Budenberg

Budenberg BGH2600
Hydraulic Dead-Weight Tester

Operating and
Maintenance Instructions

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CONTENTS

SAFETY PRECAUTIONS

MINERAL OILS HEALTH AND SAFETY (C.O.S.H.H.) INFORMATION

Budenberg provide hydraulic mineral oil in 500 ml containers labelled "ISO VG 22" for use up to 2600 bar in dead-weight testers. It is no more hazardous than other common lubricating oils.

It is the nature of the way in which this equipment is used, that there could be frequent and/or prolonged skin contact; in a few individuals this could give rise to skin irritation (Keratosis or Dermatitis). The use of an effective barrier cream will greatly reduce this possibility.

DESCRIPTION

Closed flash point:	greater than $120^{O}C$
Storage:	not above $30^{0}C$.
Oral LD 50:	15 g per kg body weight.
Threshold limit value:	5 mg/m^3.
Fire extinguishing media:	carbon dioxide/dry chemical foam or water fog
Spillage:	soak with absorbent clay or proprietary absorbent
Waste disposal:	burn or dump in approved area.

EMERGENCY TREATMENT OF ACUTE EFFECTS

Ingestion	Do not induce vomiting. Administer 250 ml milk or olive oil. The main hazard following accidental ingestion is aspiration of liquid into lungs.
Aspiration	Send to hospital immediately
Inhalation	Remove to fresh air, if nausea persists seek medical attention.
Eye Contact	Wash with copious amounts of water for at least 10 minutes. If irritation results or persists, obtain medical advice.
Skin Contact	Where skin rashes or other abnormalities occur as a result of prolonged or repeated contact, medical advice should be obtained as soon as possible.

OTHER LIQUIDS

For some very particular applications we supply specially constructed liquids. Copies of manufacturer's data will be sent to users on request.

LIFTING OF WEIGHTS

Care must be taken when lifting the weights for the dead-weight tester. Each weight must be lifted individually and never attempt to lift stack of weights on or off the tester

DATA SHEET

1.1 TESTER DIMENSIONS

Width	:	400 mm
Depth	:	400 mm
Height	:	400 mm
Mass	:	20 kg (inclusive of oil fill)

1.2 PRESSURE RANGES

BGH2600 base with 580 EHX piston unit	:	1 to 2600 bar (10 to 40,000 lb/in^2)

1.3 LIQUIDS USED

An hydraulic mineral oil viscosity 20 to 37 cSt at 40^{O}C viscosity grade VG20 to VG37 to ISO3448 (BS4231) is used for all the 580 base units . Most users will be able to obtain locally suitable oil (see below) as used in hydraulic machinery. However, for the convenience of users we can supply a 500 ml bottle of oil, viscosity grade VG22.

Oils suitable for testers

The following oils are the commercially available oils suitable for use in the dead-weight tester.

ISO 3448 viscosity grade	viscosity	Shell	Esso	Mobil
VG22		Tellus 22 Tellus R22	Nuto H22	DTE 22
VG32	10W	Tellus V32 DTE 24	Nuto H32	DTE Oil Light
VG37		Tellus 37 Tellus R37 Tellus T37 Tellus V37		

Other liquids

The Model BGH2600 tester can be used on silicone based liquids, or inert perfluorinatedpolyethers such as Fluorolube, Fomblin, Halocarbon, which are of the viscosity mentioned above and are chemically inert, being suitable for contact with metals and with the nitrile seals which are standard on the tester. The tester can be supplied as standard tested on mineral oil for the user to clean and fill, or alternatively the tester can be supplied cleaned and tested on any suitable liquid readily available in UK.

NOTE: Fluids, which attack ABS, should be used with caution. Continual immersion of the cover in such fluids will cause deterioration. Spillage's should be wiped off immediately.

DESCRIPTION

2.1 GENERAL

The Model BGH2600 provides optimum features for laboratory users whilst being rugged enough for industrial users/environments. It provides a highly accurate measurement of pressure.

The piston unit is screwed on to the left hand side pressure block of the base unit and the instrument under test is connected to the right hand pressure block.

2.2 BGH2600 BASE UNIT

The BGH2600 series base unit consists of a solid aluminium base plate mounted on four adjustable levelling feet, a screw pump, reservoir, control valves, pipework to two stainless steel pressure connection blocks. The pipework and above mentioned assemblies are covered by an easy to clean ABS cover.

Screw pump

The screw pump is bolted to the reservoir/high pressure cylinder block fastened to the base unit. A sectioned view of the pump is shown. The rotating handwheel (C) which is operated by the spokes (D) is attached to a threaded spindle (E). The spindle is supported in a sintered bearing (F). As the spindle (E) is rotated, it drives a non-rotating ram (H and K) forward, the thrust being taken by a needle thrust bearing (G). The large diameter of the ram (H) in the barrel of the pump (J) primes the tester and provides the low pressure liquid up to approximately 140 bar (2 000 lb/in^2). The small diameter of the ram (K) in the reservoir/ high pressure cylinder block provides the higher test pressures up to 2600 bar (40,000 lb/in^2).

Reservoir

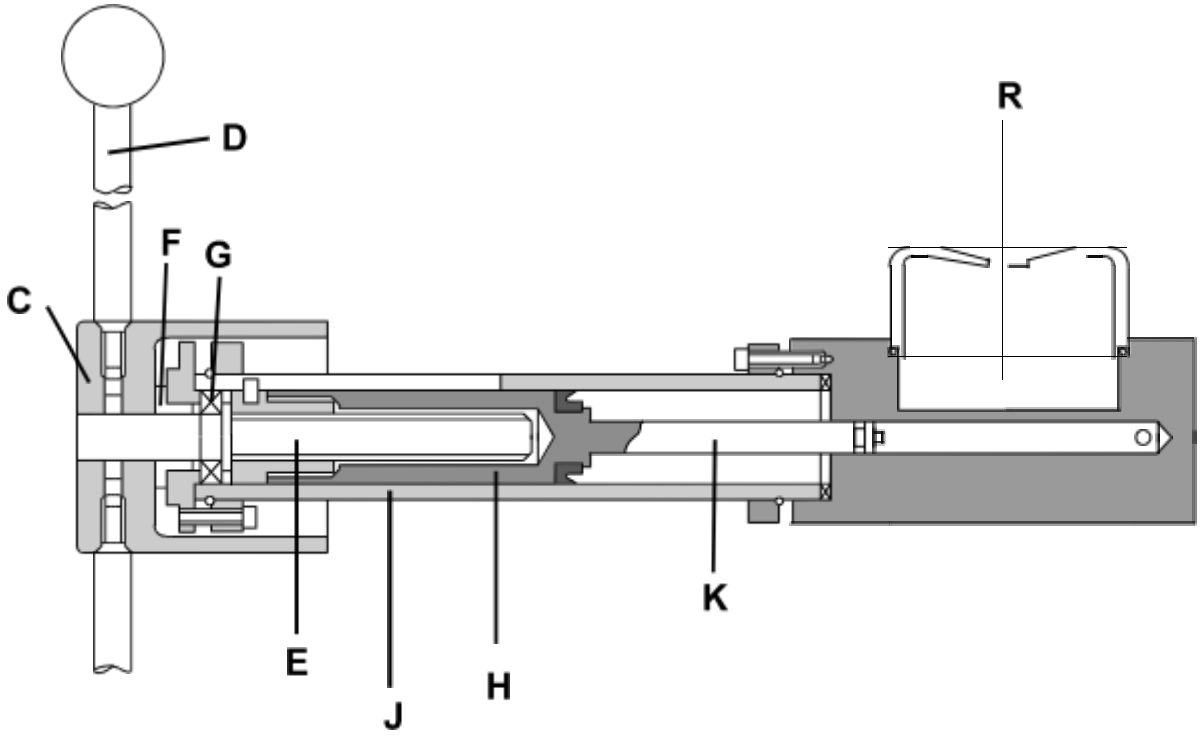
A liquid reservoir is provided on the top of reservoir/high pressure cylinder block. The reservoir is provided with a translucent cover to enable the reservoir level to be monitored plug in the middle of the reservoir cover to allow the reservoir to be filled or topped up (The plug is removed whilst the tester is in use). The reservoir contains enough liquid to enable normal operation of the tester to be carried out.

Control valves

Two control valves are provided on the top of reservoir/high pressure cylinder block. The valve mechanisms are built into the reservoir/high pressure cylinder block and they control the flow of liquid through internal drillings in the reservoir/high pressure cylinder block. The rear valve is referred to as valve A and is used to control the output from the larger diameter ram of the screw pump. The front valve is referred to as valve B and is used to control the flow of liquid to and from the reservoir.

Connection blocks

Pressure supply pipes from the screw pump are terminated at two pressure blocks mounted on the base unit. The pressure blocks are fitted with threaded bosses projecting up through the cover plate of the base unit. These threaded bosses enable piston units to be directly screwed on to them or differential connections for various sizes of gauge connections to be screwed on to them. Oil cups are fitted to the unit cover around the threaded bosses of the connection blocks to catch any oil drips from the gauge stand during gauge fitting and removal.

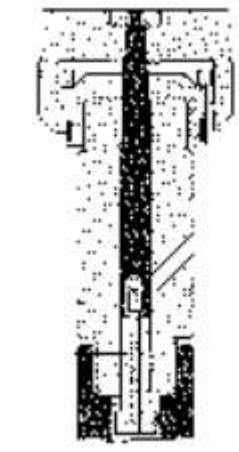


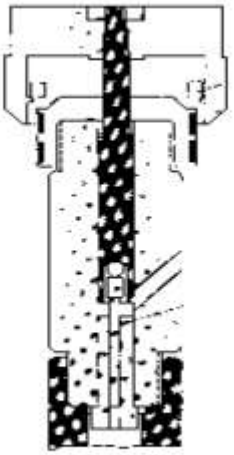
Sectioned view of screw pump

2.3 BGH2600 PISTON UNIT

The BGH2600 piston unit is a dual range piston unit, which covers the range up to 2600 bar (40,000 lb/in^2). The piston head, which carries the calibration weights, is operated by two pistons; a low pressure piston and a high pressure piston. As the supply pressure is increased, the low pressure piston is operated until the flange on the end of the piston abuts the end of the low pressure cylinder. As the pressure continues to increase, the high pressure piston operates through the middle of the low pressure piston, which is now acting as the high pressure cylinder. Indication of the range in which the piston is operating and that the piston head is floating is given by the position of the piston head as seen against two coloured bands on the cylinder. The pressure datum level of the piston unit is marked on the connection used to screw the piston cylinder unit on to the base unit pressure connection block threaded boss.

VIEW OF PISTON/ CYLINDER UNIT OPERATING ON ITS 1/8in² PISTON





VIEW OF PISTON/ CYLINDER UNIT OPERATING ON ITS 1/160in² PISTON

DATUM LEVELS

When testing instruments on liquid it is occasionally necessary to take into account heads of liquid since a height difference of 10mm corresponds to approximately 1 mbar. The datum level on the piston/cylinder unit is marked with a groove on the outside diameter of the piston.

The diagram shows the head effect that may have to be compensated for when high accuracy calibration is desired. The following formula will enable the head correction to be calculated:

▲P DUE TO HEAD EFFECTS

PRESSURE (Pa) = σ. H.G

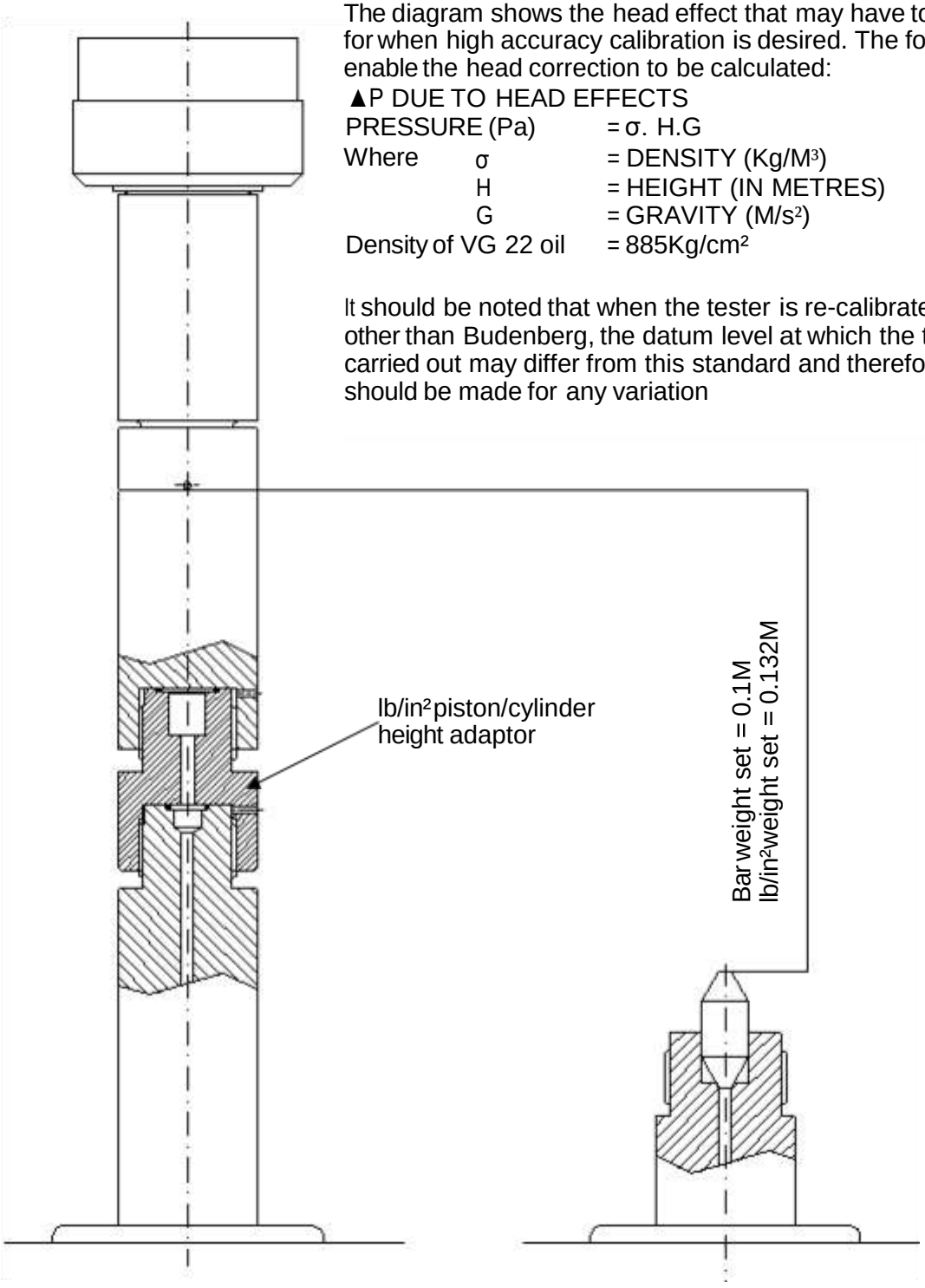
Where σ = DENSITY (Kg/M^3)

H = HEIGHT (IN METRES)

G = GRAVITY (M/s^2)

Density of VG 22 oil = 885Kg/cm^2

It should be noted that when the tester is re-calibrated by a laboratory other than Budenberg, the datum level at which the tests have been carried out may differ from this standard and therefore allowance should be made for any variation



2.4 FUNCTIONAL

Operation of the tester is controlled by the two valves A and B on the top of the reservoir/high pressure cylinder block. When initially priming the system valves A and B are opened to fill the system with oil from the reservoir. Valve B is then closed with valve A left open and the screw pump operated to provide the lower test pressures. To provide the higher pressures valve A is closed to seal off the test circuit from the low pressure part of the screw pump and valve B is opened to allow the liquid in the low pressure part of the screw pump to return to the reservoir as the pump is operated. This ensures that the pump can be operated without having to put large forces on the screw pump handwheel. To release the test pressure the screw pump is wound out and valve A is opened.

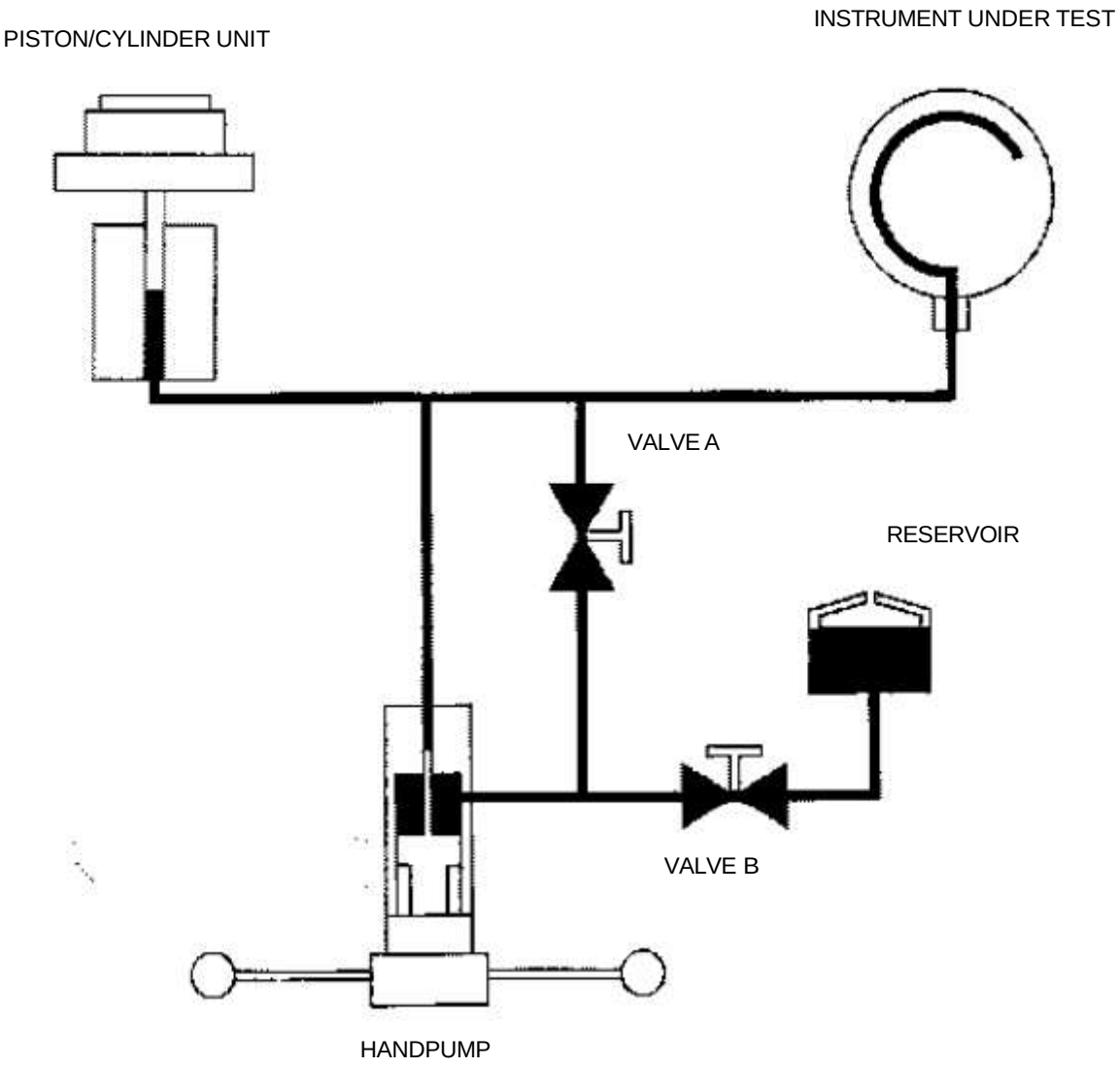


Fig 2.5 Schematic diagram

INSTALLATION

3.1 UNPACKING THE TESTER

As soon as possible after delivery open the packaging of the system and check that you have all the items detailed in the packing list in section 3.4.

As you are unpacking the items, examine them for signs of damage or breakage during transit.

If any items are missing get in touch immediately with Budenberg to inform us of the shortage.

3.2 ENVIRONMENTAL REQUIREMENTS

When siting the tester if not in a temperature controlled laboratory look for an area that satisfies the following criteria as much as possible

- a constant temperature area free from draughts and sources of heat or cold
- an area free from noise and vibration if possible an area away from any constantly used pathways
- a clean dry area free from corrosive liquids or vapours.

A strong, stable, level table or workbench with the capability of supporting the system with sufficient space to operate is required

3.3 ASSEMBLY OF BASE UNITS

Fastening base to bench

The base is to be mounted on a firm, level table or bench about 0.9 m high. The centre line of the front adjustable feet of the unit should be about 40 mm from the front edge of the bench to allow adequate clearance for the handwheel.

(1) Mark the position of the adjustable feet of the unit on the top of the bench.

(2) Position a level plate at the centre of each of the adjustable feet of the unit and screw the plate to the bench to ensure that the tester is rigid.

(3) Fit the base unit on the bench with the adjustable feet on the level plates and the handwheel shaft projecting over the front of the bench.

(4) Screw in the four handwheel spokes into the hub.

(5) Using the spirit level provided level the unit in both the front/rear axis and the side to side axis by adjusting the four knurled feet. This is best achieved by placing the spirit level on top of the piston cylinder unit.

(6) Remove the grommet on the left-hand side of the cover to access the piston cylinder support foot. Position the fifth level plate under the base, in line with the piston cylinder support foot, and adjust this until it contacts the level plate. Care must be taken to ensure this operation does not affect the level obtained in operation 5.

3.4 PACKING LIST

The system carton should contain: -

1 - copy of the operating and maintenance instructions (this manual)
1 - BGH2600 base
1 - BGH2600 PCU and overhang
1 - 500 ml bottle of oil
4 - Handwheel spokes

1 - certificate of calibration
1 - Set of weights supplied in separate carton
1 - tool roll containing: -
- 1 - hexagon wrench key 3 mm A/F
- 1 - 30 mm A/F spanners
- 1 - spirit level
- 5 - Level Plates
- 1 - Bag of seals
- 1 - 1/2 in B.S.P. angle connection (if ordered separately)
- 1 - pointer punch
- 1 - pointer remover
- 1 - G1/2 differential connection
- 1 - G3/8 differential connection
- 1 - Conejoint (plain)

- 1 - lb/in² piston cylinder height adaptor (if lb/in² weight set ordered only)
- 1 - set of connections (if ordered separately)

B.S.P.	A.P.I.	METRIC
1 - 1/8 in❶	1 - 1/8 in❷	1 - M12 x 1.5
1 - 1/4 in	1 - 1/4 in	2 - M20 x 1.5
1 - 3/8 in	1 - 3/8 in	
1 - 1/2 in	2 - 1/2 in	

B.S.P. CONNECTIONS HAVE MAXIMUM PRESSURE RATINGS AS FOLLOWS (BASED ON EN837):

	CONNECTION MATERIAL	
SIZE	BRASS	STAINLESS STEEL
G1/8	400 bar	400 bar
G1/4	600 bar	1000 bar
G3/8	600 bar	1000 bar
G1/2	1000 bar	1600 bar

❶ Not supplied in a standard set of connections

N.P.T. CONNECTIONS HAVE MAXIMUM PRESSURE RATINGS AS FOLLOWS (BASED ON EN837):

	CONNECTION MATERIAL	
SIZE	BRASS	STAINLESS STEEL
1/8 in	400 bar	400 bar
1/4 in	600 bar	1000 bar
3/8 in	600 bar	1000 bar
1/2 in	600 bar	1000 bar

❷ Not supplied in a standard set of connections

METRIC CONNECTIONS HAVE MAXIMUM PRESSURE RATINGS AS FOLLOWS (BASED ON EN837):

	CONNECTION MATERIAL	
SIZE	BRASS	STAINLESS STEEL
M12 x 1.5	600 bar	1000 bar
M20 x 1.5	1000 bar	1600 bar

SETS OF WEIGHTS SUPPLIED FOR MODEL BGH2600

BAR WEIGHT SETS

Range 1 to 1600 bar

ITEM	QUANTITY	LOW RANGE	HIGH RANGE
PISTON & M.U.W	1	1	20
TOP LOADING WEIGHT	1	9	180
TOP LOADING WEIGHT	1	10	200
TOP LOADING WEIGHT	1	5	100
TOP LOADING WEIGHT	2	2	40
TOP LOADING WEIGHT	1	1	20
TOP LOADING WEIGHT	2	0.5	10
OVERHANG	1	10	200
OVERHANG MAKE UP WEIGHT	1		
ANNULAR WEIGHT	4	10	200

Range 1 to 2000 bar

ITEM	QUANTITY	LOW RANGE	HIGH RANGE
PISTON & M.U.W	1	1	20
TOP LOADING WEIGHT	1	9	180
TOP LOADING WEIGHT	1	5	100
TOP LOADING WEIGHT	2	2	40
TOP LOADING WEIGHT	1	1	20
TOP LOADING WEIGHT	2	0.5	10
OVERHANG	1	10	200
OVERHANG MAKE UP WEIGHT	1		
ANNULAR WEIGHT	7	10	200

Range 1 to 2500 bar

ITEM	QUANTITY	LOW RANGE	HIGH RANGE
PISTON & M.U.W	1	1	20
TOP LOADING WEIGHT	1	9	180
TOP LOADING WEIGHT	3	10	200
TOP LOADING WEIGHT	2	2	40
TOP LOADING WEIGHT	1	1	20
TOP LOADING WEIGHT	2	0.5	10
OVERHANG	1	10	200
OVERHANG MAKE UP WEIGHT	1		
ANNULAR WEIGHT	7	10	200

Range 1 to 2600 bar

ITEM	QUANTITY	LOW RANGE	HIGH RANGE
PISTON & M.U.W	1	1	20
TOP LOADING WEIGHT	1	9	180
TOP LOADING WEIGHT	3	10	200
TOP LOADING WEIGHT	1	5	100
TOP LOADING WEIGHT	2	2	40
TOP LOADING WEIGHT	1	1	20
TOP LOADING WEIGHT	2	0.5	10
OVERHANG	1	10	200
OVERHANG MAKE UP WEIGHT	1		
ANNULAR WEIGHT	7	10	200

lb/in² WEIGHT SETS

Range 10 to 20,000 lb/in²

ITEM	QUANTITY	LOW RANGE	HIGH RANGE
PISTON & M.U.W	1	10	200
TOP LOADING WEIGHT	1	90	1800
TOP LOADING WEIGHT	1	100	2000
TOP LOADING WEIGHT	1	50	1000
TOP LOADING WEIGHT	2	20	400
TOP LOADING WEIGHT	1	10	200
TOP LOADING WEIGHT	1	5	100
OVERHANG	1	100	2000
OVERHANG MAKE UP WEIGHT	1		
ANNULAR WEIGHT	7	100	2000

Range 10 to 25,000 lb/in²

ITEM	QUANTITY	LOW RANGE	HIGH RANGE
PISTON & M.U.W	1	10	200
TOP LOADING WEIGHT	1	90	1800
TOP LOADING WEIGHT	1	100	2000
TOP LOADING WEIGHT	1	50	1000
TOP LOADING WEIGHT	2	20	400
TOP LOADING WEIGHT	1	10	200
TOP LOADING WEIGHT	1	5	100
OVERHANG	1	100	2000
OVERHANG MAKE UP WEIGHT	1		
ANNULAR WEIGHT	9	100	2000

Range 10 to 30,000 lb/in²

ITEM	QUANTITY	LOW RANGE	HIGH RANGE
PISTON & M.U.W	1	10	200
TOP LOADING WEIGHT	1	90	1800
TOP LOADING WEIGHT	1	100	2000
TOP LOADING WEIGHT	1	50	1000
TOP LOADING WEIGHT	2	20	400
TOP LOADING WEIGHT	1	10	200
TOP LOADING WEIGHT	1	5	100
OVERHANG	1	100	2000
OVERHANG MAKE UP WEIGHT	1		
ANNULAR WEIGHT	12	100	2000

Range 10 to 35,000 lb/in²

ITEM	QUANTITY	LOW RANGE	HIGH RANGE
PISTON & M.U.W	1	10	200
TOP LOADING WEIGHT	1	90	1800
TOP LOADING WEIGHT	1	100	2000
TOP LOADING WEIGHT	1	50	1000
TOP LOADING WEIGHT	2	20	400
TOP LOADING WEIGHT	1	10	200
TOP LOADING WEIGHT	1	5	100
OVERHANG	1	100	2000
OVERHANG MAKE UP WEIGHT	1		
ANNULAR WEIGHT	14	100	2000

Range 10 to 40,000 lb/in²

ITEM	QUANTITY	LOW RANGE	HIGH RANGE
PISTON & M.U.W	1	10	200
TOP LOADING WEIGHT	1	90	1800
TOP LOADING WEIGHT	4	100	2000
TOP LOADING WEIGHT	1	50	1000
TOP LOADING WEIGHT	2	20	400
TOP LOADING WEIGHT	1	10	200
TOP LOADING WEIGHT	1	5	100
OVERHANG	1	100	2000
OVERHANG MAKE UP WEIGHT	1		
ANNULAR WEIGHT	14	100	2000

WEIGHT SETS CAN BE PROVIDED IN ALTERNATIVE PRESSURE UNITS AND MANUFACTURED FOR LOCAL GRAVITY. CONSULT YOUR LOCAL DISTRIBUTOR FOR ADVICE ON AVAILABILITY

Assembly of the Dead weight tester

(1) Fit the piston unit to the left hand connection. Ensure that the mating faces is clean and the 12 mm diameter 'O' ring seal correctly located. If using a lb/in²weight set, the piston height adaptor will also have to be fitted. Excess force is not required to achieve an effective seal.

(2) Check the level of the system base with the spirit level on the piston cylinder unit. Level if necessary by using the levelling screws.

(3) Fit the appropriate differential nut connection to the gauge stand, using the coned joints to make the joint and screw a test gauge (for installation use a known gauge) into position.

Filling the base unit with liquid

(1) Remove filler plug from reservoir by slackening screw and prising plug out. (This plug should be left out whilst in use).

(2) Open valves A and B.

(3) Wind screw pump handle fully clockwise.

(4) Fill reservoir with appropriate liquid. Use the oil supplied or an approved substitute for oil systems. Do not use other liquids. Castor based oils, Skydrol, solvents or similar liquids will attack the seals fitted in the standard tester.

(5) Wind screw pump handle fully anti-clockwise.

(6) Top up reservoir if necessary.

Post assembly test

(1) Carry out a test calibration of a known instrument (Section 4) to ensure that the unit is working correctly.

(2) Release the pressure and remove the test instrument.

NOTE

To remove the instrument from the system, use the appropriate size of spanners on the top section of the pressure connection and on the body of the instrument only. Ensure that the lower part of the pressure connection is not rotated as this may release it from the base.

(3) The system is now ready for use.

OPERATING INSTRUCTIONS

Caution

If the volume required to be filled is very large requiring the use of an additional pump and reservoir to be connected to the Model BGH2600, it is ESSENTIAL to ensure that valve B is kept open and valve A closed at all times otherwise a high pressure can be built up on the low pressure ram of the screw press and damage caused. To ensure this does not happen we can supply the system fitted with a relief valve, which will release at a set pressure, should the valve operation be incorrect. Alternatively, we can supply a modified system and hand pump for this operation. For further information on both items contact Budenberg.

Notes

(1) When testing equipment with a large volume, the capacity of the screw pump (65 cc) may be insufficient to reach the pressure required. In this case, the equipment should be filled as far as possible with the liquid before connecting it to the system, so that the displacement needed is reduced.

(2) Dirty or chemically contaminated instruments should not be fitted as they contaminate the system unless they are first cleaned.

4.1 PROCEDURE

(1) Fit instrument to be tested to gauge stand.

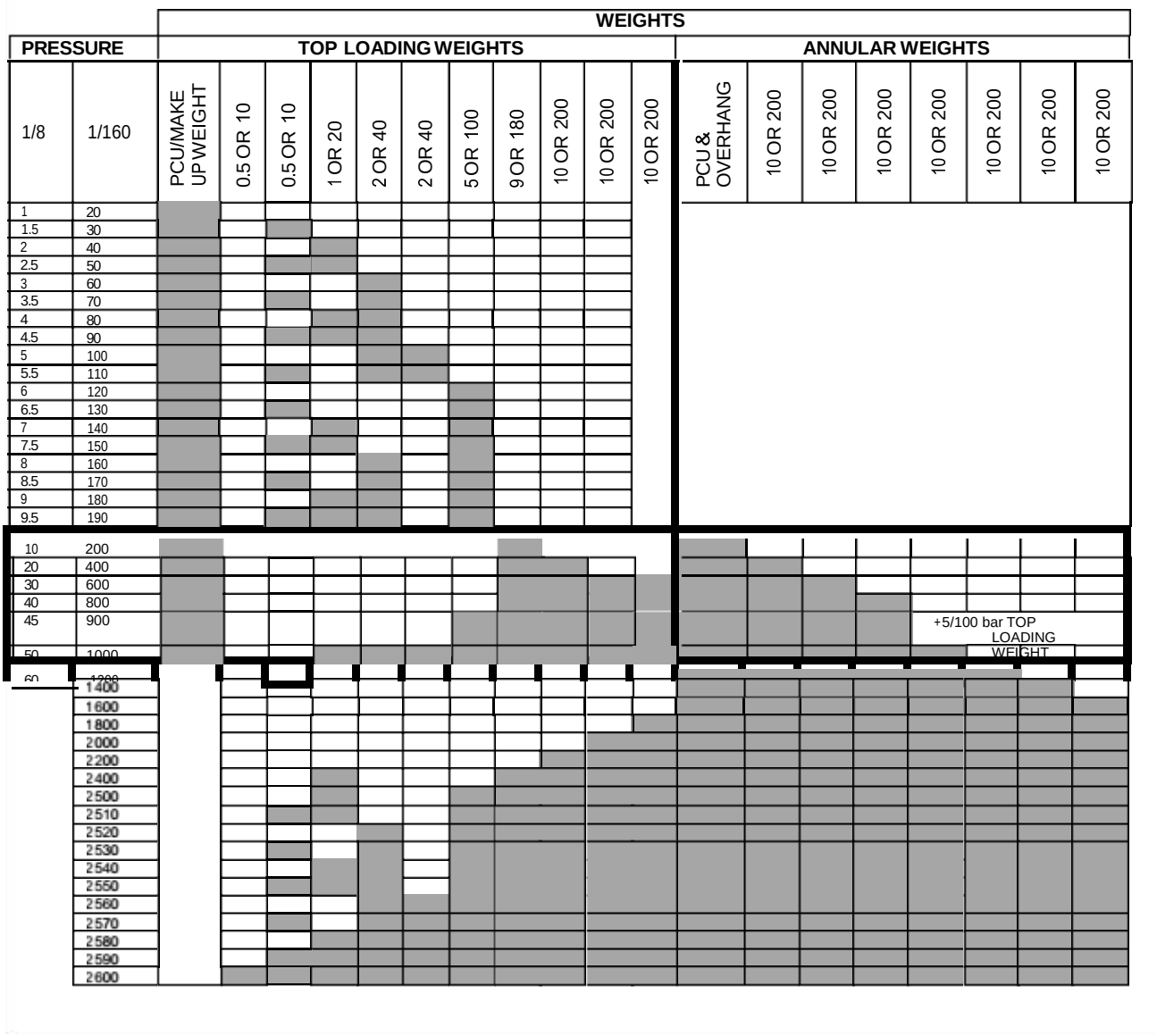
(2) Load the weight carrier/overhang with the weights equivalent to the desired pressure. Each weight is marked with two pressures, one for the low pressure range and one for the high pressure range. The equivalent weight of the carrier/overhang must also be taken into account. The piston cylinder unit has a basic 10 lb/in² start, for other pressure units a make-up weight is added to the weight carrier for conversion to 1 bar.

(2.1) For calibrating pressures below 50 bar or 600 lb/in^{2,} it is recommended that the top loading weights are used for calibration. When the required pressure calibration unit is bar, it is essential that the make-up weight is fitted first before any other top loading weights.

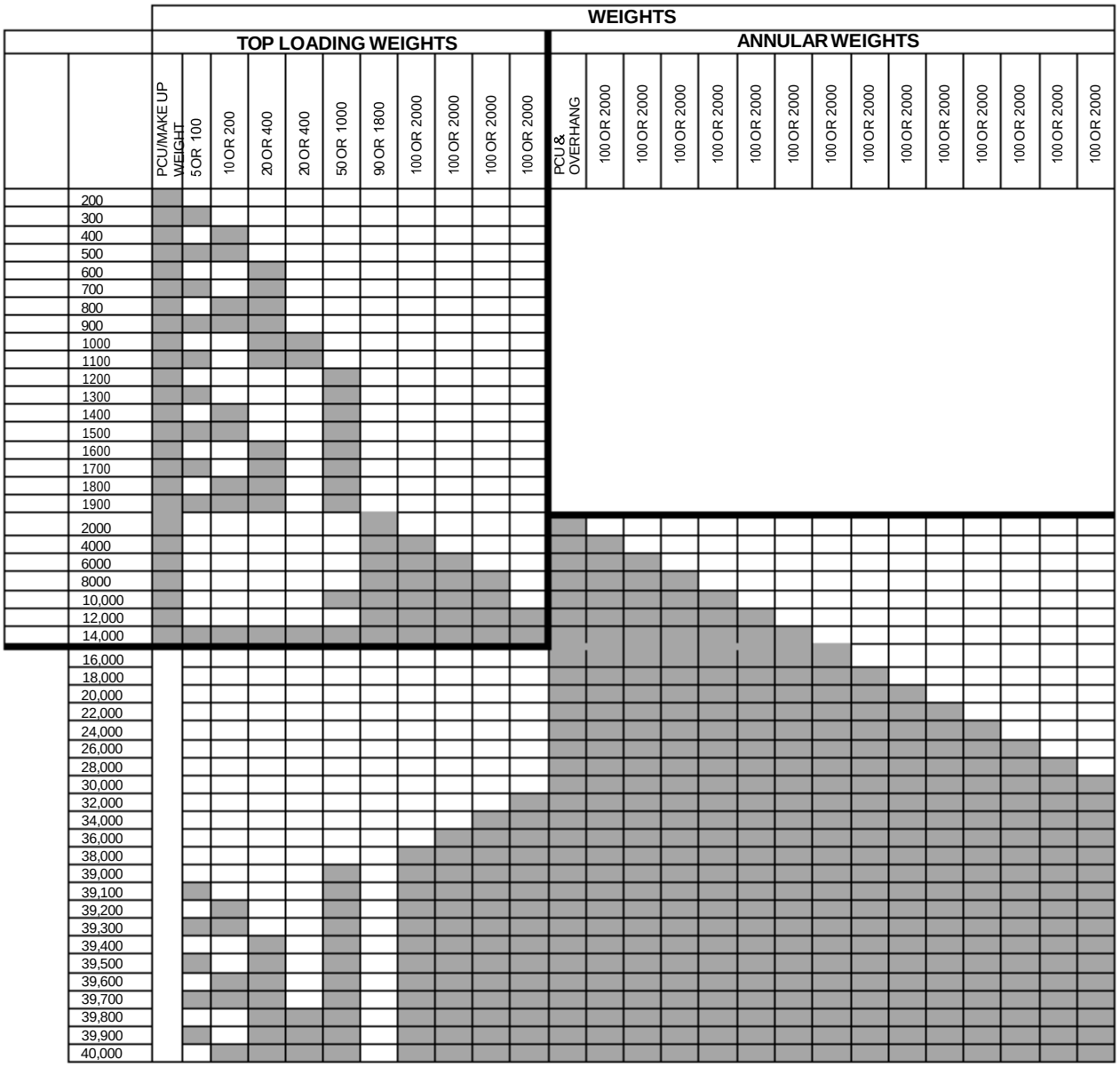
(2.2) For calibrating pressures above 50 bar or 600 lb/in^{2,} the overhang should be fitted. All top loading weights must be removed before fitting the overhang. When the overhang is fitted, the initial weight that goes onto it is a large annular make-up weight. The small type make-up weight should not be used when the overhang is fitted.

The following tables list the weights, and how they are used to obtain the desired pressure. Note that the tables do not show the maximum number of pressure increments that are attainable.

bar weight set



lb/in²weight set



TO APPLY PRESSURE

For pressures up to 140 bar (2000lb/in²)

(1) Close valve B (valve A remaining open).

(2) Wind screw pump handle clockwise. This will generate pressure up to approximately 140 bar or 2000 lb/in^2, as handle is wound in. When handle becomes stiff to rotate this will indicate that the pressure limit for this range has been reached.

For pressures above 140 bar (2000lb/in²)

(1) Ensure valve B closed and valve A open.

(2) Wind screw pump handle clockwise until the handle becomes stiff to operate.

(3) Close Valve A and open valve B

(4) Continue to wind screw pump handle clockwise. This will generate pressure up to approximately 2600 bar or 40,000 lb/in^2.

(5) When the piston rises and the piston head skirt floats, this indicates it is at its nominal desired pressure.
When the piston is floating within the blue band this indicates the pressure generated on the low pressure range (i.e. 1/8in² piston).
When the piston is floating within the red band this indicates the pressure generated on the high pressure range (i.e. 1/160in² piston).
The bands are easily visible from a seated position. To engage the high pressure range apply further pressure with the screw pump until the piston lifts higher and the piston head skirt floats within the red band. A slight leakage through the vent hole of the piston/cylinder unit is normal.

DURING CALIBRATION

When the tester is correctly set up and there are no leaks the piston should "float" for many minutes without it being necessary to touch the screw pump handwheel. On the initial setting up, however, there may be some air trapped in the base of the piston/cylinder unit. As this leaks past the piston the weights may fall slightly but it will only be for a matter of a few minutes until the air has escaped. If the piston continues to fall, check the connections for leaks.

During calibration, the weights should be rotated by hand. It is desirable that the weights should only be rotated when approximately the correct pressure is obtained. Changing from the low pressure range to the high pressure range with the weights spinning does no harm. Weights should not be brought to rest by fully releasing the pressure and allowing the piston head to rotate against its stop under the full load of the weight pile.

Stops come into action if the pressure is too high or too low and it is essential that the weights should be spinning freely whilst taking readings. At the lowest pressures the weights will not spin for more than a few seconds unless a very thin oil is used, but providing the weight is rotated by hand before taking a reading and is obviously "floating" an accurate reading will be given.

4.2 COMPLETION

(1) After the test is finished wind screw pump handle anti-clockwise to lower pressure.

(2) Gently open valve A or B to release residual pressure

(3) Ensure that both valves A and B are fully open.

The system is now ready for another test and any residual pressure is relieved.

NOTE: A black deposit may become evident in the reservoir after the screwpress has been operated at pressure. This is due to wear on the high pressure seals. It will not affect the operational use of the tester.

4.3 PRESSURE CALCULATION CLASS A SOFTWARE

This software enables the user to define his equipment and local conditions (gravity, temperature), so that when nominal mass values are entered, actual achieved pressures are displayed

These actual pressures will then be to the Class A accuracy of the tester.

NOTE: This software is provided on a standard USB pen drive and Class A testers are supplied with a UKAS Area and Mass certification as standard

4.4 TEMPERATURE MEASUREMENT OF PISTON UNITS

For many purposes, such as calibrating most type of dial gauges and transducers, accurate knowledge of the temperature of a piston unit is not necessary. However, in order to achieve the utmost accuracy from a dead-weight tester it is important to know the temperature of the piston unit as close as possible to the working part of the unit.

In laboratories where the room temperature is controlled it is most likely that the temperature of the working parts of the unit will not differ from the ambient temperature by more than 0.5°C. When working in uncontrolled temperatures, however, one would have to measure the temperature of the piston unit

A possible way to do this is to use a disc shaped thermistor type probe sensing element taped to the outer surface of the piston unit. The sensing element should be insulated from the ambient temperature by covering the element with a thin strip of polystyrene, or other insulating material, then taping this to the piston unit.

We can supply a suitable instrument. Consult you local distributor for advice on availability

4.5 CLEANING GAUGES

THIS CLEANING/ DEGREASING PROCESS IS ONLY SUITABLE FOR USE WITH PRESSURE GAUGES WITH EITHER PHOSPHOR BRONZE, BERYLLIUM COPPER, MONEL OR STAINLESS STEEL BOURDON TUBES IN THE FORM OF A 'C'.

IT IS NOT ADVISABLE TO DEGREASE PRESSURE GAUGES WITH STEEL BOURDON TUBES SINCE A VERY SMALL AMOUNT OF CORROSION ON THE BORE OF A BOURDON TUBE CAN CAUSE INACCURACIES OF READING AND EARLY FAILURE OF THE TUBE.

THIS METHOD OF CLEANING IS NOT SUITABLE FOR USE WITH PRESSURE GAUGES WHICH ARE FITTED WITH COILED BOURDON TUBES, NOR ANY GAUGES WHICH ARE TO BE USED ON OXYGEN, AS COMPLETE REMOVAL OF OIL IS NOT ASSURED, REFER TO MANUFACTURER.

Equipment

This consists of a syringe and a special needle with the point bent through 90^{O}.

Instructions

(1) Fill syringe with solvent (Proprietary cold degreasing liquid)).

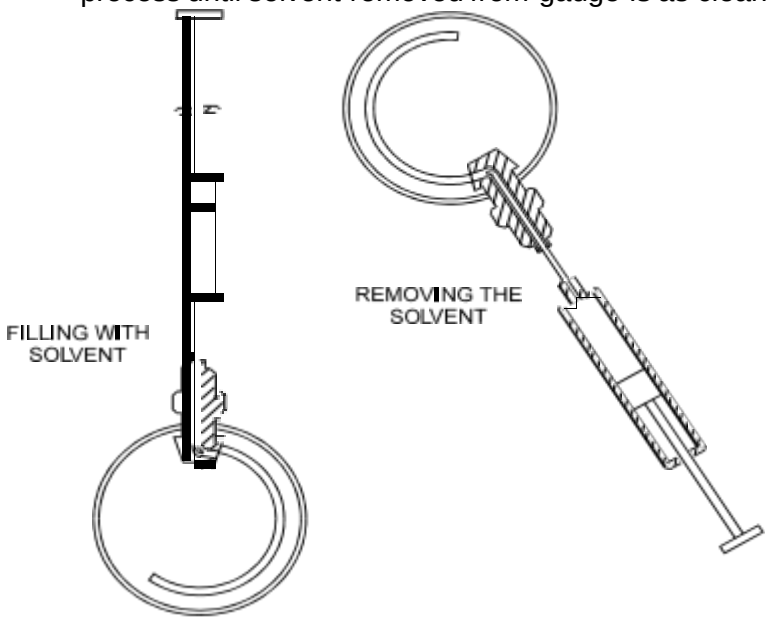
(2) With gauge connection pointing upwards put needle into connection and insert by feel the point into the hole leading to the tube.

(3) Inject the solvent. Ideally the tube should be half full.

(4) Shake gauge in various attitudes to agitate solvent.

(5) Suck solvent back into syringe, holding gauge at an angle.

(6) Check that solvent removed is clean. To be sure that all oil has been removed, repeat cleaning process until solvent removed from gauge is as clean as that put in.



Cleaning of gauges

FAULT FINDING

The following chart is an aid to fault finding on your equipment in case of a fault occurring.

Fault	Possible cause	Remedy
Equipment does not provide any output pressure.	No liquid in tester.	Check that tester is filled with liquid. Fill the equipment with fluid as necessary. Refer to section 3 (Filling the equipment with
	Valve B is open	Close valve B and try again
	Component being tested has a large volume	Pre-fill component with liquid before test.
	Missing or damaged liquid seals shown by signs of unexplained liquid leaks.	Examine seals on equipment to ensure they are fitted correctly and are undamaged. Replace as necessary.
	Valve B handwheel disconnected from spindle	Examine valve B. Tighten up nut securing handwheel to spindle as
	Valve B assembly or valve seat damaged.	Examine condition of valve B and valve seat. Replace valve assembly or return tester to DH-Budenberg for overhaul as
	If unable to locate a cause	Return tester to Budenberg for investigation
Equipment provides pressure but pressure decays to zero	Incorrect operating procedure being used.	Ensure that correct operating procedure is being followed (Refer to section 4)
	Missing or damaged liquid seals shown by signs of unexplained liquid leaks.	Examine seals on equipment to ensure they are fitted correctly and are undamaged. Replace as necessary.
	Valve A or Valve B valve assembly or valve seat damaged.	Examine condition of valves A and B and valve seat. Replace valve assembly or return tester to Budenberg for overhaul as necessary.
	If unable to locate a cause	Return tester to Budenberg for investigation
Equipment provides pressure but pressure decays when valves A and	Incorrect operating procedure being used.	Ensure that correct operating procedure is being followed (Refer to Section 4)
	If unable to locate a cause	Return tester to Budenberg for investigation
Equipment provides pressure but pressure decays to lower value then remains steady.	Insufficient liquid in tester.	Check liquid level in reservoir. Fill reservoir with correct liquid as necessary (Refer to
	Air in the system	Prefill component under test with appropriate liquid. If necessary re-fill tester with appropriate liquid.
	If unable to locate a cause	Return tester to Budenberg for investigation
	Internal damage	Return tester to Budenberg for investigation.
	Incorrect operating procedure being used.	Ensure that correct operating procedure is being followed (Refer to Section 4)
	If unable to locate a cause	Return tester to Budenberg for investigation
Tester screw press becomes very stiff to operate when tester is being used in range below 140 bar (2 000	Internal damage	Return tester to Budenberg for investigation.
Tester screw press becomes very stiff to operate when tester is being used in range above 140 bar (2 000	Incorrect operating procedure being used.	Ensure that correct operating procedure is being followed (Refer to Section 4)
	If unable to locate a cause.	Return tester to Budenberg for investigation.

PERIODIC MAINTENANCE

6.1 CLEANING THE UNIT AND CHECKING THE LIQUID LEVELS.

Cleaning the units and checking the liquid levels is the only periodic maintenance required. With normal use, no further maintenance should be necessary. If required, the system can be returned to our works for re-conditioning. Accuracy, overhaul and re-certification is also explained in corrective maintenance.

NOTE: Fluids, which attack ABS, should be used with caution. Continual immersion of the cover in such fluids will cause deterioration. Spillage's should be wiped off immediately.

Oil operation

Keep the system clean and free from spilt oil, wipe out the oil cups under the gauge stands as necessary. Do not use any cleansing solvents as they may damage the seals.

Ensure that the reservoir contains sufficient liquid to carry out any calibrations required. If necessary top up the reservoir with the same liquid that is already being used. Do not mix various types or brands of liquid in the tester.

If the oil in the system becomes dirty, use the screw pump to flush through the clean oil with a drain screwed in the gauge stand. (An angle connection is suitable). The screw pump should be turned fully clockwise before starting.

CORRECTIVE MAINTENANCE

7.1 GENERAL

This section contains details on stripping the unit and replacing the spare parts which are listed in section 8. The component identification numbers in brackets in each procedure refer to figure 7.1

7.2 REMOVING THE COVER

(1) Drain as much oil as possible from the tester by winding the screwpress fully clockwise and using a drain screwed in the gauge stand.

(2) Unscrew the differential nut and piston cylinder unit.

(3) Remove the oil cups by levering upwards carefully.

(4) Slacken the socket set screw using a 3mm hexagon wrench key and remove both handwheels.

(5) Remove the four cover retaining screws and lift off the cover.

7.3 RESERVOIR SEALS

(1) Unscrew two screws and remove the reservoir cover.

(2) Remove the 'O' ring seal (6) from the recess and the Seloc seal (7) from the screws.

(3) On replacement ensure all sealing faces are absolutely clean and do not overtighten screws.

7.4 VALVE SEALS

(1) Unscrew the gland nut.

(2) Unscrew the valve spindle and remove the bonded seal.

(3) Slide gland nut off spindle.

(4) Using a suitable hooked tool remove the 'O' ring seal (9) from the bore of the gland nut. Renew 'O' ring and bonded seal (10).

(5) On replacement ensure that 'O' ring is correctly located in the groove and all sealing faces are clean. Remove all burrs from spindle.

7.5 SCREW PUMP

(1) Using a 4mm hexagon wrench key unscrew the six socket head cap screws securing the hub locating plate. (These are positioned inside the recess in the back of the aluminium hub).

(2) By carefully pulling the hub the complete ram assembly can now be withdrawn from the barrel (During this operation a container is required beneath the barrel to catch any liquid).

(3) Unscrew the ram from the hub assembly.

(4) The high pressure seal (10) and low pressure seal (15) can now be replaced. The high pressure seal should be cut to aid removal. The new seals should be replaced as shown in figure 8.3. Before fitting the new seals check the ram is not scored on the locating diameters.

(5) At this point the hub assembly should be checked for excess play indicating wear in the bearing and for wear in the screwed spindle and nut. If any wear is found it will be necessary to dismantle the hub assembly.

(6) Check the bore of the block assembly (11) is not badly scored or pitted. If a replacement is required this item is supplied complete with valves. The block is attached to the base by socket head cap screws.

(7) Re-assembly is a straightforward reversal of the above procedures.

NOTES:

(1) On assembly care should be taken to align the ram to prevent bending, or damage to the seals. Excessive force should not be used.

(2) The socket head cap screws are not spaced equally around the locating flanges so check hole alignment before inserting screws.

7.6 HUB ASSEMBLY

(1) Unscrew the ram from the spindle. NOTE:- left hand thread.

(2) Unscrew the spokes from the hub.

(3) Knock out the spring pin (1), found at the bottom of one of the tapped spoke holes in the hub, using a punch 6mm dia. Pull off hub.

(4) The hub locating plate and thrust bearing can now be removed from the spindle.

(5) If the flanged bush(2) is to be renewed, it should be pressed out of the locating plate and a new one pressed in squarely.

(6) The thrust bearing (3) is renewed as a complete assembly.

(7) The nut, pin and spindle sub-assembly (4) can only be replaced as a matched pair. Unscrew the nut from the ram, gripping in a soft jaw vice and screw in the new nut.

(8) Assemble the thrust bearing, locating plate and hub on to the spindle, lubricating with molybdenum disulphide grease.

(9) Clamp these items together to eliminate end play and re-assemble spring pin. If using new spindle drill through 6.3mm diameter to fit spring pin (1).

(10) Lubricate the thread with molybdenum disulphide grease and screw into ram nut.

7.7 PISTON/CYLINDER UNIT

As the piston/cylinder unit represents a high proportion of the total value of the tester, it should always be handled with care and every effort made to keep it clean.

The piston/cylinder unit is made to extremely fine limits of accuracy and it is not advisable to dismantle it. If it is necessary to clean it, the piston and cylinder bore must be oiled immediately, in order to protect the high grade finish.

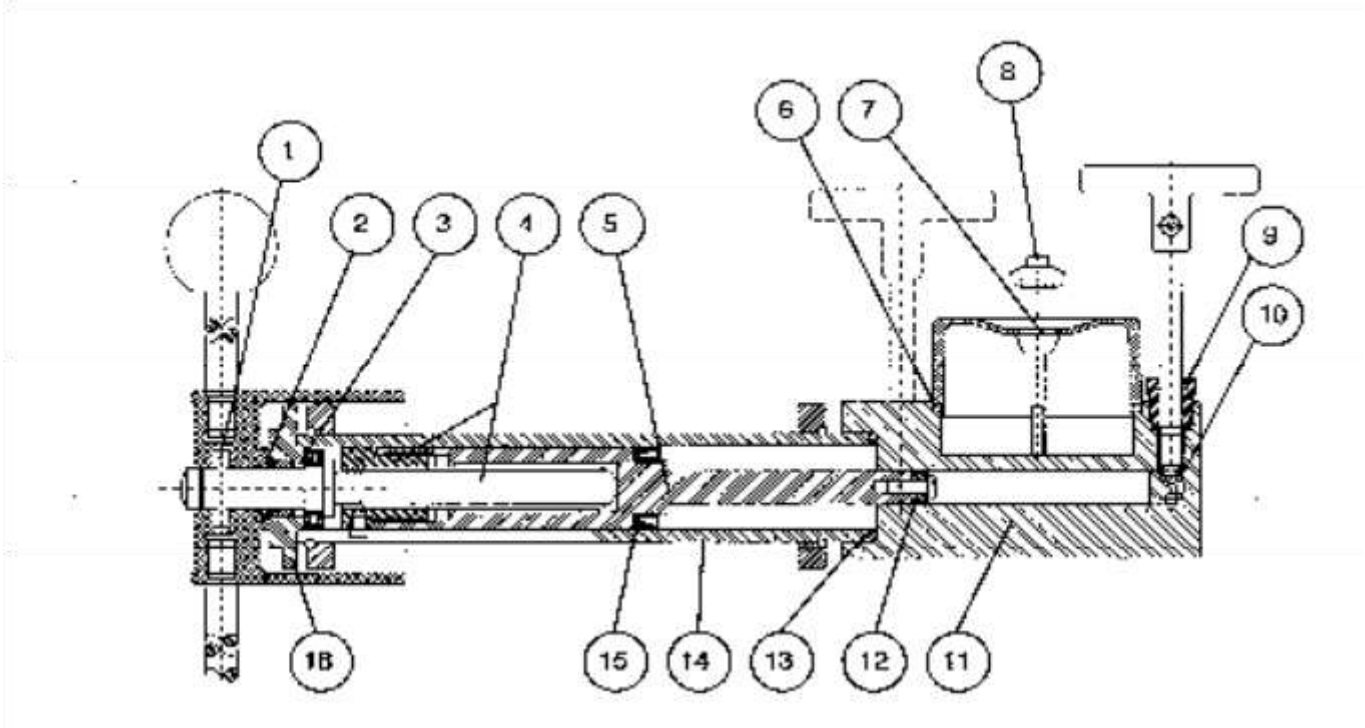
Should the unit become damaged it should be returned complete for replacement or repair. Parts from different units are not interchangeable as they have to be weighed and evaluated as a whole.

The serial number of the piston/cylinder unit appears in the certificate of accuracy and is marked on the body of the unit. This number, as well as the tester serial number should always be quoted in correspondence concerning the piston/cylinder unit.

The piston/cylinder connections should be blanked if it is removed from the tester. If the unit is taken off for any reason it should be stored upside-down, resting on its weight carrier.

This covers stripping the unit to enable simple repairs and the fitting of recommended spare parts to be carried out.

FIGURE 7.1 Sectioned view of screw pump and high pressure block.



7.8 FACTORY OVERHAUL AND RE-CERTIFICATION OF DEAD-WEIGHT TESTERS MAINTENANCE OF ACCURACY.

The accuracy of a dead-weight tester depends primarily on the effective area of the piston unit and on the weights applied to the piston. The effective area of the piston unit can be affected by wear of the unit. This is generally caused by contamination of the oil in the tester by foreign matter from instruments being calibrated, by water, or by chemicals from instruments, or by rust or corrosion caused by contaminants.

Weights are made of austenitic stainless steel which are entirely stable. They should be periodically cleaned using a non abrasive method to remove any foreign matter.

NEED FOR OVERHAUL AND RE-CERTIFICATION

We recommend that the tester be returned to us for overhaul and re-certification at any time if when used in accordance with instructions:

(a) The piston does not spin freely.

(b) The rate of fall of the piston is appreciably greater than when new and makes use of the tester difficult.

(c) The weights are damaged.

(d) The tester cannot be made to operate satisfactorily due to wear or damage to pump piping or valves which cannot be rectified by the user.

This tester can be used for calibration of instruments with an expected accuracy of 1, 0.5 or 0.25%. Such testers need not be sent back frequently for overhaul and re-certification and provided they are working well can be trusted for many years. Under these circumstances, an interval of two years might be appropriate between overhauls.

When high accuracy is required of dead-weight testers the tester, it should be returned for overhaul and re-certification more frequently. The actual period will depend on how the tester is used. A tester kept in a laboratory and carefully used might need to be returned every two to three years. A tester carried from site to site and used for calibrating high accuracy gauges or transducers from industrial process plant or for measuring pressures directly might well need to be returned at intervals of less than a year.

The actual period between overhaul and re-certification should be fixed by the user in the light of the above comments taking into account the requirements of any inspection authority, which might be involved.

IDENTIFICATION OF WEIGHTS

All weight sets supplied with a dead-weight tester have allocated, and are marked, with a weight set number. Additionally, if users wish to ensure that only specific weights are used with an individual deadn weight tester or piston and cylinder unit, then the serial number of the tester, and/or piston cylinder unit may also be marked on the main weights. Regrettably due to size, increment weights can only be marked with the serial number of a piston and cylinder unit.

OVERHAUL AND RE-CERTIFICATION

To provide the best possible service, the tester should be returned as complete units comprising the base, the piston and cylinder unit, and all the weights. Users may at their discretion elect to service the base themselves and only return the piston and cylinder unit with weights for overhaul. In such instances, certification issued after overhaul can only refer to the piston and cylinder and weight set numbers and not to the base to which they were originally fitted.

Tester bases will be stripped, all pipework cleaned, all seals replaced, worn components replaced where desirable, and all reassembled and tested.

The weights will all be checked and brought to within original limits if possible. If one or two weights are missing or beyond economical repair they will be replaced. If more are missing/ beyond economical repair customer instructions will be sought.

The piston unit will be checked for accuracy and sensitivity. If it is not satisfactory for any reason a quotation will be submitted for a replacement unit.

A new certificate of accuracy will be issued for each overhauled tester. Unless otherwise instructed on order when there has been a slight change in area of the piston unit the certificate will reflect this; the accuracy will not be affected by more than 0.03%. For example the certificate of accuracy of an overhauled tester might show that the error does not exceed 0.05% when the original certificate shows that the error did not exceed 0.02%.

We can issue an UKAS certificate of calibration for an overhauled system. Details will be supplied on request.

ORDERING AND PRICING

An open order should be placed to avoid delays and correspondence. No tester will be overhauled if it is not economic to do so. By far the most expensive component likely to need replacement is the system piston unit; this unit will not be replaced unless customer's approval has been obtained.

When customers ordering procedure does not allow an open order to be placed, we quote a basic price for the overhaul and re-certification of that particular model. This assumes that the tester and weights are in good condition and covers stripping, cleaning of pipework, replacement of seals, re-assembly and testing, checking of weights and of piston unit. The basic price covers our certificate of accuracy in the typical form. Customers requiring a more detailed certificate of calibration should state this on their order.

Any additional work required will be carried out and will be quoted separately and will not commence until agreed so by the customer involved.

SPARE PARTS

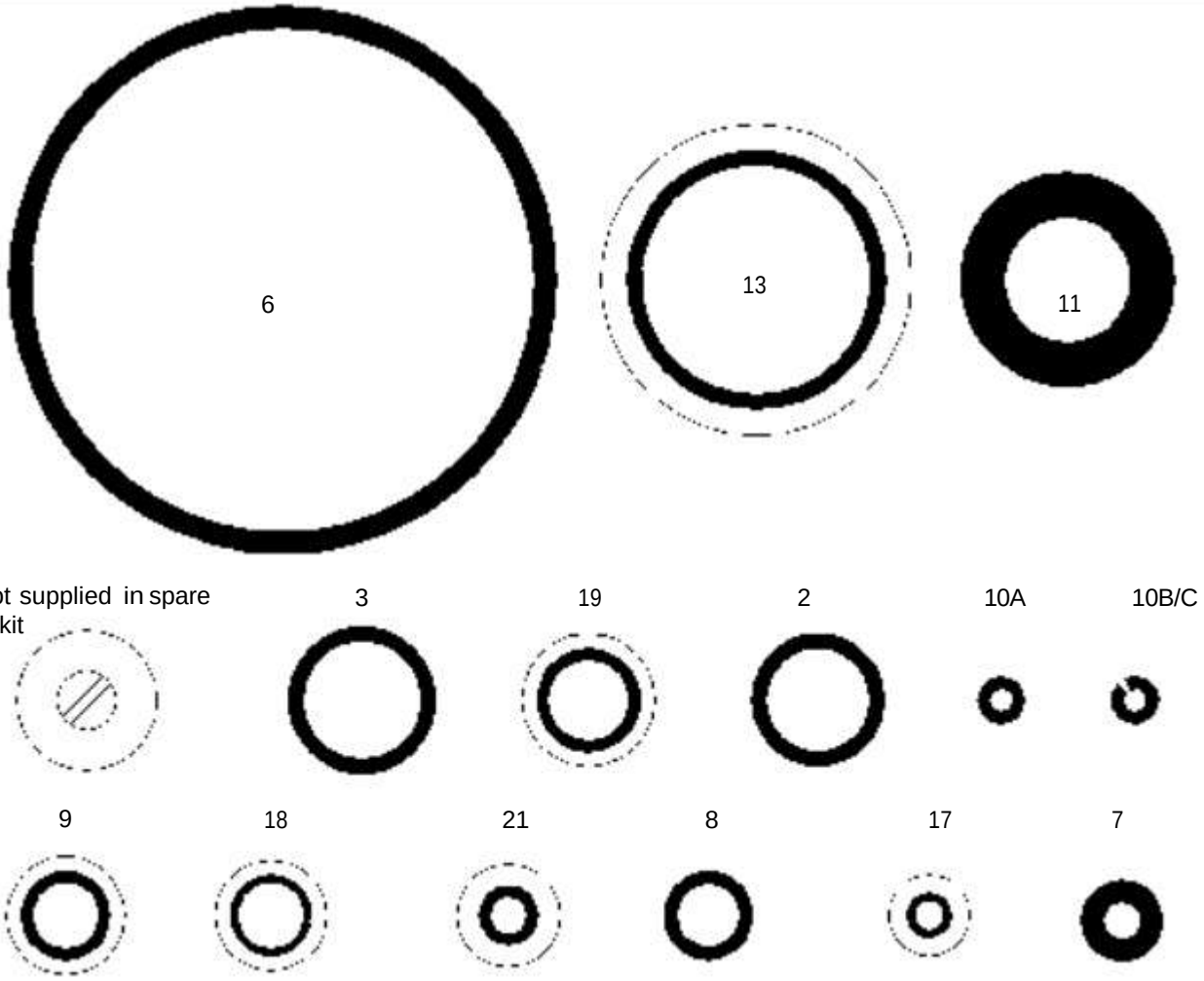
8.1 SPARE PARTS LIST

This list covers all the items subject to wear. Any enquiries should be addressed to Budenberg.

Unit	Item No.	Description	Part No.
Piston/cylinder	1	Model BGH2600	3/3553
	2*	'O' ring	YR1372
	3*	'O' ring	YR1440
	4	lb/in²piston cylinder height adaptor	C4044
Reservoir	5	Plug assembly	YC2597
	6*	'O' ring	YR1387
	7*	Seloc seal	YR1475
Valves	8*	'O' ring (also used on stands)	YR1436
	9*	Bonded seal	YR1351
Screw pump	10A*	High pressure seal	YR1356
	10B*	High pressure seal anti-extrusion ring	YR7125
	10C*#	High pressure seal anti-extrusion ring	QC/0011/5
	11*	Distributor seal	YR1455
	12*	Barrel	YC2530
	13*	Bonded seal	YR1330
	14A	Spring pin	YR1678
	14B	Sub-assembly nut, pin and spindle	YC2290
	15	Flanged bush	YR2825
	16	Needle thrust bearing	YR3240
Gauge connections	17*	Bonded seal 1/8 in BSP	YR 1315
	21*	Bonded seal 1/4in BSP	YR 1352
	18*	Bonded seal 3/8 in BSP	YR 1320
	19*	Bonded seal 1/2in BSP	YR 1321
Differential connections	23	G3/8 differential connection	YC1195
	24	G1/2 differential connection	YC1200
	25	Conejoint (plain)	YC1205
	26	Conejoint (recessed)	YC1210

Items marked thus * are contained in the bag of seals supplied with the system which is also available as a spare.
Used after Serial Number , (November 2006 onwards)

8.2 SPARE SEAL IDENTIFICATION CHART



8.3 ORDERING SPARES

When ordering spares or making enquiries always give:

1) System Model No. (on front of this manual)
2) System serial No. (on nameplate)
3) Description of part. See spare parts list.

Whilst every effort is made to ensure that the correct parts are supplied, this cannot be guaranteed unless full information is given.

Ordering spares can be carried out from our service department at the following addresses:

Budenberg

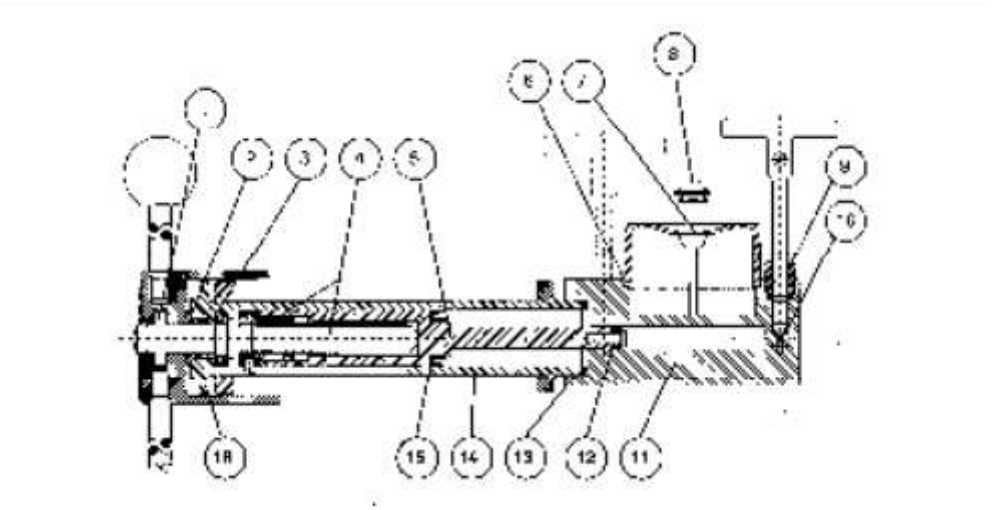
Budenberg Gauge Co. Ltd.
Unit B2 Stuart Road
Altrincham Business Park,
Altrincham WA14 5GJ
Tel: +44 161 777 7300.
Email: sales@budenberg.co.uk

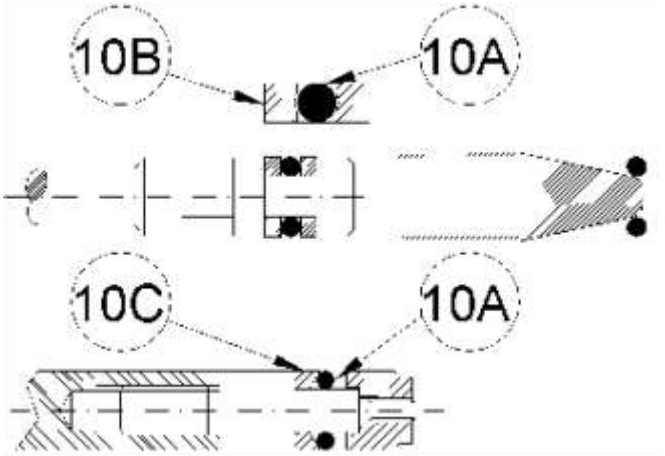
Budenberg Gauge Pvt. Ltd.
299-300, IInd Main Road,
Nehru Nagar,
Old Mahabalipuram Road (OMR) ,
Chennai - 600 096,
Tamil Nadu , India
Tel : +91 44 24541074
Tel/Fax: +91 44 24541075
Email: sales@budenberg-gauge.in

Budenberg Gauge Asia Pacific Ltd
Unit 109 Cheung Fat Ind Bldg
64-76 Larch St Tai Kok Tsui
Kln
Hong Kong
Tel : +852 3709 0020
Email: sales@budenberg-gauge.asia

Budenberg Middle East LLC
PO Box 18980
Dubai
United Arab Emirates
Tel: +971 4 2511670
Email: sales@bme-me.com

FIG 8.3 SECTIONED VIEWS SHOWING SEAL IDENTIFICATION DETAILS





High Pressure seal arrangement – Post November 2006
Serial No upto 29062

High Pressure seal arrangement – November 2006
Serial No 29063 onwards

OPTIONAL EXTRAS

9.1 OIL FREE TESTING

Model 38 and 25 oil seals are available for use during oil free testing. The seals have a synthetic rubber sac, which separates the oil in the system from the liquid on which the instrument is to be tested. The Model 38 oil seal can be used on any system up to a maximum working pressure of 700 bar or 10 000 lb/in^2.

The Model 25 oil seal is similar to above but with smaller displacement and for use up to 1 200 bar or 18 000 lb/in^2.

9.2 FINE INCREMENT WEIGHTS

Extra weight set to give fine increments of pressure less than those normally supplied with the tester can be supplied for use all piston/cylinder units.

9.3 MODEL 27 – TWO GAUGE STAND

This is available for the testing of two gauges simultaneously.
The maximum working pressure range of the Model 27 is 1 200 bar or 18 000 lb/in^2.

9.4 MODEL 360 BASE

A Model 360 oil dead-weight pressure balance incorporating the piston unit and weights used in the Model BGH series dead-weight tester. This balance enables an operator to calibrate a transducer or a pressure gauge at two different pressures without adding/removing any weights, thus speeding up the calibration process.
The maximum working pressure range of the Model 360 is 1 200 bar or 18 000 lb/in^2.

9.5 CARRYING CASES

These cases are designed for transporting the dead-weight tester to site and are suitable for use by commissioning teams on large projects such as chemical plants. They enable the complete calibrating system to be conveniently transported without the loss of items. The provision of a can of oil will be found particularly useful on remote locations.

9.6 WEIGHT STORAGE CASES

These cases are designed for storing of weights in the laboratory or workshop and would be ideal in any standards room or area where equipment needs to be stored when not in use. They also keep the weight set together to prevent weights going astray and protect them from accidental damage.

9.7 UKAS CERTIFICATE OF CALIBRATION

All testers are available with certificates of calibration on pressure, also calibration of effective area and mass of the piston unit, also the mass of the weights.
Consult your local distributor for advice.

Consult your local distributor for advice on any additional equipment required for calibration requirements.

EC DECLARATION OF CONFORMITY

ISSUED IN ACCORDANCE WITH THE

PRESSURE EQUIPMENT DIRECTIVE (PED) 97/23/EC

PRODUCT DESCRIPTION	:	HYDRAULIC DEAD-WEIGHT
MODEL No	:	TESTER MODEL BGH2600
MANUFACTURE	:	Budenberg Altrincham ENGLAND
MAXIMUM WORKING PRESSURE	:	2600bar (40,000lb/in²)
HYDROSTATIC PRESSURE TEST:		3450 bar (50,000lb/in²)
ASSEMBLY DIMENSIONS	:	
SIZE	:	40cm x 40cm x 40cm (WxDxH)
WEIGHT	:	BASE (PISTON/CYLINDER FITTED) : 20Kg (44lbs) – FILLED BASE (PISTON/CYLINDER FITTED) : 20Kg (44lbs) – UNFILLED WEIGHTS - bar : 106.5Kg (234lbs) - lb/in² : 118.5Kg (260.7lbs)
VOLUME	:	RESERVOIR : 0.15 LITRES PRESSURISED VOLUME : 0.065 LITRES
INTENDED USE	:	CALIBRATION OF PRESSURE TRANSDUCERS. CALIBRATION OF PRESSURE GAUGES. PRESSURE GENERATION DEVICE.

PRESSURE EQUIPMENT DIRECTIVE DEFINITION : PRESSURE ASSEMBLY
PRESSURE EQUIPMENT DIRECTIVE CLASSIFICATION : CAT I
PRESSURE EQUIPMENT DIRECTIVE CONFORMITY ASSESSMENT : MODULE A

CLASSIFICATION OF THE PRESSURE ASSEMBLY IS BASED ON THE PRESSURIZED INTERNAL VOLUME (V) AS DEFINED IN ANNEXE B OF THE PRODUCT CLASSIFICATION CHART IN THE PRESSURE EQUIPMENT DIRECTIVE 97/23/EC.

	GAS		LIQUID	
GROUP	1	2	1	2
PRESSURE <200 bar	SEP	SEP	SEP	SEP
>200 bar	CAT III	SEP	SEP	SEP
>500 bar	CAT III	SEP	CAT 2	SEP
>1000 bar	CAT IV	CAT III	CAT II	CAT I

NOTE: THE ABOVE TABLE IS BASED ON Budenberg EQUIPMENT THAT HAS A PRESSURISED INTERNAL VOLUME OF LESS THAN ONE LITRE.

DETAILS OF HARMONISED STANDARDS/TECHNICAL STANDARDS/EUROPEAN COMMUNITY DIRECTIVES SPECIFIED/USED:

STANDARD	DESCRIPTION
EN 837-1:1998	Pressure Gauges - Part 1: Bourdon tube pressure gauges – Dimensions, Metrology, Requirements and Testing

Budenberg QUALITY ASSURANCE SYSTEM : ISO 9001:2015
Budenberg QUALITY ASSURANCE MONITORS : LLOYDS REGISTER