12.4.2b.

12.4.4 If the Pump Handle rises, then the Outlet Non-Return Valve (37) is leaking. Inspect as per 12.4.2b.

**Note: Do not continue to pressurise if Pump Handle rises, as this can damage the pump Inlet Non-Return Valve (39).**

12.5 PISTON DROPS QUICKLY

GENERAL: The Piston will always drop slowly due to a small leak between the Piston and Cylinder. This drop rate will never be so quick that a stable reading cannot be made.

12.5.1 If the system has been pressurised quickly then it must be allowed to thermally stabilise. Continue re-floating the Piston until it stabilises, this should take no longer than one minute.

12.5.2 Check 12.3.

12.5.3 IF PISTON HAS JUST BEEN RE-FITTED AFTER CLEANING:
Air pockets can be introduced when re-fitting Piston. This will cause the Piston to drop faster whilst the air bleeds past the Piston and Cylinder.
Continue to re-float the Piston until the drop-rate slows down. If the Piston continues to drop quickly then check the fluid leakage around base of Piston/ Cylinder assemblies. Check for loose/damaged/dirty Seal (6) under assembly. (Remove Piston Weight Carrier (11). Tighten, clean or replace Seal as necessary (See Section 9.4, Page 9).

12.5.4 Valve (27) leaking.
Remove Reservoir Bung (69) and observe fluid level, it will rise slowly if the valve leaks

12.6 CANNOT ATTAIN MAXIMUM PRESSURE HAVING SCREWED CAPSTAN FULLY IN

12.6.1 Check 12.3 & 12.5.

12.6.2 Ensure that the Capstan (24) is FULLY OUT and the Hand-Pump (57) is used for initial pressurisation. See Section 5, Page 5.

12.6.3 If the instrument under test has a large internal volume or there is air in the system, then re-prime, see Section 5, Page 5, increasing the initial pressurisation with the Hand-Pump (57) from 1000 psi/70 bar to 2000 psi/140 bar.

## 13.0 OVERHAUL AND RECERTIFICATION

The Deadweight Tester's accuracy depends primarily on the effective area of the Piston and the mass of the Weights.

The Deadweight Tester will require periodic recertification, the frequency of which is dependent on use. An approximate guide is as follows:-

(i) High accuracy on-site use, recertify annually or sooner
(ii) Harsh, rough on-site use, recertify annually or sooner
(iii) High accuracy careful laboratory use, recertify every 2 to 3 years
(iv) Low accuracy careful use, recertify every 5 years

The Deadweight Tester should immediately be overhauled and recertified if either:-

(a) The Piston performance degrades (spin, sensitivity, drop rate).
(Ensure that the instructions in Section 9.0, Page 8, have been carried out).
(b) The Weights are damaged or seriously corroded.

The recalibration frequency must ultimately be specified by the user, with reference to the above comments and any organisational or inspection authority requirements.