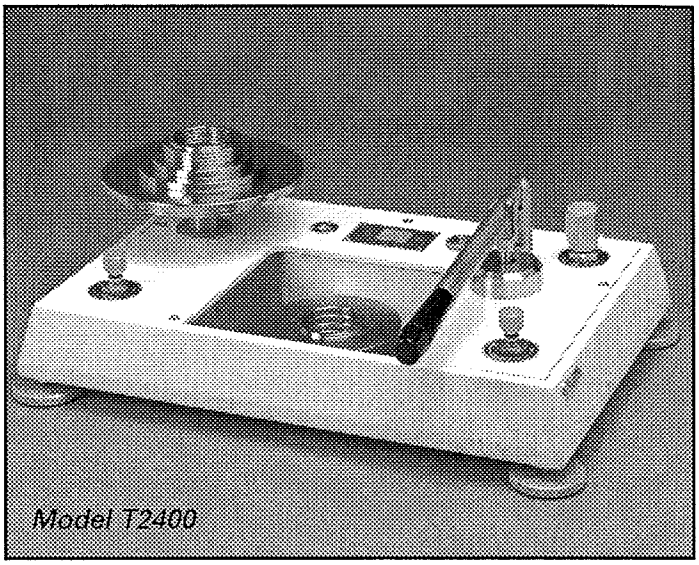
USERS HANDBOOK
Low Pressure Pneumatic Deadweight Testers

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.


Model T2400

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 or 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

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

$$= 1.0005812 \times 250$$

$$= 250.1453 \text{ psi}$$

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

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

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

$$= 250 - 0.02$$

$$= 249.98 \text{ psi}$$

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

2.0 Supplied As Standard Equipment With Each Instrument

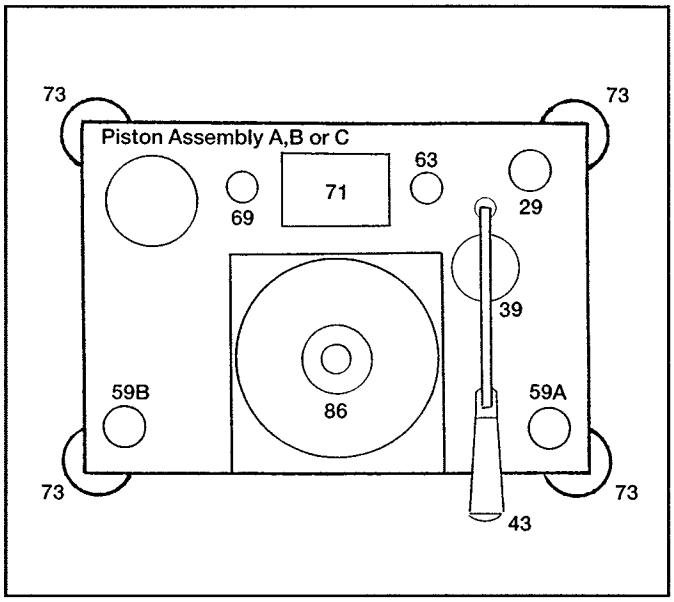
Calibrated Weight Set stored within Tester Case.
Certificate of Overall Accuracy.
Certificate of Piston Effective Area.
Computer print-out of weight masses.
Female Adaptors: 1/8", 1/4", 3/8" & 1/2" BSP or NPT.
Spare seals (28)

3.0 Connection To An External Pressure Source

Inlet Port (63) 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.

IMPORTANT; THE EXTERNAL PRESSURE SOURCE MUST BE REGULATED TO EITHER THE MAXIMUM RANGE OF THE DEADWEIGHT TESTER (Engraved on the Instrument Nameplate (71) 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 Pump Handle (43) from case lid and screw onto Pump Arm (39).
4.3 Level the Tester using the four Adjustable Feet (73) to the Spirit Level (69) mounted on the top plate.
4.4 Fit instrument to be tested to Test Station (29).
4.4.1 Screw the appropriate Adaptor (27) fully onto the instrument to be tested.
4.4.2 Screw assembly down **ANTI-CLOCKWISE** onto 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 (28) on the Test Station.
4.4.3 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.
4.4.4 To calibrate Rear Connection Gauges use a T3700 Angle Adaptor - see Ancillary Equipment, Section 9, Page 6.

IMPORTANT: ENSURE THAT ANY INSTRUMENT FITTED TO THE TEST STATION IS INTERNALLY CLEAN. - See Ancillary Equipment, T4400, Section 9, Page 5.

5.0 Operation

5.1 Ensure that both Increase and Decrease Valves (59A and 59B) are closed.
DO NOT OVERTIGHTEN, AS DAMAGE TO VALVE SEAT CAN OCCUR.

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

5.3 Use the Handpump to generate pressure until the Piston floats (ie not touching the top or bottom stop).
Note on Handpump use: Slow down-strokes will only partially contribute pressure.
For higher pressurisation, a faster down-stroke is required.
Alternatively, if connected to an external supply, SLOWLY open and close Increase Valve (59A) until the Piston floats.
If system is over-pressurised (Piston against top-stop) then reduce pressure by SLOWLY opening and closing Decrease Valve (59B) until the Piston floats.

5.4 Rotate the Weight stack clockwise.
For optional Motor Drive (Only available for Models T2400 and T2500), See Section 9, Page 5.
DO NOT ROTATE WEIGHTS WHEN PISTON IS AGAINST TOP OR BOTTOM STOPS.
(When Piston is against a stop, a rubbing noise can be heard).

5.5 Observe reading of instrument under test.

5.6 For next higher pressure point, repeat from 5.2 above.

5.7 To measure lower pressures, remove the necessary Weights, and by opening and closing the Decrease Valve (59B), slowly reduce the system pressure until the Piston floats, then rotate clockwise.

5.8 Depressurise by SLOWLY opening and closing Decrease Valve (59B).

5.9 Remove weight stack.

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 S700, Section 9, Page 5.

7.0 Storage and transportation

7.1 Unscrew Pump Handle (43) and store in the case lid.

7.2 Replace Weight set in the storage compartment and secure with Clamp (86).

7.3 For transportation, tape down Adaptors (27) in Accessory Block (82).

7.4 Replace Tester case lid, ensuring that the Hinges (75) are properly engaged, and secure with Toggle Clips (76) at sides.

8.0 Piston Care

Model	Assembly
T1100	B
T1150	C
T2400	A
T2500	A

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.

Piston assemblies, Figures A, B & C (See Page 5), are specific to the following models:

Note: Ensure Tester system is depressurised before attempting Piston removal, open Valve (by SLOWLY opening Decrease Valve (59B)).

8.1A PISTON REMOVAL ASSEMBLY A

8.1A.1 Lift up Weight Carrier (3), and tap sharply downwards onto Cylinder (2).
Alternatively, using a small pin-head hammer and suitable flat-ended punch, tap lightly on the end of the Piston (1) through the centre of the Weight Carrier (3). Remove Weight Carrier.

8.1A.2 Unscrew Cylinder (2), use the dowel hole if Cylinder is tight.

8.1B PISTON REMOVAL - ASSEMBLY B

8.1B.1 Unscrew Cylinder (10) and lift out Piston/Cylinder assembly.

8.1B.2 Unscrew and remove Piston Stop (15).

8.1B.3 Piston and Weight Carrier (11 and 20) can now be carefully withdrawn from Cylinder (10).

8.1C PISTON REMOVAL - ASSEMBLY C

8.1C.1 Lift up Weight Carrier (24).

8.1C.2 Unscrew Bearing Cap (25) and remove.

8.1C.3 Piston and Weight Carrier (22 & 24) can now be carefully withdrawn from Cylinder (23).

8.1C.4 Unscrew Cylinder.

8.2A PISTON CLEANING

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

ASSEMBLY A

8.2A.1 Use 'non-fluffing', non-abrasive, lint-free tissue or absorbent cloth. Hold the Piston (1) by the larger 'head' end, and rub the tissue/cloth back and forth along its length.

8.2A.2 To remove all traces of contamination , the Piston must be immersed in a suitable solvent.

8.2A.3 Using a NEW tissue, clean the Piston as before, pressing hard between thumb and forefinger along the Piston's length.

8.2A.4 Lay Piston carefully on a NEW tissue where it will not become dirty or damaged whilst the Cylinder (2) is cleaned.

8.2B ASSEMBLY B OR C

8.2B.1 Use 'non-fluffing', non-abrasive, lint-free tissue or absorbent cloth. Hold the Piston assembly by the Weight Carrier (20 or 24), and rub the tissue/cloth back and forth along the Piston length.

8.2B2 When immersing Piston in a solvent (See 8.2A.2 above), hold Weight Carrier (20 or 24) and keep Piston VERTICAL. Ensure any solvent inside Piston (11 or 22) is removed.

8.2B.3 Clean the Piston as before, (See 8.2A.3 & 8.2A.4).

8.3 CYLINDER CLEANING

8.3.1 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.

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

8.3.3 After removal from the solvent, repeat the cleaning process in 8.3.1.

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.
If resistance is felt, 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.

8.4.1 Assembly A:
Hold Piston (1) by larger, 'head' end, and introduce the tapered end into the threaded end of the Cylinder (2). Place assembly vertically on a clean, hard, stable surface.
Ensure Weight Carrier (3) is clean, especially the central mounting hole, and place on tapered end of Piston.
Tap lightly using the palm of the hand to locate on the taper.

8.4.2 Assembly B:
Hold Piston assembly by Weight Carrier (20) and introduce into Cylinder (10), ensuring that Bearing (19) is located on top of the Cylinder. Screw Piston Stop (15) into the base of the Piston.

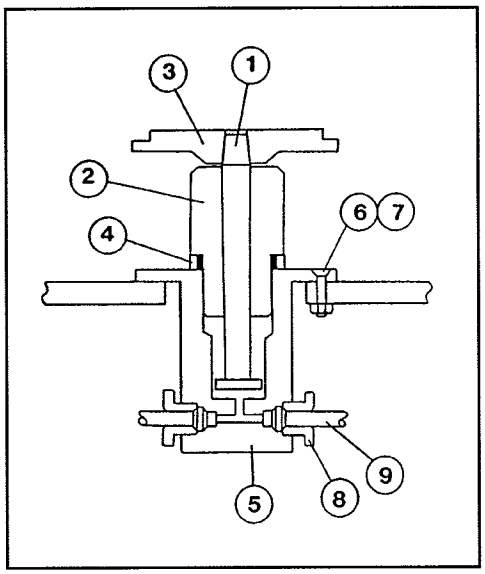
8.4.2 Assembly C:
Hold Piston assembly by Weight Carrier (24) and introduce into Cylinder (23). Secure by screwing Bearing Cap (25) onto Cylinder, around the stem of the Weight Carrier.

8.5 RE-FITTING

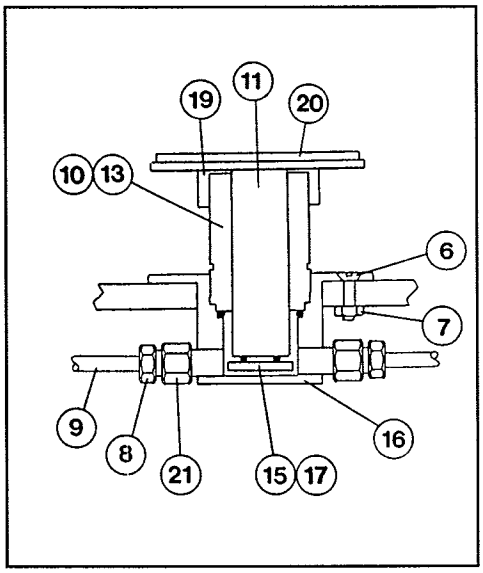
Screw assembly into Piston body, ensuring that the bonded seal 'O' ring is clean and correctly refitted. Do not overtighten.

General Arrangement Drawings & Parts List - Piston Assemblies

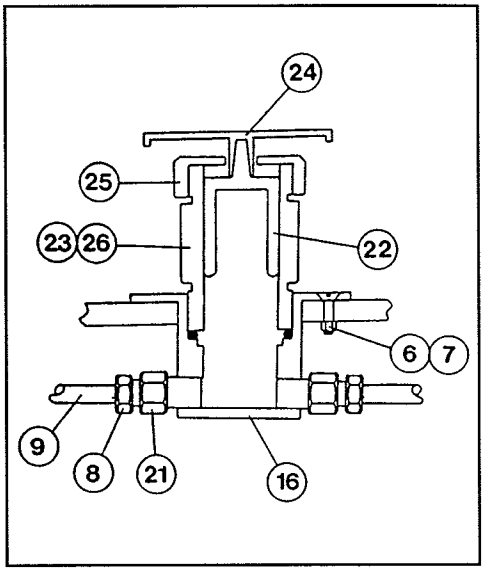
Assembly A



Assembly B



Assembly C



ITEM	PART	DESCRIPTION
1	D4116	PISTON
2	D4117	CYLINDER
3	B1819	WEIGHT CARRIER
4	B1802	BONDED SEAL
5	D2402	PISTON BODY
6	B1808	SCREW
7	B1073	NUT
8	B1805	MALE COUPLING
9	B1804	PIPE

ITEM	PART	DESCRIPTION
10	D1101	CYLINDER
11	D1102	PISTON
13	B1106	'O' RING
15	D1108	PISTON STOP
16	D1110	PISTON BODY
17	B1025	'O' RING

ITEM	PART	DESCRIPTION
19	D1112	NYLON BEARING
20	D1107	WEIGHT CARRIER
21	B1806	FEMALE CONNECTOR
22	D1150	PISTON
23	D1152	CYLINDER
24	D1151	WEIGHT CARRIER
25	D1154	BEARING CAP
26	B1162	'O' RING

9.0 Ancillary Equipment

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

S700 SERIES CALIBRATION SOFTWARE

User friendly, menu driven, DOS based calibration software designed specifically for primary pressure standards, Deadweight Testers. This software has been developed as a flexible working tool to make pressure calibrations quicker, easier and more accurate. The software calculates which weights are required to generate a specific pressure. The programme can also calculate the pressure given the weights and piston used. The software will work in an unlimited number of pressure units, regardless of the pressure unit the Deadweight Tester has been manufactured to. You can store details on as many Deadweight Testers as required. The software generates calibration certificates which can be either printed or stored.

T4400 DIRT/MOISTURE TRAP

Prevents the instrument under test from contaminating the sensitive Deadweight Tester system. The unit is mounted directly onto the Test Station.

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

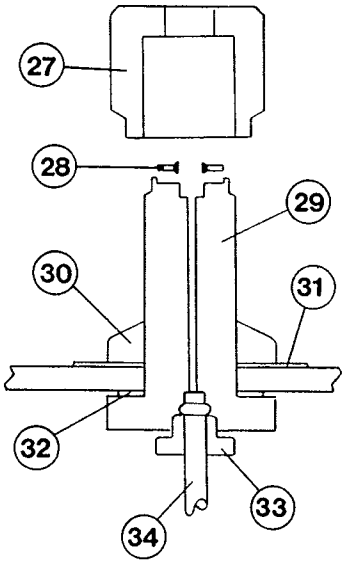
To remove and refit the pointer of a Pressure Gauge. This two-in-one tool has a spring-loaded plunger to quickly and consistently refit the pointer.

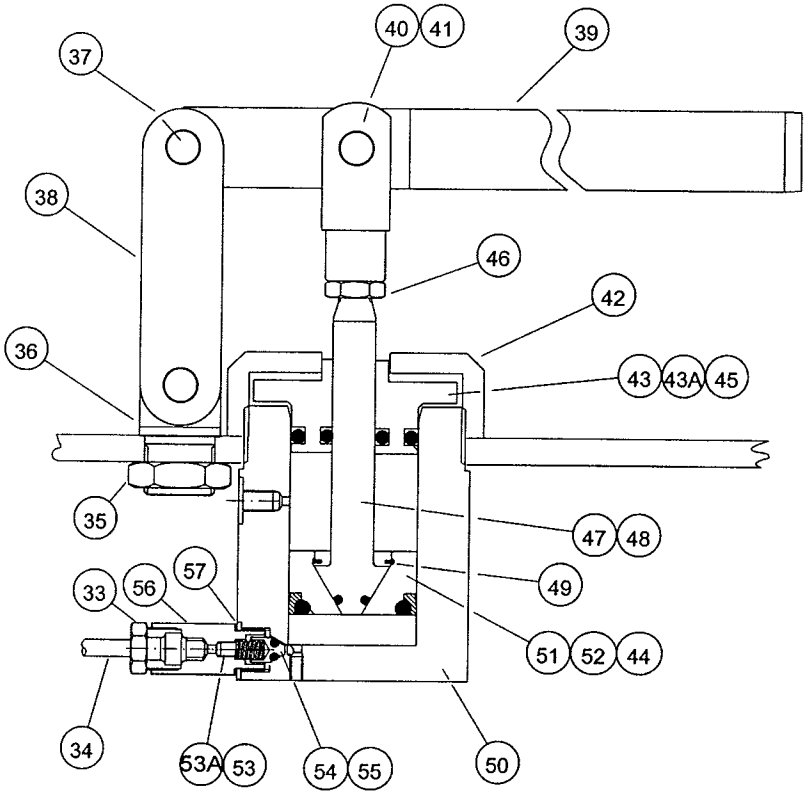
OPTIONAL EQUIPMENT:

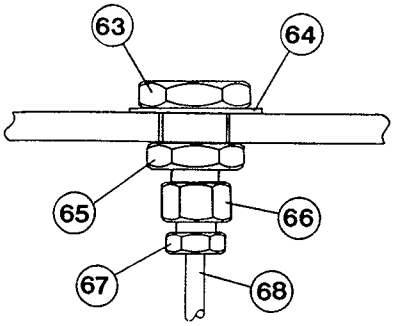
MOTOR DRIVE (Models T2400 & T2500 only)

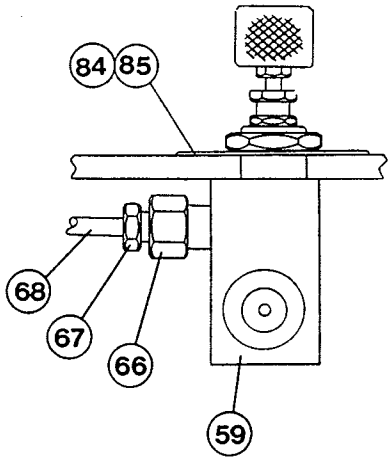
A motor drive can be fitted to rotate the Weights if a continuous pressure is required for long-term testing. This should be specified at the time of order, but can be retro-fitted if necessary.

10.0 General Arrangement Drawings & Parts List



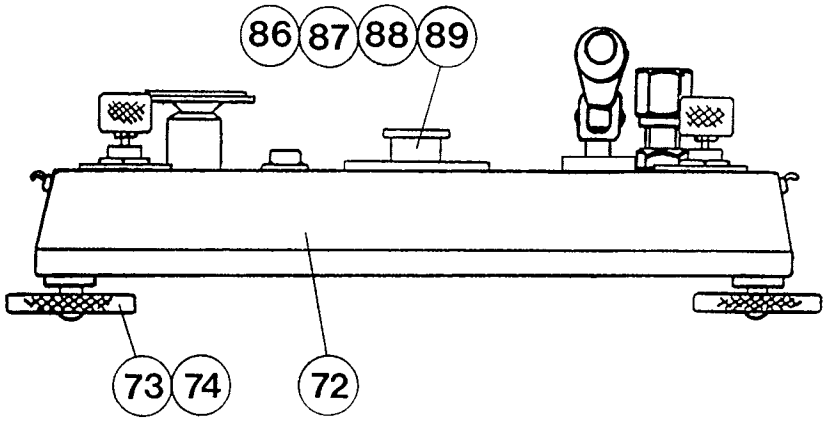




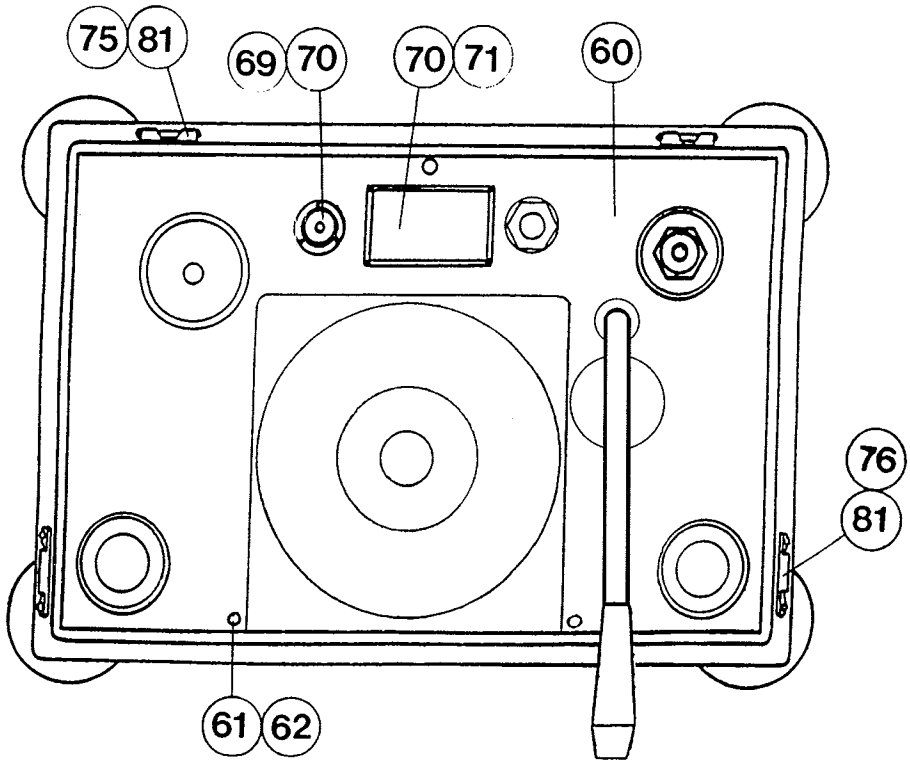


ITEM	PART	DESCRIPTION
27	D1018	ADAPTORS
28	B1066	TEST SEAL
29	D1401	TEST STATION
30	D1039	DOME NUT
31	D1098	LABEL: HAND TIGHT ONLY
32	B1407	LOCK WASHER
33	B1805	MALE COUPLING
34	B1804	PIPE
35	B2421	LOCKNUT
36	D2457	EYE BOLT
37	D4718	PIVOT SCREW
38	D2455	PIVOT SUPPORT PILLAR
39	D2456	PIVOT ARM
40	B4213	FORK END
41	B4214	PIN
42	D2469	PUMP LOCK
43	D2468	SECONDARY SEAL
43A	B2497	'O' RING
44	B2461	'O' RING
45	B2467	'O' RING
46	B2420	LOCK NUT
47	D2465	SHAFT
48	B2464	'O' RING
49	B2466	CIRCLIP

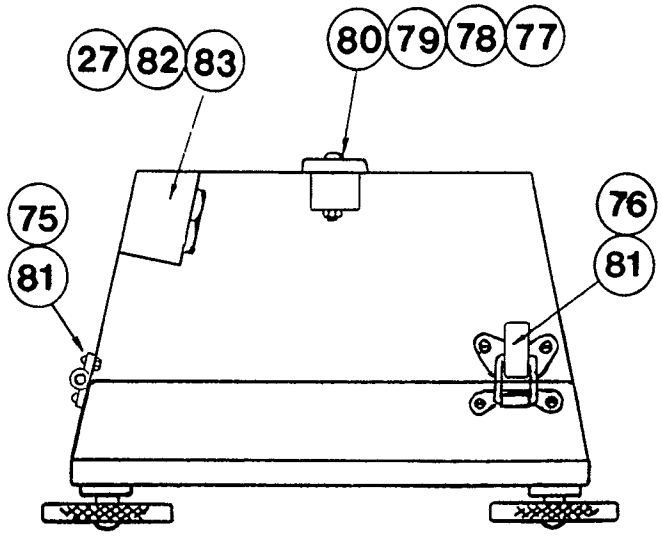
ITEM	PART	DESCRIPTION
50	D2460	CYLINDER
51	D2463	PISTON
52	D2462	SEALING RING
53	B2474	SPRING
53A	D2475	SPRING GUIDE
54	D2473	NON-RETURN VALVE
55	B2472	'O' RING
56	D2479	VALVE BODY
57	B2497	BONDED SEAL



ITEM	PART	DESCRIPTION
59	T1700	NEEDLE VALVE
60	D1103	TOP PLATE
61	B1086	SCREW
62	B1082	CAPTIVE NUT
63	D1405	INLET PORT
64	B1407	LOCK WASHER
65	B1807	LOCKNUT
66	B1806	FEMALE CONNECTOR
67	B1805	MALE COUPLING
68	B1804	PIPE
69	B1045	SPIRIT LEVEL
70	B1044	SCREW
71	D1035	NAMEPLATE
72	D2422	CASE
73	D1048	FOOT
74	D1047	STUD
75	B1077	HINGE
76	B1076	TOGGLE CLIP
77	B1072	SCREW
78	B1073	NUT
79	D1836	SUPPORT BAR
80	B1078	STRAP HANDLE
81	B1097	RIVET
82	D4113	ACCESSORY BLOCK
83	B4114	SPARES BOTTLE
84	D1404	LABEL: INCREASE
85	D1404	LABEL: DECREASE
86	D1046	INSERT
87	D1057	CLAMP WASHER
88	B1833	LOCKNUT
89	D1060A	STUD
PARTS NOT ILLUSTRATED		
90	D1008	WEIGHT
91	D1009	WEIGHT
92	D1010	WEIGHT
93	D1011	WEIGHT
94	B1116	TEE ADAPTOR
95	B2416	CROSS ADAPTOR



When ordering parts,
always quote Tester Serial Number



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, PAGE 4.

11.1.1 If the Piston 'squeaks' when rotated, it must be cleaned. (See Section 8, Page 4).

11.1.2 The Piston and Weight Carrier alone, when floating, should spin for at least 15 seconds. If the spin time is shorter, then clean the Piston (See Section 8, Page 4).

11.1.3 Open Decrease Valve (59B). Hold the Weight Carrier and lift gently up and down. The Piston should slide freely within its Cylinder, if any resistance or a 'gritty' sensation is detected, then it must be cleaned. (See Section 8, Page 4).

11.1.4 If spin/sensitivity of a cleaned Piston deteriorates quickly then it is likely that the Deadweight Tester system is contaminated and must be completely dismantled, cleaned and rebuilt.

11.2 SYSTEM WILL NOT PRESSURISE

11.2.1 Check that both Increase and Decrease Valves (59A & 59B) are closed.

11.2.2 Check for missing/damaged/dirty Test Seal (28) in Test Station (29).

11.2.3 Check that the face of the instrument under test is contacting the Test Seal (28), and the face is not dented or scored.

11.2.4 Check that external source (if being used) 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.

Do not put soap solution on Piston, as air will always be leaking between Piston and Cylinder.

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

1.3 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.

11.4 HANDPUMP HAS FAILED

11.4.1 If continuous quick pumping does not generate pressure, check 11.2.

11.4.2a If the system pressurises and depressurises in conjunction with the downward and upward strokes of the Pump (39), then the Outlet Non-Return Valve (56) has failed.

11.4.2b Disassemble Valve and inspect all parts (53, 54, 55, 53A, 56,57), for dirt or damage. After inspection, clean all parts thoroughly, replace as required, and re-assemble correctly.

11.4.3 If the Pump Handle (39) rises, then the Outlet Non-Return Valve (56) is leaking. (See 11.4.2b).

11.4.4 If continuous quick pumping does not generate any pressure, and all the above checks have been carried out, then the Inlet Non-Return Valve has probably failed. Inspect 'O' ring (48) and circlip (49) for damage.

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 the instructions in Section 8.0, Page 4, have been correctly 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.