USER'S MANUAL

T2700L

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GAS OPERATED, LIQUID LUBRICATED DEADWEIGHT TESTER

USER'S MANUAL

Manufactured by;

GE RUSKA

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REVISION NOTICE

RELEASE NUMBER	REVISION	DATE OF REVISION	DESCRIPTION
PMAN-101-1D01	A	01/09/03	Original release.

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.

USERS HANDBOOK
GAS OPERATED LIQUID LUBRICATED DEADWEIGHT TESTER

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	:	0.002%
Indicated Pressure	:	250 psi

$$\text{True Pressure} = 250 + (20 - 24) \times \frac{0.002}{100} \times 250$$

$$= 250 - \frac{0.008}{100} \times 250$$

$$= 250 - 0.02$$

$$= \mathbf{249.98\ psi}$$

Fluid Head

The piston assembly is liquid-lubricated in this particular model of Deadweight Tester, therefore variance in the fluid level within the piston chamber will have an effect on the pressure within the system.
The Deadweight Tester has been manufactured to the average fluid height relative to the bottom of the piston in it's mid-operating position.
The change in pressure as a result of variations in the relative fluid level, during normal operation, will not exceed:

0.00038 bar/0.0055 psi for oil-lubricated systems.
0.00082 bar/0.0118 psi for Krytox GPL101 lubricated systems.

The fluid level is not visible, therefore the exact height cannot be ascertained.
However, if an accurate calibration is required, then fill chamber to it's upper limit and then operate. The fluid level will be 4.5 mm above the the calculated average.
If running at this level, **reduce** the pressure measurement by:

0.00038 bar/0.0055 psi for oil.
0.00082 bar/0.0118 psi for Krytox GPL101.

The change in fluid height per minute at maximum pressure for the initial 2 mm is typically 0.01 mm, which equates to:

0.0000008 bar/0.000012 psi for oil.
0.0000018 bar/0.0000262 psi for Krytox GPL101.

The change in fluid height per minute at maximum pressure after the initial 2 mm will reduce to typically 0.005 mm, which equates to:

0.0000004 bar/0.000006 psi for oil.
0.0000009 bar/0.0000131 psi for Krytox GPL101.

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

* See Ancillary Equipment, PDP 101, Section 9.

2.0 SUPPLIED AS STANDARD EQUIPMENT WITH EACH INSTRUMENT:

Calibrated Weight Set in wooden case.
Certificate of Overall Accuracy.
Certificate of Piston Effective Area.
Computer print-out of Weight masses.
Female Adaptors: 1/8", 1/4", 3/8" & 1/2" BSP or NPT.
Spare Seals (53, 67, 68).
Piston Lubricating Oil - Specification: Our reference ST25
Oil supplied - Shell Tellus R10
Compatible oils - Esso Nuto H10 / Mobil Velocite No.6

3.0 CONNECTION TO AN EXTERNAL PRESSURE SOURCE

Inlet Port (21) thread: 1/4" BSP or NPT female:
External air supply is connected to the Inlet Port
Ensure that the supply is both clean and dry
A compressed gas bottle (nitrogen or dry air) fitted with a pressure regulator is recommended.
Factory (compressor) air-lines should only be used if a series of filters are fitted to ensure the air supply is clean and dry.
The Capstan can be used to increase the system pressure if the external source is insufficient. If used for this purpose, then screw Capstan FULLY OUT in Preparation Step 4.4.

IMPORTANT: THE EXTERNAL PRESSURE SOURCE MUST BE REGULATED TO EITHER THE MAXIMUM RANGE OF THE DEADWEIGHT TESTER (Engraved on the Instrument Nameplate (31) OR 10% ABOVE THE MAXIMUM PRESSURE REQUIRED, WHICHEVER IS THE LOWER. DO NOT OVER-PRESSURISE THE DEADWEIGHT TESTER!

4.0 PREPARATION

4.1 Find a flat, stable surface.

4.2 Remove Capstan (44) from case lid using Allen Key (38) and fit to Hub (63) on the front of the Tester.

4.3 Level the Tester using the four Adjustable Feet (25) to the Spirit Level (29) mounted on the top plate.

4.4 If the instrument is to be primed for the first time after draining for storage/transportation, then the following points apply:

4.4.1 Remove Piston assembly - see Section 8.1

4.4.2 Remove Filler Plug (7).

4.4.3 Using Filler Bottle (88), fill the chamber through the top port until the oil level reaches the 'O' Ring (5). Allow time for the oil level to stabilise.

4.4.4 Continue this procedure until the oil level reaches the bottom of the Filler Plug port, - do not over-fill. If this occurs, allow the excess oil to drain out of the port.

4.4.5 Replace the Filler Plug.

4.4.6 Replace the Piston assembly - see Section 8.5

4.5 Screw Capstan half-way out.

4.6 Fit instrument to be tested to Test Station (49).

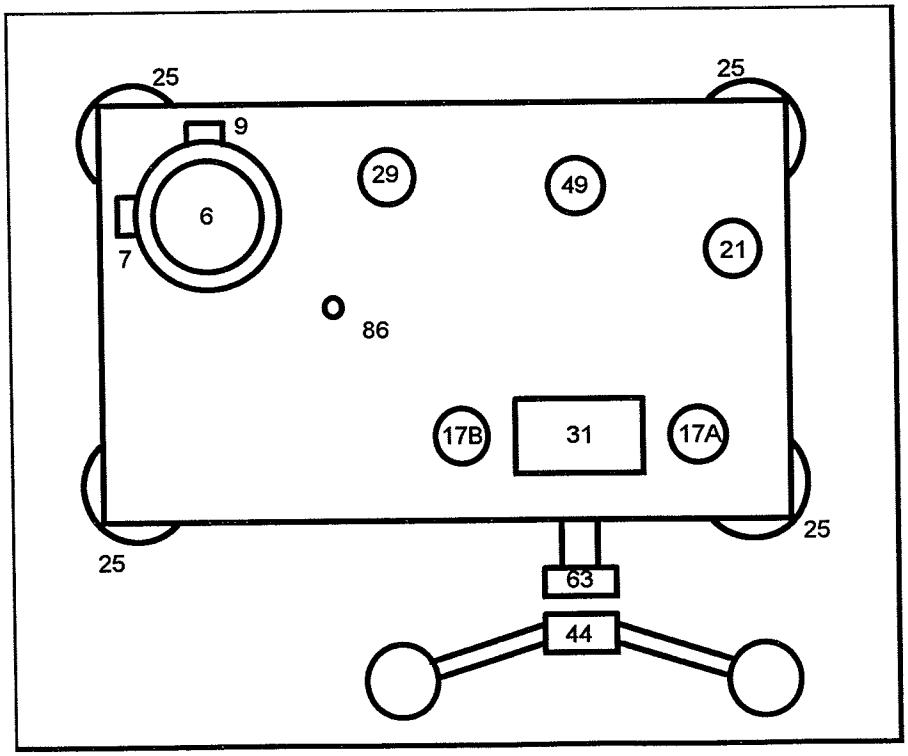
4.6.1 Screw the appropriate Adaptor (52) fully onto the instrument to be tested.

4.6.2 Screw assembly down ANTI-CLOCKWISE onto the Test Station.
Note: The internal thread in the lower half of the Adaptor is LEFT-HANDED
Hand-tight is sufficient; ensure that the bottom face of the instrument to be tested contacts the Test Seal (53) on the Test Station.

4.6.3 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 Test Seal

4.6.4 To calibrate Rear Connection Gauges use a T3700 Angle Adaptor - see Ancillary Equipment, Section 9.

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



5.0 OPERATION

5.1 Ensure that both Increase and Decrease Valves (17A & 17B) are closed.
DO NOT OVERTIGHTEN, AS DAMAGE TO VALVE SEAT CAN OCCUR

5.2 Select required Weights * and stack on the Piston. The pressure measured is the total of the Weights plus the Weight Carrier (6)
(*Fractional Weights: smaller increment Weights are available)

5.3 SLOWLY open and close Increase Valve (17A) until the Piston rises
Notes:

a) Ensure that the bottom face of the lowest weight is aligned within the limits marked on the Indicator Rod (86) (See Figure 5.3).
If the system is over-pressurised (Piston against top-stop) then reduce the pressure by SLOWLY opening and closing Decrease Valve (17B) until the Piston floats.
Use Capstan (44) for final fine control. Screw in to increase, and out to decrease pressure.

b) At low pressures, the Piston may require lifting manually to overcome the 'oil-stick' due to the film of oil that will develop between the top of the Cylinder and the underside of the Weight Carrier.

5.4 Rotate the Weight stack clockwise.
DO NOT ROTATE WEIGHTS WHEN THE PISTON IS AGAINST THE TOP OR BOTTOM STOP.

5.5 Observe reading of instrument under test

5.6 For the next higher pressure point, repeat from 5.2

5.7 To measure lower pressures, remove the necessary Weights, and slowly open and close the Decrease Valve (17B), reducing the system pressure until the Piston floats.
Use Capstan (44) for final adjustment, then rotate the Weight stack clockwise.

5.8 Depressurise by SLOWLY opening and closing Decrease Valve (17B).
NEVER DEPRESSURISE THE SYSTEM QUIKLY.

5.9 Remove Weight stack.

5.10 The oil level should be checked, and maintained as required, periodically (dependant upon use). The level should be maintained by removing the Filler Plug, and introducing more oil with the Filler Bottle until it reaches the bottom of the Filler Plug port.
ALWAYS ENSURE THAT THE SYSTEM IS FULLY DEPRESSURISED BEFORE REMOVING THE FILLER PLUG.

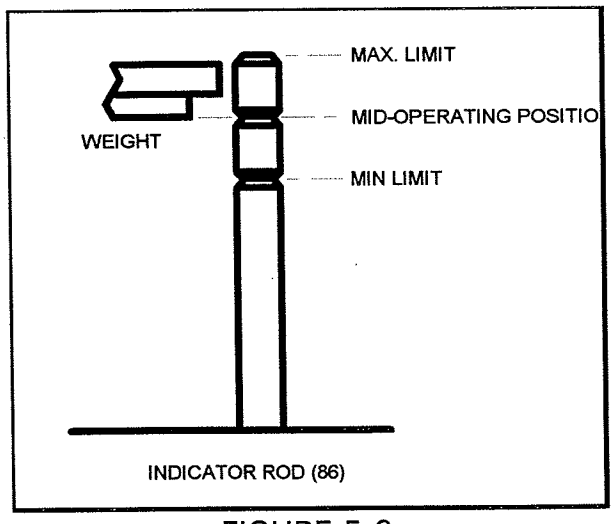


FIGURE 5.2

6.0 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 PDP 101, Section 9, Page 5

7.0 STORAGE AND TRANSPORTATION

7.1 Disconnect external pressure source

7.2 Screw Capstan (44) fully in, disassemble, and store in the case lid

7.3 For transportation:

a) Tape down Adaptors (52) in Accessory Block (36).

b) To avoid accidental internal oil contamination caused by tipping the instrument away from the horizontal, the oil can be drained by removing the Drain Plug (9). Always ensure the system is FULLY depressurised before removing this plug. Have a cloth or tissue ready to absorb the oil as it drains out onto the rear of the Deadweight case.

7.4 Replace Tester case lid, ensuring that the Hinges (35) are properly engaged, and secure with Toggle Clips (33) at sides

7.5 Place ALL the appropriate Weights on the base of the Wooden Weight Case (74), cover with the lid and secure by screwing Handle (69) fully down. Ensure Handle is tight.

8.0 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 Decrease Valve (17B)

8.1 PISTON REMOVAL

8.1.1 Lift Weight Carrier (6) and unscrew Cylinder Retainer (4). Remove assembly.

8.1.2 Using small Allen Key (38) in Accessory Block (36), unscrew Grub Screw (13) in Weight Carrier.

8.1.3 Gently pull off Weight Carrier. DO NOT PULL IN SUCH A WAY THAT THE PISTON CAN BEND.

8.1.4 Lift off Cylinder Retainer.

8.1.5 Separate Piston (11) and Cylinder (10).

8.2 PISTON CLEANING

8.2.1 Use 'non-fluffing', non-abrasive, lint-free tissue or absorbent cloth. Hold the Piston (11) by the larger 'head' end, and rub the tissue back and forth along its length.

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

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

8.2.4 Place Piston carefully on a NEW tissue where it will not become dirty or damaged whilst the Cylinder (10) 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

8.3 CYLINDER CLEANING

8.3.1 Wipe excess fluid from the outside surfaces of the Cylinder (12).

8.3.2 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

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

8.3.4 After removal from the solvent, using a NEW tissue, repeat the cleaning process in 8.3.2

8.4 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

8.4.1 Holding the Piston by the 'Head' end, dip the other end into a container of clean lubricating oil, and transfer to the bore in the larger diameter end of the Cylinder.

8.4.2 Allow the oil to run through the bore. Repeat this procedure 2 or 3 times to ensure an even film of clean oil exists in the Cylinder bore.

8.4.3 Carefully introduce the end of the Piston into the underside 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 permenant damage may have occurred. In which case the complete assembly will need to be replaced or returned for evaluation.

8.4.4 Replace Cylinder Retainer (4), taking care not to allow it to touch the working surface of the Piston.

8.4.5 Replace Weight Carrier (6), ensuring that it is fully home. Lightly secure Weight Carrier to Piston with Grub Screw (13) - DO NOT OVERTIGHTEN.

8.5 REFITTING PISTON

8.5.1 Ensure the oil level within the PCU Housing is to the 'O' Ring (5).

8.5.2 Holding the Piston assembly by the Weight Carrier, locate assembly into PCU Housing (1), ensuring that the 'O' Ring (5) is clean and undamaged.

8.5.3 Lift Weight Carrier and screw Cylinder Retainer fully down.

9.0 ANCILLARY EQUIPMENT

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

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.

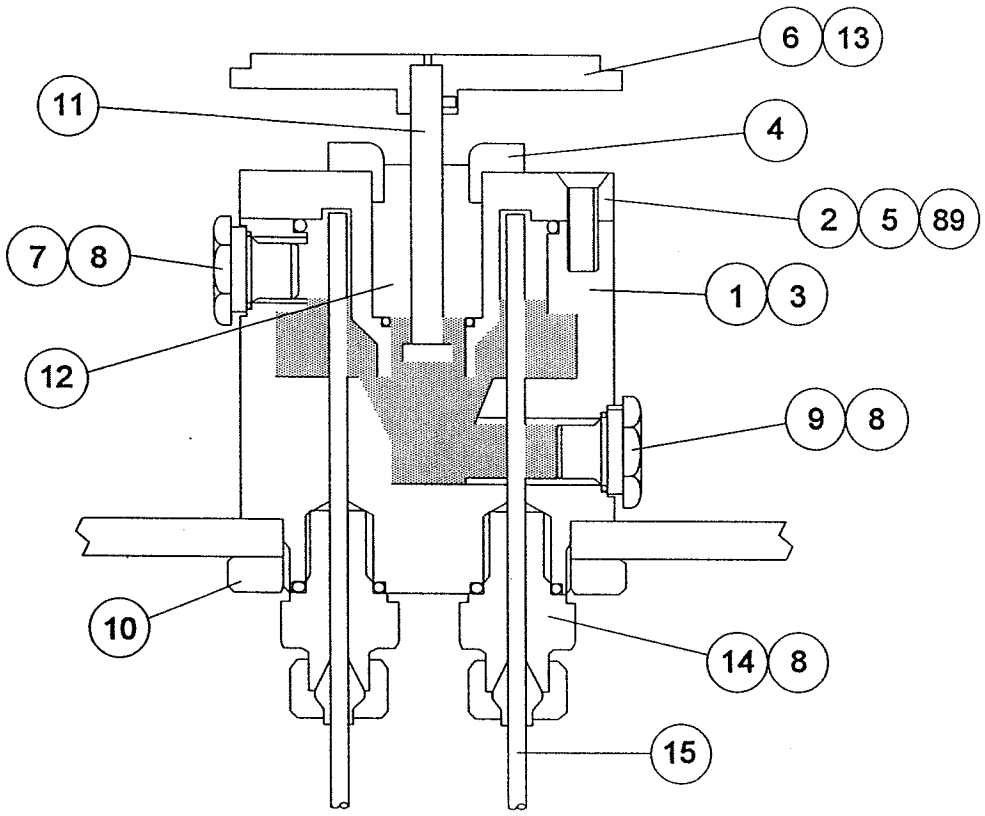
T3700 ANGLE ADAPTOR

To calibrate rear/back Connection Gauges in their correct position, an Angle Adaptor must be used. The Angle Adaptor fits directly onto the Test Station, converting it through 90 degrees, allowing the same Adaptors to be used.

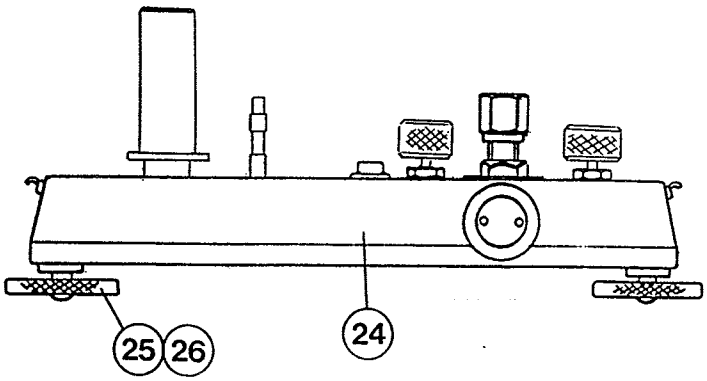
T4600 POINTER REMOVER/PUNCH

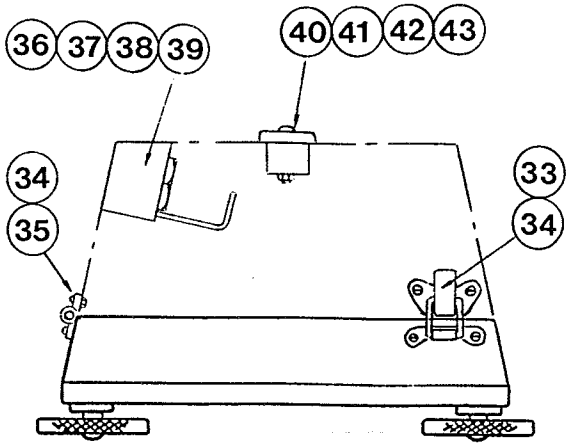
To remove and refit the pointer of a Pressure Gauge. This two-in-one tool has a spring-loaded plunger to quickly and consistently refit the pointer.

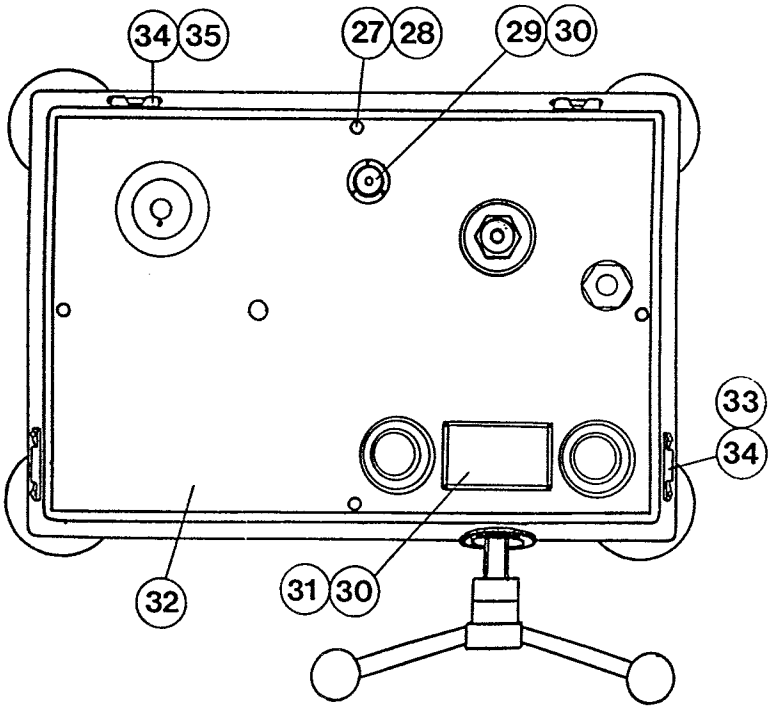
10.0 GENERAL ARRANGEMENT DRAWINGS & PARTS LIST

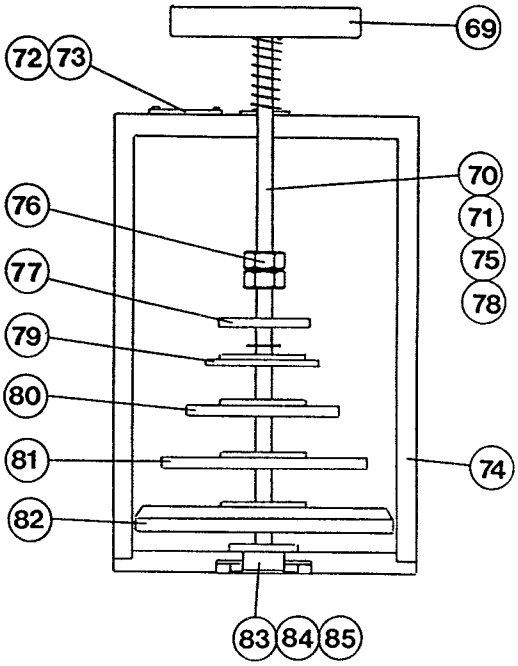


ITEM	PART	DESCRIPTION
1	D2901	PCU HOUSING
2	D2902	CYLINDER HOLDER
3	B2908	'O' RING
4	D2903	CYLINDER RETAINER
5	B2907	'O' RING
6	D2904	WEIGHT CARRIER
7	D2905	FILLER PLUG
8	B2906	'O' RING
9	D2905	DRAIN PLUG
10	B6116	LOCKNUT
11	D4001	PISTON
12	D4002	CYLINDER
13	B2911	GRUB SCREW
14	B4723	NUT/OLIVE COUPLING
15	B4724	PIPE

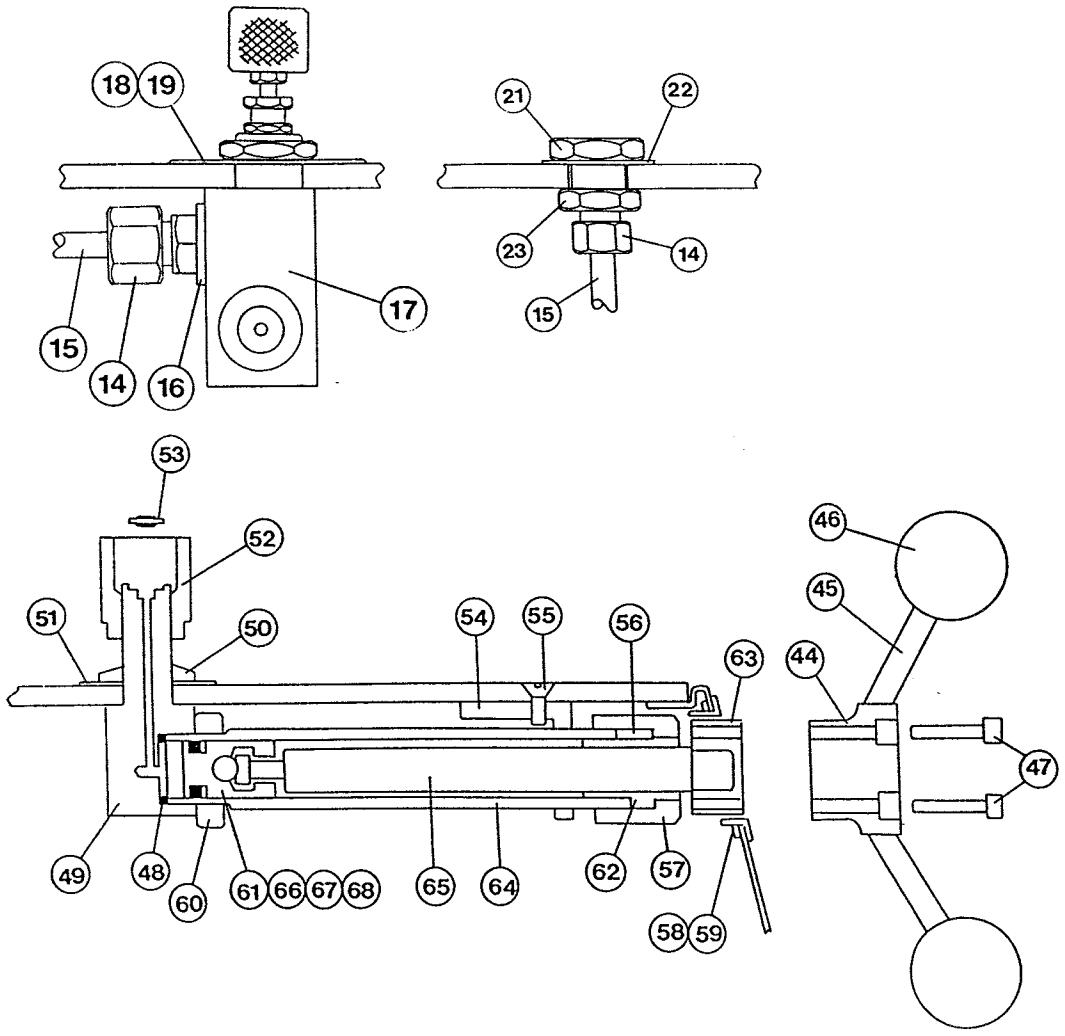








16	B4725	CENTRED BONDED SEAL	37	B1071	ALLEN KEY (LARGE)
17	T1700	NEEDLE VALVE	38	B1070	ALLEN KEY (SMALL)
18	D1404	LABEL:INCREASE	39	B4114	SPARES BOTTLE
19	D1404	LABEL:DECREASE	40	D1836	SUPPORT BAR
20	B1822	SCREW	41	B1078	STRAP HANDLE
21	D5023	INLET PORT	42	B1075	SCREW
22	B1407	LOCK WASHER	43	B1081	NUT
23	B1807	LOCKNUT	44	D1041	OUTER HUB
24	D1007E	CASE	45	D1020	SPOKE
25	D1048	FOOT	46	B1021	KNOB
26	B1047	STUD	47	B1042	SCREW
27	B1086	SCREW	48	B1054	'O' RING
28	B1082	CAPTIVE NUT	49	D1038	TEST STATION
29	B1045	SPIRIT LEVEL	50	D1039	DOME NUT
30	B1044	SCREW	51	D1098	LABEL:HAND TIGHT ONLY
31	B1035	NAMEPLATE	52	D1018	ADAPTORS
32	D1909	TOP PLATE	53	B1066	TEST SEAL
33	B1076	TOGGLE CLIP	54	D1823	SUPPORT BRACKET
34	B1097	RIVET	55	B1043	SCREW
35	B1077	HINGE	56	D1053	KEY
36	D4113	ACCESSORY BLOCK	57	D1019	BARREL UNION



58	D1087	'C' CLIP	76	B1833	LOCKNUT
59	D1050	SHROUD	77	D1057	WEIGHT RETAINER
60	B1023	LOCKNUT	78	B1061	CIRCLIP
61	B1022	BALL	79	D1008	WEIGHT
62	D3902	RAM NUT	80	D1009	WEIGHT
63	D1040	INNER HUB	81	D1010	WEIGHT
64	D3903	BARREL	82	D1011	WEIGHT
65	D3901	RAM SCREW	83	D1056	LOCATING STAND
66	D3904	RAMBLER	84	B1083	WASHER
67	B4707	'O' RING	85	B1063	LOCKNUT
68	B3906	ANTI-EXTRUSION RING	86	D2910	INDICATOR ROD
69	D1058	HANDLE	87	B1822	SCREW
70	B1834	SPRING	88	B2909	FILLER BOTTLE
71	B1835	WASHER	89	B2912	SCREW
72	D1036	NAMEPLATE			
73	B1044	SCREW			
74	D1079	WEIGHT CASE			
75	D1060	STUD			

11.0 FAULT FINDING

11.1 POOR PISTON SPIN/SENSITIVITY

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

11.1.1 Holding the Weight Carrier (6), lift gently up and down. The Piston (11) should slide freely within its Cylinder (12), if any resistance or a 'gritty' sensation is detected, then it must be cleaned (See Section 8).

11.1.2 If spin/sensitivity of a cleaned Piston deteriorates quickly then it is likely that the lubricating oil within the PCU Housing is contaminated. This must be drained out, the PCU Housing cleaned and re-primed with clean oil, see Section 4.4.

11.2 SYSTEM WILL NOT PRESSURISE

11.2.1 Check that Increase and Decrease Valves (17A & 17B) are closed.

11.2.2 Check for missing/damaged/dirty Test Seal (53) in Test Station (49).

11.2.3 Check that the face of the instrument under test is contacting the Test Seal (53), and the face is not dented or scored.

11.2.4 Check that external source is correctly connected and that it is fully functional.

11.2.5 Check that instrument under test is not leaking.

11.2.6 Check system for leaks by brushing soap solution onto joints and continually pressurising. The soap solution will bubble at the point of leakage. Replace Seal/Part, ensuring that sealing faces are clean and undamaged when re-assembling.

Wipe away ALL traces of soap solution immediately after test. Prolonged soaking may cause certain parts to corrode.

11.3 PISTON DROPS QUICKLY

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. If a stable reading cannot be made then check Section 11.2

12.0 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 8.0, Page 4, 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.