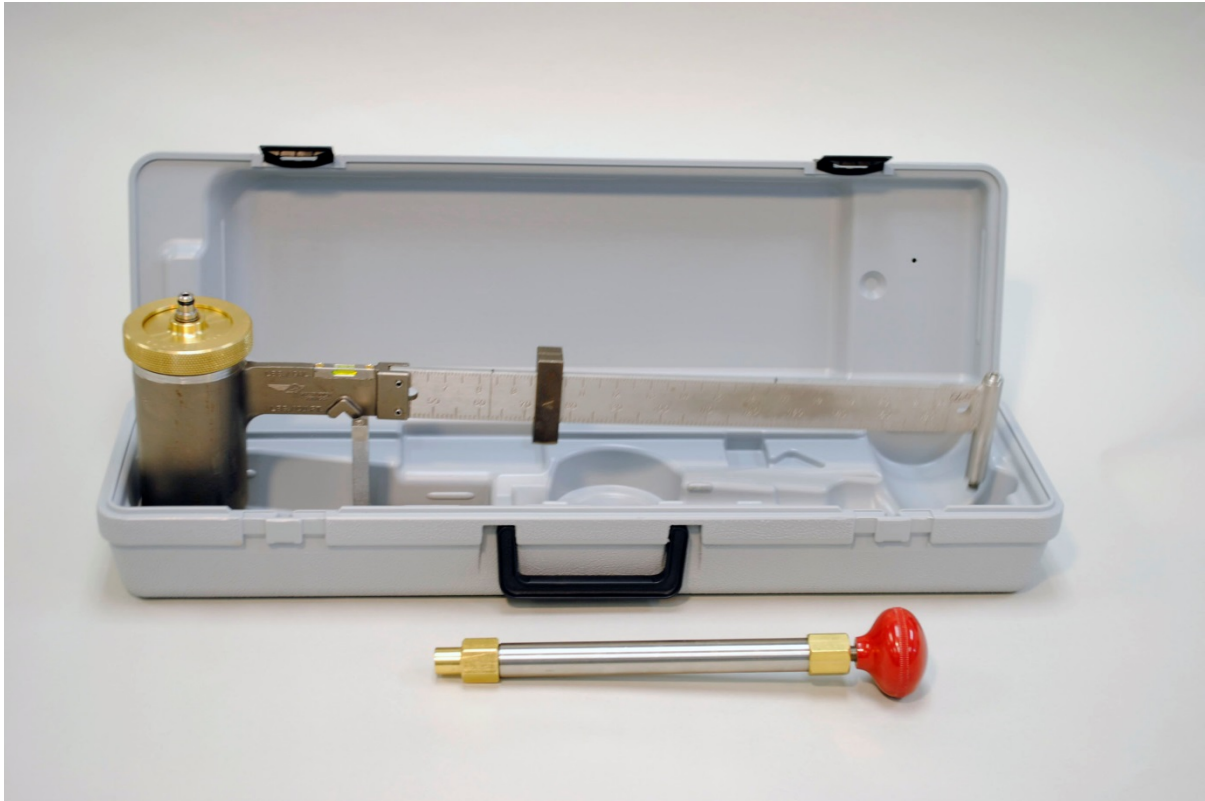


TRU-WATE™ Fluid Density Balance, Model 141

Instruction Manual



Manual No. 100063065, Revision J
Instrument No. 100003565

TRU-WATE™ Fluid Density Balance Instruction Manual

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Houston, Texas, USA

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1 Introduction

The TRU-WATE™ Fluid Density Balance provides a simple and practical method for accurately measuring fluid density (mud weight or mud density). This balance operates similarly to a conventional mud balance except it uses pressure. The pressure is applied to the sample cup.

Drilling fluids and cement slurries often contain a considerable amount of entrained air. The volume occupied by the entrapped gas bubbles may distort the density measurement. By pressurizing the fluid, the entrained air volume can be decreased to a negligible amount. Therefore, the density can be measured more accurately.

The effect of air entrainment in a fluid is shown in Figure 1-1. Testing of 50 slurries indicated that the amount of air entrainment varied from 0 to 14%. This variance can make a considerable difference in the weight obtained using the non-pressurized mud balance.

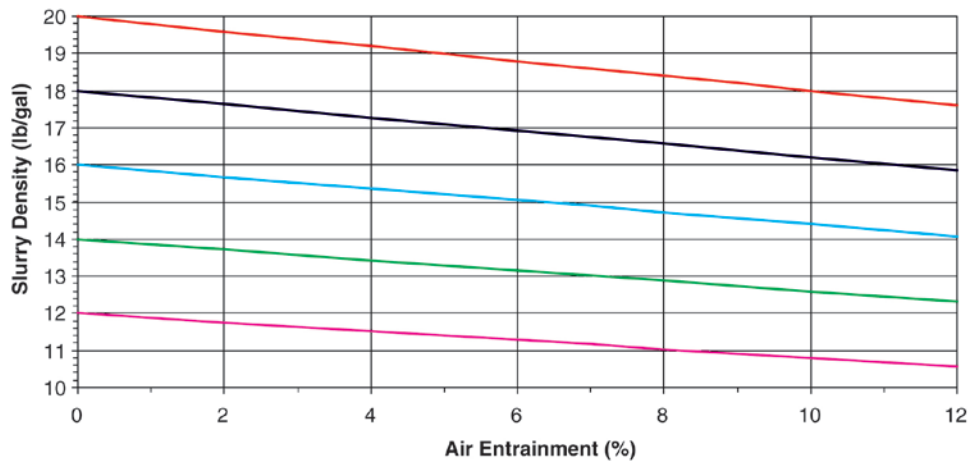


Figure 1-1 Effect of Air Entrainment on Fluid Density at Atmospheric Pressure

The effect of pressure on the fluid density containing air entrainment versus the density of the same fluid without air entrainment is shown in Figure 1-2. As shown in Figure 1-3, the effect of air entrainment up to approximately 15% can be kept to a negligible amount. It shows the fluid pressure required to bring the apparent fluid density to within 1% of the actual density.

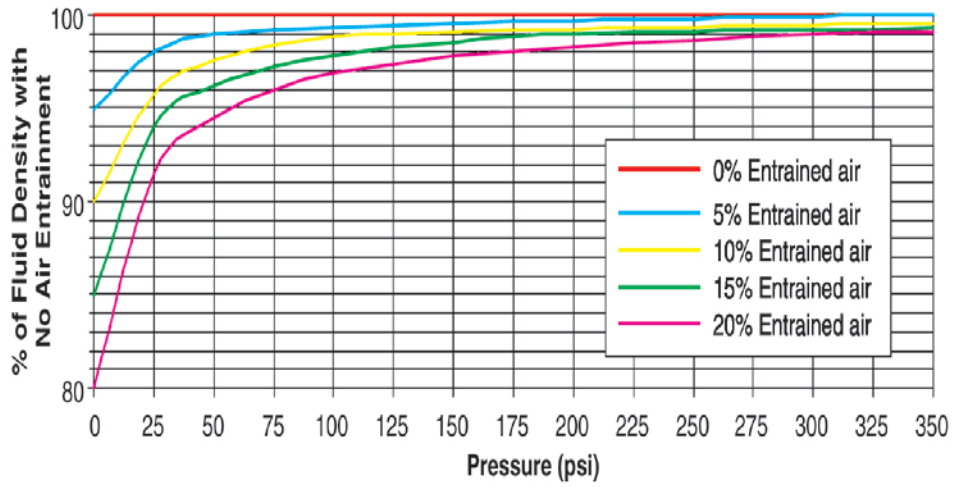


Figure 1-2 Fluid Density Reduction: Air Entrainment vs. Pressure

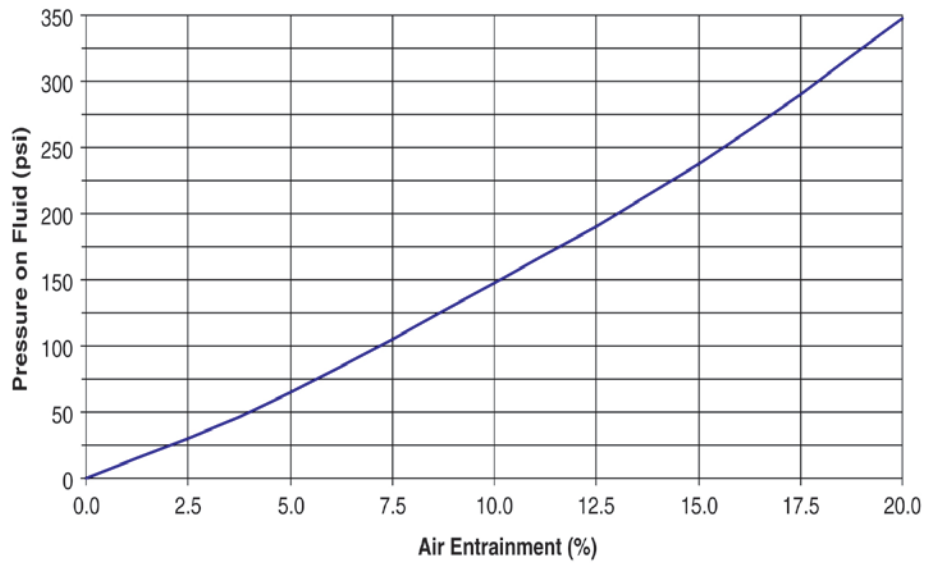


Figure 1-3 Pressure on Fluid versus Air Entrainment

1.1 Document Conventions

The following icons are used as necessary in this instruction manual.



NOTE. Notes emphasize additional information that may be useful to the reader.



CAUTION. Describes a situation or practice that requires operator awareness or action in order to avoid undesirable consequences.



MANDATORY ACTION. Gives directions that, if not observed, could result in loss of data or in damage to equipment.



WARNING! Describes an unsafe condition or practice that if not corrected, could result in personal injury or threat to health.



ELECTRICITY WARNING! Alerts the operator that there is risk of electric shock.



HOT SURFACE! Alerts the operator that there is a hot surface and that there is risk of getting burned if the surface is touched.



EXPLOSION RISK! Alerts the operator that there is risk of explosion.

2 Safety

Hazardous Chemicals

Some chemicals used in this procedure may be hazardous under certain conditions.

- Always work in a well-ventilated area while using aerosol sprays.
- Always wear protective eyewear when working with aerosol spray solvents.
- Never use aerosol sprays near open flames or objects at high temperatures.
- Use protective gloves to avoid prolonged contact between skin and solvents.
- Wash hands thoroughly before eating, drinking, smoking, or using the restroom.

Protective Equipment

- Wear appropriate hand and foot protection when working with the equipment used in this procedure.
- Wear protective eyewear when performing any operation that has the potential of creating flying debris.



Wear appropriate heat-resistant gloves when exposed to high temperature.

Sharp Edges



Sharp edges can create a cut hazard. Avoid direct contact with sharp edges.

Material Safety Information

Material Safety Data Sheet (MSDS) information should be reviewed before using any hazardous chemical or solvent.

Waste Disposal

- Always follow your waste management procedures.
- Segregate all trash and waste by placing in properly labeled containers.
- Do **not** pour chemicals down any drains.
- Do **not** wash tools, instruments or containers over sinks or drains.
- Always provide your environmental contact with details when new products, chemicals or processes are introduced into work environment.
- Immediately contain and report any spills or releases of chemicals, products or contaminated materials or wastes to the HSE Department.

3 Features and Specifications

The balance consists of a graduated balance beam with cup, lid cap, a base with fulcrum, a plunger, and a plastic carrying case. See Figure 3-1.

The beam has four graduated scales (two per side):

- pounds per gallon
- specific gravity
- pounds per cubic foot
- pounds per square inch per 1,000 feet

This feature makes it possible to choose the appropriate density units.

The balance beam also has a sliding weight (rider) that moves along the graduated scale on the beam and a bubble level that indicates when it is balanced. The indentation on the beam sits securely on the knife edge of the fulcrum.

The plunger operates like a syringe. It is used to pressurize the sample cup.

Table 3-1 TRU-WATE™ Fluid Density Balance, Model 141 Specifications

Category	Specification	
Measuring Range	lb/gal	7-22
	lb/in ² /1000 ft	350-1150
	lb/ft ³	50-165
	g/cm ³ (Specific Gravity)	0.75-2.60
Dimensions (Width x Depth x Height)	21.5 x 4 x 4.55 inches 54.6 x 10.2 x 11.6 centimeters	
Weight	9 lb (4.1kg)	

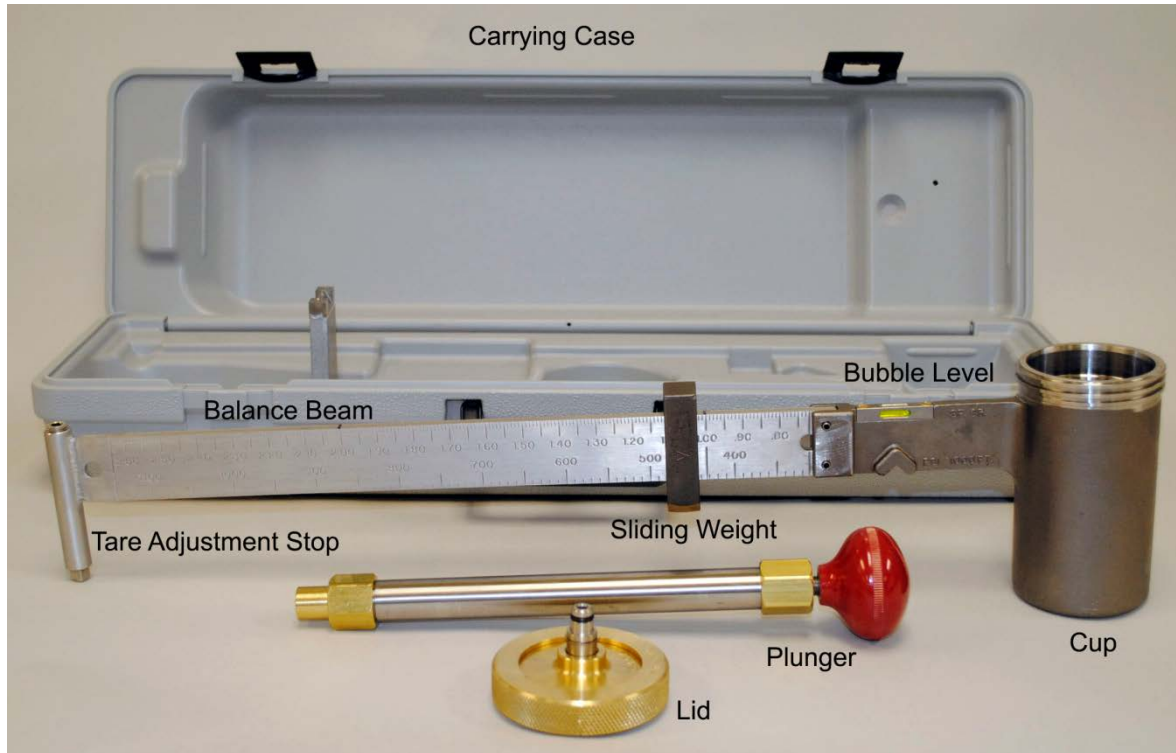


Figure 3-1 TRU-WATE™ Fluid Density Balance

4 Operation



Place the pressurized mud balance on a flat level surface.

This section describes the basic operating instructions and the calibration procedure.

4.1 Procedure

4.1.1 Load Sample

1. Fill the sample cup with the fluid (Figure 4-1) to a level slightly below the upper edge of the cup (approximately 1/4 inches).

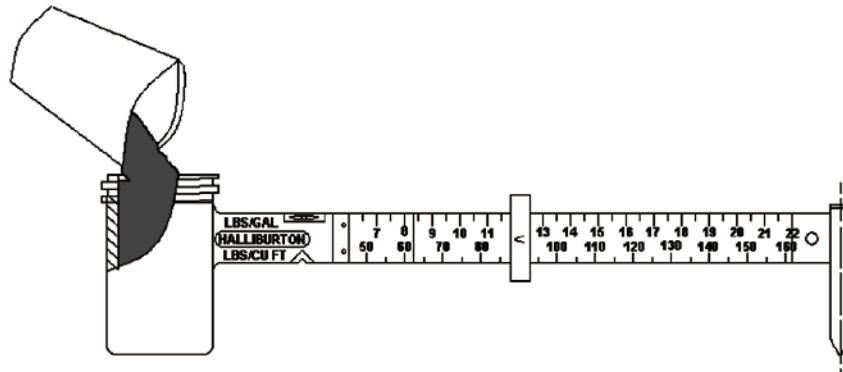


Figure 4-1 Adding fluid to sample cup

2. Place the lid on the cup with the attached check valve in the down position (open).
3. Push the lid downward into the cup until surface contact is made between the outer skirt of the lid and the upper edge of the cup.



If the O-ring on the lid makes it difficult to push the lid onto the cup, do not force it. Forcing the lid can cause fluid to exit from the check valve opening and possibly spray the person in the face

4. Place the threaded cap over the lid and screw it into place. This placement forces the lid against the cup and allows excess fluid to slowly flow out the check valve opening, preventing a sudden spray of fluid. If necessary place a rag over the check valve opening.



Fluid could spray from the connection. Take precautions to avoid fluid contact with face or eyes.

5. As previously mentioned, some fluid should flow out the check valve (Figure 4-2). If fluid does not flow out, remove the lid and pour more fluid into the cup.

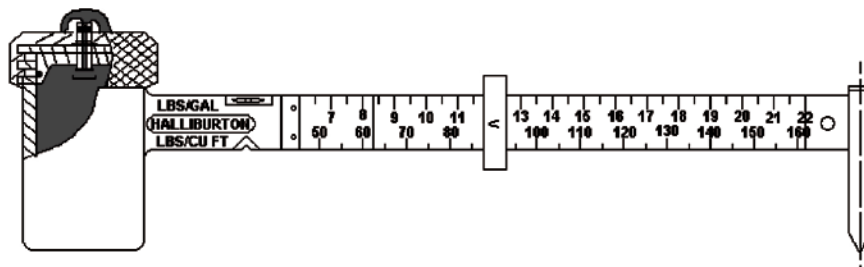


Figure 4-2 A properly filled sample cup

4.1.2 Apply Pressure

1. The pressurizing plunger is similar to a syringe. Fill the plunger by submerging the nose of the plunger into the fluid (Figure 4-3). Then, pull the piston rod upward to fill the plunger.

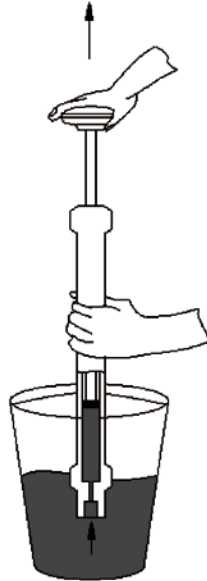


Figure 4-3 Filling the plunger

2. Push the nose of the plunger onto the check valve (Figure 4-4). To pressurize the sample cup, forcefully hold the cylinder to keep the check valve down (open); and simultaneously, apply and maintain approximately 50lb of force on the piston rod.

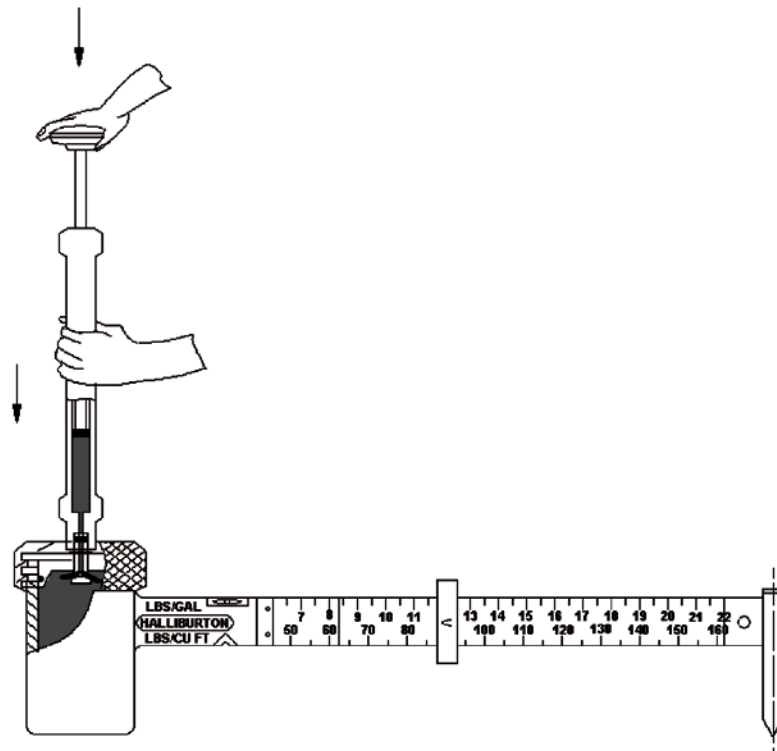


Figure 4-4 Pressurizing the sample cup

3. The check valve is pressure actuated. When pressure is applied within the cup, this same pressure pushes the valve upward into the closed position. Therefore, the valve is closed gradually.
4. While maintaining the same force on the plunger, decrease the force on the cylinder by lessening your grip. This process allows the check valve to move upward slightly (Figure 4-5).
5. When the check valve closes, pressure releases from the plunger and the cylinder disconnects from the check valve.

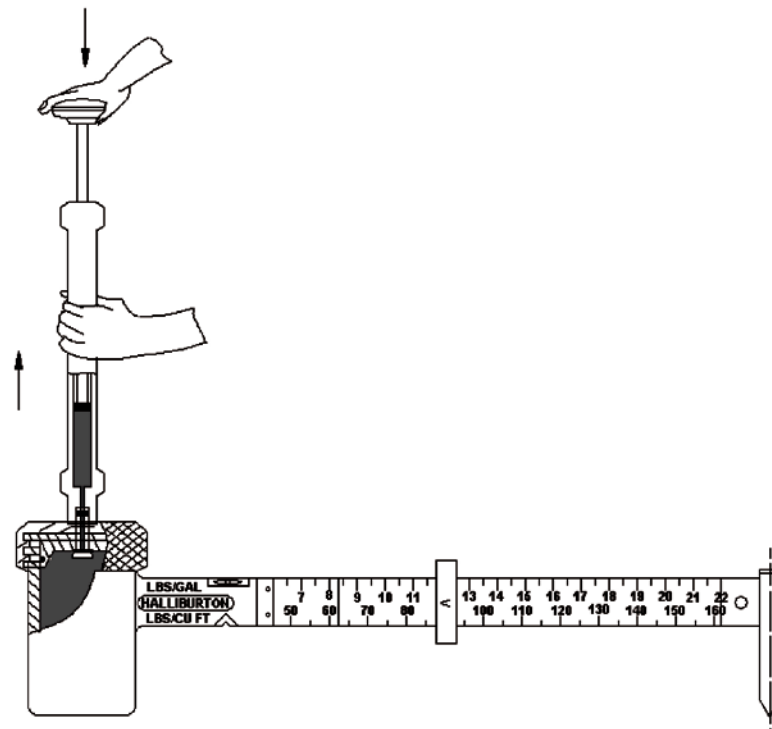


Figure 4-5 Removing the plunger



Observe how far the check valve moves. It should move $3/8$ inch. Make sure the check valve and cylinder are moving up. If the cylinder moves up without the valve moving up, the plunger can disconnect from the check valve and spray fluid. If the plunger housing is raised more than approximately $1/4$ inch while pressure is held on the plunger, the connection will be lost and fluid will spray onto the operator and others nearby.

4.1.3 Weigh Pressurized Sample

The pressurized fluid is now ready for weighing. See Figure 4-6.

1. Rinse the exterior of the cup and wipe it dry.
2. Place the instrument on the knife edge as illustrated in Figure 4-6.
3. Move the sliding weight left or right until the beam is balanced. The beam is balanced when the bubble is centered between the two black marks.

4. Obtain the density by reading one of the calibrated scales on the arrow side of the sliding weight.
5. The density can be read directly in units of lb/gal, specific gravity, psi/100 ft, and lb/ft³.

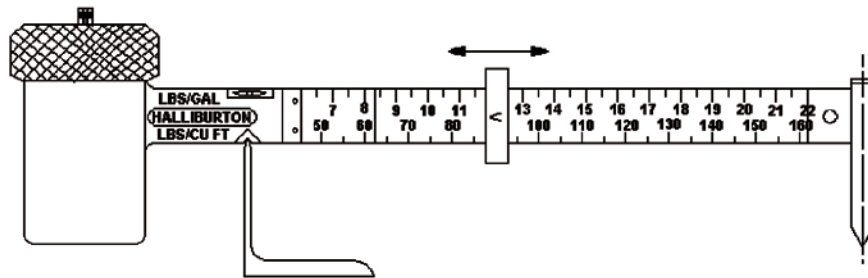


Figure 4-6 Weighing pressurized sample

4.1.4 Release Pressure and Clean-up

1. Reconnect the empty plunger and push down on the cylinder to release pressure. See Figure 4-7.



Do not press downward on the check valve if the plunger assembly is not connected. Pressing downward without the plunger assembly connected will allow the pressurized fluid to spray from the check valve opening.

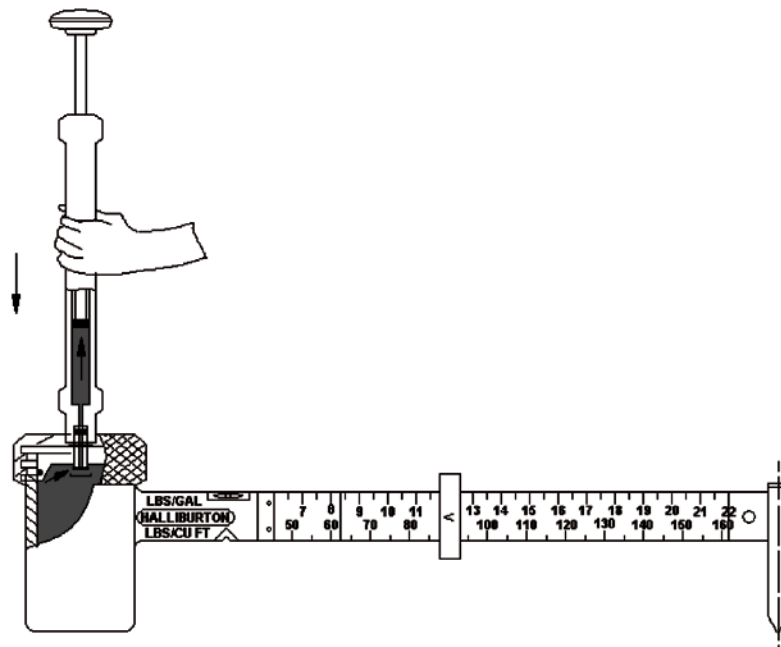


Figure 4-7 Releasing pressure

2. Empty the cup and thoroughly cleanse all components with water. Pull water into the plunger and expel it several times until clear water flows from the plunger.



For best operation, the O-ring should occasionally be lightly greased with waterproof grease.

3. Verify that the check valve works properly by pushing and pulling on it. If it does not move easily, remove the retaining ring (in the groove above the lid) and the sliding check valve.
4. Inspect the O-ring on the sliding check and replace if damaged.
5. Lightly grease the sliding check valve, reinstall it into the lid, and attach the retaining ring.

4.2 Calibration

There are two types of calibration— basic and thorough.

4.2.1 Basic Calibration

This procedure is normally performed in the field. You can perform the basic calibration before using the balance to measure fluid densities during a job.

1. Thoroughly clean the cup and beam assembly. Fill the cup with clear fresh water and place it on the pivot point. Be sure to remove all cement to ensure proper calibration and accurate measurement.
2. Slide the sliding weight to 1.00 on the specific gravity (Sp. Gr.) scale.
3. If the balance bubble is not centered, add or remove lead shot to the tare adjustment stop until the balance is centered.



The cap screw must be in place along with the lead shot when the sliding weight indicates 1.00 on the Sp. Gr. scale.

4. Replace the cap screw on the tare adjustment stop and empty the water from the cup. The basic calibration is now completed.

4.2.2 Thorough Calibration

If a problem is noticed during the basic calibration, perform the thorough calibration. If the balance is damaged or altered (e.g., metal chipped off or inside of cup worn), perform both the basic and thorough calibrations. Always perform the basic calibration before performing a thorough calibration.

The first phase of a thorough calibration determines the weight of water that the cup will hold and is performed as follows:

1. Thoroughly clean the cup and beam assembly. Tare (or weigh) the cup/beam assembly on a digital scale to determine a zero point (or weight in grams).
2. Fill the cup with water, install the lid, and pressurize the cup.
3. Place the cup/beam assembly on the pivot and ensure that the indication on the balance beam is 8.33 lb/gal.

4. Remove the cup/beam assembly from the pivot and place it back on the digital scale to determine the weight of water in the cup. Record the grams of water.
5. Empty the water from the cup and dry it.

When the basic calibration is complete, perform the following steps to complete the thorough calibration.

1. In the cup, add lead shot equal to the weight of water that was in the cup. The lead shot must be leveled inside the cup.
2. Place the cap on the cup and determine the weight indication. Record this value and compare it against the 8.33 lb/gal calibrated density of the water.
3. Place lead shot into the cup in weights of 250, 300, 350, 400, 450, 500, 550, and 585 grams. Level each lead shot and place the lid on the cup. Determine the density for each lead weight and record it.

Use this equation to calculate the true density of the lead weight in the cup:

$$D_t = (L_g / W_g) \times D_w$$

Where:

D_t = True density based on the grams of lead shot in cup.

L_g = Grams of lead shot in cup.

W_g = Grams of water in cup for basic calibration check.

D_w = Density of water in cup in lb/gal. Normally, this will be 8.33 based on water having a specific gravity of 0.9981 (normal for tap water at 68°F). If the specific gravity of the water is determined, it should be used instead of the 0.9981, and the resultant density indication of the water in the cup may vary slightly from 8.33 lb/gal.

The density measurement depends partially, on the user's technique. On average, the density can be estimated within 0.1 lb/gal. The calculated density of the lead shot should be within approximately 0.05 lb/gal of the observed density.

A custom-designed spreadsheet is available for recording the calibration. See Figure 4-8. Please contact Fann Instrument Company to receive this spreadsheet (Excel[®]) for download.

On the spreadsheet, you can enter the basic and thorough calibration data points in the cells highlighted in yellow. The data points will be graphed. You can use this information to evaluate the calibration accuracy of your TRU-WATE™ Fluid Density Balance.

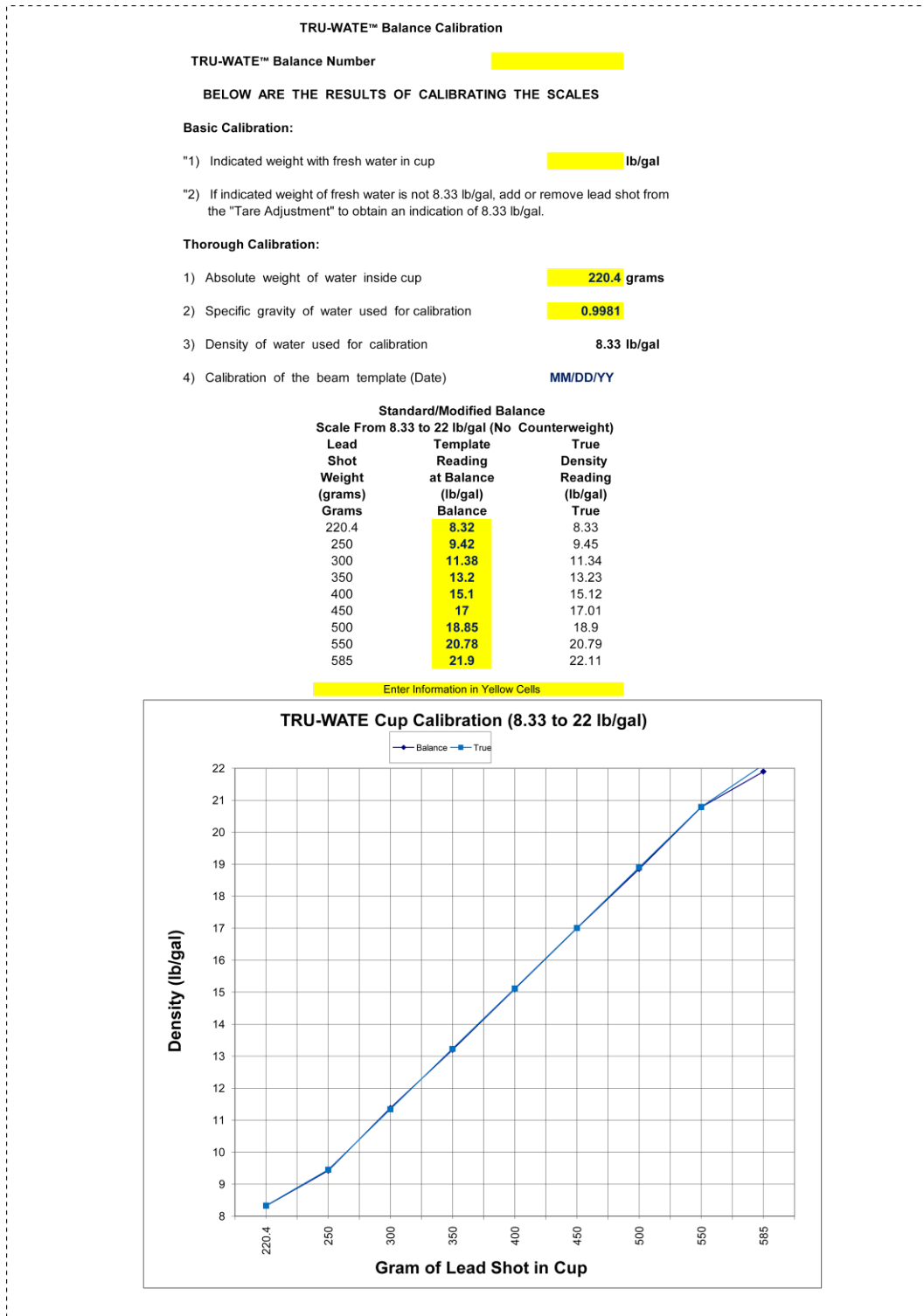


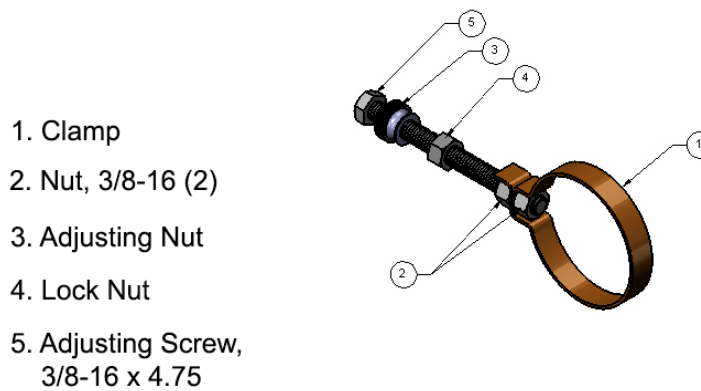
Figure 4-8 TRU-WATE™ Balance Calibration Spreadsheet

4.2.3 Sliding Weight Calibration



This procedure is normally performed when the instrument is manufactured. Calibration should not be necessary unless the cup and beam assembly have been damaged.

1. Attach the Calibration Adjustment Assembly (Figure 4-9) to the sample cup (Figure 4-10) Tighten the adjusting screw to secure the clamp around the circumference of the cup.



1. Clamp
2. Nut, 3/8-16 (2)
3. Adjusting Nut
4. Lock Nut
5. Adjusting Screw, 3/8-16 x 4.75

Figure 4-9 Calibration Adjustment Assembly

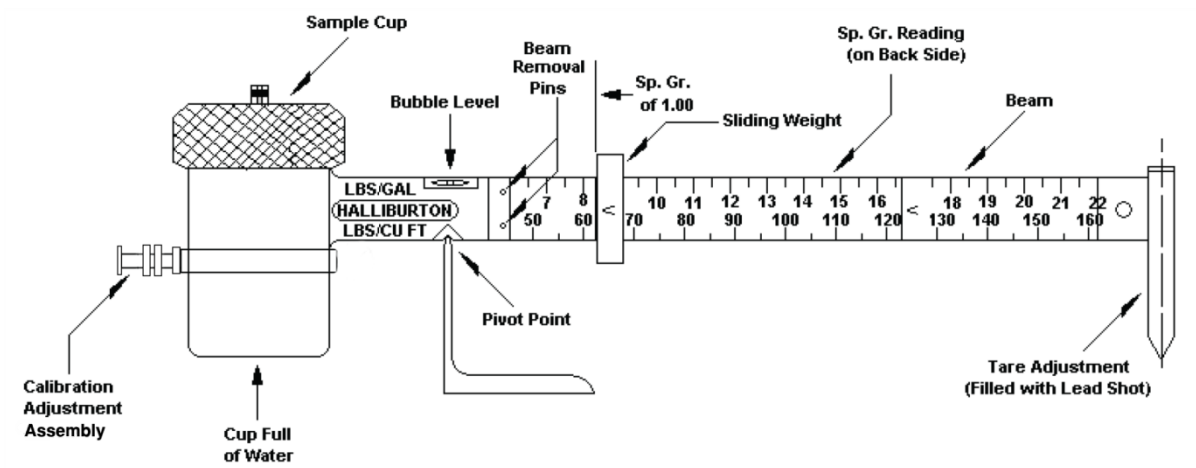


Figure 4-10 Calibration Adjustment Assembly attached to the sample cup

2. Place the empty assembly on the pivot point with the cap and lid in place.

3. Move the sliding weight to 1.00 on the specific (Sp. Gr) scale (Figure 4-10). The Sp. Gr. Scale is on the back of the balance beam. The arrow side of the weight points to the weight.
4. Rotate the adjusting nut and lock nut together onto the adjusting screw until the instrument is balanced according to the bubble level. Lock these nuts in the balanced position.
5. Fill the sample cup with water and pressurize.
6. Using the sliding weight, to rebalance the instrument. Record the specific gravity observed on the balance.
7. Detach the beam from the cup by removing the roll pins. Remove the sliding weight. Weigh the sliding weight on an accurate digital balance. Record the weight in grams.
8. Use the following equation to determine the correct weight for the sliding weight. Then adjust the sliding weight accordingly. Remove excess weight by grinding on the sliding weight or add weight by soldering to the sliding weight.

$$W_c = (\text{Sp. Gr.} - 1.00) \times W_a$$

Where:

W_c = The correct weight in grams of the sliding weight after adjustment.

Sp. Gr. = The specific gravity recorded in step 6.

W_a = The unadjusted weight in grams as measured in Step 7.

9. After adjusting the sliding weight, replace the sliding weight on the beam and reattach the beam. Insert the roll pins to secure the balance beam to the cup.
10. With the cup still full, remove the calibration adjustment assembly and place the instrument on the pivot point.
 - a. Slide the sliding weight to 1.00 on the Sp. Gr. Scale.
 - b. Remove the cap screw from the top of the tare adjustment tube.
 - c. Add lead shot to the tare adjustment tube on the end of the beam until balance is achieved.



The cap screw must be in place along with the lead shot when the sliding weight indicates 1.00 Sp. Gr. Scale.

- d. Replace the cap screw and empty the water from the cup. The unit is now calibrated.

5 Test Analysis

The density can be read directly in units of lb/gal, specific gravity, psi/100 ft, and lb/ft³.

This instrument and method for measuring fluid density complies with the following API standards:

- API Recommended Practice for Testing Well Cements, API RP 10B-2
- API RP 13B-1 Recommended Practice for Field Testing Water-based Drilling Fluids
- API RP 13B-2 Recommended Practice for Field Testing Oil-Based Drilling Fluids

6 Troubleshooting and Maintenance

To properly care for the TRU-WATE™ Fluid Density Balance, follow these tips:

- Thoroughly wash and dry the balance after each measurement.
- Check and replace damaged, cracked or worn O-rings on the lid and check valve.
- Test the check valve for proper operation by pushing and pulling it. If it does not move easily, the retaining ring (on the groove above the lid) and the sliding check valve should be removed and inspected. Lightly grease the sliding check valve.
- Be sure to move the check valve in and out in the lid when cleaning it to remove any cement or drilling fluid.
- The O-rings and sliding portion of the check valve and large O-ring on the lid may be lightly coated with grease to allow it to move easier during a test.

7 Accessories

This instrument does not have any accessories. However, you may order the optional equipment listed in Table 7-1 and Table 7-2.

Table 7-1 Optional Equipment for the TRU-WATE™ Balance

Part Number	Description
206742	LEAD SHOT FOR CALIBRATION
206807	TRU-WATE™ REBUILD KIT
100034509	MULTI-PURPOSE GREASE
102447319	CALIBRATION ADJUSTMENT ASSEMBLY

Table 7-2 TRU-WATE™ Rebuild Kit, P/N 206807, Rev D

Item No.	Part No.	Quantity	Description
0001	100000947	4	O-RING, 90 DURO, 3/8 X 1/4 X 1/16
0002	100001880	4	O-RING, 70 DURO, 1/2 X 3/8 X 1/16
0003	100001884	2	O-RING, 70 DURO, 2 3/16 X 2 X 3/32
0004	100003575	1	BUBBLE LEVEL ASSEMBLY
0005	100001916	1	O-RING, 70 DURO, 3/4 X 9/16 X 3/32
0006	100003569	1	PACKING, CUP
0007	100003574	1	CHECK VALVE

8 Parts List

Table 8-1 TRU-WATE™ Balance, P/N 100003565, Rev H

Item No.	Part No.	Quantity	Description
0001	102026609	1	CARRYING CASE, 4 X 4 5/8 X 21 1/2
0002	100003572	1	CUP, FLUID SAMPLE
0003	100003566	1	PLUNGER ASSEMBLY
0004	100028783	2	ROUND HEAD SCREW, BRASS
0005	100026604	2	WING NUT, BRASS
0006	100029866	2	FLAT WASHER, #10, STAINLESS STEEL
0007	100003576	1	FULCRUM POINT ASSEMBLY
0010	100063065	1	TRU-WATE BALANCE 141 INSTRUCTION MANUAL
0011	100001884	3	O-RING, 70 DURO, 2 3/16 X 2 X 3/32
0012	100001880	4	O-RING, 70 DURO, 1/2 X 3/8 X 1/16 568-012
0013	100001941	3	O-RING, NBR NITRILE 90 DURO, 3/8 X 1/4 X 1/16
0015	100001640	2	CLAMP, CABLE TIE, 0.184 W, 7.310 LG, SPEC
0017	100003571	1	CAP, LID, CUP
0018	100003573	1	LID, CUP
0019	100002151	1	RETAINING RING, EXTERNAL
0020	100003574	1	CHECK VALVE, SAMPLE CUP
0022	100063060	1	SLIDING LEVER WEIGHT
0024	100062542	2	PIPE PLUG, 1/8, SOCKET HEAD, ALLEN, 304 SS
0025	100009333	2	ROLL PIN, 5/32 X 5/8, STAINLESS STEEL
0026	100003575	1	BUBBLE LEVEL ASSEMBLY



Figure 9-1 TRU-WATE™ Balance Assembly

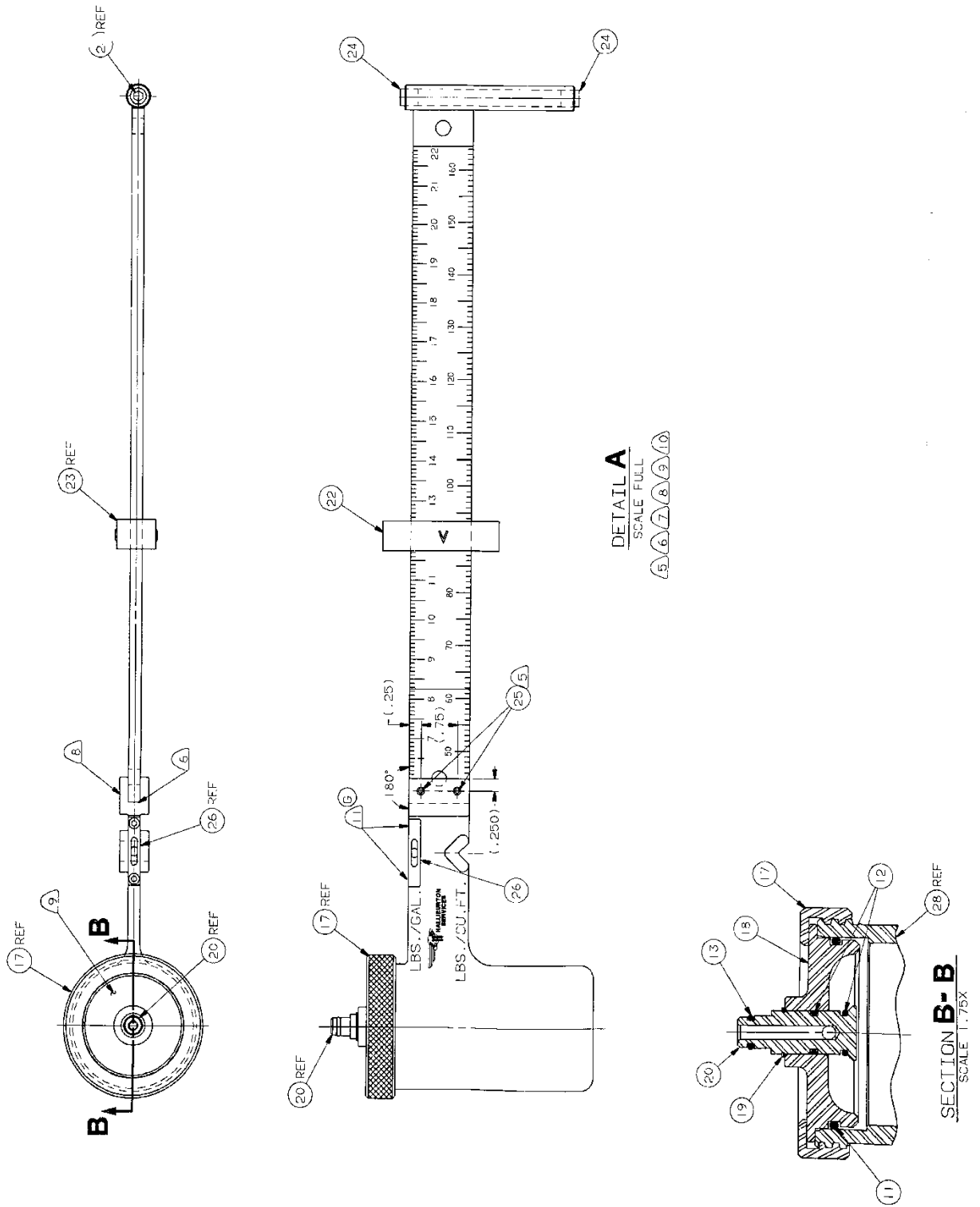


Figure 9-2 TRU-WATE™ Balance Assembly, Schematic

Table 8-2 Plunger Assembly, P/N 10003566, Revision E

Item No.	Part No.	Quantity	Description
0001	100063057	1	BRASS PISTON STOP
0002	100001916	1	O-RING, 70 DURO, 3/4 X 9/16 X 3/32
0003	100003569	1	CUP PACKING
0004	100003568	1	BACK-UP WASHER
0005	100063058	1	COMPRESSION CYLINDER
0006	100003567	1	PISTON ROD GUIDE
0007	100009375	1	PISTON ROD
0008	100001801	1	PLASTIC KNOB, 2 IN DIA, 3/8-24 NF INSERT
0009	100003570	1	SCREW, SHOULDER, #4-40NC X 9/32, SS 303

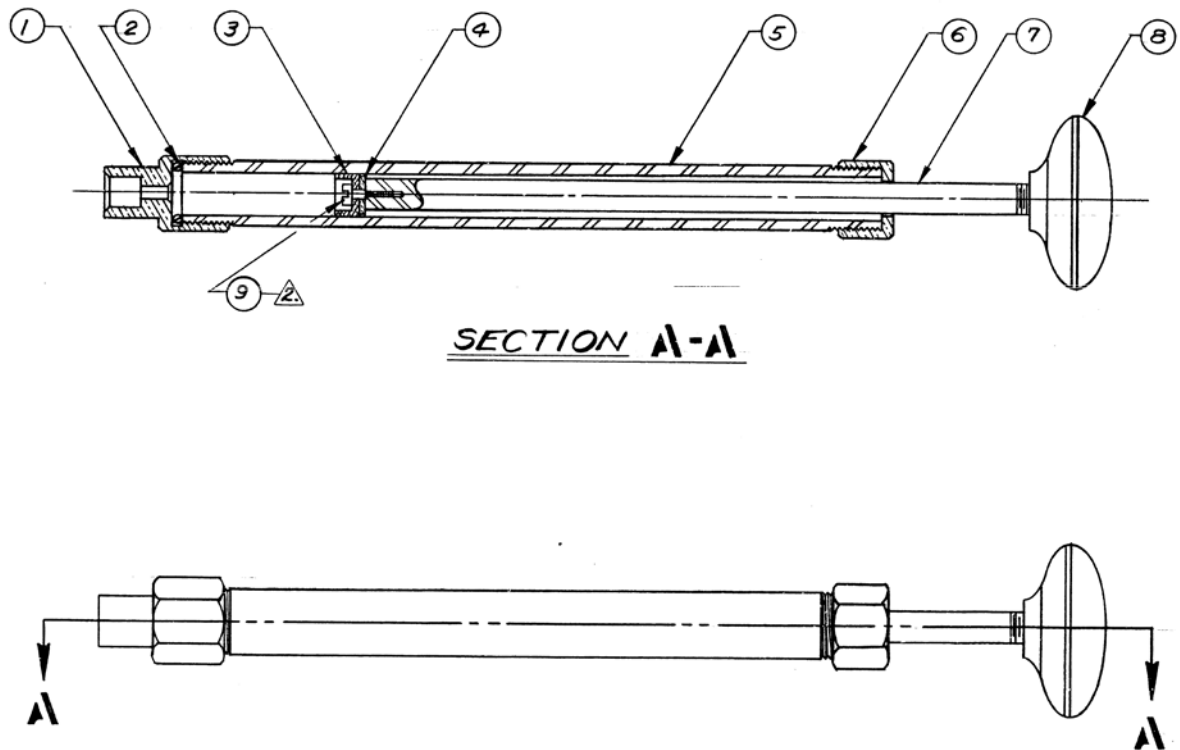


Figure 9-3 TRU-WATE™ Balance Plunger Assembly

9 Warranty and Returns

9.1 Warranty

Fann Instrument Company warrants only title to the equipment, products and materials supplied and that the same are free from defects in workmanship and materials for one year from date of delivery. **THERE ARE NO WARRANTIES, EXPRESS OR IMPLIED OF MERCHANTABILITY, FITNESS OR OTHERWISE BEYOND THOSE STATED IN THE IMMEDIATELY PRECEDING SENTENCE.** Fann's sole liability and Customer's exclusive remedy in any cause of action (whether in contract, tort, breach of warranty or otherwise) arising out of the sale, lease or use of any equipment, products or materials is expressly limited to the replacement of such on their return to Fann or, at Fann's option, to the allowance to Customer of credit for the cost of such items. In no event shall Fann be liable for special, incidental, indirect, consequential or punitive damages. Notwithstanding any specification or description in its catalogs, literature or brochures of materials used in the manufacture of its products, Fann reserves the right to substitute other materials without notice. Fann does not warrant in any way equipment, products, and material not manufactured by Fann, and such will be sold only with the warranties, if any, that are given by the manufacturer thereof. Fann will only pass through to Customer the warranty granted to it by the manufacturer of such items.

9.2 Returns

For your protection, items being returned must be carefully packed to prevent damage in shipment and insured against possible damage or loss. Fann will not be responsible for damage resulting from careless or insufficient packing.

Before returning items for any reason, authorization must be obtained from Fann Instrument Company. When applying for authorization, please include information regarding the reason the items are to be returned.

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