USERS HANDBOOK
Hydraulic Deadweight Testers with Handpump

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 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

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

$$= 1.0005812 \times 250$$

$$= 250.1453 \text{ psi}$$

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

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

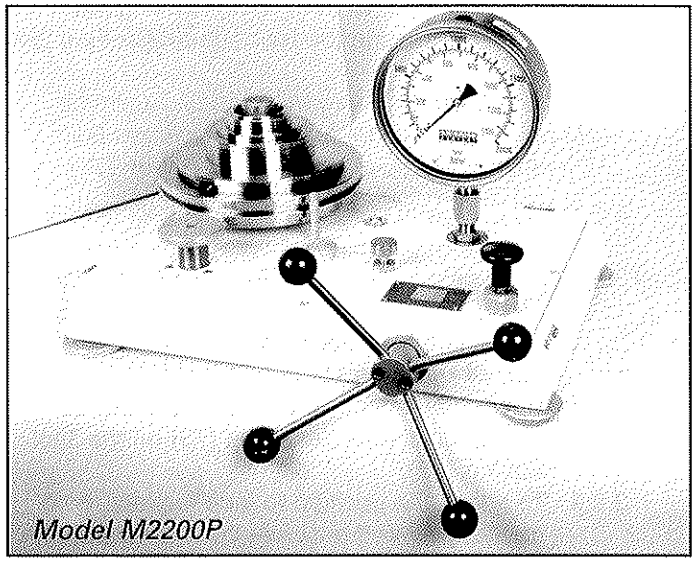
$$= 250 - \frac{0.008}{100} \times 250$$

$$= 250 - 0.02$$

$$= 249.98 \text{ psi}$$

The pressure measured is at the top of the Test Station Seal (79). Vertical height difference between this datum line and the connection to the instrument under test should be corrected. To correct for vertical heights above and below the datum line, either subtract or add respectively the amount stated on the certificate.

To ensure accuracy is maintained, the Piston and weights must be kept clean and undamaged. The Tester is accurate when the weights are rotating, but due to the fluid drag between the Piston and Cylinder, the rotation time at low pressure is short. For low pressure calibration a Pneumatic Tester should be used.


Model M2200P

2.0 Specification

Tester Overall Dimensions	:	46.5 x 32.5 x 20.5cm
Tester Weight	:	13 kg
Weight Set Weight	:	26 to 60 kg
Reservoir Volume	:	250 cc
Barrel Volume (Ram extended)	:	5.5 cc
Pump Displacement (Per Stroke)	:	4.8 cc

Supplied as standard with each Tester:

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 (4,79,93,113).
Operating fluid:

OIL OPERATED MODELS

TESTER RANGE	OUR REF.	SHELL
Up to 5000 psi/350 bar	: ST25	Morlina 10
Above 5000 psi/350 bar	: ST55	Tellus 22

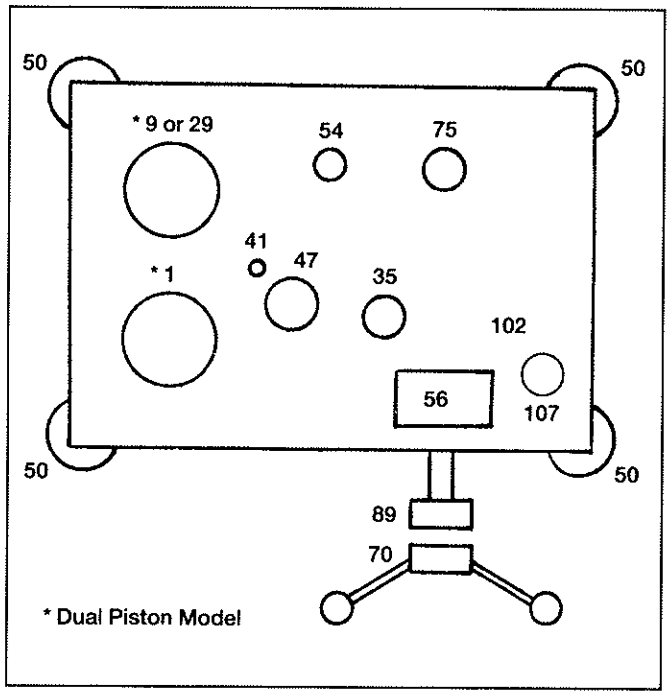
WATER OPERATED MODELS

To ensure correct operation of these Testers, use **ONLY:** ***DE-IONISED*** *or* ***DISTILLED WATER.***
Any other fluid will cause system contamination, and possible Piston damage.

3.0 PREPARATION

3.1 Find a level, stable surface.
3.2 Remove Capstan (70) from case lid using Allen Key (62) and fit to Hub (89) on front of Tester.
3.3 Level the Tester using the four Adjustable Feet (50) to the Spirit Level (54) mounted on the top plate.
3.4 Remove Reservoir Bung (47) and fill Reservoir (45) approximately 3/4 full with the correct fluid.
3.5 Fit instrument to be tested to Test Station (75).

3.5.1 Screw the appropriate Adaptor (78) fully on to the instrument to be tested.
3.5.2 Screw assembly down **ANTI-CLOCKWISE** onto Test Station (75).
Note: The internal thread in the lower half of the Adaptor is LEFT-HANDED.
Hand-tight is sufficient, ensure the bottom face contacts the Test Seal (79) on the Test Station (75).
3.5.3 To adjust the 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 on to the Test Seal.
3.5.4 To calibrate rear Connection Gauges, use a T3700 Angle Adaptor - see Ancillary Equipment, Section 9, Page 5.



IMPORTANT: ENSURE THAT ANY INSTRUMENT FITTED TO THE TEST STATION IS INTERNALLY CLEAN
- see Ancillary Equipment: T3600, API 5000, Section 9, Page 5.

4.0 PRIMING

4.1 Open Valve (35) one turn anti-clockwise and screw Capstan (70) fully in.
4.2 Pump twice (107).
4.3 *Close Valve and screw Capstan FULLY OUT.
4.4 Open Valve and screw Capstan FULLY IN.
Note: During this operation bubbles may appear in the Reservoir (45), as trapped air is expelled. For large volume instruments repeat steps 4.3 and 4.4 until no further bubbles appear.
4.5 With Valve open, screw Capstan FULLY OUT and close Valve. The Tester is now ready for use.

***WARNING:**
Screwing the Capstan (70) out with Valve (35) closed will generate 0.5 bar/15 inHg vacuum.
If the instrument under test is vacuum sensitive, leave Valve open during operation 4.3

5.0 OPERATION

5.1 Select required weights * and stack on the appropriate Piston.
(*Fractional Weights: smaller increments are available).
The pressure measured is the sum of the weights plus the Piston Weight Carrier.
Dual Piston Models:
When using the high pressure Piston Weight Carrier (9), each weight must be multiplied by the factor engraved on the Nameplate (56), either: X 10 or X 20. **Note: Do not multiply Piston Weight Carrier value.**

5.2 Use the Handpump (107) to generate the initial pressure up to 100 psi/7 bar, for higher pressure screw the Capstan (70) 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 (41). See Figure 5.2.

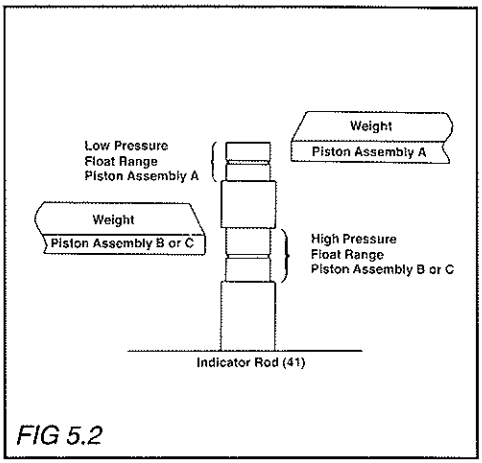


FIG 5.2

Note: Where variations of 0.0094 psi/0.00065 bar for Piston Assembly A (See Page 5) or 0.016 psi/0.0011 bar for Piston Assemblies B or C (See Page 5) are acceptable, then the bottom face of the lowest weight can align anywhere within the recessed area on the Indicator Rod.

5.3 Rotate the weight stack clockwise. (For optional Motor Drive, see Section 9, Page 5).
DO NOT ROTATE WEIGHTS WHEN THE PISTON IS AGAINST THE TOP OR BOTTOM STOP.

5.4 Observe reading of instrument under test.

5.5 For next higher calibration point, repeat from 5.1 above.

5.6 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.

5.7 Depressurise by screwing Capstan FULLY OUT.

5.8 Any pressure remaining in the system can now be released by SLOWLY opening Valve (35).
NEVER RELEASE SYSTEM PRESSURE WITHOUT SCREWING CAPSTAN FULLY OUT FIRST.

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.

Note: Dual Piston models are supplied with two special converting weights. Each is unique to the low and high pressure Piston Weight Carrier, and is marked 'LP CONV' and 'HP CONV' respectively.

Alternative option see S700, Section 9.0, Page 5.

7.0 STORAGE AND TRANSPORTATION

7.1 With Test Station (75) plugged, open Valve (35) and screw Capstan (70) fully in, close Valve.

7.2 Disassemble Capstan (70) and store in the case lid.

7.3 For transportation, tape down Adaptors (78) in Accessory Block (61).

7.4 Fluid can remain in the Reservoir (45) during transport, providing that the Tester remains horizontal.

7.5 Replace Tester case lid, ensure that the Hinges (60) are properly engaged, and secure with Toggle Clips (58) at sides.

7.6 Stack ALL the appropriate weights on the base of the wooden Weight Case (130), cover with lid and secure by screwing Handle (125) 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 Tester is depressurised before attempting Piston removal, open Valve (35), wait for 10 seconds, then close Valve.

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

	Model	Assembly		Model	Assembly
W or	M1800/P	A	W or	M1900/P	A & B
	M4000/P	C	W or	M2000/P	A & B
W or	M2000/HP	B	W or	M2100/P	A & B
W or	M2200/HP	B	W or	M2200/P	A & B
	M2800/H	B		M2800	A & B
	M2820	B			

8.1 PISTON REMOVAL ASSEMBLY A

8.1.1 Using a small pin-head hammer and a suitable flat-ended punch, tap lightly on the end of the Piston (2) through the centre of the Weight Carrier (1). Remove Weight Carrier.

8.1.2 Unscrew Cylinder (3), use the dowel hole if Cylinder is tight.

8.2 PISTON REMOVAL - ASSEMBLY B OR C

8.2.1 Lift off 'Top Hat' Weight Carrier (9 or 29) and unscrew Piston Nut (20). Use dowel hole if nut is tight. Remove assembly.

8.2.2 Use small Allen Key (63) in Accessory Block (61), unscrew Grub Screw (19 or 27) in Piston Cap (17 or 28), one turn anticlockwise.
Gently pull off Piston cap. **DO NOT PULL IN SUCH A WAY THAT THE PISTON CAN BEND.**
The Piston (13 or 25) and Cylinder (14 or 26) can now be removed.

8.3 PISTON CLEANING

8.3.1 Use 'non-fluffing', non-abrasive, lint-free tissue or absorbent cloth. Hold the Piston by the larger 'Head' end, rub the tissue back and forth along its length.

8.3.2 To remove all traces of contamination (especially important with Water Operated Testers), the Piston can be cleaned in a suitable solvent.
Note: 'O' Ring seals (where fitted) are Nitryl Rubber and should not be immersed in solvents for prolonged periods as they may become damaged. They should be dried quickly after immersion.

8.3.3 After removal from the solvent, using a NEW tissue, repeat the cleaning procedure in 8.3.1.

8.3.4 Place Piston carefully on a NEW tissue where it will not be damaged whilst the Cylinder 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

8.4 CYLINDER CLEANING

8.4.1 Wipe excess fluid from the outside surfaces of the Cylinder.

8.4.2 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.

8.4.3 Immerse Cylinder in a suitable clean solvent, see note in 8.3.2.

8.4.4 After removal from the solvent, using a NEW tissue, repeat the cleaning procedure in 8.4.2.

8.5 PISTON RE-ASSEMBLY

8.5.1 Holding the Piston by the 'Head' end, dip the other end into a container of clean operating fluid and transfer to the bore in the underside of the Cylinder:

Piston Assembly A - Threaded end of Cylinder (3).
Piston Assembly B - Counter-bored end of Cylinder (14).
Piston Assembly C - Larger diameter end of the Cylinder (26).

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

8.5.2 Carefully introduce 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 permanent damage may have occurred. In which case the complete assembly will need to be replaced or returned for evaluation.

8.5.3 **Assembly A:** Stand assembly upright on a clean, hard, stable surface. Ensure Weight Carrier (1) is clean, especially the central mounting hole, and place on tapered end of Piston (2). Tap lightly using the palm of the hand to locate on the taper.

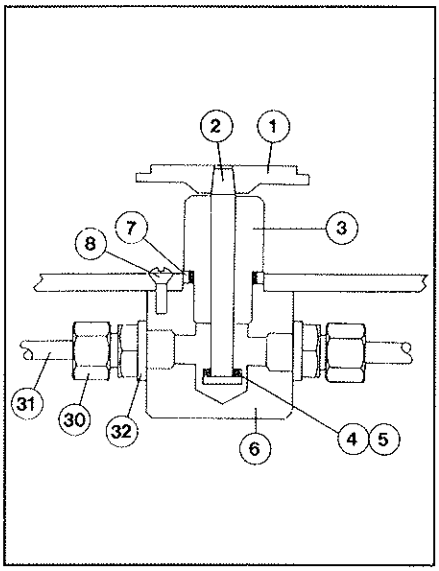
8.5.4 **Assembly B or C:** Insert Piston/Cylinder assembly into Piston Nut (20) such that it locates (as shown in drawing, Page 5). Replace Piston Cap (17 or 28), ensuring that it is fully home. Secure cap to Piston with Grub-Screw (19 or 27) **DO NOT OVERTIGHTEN.**

8.6 RE-FITTING PISTON

This is the reverse of the removal procedure outlined in Sections 8.1.2 & 8.2.1 above. Note: Ensure that the Bonded Seal (7 or 21) is clean and re-fitted before assembly. Do not over-tighten.

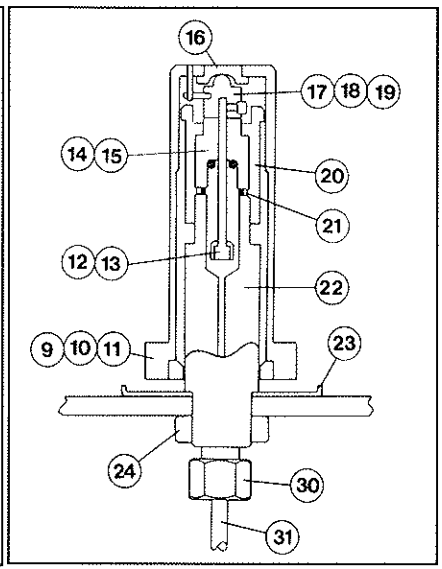
General Arrangement Drawings & Parts List - Piston Assemblies

Assembly A



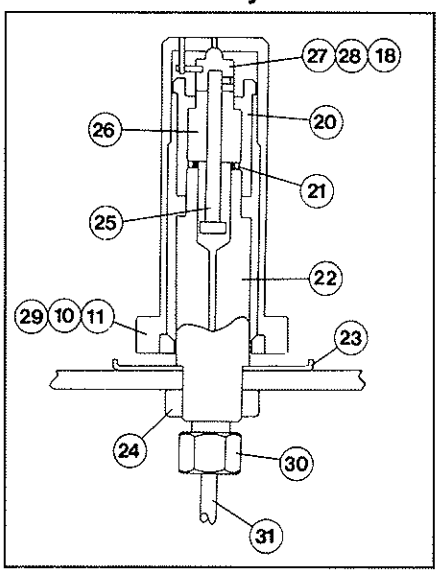
ITEM	PART	DESCRIPTION
1	D1819	WEIGHT CARRIER
2	D4116	PISTON
3	D4117	CYLINDER
*	D2802	CYLINDER
4	B4118	'O' RING
*	B2805	'O' RING
5	D1820	SUPPORT RING
6	D4109	PISTON BODY
*	D2804	PISTON BODY
7	B1802	BONDED SEAL
*	B2803	'O' RING

Assembly B



ITEM	PART	DESCRIPTION
8	B1086	SCREW
9	D4104	CARRIER TUBE
10	D4008	GUIDE BUSH
11	B4013B	PIN
12	D4106	PISTON STOP
13	D4101	PISTON
14	D4102	CYLINDER
15	B1801	'O' RING
16	D4105	BALL RETAINER
17	D4107	PISTON CAP
18	B4013A	PIN
19	B4011	SCREW

Assembly C



ITEM	PART	DESCRIPTION
20	D4103	PISTON NUT
21	B1902	BONDED SEAL
22	D4005	PISTON BODY
23	D4009	SUMP DISH
24	B4010	LOCKNUT
25	D4001	PISTON
26	D4002	CYLINDER
27	B4011	GRUB SCREW
28	D4004	PISTON CAP
29	D4007	CARRIER TUBE

***Part for Model M2800**

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.

T3600 LIQUID TO LIQUID SEPARATOR

If there is any doubt that the instrument to be tested is not internally clean, then the addition of a T3600 Liquid Separator will protect the Deadweight Tester system from contamination and possible damage. The T3600 is also particularly useful for applications where the instruments under test must not be contaminated by the operating fluid in the Deadweight Tester. It contains a flexible 'Viton' diaphragm which separates the two working fluids, preventing transfer either way. Any fluid can be used that is compatible with Viton and Aluminium Bronze.

API 5000 LIQUID TO AIR INTERFACE

For high pressure pneumatic calibration, this unit interfaces with Hydraulic Deadweight Testers giving rateless liquid to air separation. A series of fluid traps ensures the instrument under test remains dry.

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.

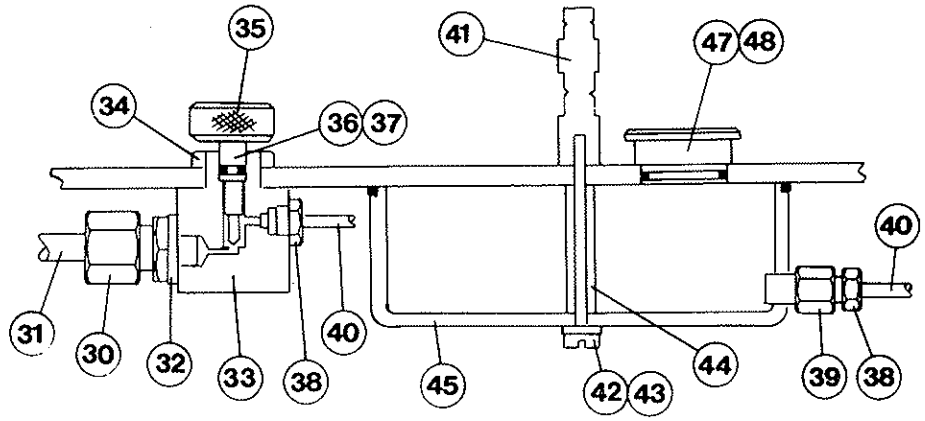
OPTIONAL EQUIPMENT:

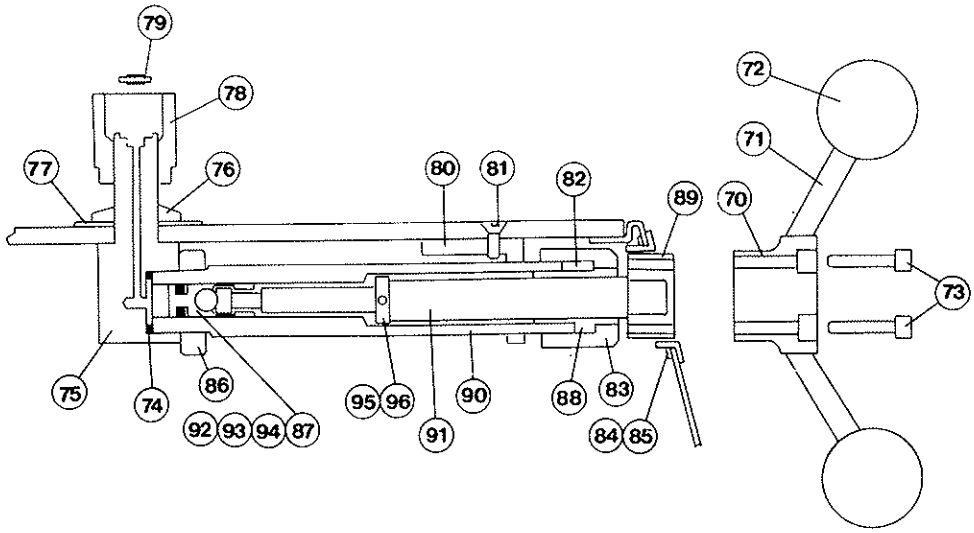
MOTOR DRIVE

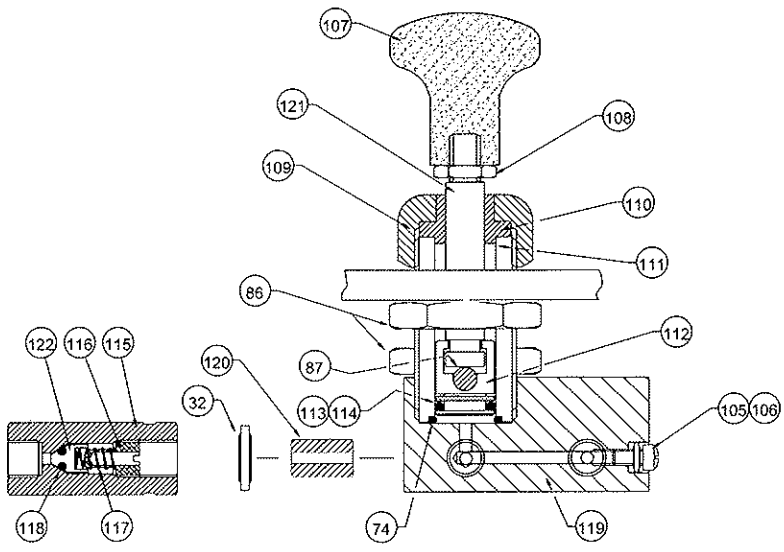
A motor drive can be fitted to rotate the weights if a continuous pressure is required for long-term testing.
This should be specified at the time of order, but can be retro-fitted if necessary. (Note: not available for M2800 / M2800H / M2820)

General Arrangement Drawings & Parts List

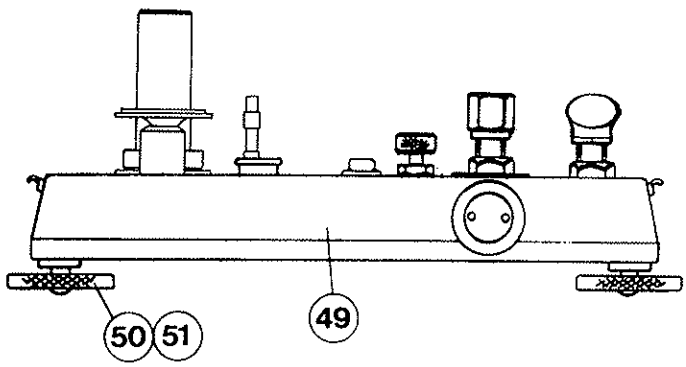
ITEM	PART	DESCRIPTION
30	B1910	NUT/OLIVE/COUPLING
31	D4108	PIPE
32	B1033	BONDED SEAL
33	D1810	VALVE BODY
34	D1807	LOCKNUT
35	D1207	VALVE SCREW CAP
36	D1811	VALVE SCREW
37	B1801	'O' RING
38	B1806	MALE COUPLING
39	D1805	COUPLING
40	D1804	NYLON PIPE
41	D4110	INDICATOR ROD
42	B1025	SEAL
43	B1089	SCREW
44	D1090	SUPPORT TUBE
45	D4713	RESERVOIR
47	D1809	RESERVOIR BUNG
48	B1069	'O' RING
49	D1007E	CASE
50	D1048	FOOT
51	B1047	STUD
52	B1086	SCREW
53	B1082	CAPTIVE NUT
54	B1045	SPIRIT LEVEL
55	B1044	SCREW
56	D1035	NAMEPLATE
57	D1909	TOP PLATE
58	B1076	TOGGLE CLIP
59	B1097	RIVET
60	B1077	HINGE
61	D4113	ACCESSORY BLOCK
62	B1071	ALLEN KEY (LARGE)
63	B1070	ALLEN KEY (SMALL)
64	D1018	ADAPTORS
65	B4114	SPARES BOTTLE
66	D1836	SUPPORT BAR
67	B1078	STRAP HANDLE
68	B1075	SCREW
69	B1081	NUT
70	D1041	OUTER HUB
71	D1020	SPOKE
72	B1021	KNOB
73	B1042	SCREW
74	B1054	'O' RING
75	D1038	TEST STATION
76	D1039	DOME NUT
77	D1098	LABEL: HAND TIGHT
78	D1018	ADAPTORS
79	B1066	TEST SEAL
80	D1823	SUPPORT BRACKET
81	B1043	SCREW
82	B1053	KEY
83	D1019	BARREL UNION
84	D1087	'C' CLIP
85	D1050	SHROUD
86	B1023	LOCKNUT
87	B1022	BALL
88	D2813	RAM NUT
89	D3908	INNER HUB

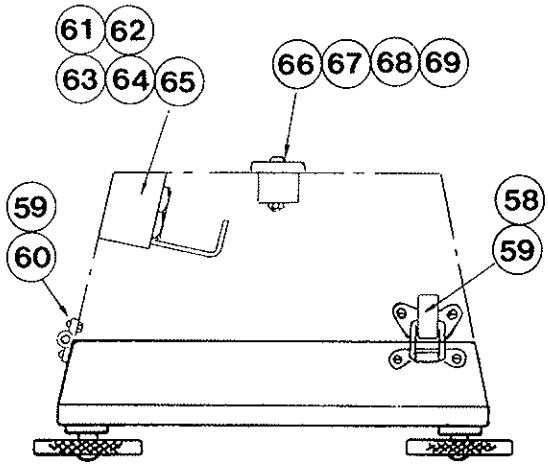


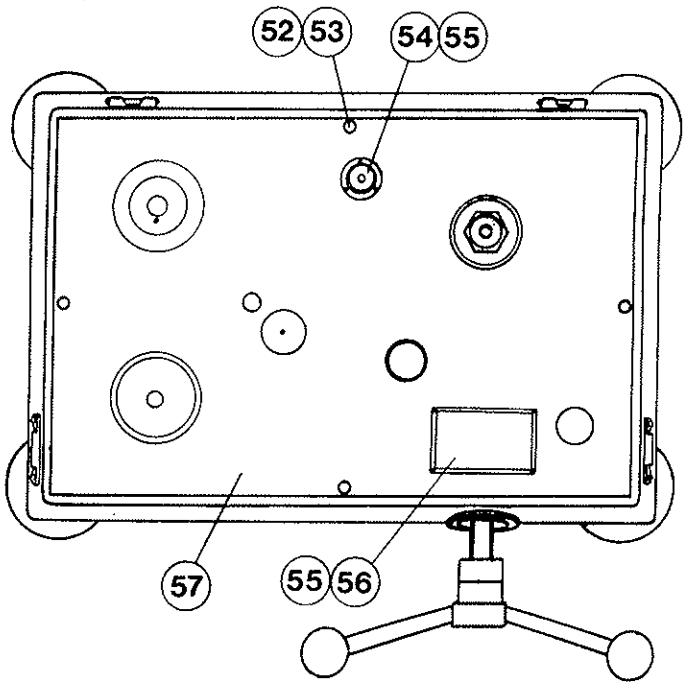


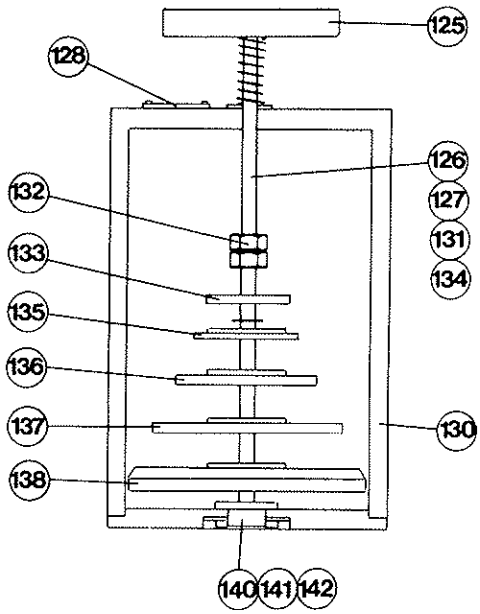


Inlet N.R.V shown Outlet reversed









ITEM	PART	DESCRIPTION
90	D2808	BARREL
91	D2812	RAM SCREW
92	D2811	RAMBLER
93	B2809	'O' RING
94	B2810	ANTI-EXTRUSION RING
95	D2814	COLLAR
96	B2817	GRUB SCREW
105	B8152	BONDED SEAL
106	B8111	SCREW
107	B4735	PUMP HANDLE
108	B2420	LOCKNUT
109	D4727	BARREL UNION
110	D4703	BUSH
111	D4704	PUMP BARREL
112	D3904A	RAMBLER
113	B4707	'O' RING
114	B4708	ANTI-EXTRUSION RING
115	D4730	NON-RETURN VALVE BODY
116	D4732	SPOOL
117	B4733	SPRING
118	B4734	'O'RING
119	D4736	END BLOCK
120	D4720	CONNECTOR
121	D4701	SPINDLE
122	D4731	BULLET
125	D1058	HANDLE

ITEM	PART	DESCRIPTION
126	B1834	SPRING
127	B1835	WASHER
128	D1036	NAMEPLATE
130	D1079	WEIGHT CASE
131	D1060	STUD
132	B1833	LOCKNUT
133	D1057	WEIGHT RETAINER
134	B1061	CIRCLIP
135	D1008	WEIGHT
136	D1009	WEIGHT
137	D1010	WEIGHT
138	D1011	WEIGHT
139	D7064	WEIGHT (NOT ILLUSTRATED)
140	D1056	LOCATING STAND
141	B1083	WASHER
142	B1063	LOCKNUT

When ordering parts, always:

a) Quote Tester Serial Number.

b) Water operated Testers, add 'W' after part.
Example: Item 79 becomes B1066W

11.0 Fault Finding

11.1 POOR PISTON SPIN/SENSITIVITY

11.1.1 **Assembly A:** Plug Test Station (75) and open Valve (35). Hold the Weight Carrier (1) and lift gently up and down. The Piston (2) should slide smoothly within its Cylinder. If any resistance greater than fluid drag or a 'gritty' sensation is detected, then it must be removed and cleaned (See Section 8, Page 4).

11.1.2 **Assembly B or C:** Pressurise with one large weight so the Piston (13 or 25) is spinning and floating correctly. Gently push down on the rotating Weight Carrier (9 or 29) and release. This should result in a smooth 'bouncing' oscillation. If the Piston does not spin or 'bounce' freely, it must be removed and cleaned. (See Section 8, Page 4).

11.1.3 If spin/sensitivity of a cleaned Piston deteriorates quickly then the Deadweight Tester system is probably contaminated and must be completely dismantled, cleaned and re-built.

11.2 SYSTEM WILL NOT PRIME

11.2.1 Check Valve (35) is closed.

11.2.2 Check there is sufficient fluid in the Reservoir (45).

11.2.3 Check for damaged/missing/dirty Test Seal (79) in Test Station (75).

11.2.4 Check that the face of the instrument under test is contacting the Test Seal (79), and that it is not scored or dented.

11.3 SYSTEM WILL NOT PRESSURISE

11.3.1 Check 11.2.

11.3.2 Ensure correct valve operation during Priming step 4.5.

11.3.3 Check instrument under test is not leaking.

11.3.4 Clean system externally, check for fluid leak by continually trying to pressurise. Wherever fluid appears, replace the Seal - check sealing faces are clean and undamaged before re-assembly.

11.4 HAND-PUMP MALFUNCTION

11.4.1 Check 11.3.

11.4.2a If pumping generates no pressure, then the Inlet Non-Return Valve (115) has probably failed.

11.4.2b 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.

11.4.3 If the system pressurises and depressurises in conjunction with the downward and upward strokes of the Pump (107), then the Outlet Non-Return Valve (115) has failed completely. Inspect as per 11 .4.2b.

11.4.4 If the Pump Handle rises, then the Outlet Non-Return Valve (115) is leaking. Inspect as per 11 .4.2b.

Note: Do not continue to pressurise if Pump Handle rises, as this can damage the pump Inlet Non-Return Valve (120).

11.5 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.

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

11.5.2 Check 11.3.

11.5.3 **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 for fluid leakage around base of Piston/Cylinder assemblies. Check for loose/damaged/dirty Seal (7 or 21) Under assembly (Remove 'Top-hat' Weight Carrier (9 or 29) for Piston assemblies B or C). Tighten, clean or replace Seal as necessary. (See Section 8.6, Page 4).

11.5.4 Valve (35) leaking.
Remove Reservoir Bung (47) and observe fluid level, it will rise slowly if the valve leaks. This indicates that the valve seat may be damaged or dirty. It should be disassembled, cleaned and inspected, then re-tested or replaced as necessary.

11.5.5 Rambler Seal (93) leaking - Check Ram Screw (91) for 'wetness' when extended (Should be greased, not running with operating fluid). If Ram Screw is 'wet', then replace the Rambler Seal (92) with the spare provided.

11.6 CANNOT ATTAIN MAXIMUM PRESSURE HAVING SCREWED CAPSTAN FULLY IN

11.6.1 Check 11.3 & 11.5.

11.6.2 Ensure that the Capstan (70) is FULLY OUT and the Hand-Pump (107) is used for initial pressurisation. See Section 4, Page 2.

11.6.3 If the instrument under test has a large internal volume or there is air in the system, then re-prime, see Section 4, Page 2, increasing the initial pressurisation with the Hand Pump (107) from 100 psi/7 bar to at least 200 psi/14 bar.

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.