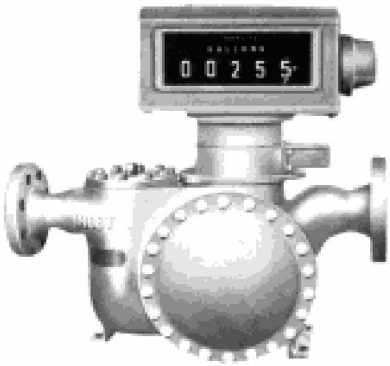
(S)X-(B-43/B-54)

# INSTALLATION & OPERATING INSTRUCTIONS

# High Pressure BiRotor Meters

Revision 01

**Models**
**B-43, B-43H, B-53, B-53H**
**B-53HF, B-54, B-55**

**CAUTION: It is recommended that this publication be read in its entirety before performing any operation. Failure to understand and follow these instructions could result in serious personal injury and/or damage to the equipment. Should this equipment require repair or adjustment, contact the nearest Sales Office. It is important that servicing be performed only by trained and qualified service personnel. If this equipment is not properly serviced, serious personal injury and/or damage to the equipment could result.**

**Brodie Meter Co., LLC**
P.O. Box 450
19267 Highway North (30461)
Statesboro, GA 30459-0450
Phone: (912) 489-0200
Fax: (912) 489-0295
*www.brodiemeter.com*

# Essential Instructions:

## Read this page before proceeding

**Brodie Meter Co., LLC designs, manufactures and tests its products to meet many national and international standards. Because these instruments are sophisticated technical products, you must properly install, use and maintain them to ensure they continue to operate within their normal specifications. The following instructions must be adhered to and integrated into your safety program when installing, using and maintaining Brodie Meter Co., LLC Products.**

- Read all instructions prior to installing, operating and servicing the product. If this instruction manual is not the correct manual, telephone Brodie Meter Co., LLC and the requested manual will be provided. Save this instruction manual for future reference.
- If you do not understand any of the instructions, contact your representative for clarification.
- Follow all warnings, cautions and instructions marked on and supplied with the product.
- Inform and educate your personnel in the proper installation, operation and maintenance of the product.
- Install your equipment as specified in the installation instructions of the appropriate instruction manual and per applicable local and national codes. Connect all products to the proper electrical and pressure sources.
- To ensure proper performance, use qualified personnel to install, operate, update, program and maintain the product.
- When replacement parts are required, ensure that qualified people use replacement parts specified by Brodie. Unauthorized parts and procedures can affect the product's performance and place the safe operation of your process at risk. Look-alike substitutions may result in fire, electrical hazards or improper operation.
- Ensure that all equipment doors are closed and protective covers are in place, except when maintenance is being performed by qualified persons, to prevent electrical shock and personal injury.

## TABLE OF CONTENTS



## LIST OF ILLUSTRATIONS

## LIST OF TABLES



## INSTRUCTION CROSS REFERENCE

| | Reference Bulletins |
|---|---|
| Model 4200 Adjustor | (S) X-4200 |
| Model 4000 Adjustor | M-5400-20 |
| Counter Extensions | M-5193-10 |
| High Frequency Pulse Generator | M-4351-20 |
| Automatic Temperature Compensator | (S) X-4400 |
| Impulse Contactor | M-4352-20 |
| Preset Counter | Form No. 251278 |
| Large Dial Register | Form No. 251325 |
| Ticket Printer | Form No. 251322 |

## Section 1 INTRODUCTION

### 1-1 General Description

These model BiRotors are designed to handle crude and refined petroleum products and many commercial liquids. They are particularly suitable for use on small pipe lines, LACT units and many similar applications.
Inlet and outlet connections are in line on all models. The B-43 and B-53 have threaded connections. All other models have flanged connections.
Models B-43, B-43H, B-53 and B-53H are complete with integral strainer, B-54 and B-55 are meters only.

### 1-2 Description—Measuring Unit

The meter generally consists of a measuring unit installed in an outer housing or case, an adjustor for calibrating the meter and the necessary counter equipment for registering the amount of liquid thruput.

The principle of operation of the meter is embodied in the function of the two rotors which are the only moving parts within the measuring unit. They are always dynamically balanced but hydraulically unbalanced. The rotors are not in metal-to-metal contact with one another or with the housing in which they rotate. They are maintained in proper timed relationship with one another by helical gears. They divide the volume being measured into segments, separate each segment from the flowing stream momentarily, then return them to the stream. The segments of flow are counted and the results are transferred to a totalizing register or other flow recording device by means of a gear train.

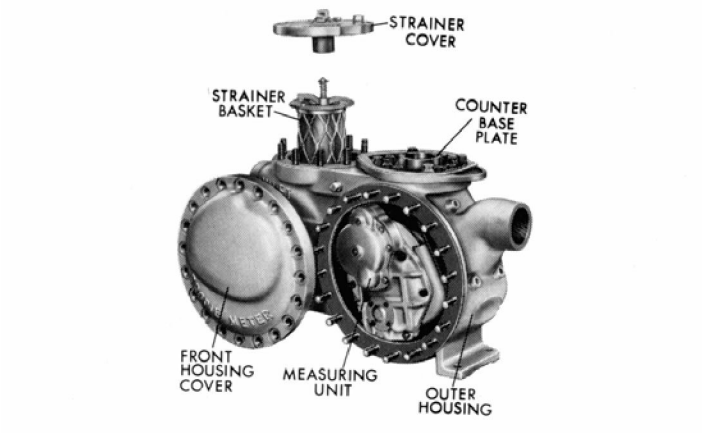
The BiRotor Meter is unique in that it does not use any sliding vanes or reciprocating parts nor are there any shock loads on the mechanism during operation resulting from the shifting of off-balance masses.

An accuracy adjustor, located on the output of the counter drive gearing permits the operator at the time of installation, to adjust the output of the measuring unit to read in an exact number of units of volume. Thus the accuracy adjustor acts as a variable gear changer (similar to the speeding up or slowing down of the timing of a watch) and allows an adjustment of + 3% of meter thruput. The meter may be supplied with any of several accessory items, such as, high frequency pulse generator, impulse contactor, automatic temperature compensator (ATC), etc. The units provide various functions for local and/or remote control and local and/or remote readout.

**NOTE: Before placing the meter into service, refer to the appropriate instruction manual for these accessory units if the meter is so equipped.**

### 1-3 Meter Model Number

The model number, serial number, flow range, and operating pressure appear on the nameplate attached to the meter body.




### 1-4 Specifications

The following specifications apply to the meter unless otherwise noted.

**Materials of Construction (Standard Meters)**

Counter Base Plate (Steel) provides connection from measuring unit to adjustor. Includes an O-Ring seal around packing shaft.
- Outer Housing—cast steel
- Housing Cover—cast steel
- Strainer Cover B-43, B-43H, B-53, B-53H—steel
- Strainer Screen B-43, B-43H, B-53, B-53H —monel 20, 40 mesh; stainless steel - 80 mesh

Measuring Unit:
- Rotors—heat treated aluminum
- Rotor Shafts—ground and polished nitralloy
- Rotor Bearings—stainless steel ball bearings

Body and End Covers — nickel cast iron -
- Gear Covers — stainless steel and heat treated aluminum
- Counter Drive Gears — nylon worm wheel, other gears stainless steel
- Counter Drive Shafts—stainless steel
- Counter Drive Shaft Bushings—teflon

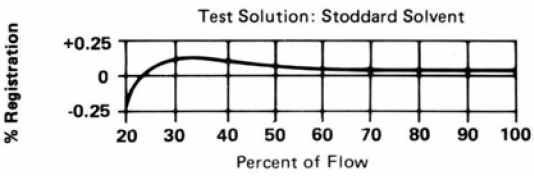
**Materials of Construction (All Ferrous Meters)**

In an all-ferrous meter no bronze, aluminum or copper bearing alloy contacts the liquid product, only iron, steel or stainless steel.
- Outer Housing and Cover—steel
- Counter Base Plate—steel
- Strainer Cover—(B-53F and B-53HF only)—steel
- Strainer Screen—(B-53F and B-53HF only)—monel or stainless steel.

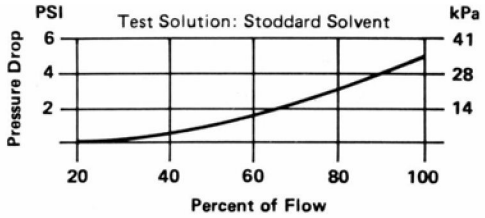
Measuring Unit:
- Body and End Covers—cast iron
- Rotors—cast iron
- Rotor Shafts—nitralloy
- Rotor Bearings—stainless steel
- Counter Drive Shafts—stainless steel
- Counter Drive Gears—stainless steel
- Gear Covers—cast iron or stainless steel
- Drive Shaft Bushings—teflon
- O-Rings—viton "A"

**Product Temperature Range:** -20°F to 150°F
-29°C to 66°C

**Typical Accuracy Curve**




**Typical Pressure Drop Curve**



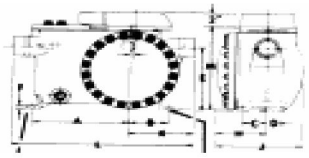

***Standard factory flow test—20% to 100% capacity for extended flow range consult factory**

CAUTION: Do not use this meter in excess of the below specified values.

| | Maximum Capacity Gasoline or Light Oil | | | | Maximum Safe Working Pressure | | | Shipping Weight | |
|---|---|---|---|---|---|---|---|---|---|
| **Model** | USGPM | IGPM | LPM | BPH | PSI | kPa | **Connections** | lbs. | kg. |
| B-43 | 80 | 65 | 300 | 115 | 300 | 2068 | 1-1/2" NPT Threaded | 95 | 43 |
| B-43H | 80 | 65 | 300 | 115 | 275 | 1896 | 1-1/2" 150 lb. ANSI Flg. | 95 | 43 |
| | | | | | 300 | 2068 | 1-1/2" 300 lb. ANSI Flg. | 95 | 43 |
| B-53 | 120 | 100 | 450 | 170 | 300 | 2068 | 2" NPT Threaded | 140 | 64 |
| B-53F | 120 | 100 | 450 | 170 | 300 | 2068 | 2" Threaded | 140 | 64 |
| | | | | | 275 | 1896 | 2"150 lb. ANSI Flg. | 140 | 64 |
| B-53H | 120 | 100 | 450 | 170 | 300 | 2068 | 2" 300 lb. ANSI Flg. | 140 | 64 |
| B-53HF | 120 | 100 | 450 | 170 | 275 | 1896 | 2" 150 lb. ANSI Flg. | 140 | 64 |
| | | | | | 300 | 2068 | 2" 300 lb. ANSI Flg. | 140 | 64 |
| B-54 | 120 | 100 | 450 | 170 | 720 | 4964 | 2" 300 lb. ANSI Flg. | 195 | 88 |
| B-54F | 120 | 100 | 450 | 170 | 720 | 4964 | 2" 300 lb. ANSI Flg. | 195 | 88 |
| B-55 | 120 | 100 | 450 | 170 | 1440 | 9928 | 2" 600 lb. ANSI Flg. | 213 | 97 |
| B-55F | 120 | 100 | 450 | 170 | 1440 | 9928 | 2" 600 1b. ANSI Flg. | 213 | 97 |

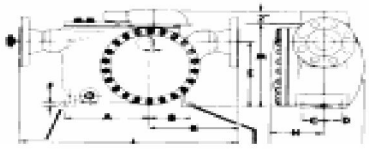
**Figure 1-1, Table 1-1 DIMENSIONS (For Certified Prints Contact Factory)**

**B-43 OR B-53**



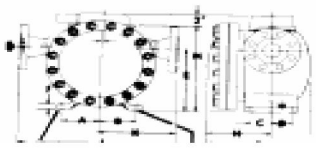
1 HOLE 2 HOLES
3 MOUNTING HOLES: B43 - 15/32"; B-53 - 1/2"

**B-43H OR B-53H**



1 HOLE 2 HOLES
3 MOUNTING HOLES: B43H—15/32"; B-53H—1/2"

**B-54 OR B-55**




2 HOLES
4 MOUNTING HOLES—9/16"

| | | Dimensions | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Model** | **mm Inches** | **A** | **B** | **C** | **D** | **E** | **F** | **H** | **J** | **K** | **L** | **M** | **P** |
| B-43 | mm | 227 | 93 | 54 | 19 | 186 | 10 | 130 | 213 | 152 | 428 | 248 | |
| | Inches | 8-15/16 | 3-11/16 | 2- 1/8 | 3/4 | 7-5/16 | 3/8 | 5-1 /8 | 8-3/8 | 6 | 16-7/8 | 9-3/4 | |
| * B-43H | mm | 227 | 93 | 54 | 19 | 186 | 10 | 130 | 213 | 187 | 498 | 248 | |
| | Inches | 8-15/16 | 3-11/16 | 2-1/8 | 3/4 | 7-5/16 | 3/8 | 5-1 /8 | 8-3/8 | 7-3/8 | 19-5/8 | 9-3/4 | |
| B-53 | mm | 225 | 108 | 57 | 44 | 220 | 11 | 143 | 248 | 203 | 514 | 281 | |
| B-53F | Inches | 8-7/8 | 4-1 /4 | 2-1 /4 | 1 -3/4 | 8-11/16 | 7/16 | 5-5/8 | 9-3/4 | 8 | 20- 1/4 | 11-1/16 | |
| *B-53H | mm | 225 | 108 | 57 | 44 | 220 | 11 | 143 | 248 | 232 | 572 | 281 | |
| B-53H F | Inches | 8-7/8 | 4-1/4 | 2-1/4 | 1 -3/4 | 8-1 /16 | 7/16 | 5-5/8 | 9-3/4 | 9-1/8 | 22-1/2 | 11-1/16 | |
| B-54 | mm | 108 | 108 | 60 | 60 | 230 | 19 | 184 | 295 | 222 | 457 | 316 | 32 |
| B-54F | Inches | 4-1/4 | 4-1/4 | 2-3/8 | 2-3/8 | 9-1 /16 | 3/4 | 7-1 /4 | 11 -5/8 | 8-3/4 | 18 | 12-7/16 | 1 -1 /4 |
| B-55 | mm | 108 | 108 | 60 | 60 | 230 | 19 | 195 | 306 | 232 | 476 | 316 | 32 |
| B-55F | inches | 4-1/4 | 4-1/4 | 2-3/8 | 2-3/8 | 9-1/16 | 3/4 | 7-11/16 | 12-1/16 | 9-1/8 | 18-3/4 | 12-7/16 | 1-1/4 |

***"L" Dimension for B-43H 150 lbs. 19-1/8" (486 mm) and B-53H and B-53HF 150 lbs. 22-1/16" (560mm)**

## Section 2 INSTALLATION

### 2-1 General

This section contains the procedures for receipt and installation of the meter Specific instructions are provided for accessory equipment.

### 2-2 Receipt of Equipment

When the equipment is received, the outside of the packing case should be checked for any damage incurred during shipment. If the packing case is damaged, the local carrier should be notified at once regarding his liability.
A report should be submitted to the Product Service Department, Brodie Meter Co., LLC, Statesboro, Georgia 30458.
Remove the envelope containing the packing list. Carefully remove the equipment from the packing case. Make sure spare, or replacement parts are not discarded with the packing material. Inspect for damaged or missing parts.
In many cases the accessory items that form the "stack-up" of the meter have not been shipped assembled to the meter. The "stack-up" assembly will be shipped as a complete unit where possible. If not, it will be broken apart into as few assemblies as is practical. Refer to the Packing List for information as to what is supplied for your particular meter. In the event that any items are missing from your shipment, contact your local representative or sales office. Provide him with the serial number and sales order number.

### 2-3 Return Shipment

To be able to process returned goods quickly and efficiently, it is **IMPORTANT** that you provide essential information. Do not return any assembly or part without an "R.M.R." (Returned Material Report) or a letter which describes the problem, corrective action (if any) and the work that is to be performed at the factory. "R.M.R." forms can be obtained from sales offices or the Service Department, Brodie Meter Co., LLC, Highway 301 North, Statesboro, Georgia 30458.
Place a copy of either of the above inside the shipping container and attach it physically to the material being returned. A copy of your packing list should be placed inside an envelope and attached to the outside of the shipping container or placed inside the container
Failure to follow the above procedures could possibly result in considerable delay due to improperly or totally unidentified items.

### 2-4 Recommended Procedures

Prior to installation of the meter, the following items of general information and recommendations should be considered:

1. On new installations, the lines should be flushed thoroughly to rid the pipe of welding bead, pipe scale, etc., before the meter is placed in service. This can be done by using a spool-piece in place of the meter.
2. All counters can be rotated and secured in any of eight positions.
3. Flow direction is marked on the meter case, near the inlet flange.
4. Install a strainer ahead of the inlet of the meter. (B-54 and B-55 Meters only).
5. The meter should be level for proper and specified operation. The rotors in the measuring element must be in a horizontal position.
6. Shut-off or control valves should be located downstream of the meter.
7. Do not use guide wires or stabilizing ropes on any part of the stack-up. Some stack-ups will require support by use of support blocks and brackets secured to structural members.
8. Block valves located upstream and downstream of the meter are recommended to isolate the meter from fluid flow.

## Section 3 OPERATION

**CAUTION: Do not operate this meter in excess of the values listed in Section 1-4 Specifications.**

### 3-1 General

1. When the meter is first put into operation, or at any time the meter has been drained, it should be started slowly until all air has been exhausted from the outer housing.
2. To prevent high shock pressures or surges, care should be exercised in opening or closing valves when starting or stopping flow through the meter.
3. On new installations, the lines should be flushed thoroughly to rid the pipe of welding bead, scale, etc., before the meter is placed in service. This can be done by using a spool-piece in place of the meter.
4. If the meter has been installed before the flushing operation, then the measuring unit should be removed from the outer housing while the line is being flushed.

**Note: Failure to perform the above procedure could result in serious damage to the meter.**

Water should never be used as a flushing medium through this meter. Always use a flushing medium that is compatible with the metallurgy of the meter and its internal parts, and similar to the product for which this meter was intended. See Materials of Construction, Section 1-4.

5. A strainer of proper size should be installed upstream of the meter to protect it from the entrance of foreign material which might damage the measuring unit.
6. A regular schedule should be set up to clean the strainer basket to prevent air from filling and rupturing the screen. Pressure gauges installed on either side of the strainer will show the differential pressure across the strainer. High differential pressure may cause the basket to rupture, permitting large quantities of foreign matter to enter the meter suddenly. This would result in stoppage of the meter and require it to be disassembled and cleaned.

## Section 4 MAINTENANCE

**CAUTION: Extreme care must be exercised when the measuring chamber is exposed and handled. Hands must be kept clear of the timing gears, rotors and measuring chamber or serious personal injury can occur. Due to the precision balance of the rotors and timing gears, they can be set in motion easily. Keep hands clear of these parts at all times! At no time should hands be used to brace these parts while servicing.**

### 4-1 General

The amount of maintenance necessary for efficient meter performance depends upon such factors as:

1. Continuity of Operation — A meter which operates continuously, will require more attention than one on intermittent duty.
2. Rate of Flow — The practical life of any piece of equipment is proportional to its speed of operation. A meter operating at, or close to its maximum rating will have a shorter life than one operating at a reduced rate.
3. Lubricating Value of Product — Other factors being equal, a meter handling a light lubricating oil will have a longer life than one measuring a dry motor fuel.
4. Cleanliness of Product — Abrasive solid matter accelerates meter wear.

Meters that are given a little attention regularly will deliver better performance and have a longer life than those that are given no attention until they have failed. Frequently a meter's performance will depend, to a considerable extent, upon the proper functioning of the accessory equipment in the piping system. Following are listed some of the conditions and factors influencing meter performance:

1. A meter should be kept filled with the liquid it is measuring. Draining results in the formation of deposits and gums which increase the mechanical friction. Any leaky shut-off valves or check valves which would permit the meter to drain should be repaired or replaced.
2. A petroleum meter should be kept free of water. Usually, regular inspection and draining of storage tanks is sufficient protection.
3. Clean the strainer basket frequently.
4. Soft closing loading valves or shock chambers for eliminating water hammer should be kept in good working order.
5. The valves and operating mechanism of an air eliminator should be given occasional inspection. This is especially true where a critical air condition exists and for this reason, meter performance is very dependent upon proper air elimination. The valves and operating mechanism of an air eliminator are subject to very difficult operating conditions. With some products alternate wetting and drying results in gum formations. The vapors of most petroleum products are more corrosive than the liquids. In some installations salt air is a corrosive factor.
6. The counter of the meter should be given some protection during extreme weather conditions.
7. A meter taken out of service for any length of time should be filled with light lubricating oil.
8. Keep applicable service bulletins available for reference.

**CAUTION: Before performing any disassembly or reassembly procedures, all flow to meter should be off. All electrical connections to accessories should be disconnected. Service should be performed by trained and qualified personnel only.**

9. Meter should be drained as much as possible. The design of these meters makes it possible to completely disassemble and reassemble without removing from line.

### 4-2 General Meter Disassembly

Cleanliness is of prime importance when working on a precision instrument. The work area should be clean and the meter parts thoroughly washed. All gaskets and O-Rings should be removed and replaced. This policy will assure maximum performance from your BiRotor Meter at less expense and with greater accuracy.

**A. Removing Measuring Unit (Refer to Figure 6-1 )**

1. Remove drain plug (item 33), drain meter and replace plug.
2. Remove all accessories, including adjustor (item 18) and counter base plate (item 15) by removing screws (items 17 and 21).
3. Remove housing cover (item 3) from meter housing (item 2).
4. Remove the strainer cover (item 7) by removing nuts (item 6) and lift out the strainer basket assembly (item 31). (Not required for B-54 and B-55).

**NOTE: The inner screen can be removed by turning the top ring to unlock. The inner screen must be inspected for holes or torn places that will allow solid matter to pass into the measuring unit. Clean inner screen and have ready for replacement or if damaged, replace with new one.**

5. Remove screws (item 12), washer (item 13) and seal washer (item 32) attaching measuring unit assembly (item 1) to meter housing (item 2).
6. Lift measuring unit assembly (item 1) out of the meter housing.
7. The measuring unit may now be inspected. In some cases, a thorough washing in cleaning solvent or kerosene will be sufficient to free the rotors of corrosion or foreign material and the unit may be reinstalled without further disassembly. In the event the rotors are blocked with solid matter, it will be necessary to remove the rotors and end plate assembly for further cleaning.

**CAUTION: Extreme care must be exercised when the measuring unit assembly (item 1) is exposed or handled. Hands must be kept clear of all gears and rotors or serious personal injury can occur. Due to the precision of the rotors and drive gears, they can be set in motion**

**easily. Keep hands clear of these parts at all times. At no time should the hands be used to brace these parts while servicing.**

**B. Measuring Unit Disassembly** (Refer to Figure 6-2)

1. Place measuring unit in a wooden cradle as a convenient support. Orient measuring unit with front end cover (item 7) upward.
2. Remove bearing plate (item 17) by removing screws and washers (items 18 and 19), lift out compound gear (item 16).
3. Remove spring clip (item 4).

**NOTE: Step 3 above is not required on No. 43105 and No. 4310-300 Measuring units. It is not necessary to remove the gear and shaft assembly (item 2) unless damaged.**

4. Loosen set screws (item 15), remove gear (item 14) and retaining ring (item 36).
5. Remove the bearing retainer cap (item 11), screw (item 13) and lockwasher (item 12).
6. Remove screw (item 34), lockwasher (item 33) and bearing key (item 32).

**NOTE: DO NOT REMOVE FRONT END COVER (ITEM 7) AT THIS TIME.**

7. Rotate the measuring unit and remove screws (item 22). This will enable removing the rear gear cover (item 21).
8. Remove screws (item 9) and separate rear end cover (item 20) from body (item 1).
9. The rotors and rear end cover assembly can now be washed thoroughly with solvent or kerosene and inspected. If the rotors show no evidence of contact with each other, and if the timing gears appear satisfactory, further disassembly will not be necessary.

**C. Removing Timing Gears and Rotors (Refer to Figures 4-1 and 4-2)**

Severe scoring of the rotors or grit in the bearings may necessitate removing the rotors from the rear end cover.

1. Place a small piece of soft material (rubber, wood, etc.,) between the timing gears or rotors and remove locknuts (item 28) and lockwashers (item 27).
2. Timing gears are taper fitted to the shafts and can be removed one at a time by striking the face of the gear inside the teeth with a plastic hammer. Be careful not to damage the rotor shaft threads when removing the timing gears.
3. Remove spacer key (item 23) and bearings (item 10) from rear end cover (item 20). Push rotor shafts through ball bearings.

**NOTE: Ball Bearings (item 10) can be removed from end covers by gently tapping or pressing on the inner race of the ball bearings from inside the end covers.**

4. Rotate measuring unit body (item 1) and remove screws (items 8 and 9).
5. This will allow removal of the front end cover (item 7). The ball bearings can be removed as indicated in item 3 Note above.

**D. Cleaning Measuring Unit**

1. Scored metal should be removed with a scraper or file. Remove only the high points and do not remove any more metal than necessary.
2. Polish rotors with crocos cloth and wash carefully in solvent or kerosene to remove all particles of grit or metal.
3. File lightly the end covers (item 7 and 20) to remove any burrs or high spots. Use fine sandpaper to remove corrosion and burrs from the surface of the bores that carry the bearings.
4. Ball bearings should be cleaned and inspected for wear.
5. All gears and shafts should be inspected. Check all 0-Rings, bushings and gaskets for wear and replace where necessary.

**NOTE: Wash all parts thoroughly in solvent, light fuel oil or kerosene. Dry thoroughly with compressed air and/or with lint free wipers.**

**E. Reassembly—Measuring Unit**

1. Lubricate all bearings, gaskets and O-Rings with a light weight oil.
2. Position measuring unit body (item 1) in wooden cradle and attach front end plate (item 7) by installing screws (items 8 and 9).

**NOTE: Align the port openings of the front end cover (item 7) with those of the meter body (item 1) using care to align the two locating dowel screws (item 9) with their corresponding holes. Secure the front end plate (item 7) to the measuring unit body by the two dowel screws (item 9) and install the socket head screws (item 8), alternating from one side to another when tightening.**

3. Install ball bearings (item 10) within the bearing bore of the front end plate (item 7). Use a sleeve or deep socket with an outside diameter slightly less than that of the bearing outer race to press or tap the bearings into bearing bore until securely seated. Use care to drive bearing straight down and make certain that no foreign materials enter the bearing.

**NOTE: Slot in outer race of ball bearings must align with roll pin (item 35) in bottom of bearing bore. (Reference Figure 4-3).**

4. Rotate measuring unit body and replace rotors (item 30 and 31) in proper slots so that the threaded, tapered rotor shafts protrude from the open end of the measuring unit body.
5. Attach the rear end cover (item 20) to the body (item 1) using care to align the two locating dowel screws (item 9) with their corresponding holes.
6. Install ball bearings (item 10) within the bearing bore of the rear end cover (item 20).

**NOTE: Slot in outer race of ball bearings (item 10) must align with roll pin (item 35) in bottom of bearing bore. (Reference Figure 4-3).**

7. Replace spacer key (item 23), timing gears (item 24 and 29), lockwasher (item 27) and locknut (item 28). The large timing gear fits on the 4T rotor and the small timing gear on the 3T rotor.

**NOTE: Short tab on the spacer key fits in the inner race of the ball bearings and the long tab seats into slot on the timing gears.**

**NOTE: Tab on lockwasher (item 27) must seat into slot on timing gears.**

8. **TIMING PROCEDURE** (See Figure 4-2). Insert a holding device, such as a nylon or wooden dowel, into the port opening of the measuring unit body to prevent the rotors from turning, and tighten the locknut (item 28) at the small timing gear on the shaft of the three tooth rotor (item 30). Under no circumstances should a metal (or any hard material) holding device be used. Place a .004 inch feeler gauge between a lobe of the three tooth rotor and flute of the four tooth rotor through the port opening. Using the holding device to keep the rotors from turning, tighten the locknut (item 28) of the large timing gear (item 24) on the shaft of the four tooth rotor (item 31). Remove feeler gauge and holding device, check to see if rotors spin freely. Check for proper clearance at several points between rotors. If rotors do not spin freely or there is contact between rotors, timing procedure must be repeated. If the rotors were damaged, it will sometimes be found that all of the high spots were not removed. In such cases, it is necessary to find these spots and remove them.
9. Bend one tab of lockwashers (item 27) against a flat side of the locknuts (item 28) on the timing gears to secure locknut.
10. Replace bearing key (item 32), lockwasher (item 33) and screw (item 34).
11. Replace the bearing retainer cap (item 11), secure with lockwashers (item 12) and screws (item 13).
12. Replace retaining ring (item 36) and gear (item 14). Secure with two set screws (item 15).
13. Replace compound gear assembly (item 16) and bearing plate (item 17), secure with lockwashers (item 18) and screws (item 19).

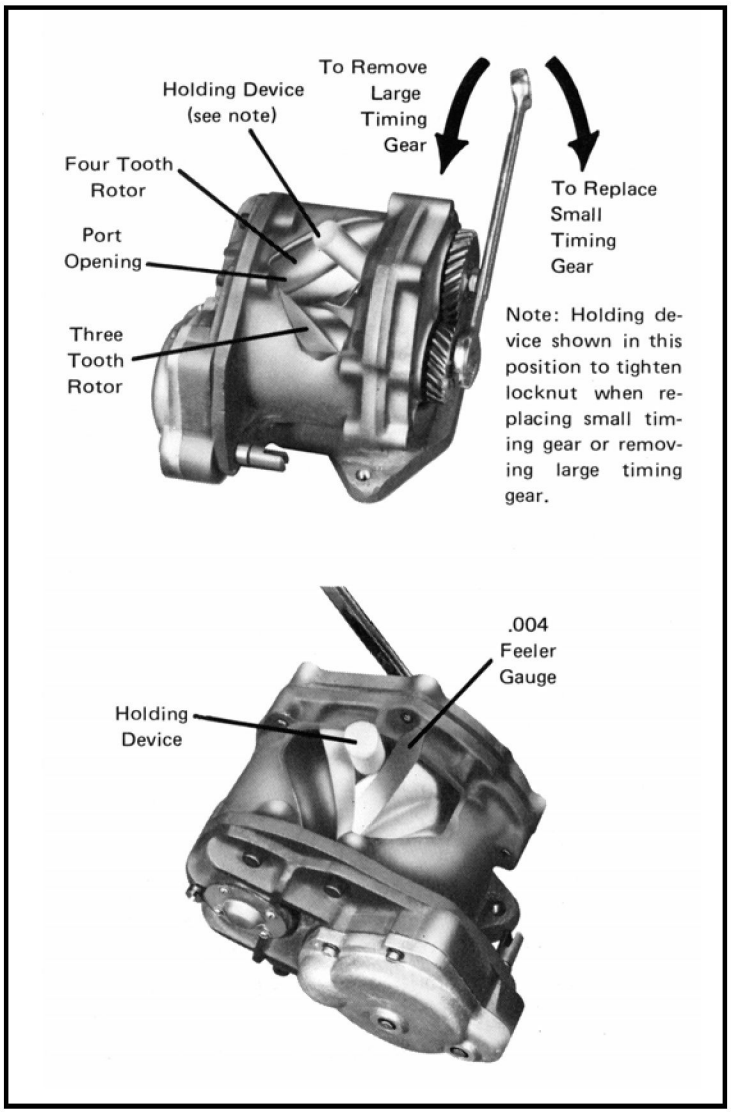



Figure 4-1 Typical Method for Blocking Rotors when replacing small Timing Gear or removing large Timing Gear.

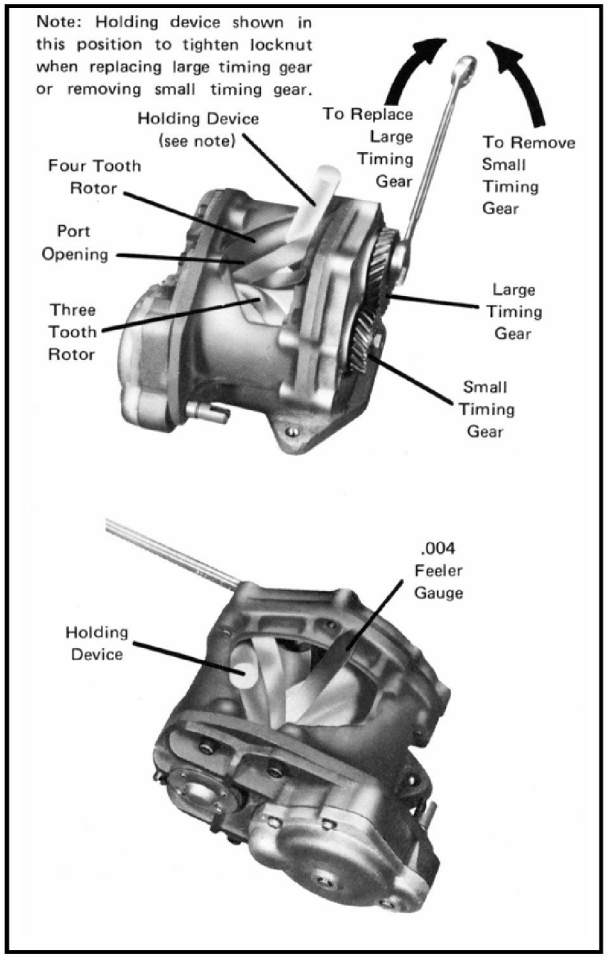



Figure 4-2 Typical Method for Blocking Rotors when Timing Rotors and when replacing large Timing Gear or removing small Timing Gear.

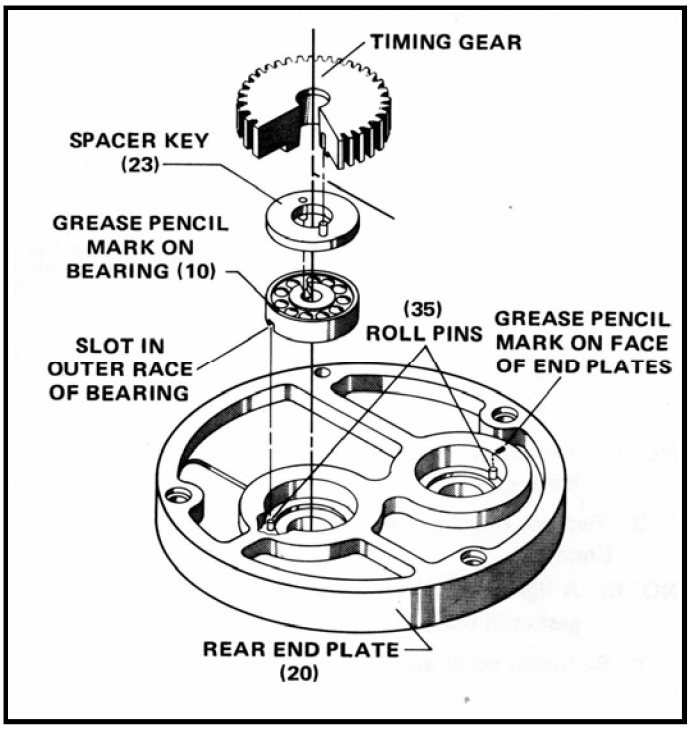



**Figure 4-3 Typical End Plate, Bearing, Spacer Key and Timing Gear Alignment Detail**

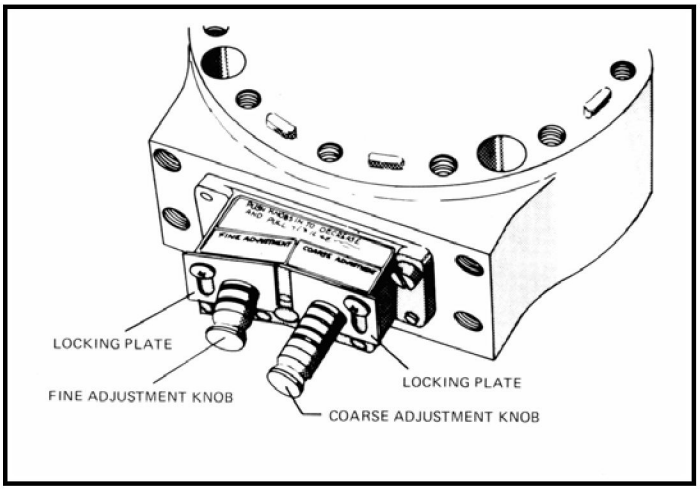



**Figure 4-4 Accuracy Adjustment**

**NOTE: If the gear and shaft assembly (item 2) was removed, replace before installing the bearing plate assembly (item 17). All gears must be meshed with each other to drive correctly.**

14. Replace spring clip (item 4).

**NOTE: Step 14 above is not required on No. 43105 and No. 43105-300.**

15. Replace gear cover (item 21), secure with screws (item 22).

**F. Reassembly—Meter (Refer to Figure 6-1)**

1. Position gasket (item 14) onto measuring unit and replace into housing making sure to engage the coupling (B) on the meter with the counter base coupling (A). Secure with socket head screws (item 12). With measuring unit in place turn rotors to be sure coupling is engaged.

**NOTE: A light film of grease will aid in holding gasket (item 14) in place. Be sure to use new seal washers (item 13 and 32).**

2. Install the strainer basket (item 31) with gaskets (items 27 and 9) and replace cover (item 7). Secure with nuts (item 6).

**NOTE: The above step not required for B-54 and B-55 Meters.**

3. Replace housing cover (item 3) and front dome gasket (item 4).

**NOTE: A light film of grease will aid in holding front dome gasket in place.**

4. Re-install other accessories.

**4-3 Series 4000 and 4200 Adjustor (Refer to Figure 6-1)**

**A. Removal**

Remove counter and accessories. Remove four screws (item 21) and lift off adjustor (item 18) from top of counter base plate assembly (item 15). If the adjustor assembly is found to be damaged, worn or otherwise unserviceable, a service exchange replacement assembly should be ordered from the nearest Regional Office.

**B. Installation**

Place adjustor (item 18) in position carefully on top of counter base plate (item 15) making certain that coupling (item 19) on bottom side of adjustor is aligned properly with square output coupling on the packing shaft of the counter base plate. When packing shaft and coupling are properly engaged, the adjustor will be correctly seated on the counter base plate. This engagement may be verified by temporarily operating the meter and checking for corresponding adjustor output. Secure adjustor to counter base plate by installing twelve screws (item 17).

**C. Accuracy Adjustment**

The BiRotor Meter is adjusted for accuracy by changing the gear ratio between the meter packing shaft and the counter until the counter registers the exact amount of liquid measured. The adjustor accomplishes this change in positive and definite increments. The adjustor is provided with two adjusting knobs (see Figure 4-4). One knob is used to make coarse adjustments; the other to make fine adjustments. To make an adjustment, lift locking plate and push in or pull out on adjusting knob. Pushing the knobs into the adjustor decreases the counter reading, while pulling the knobs out will increase the readout. Each groove of the coarse adjustment equals .6% of the volume delivered, and each fine adjustment groove equals .05%.

**4-4 Counter Base Plate Assembly**

**A. Removal/Disassembly (Reference Figure 6-1)**

1. Remove counter and accessories.
2. Remove four screws (item 21) and lift off adjustor assembly (item 18).
3. Remove twelve screws (item 17) to allow the counter base plate assembly (item 15) to be lifted off from the meter housing (item 2). Refer to Figure 6-3.

4. Remove four screws (item 5) holding the gland assembly (item 4). Install two screws in two threaded holes provided in the gland assembly and jack out the gland assembly.
5. Remove three screws (item 10) holding the bracket assembly (item 9) to the counter base plate (item 1). Remove the gear bracket (item 9) with attached parts from the counter base plate.
6. Remove nut (item 16) and screw (item 21) to disassemble rest of the counter base plate.
7. Remove O-Rings (items 2 and 3) from its recess on the gland assembly (item 4).

**B. Reassembly/Installation (Reference Figure 6-3)**

1. Inspect the worm and shaft assembly (item 17) and the worm wheel (item 13) for signs of wear. Procure replacement parts as necessary.
2. Replace ball bearing (item 23) on the packing shaft (item 7).
3. Position worm and shaft (item 17) and install into the bracket (item 9). Secure with pin (item 19).
4. Replace worm wheel (item 13) and secure with nut (item 16).
5. Fasten the bracket (item 9) with attaching parts to the counter base plate (item 1) by installing three screws and washers (items 10 and 1 1).
6. Replace spacer (item 6) over the packing shaft (item 7).
7. Place new O-Rings (items 2 and 3) in place on the gland assembly (item 4).
8. Place gland assembly (item 4) in place and secure with four screws (item 5).
9. Install new counter base plate gasket (item 16) in place on the meter housing (Figure 6-1).
10. Mate the counter base plate assembly (item 15) with the coupling shaft on the measuring unit and attach with screws (item 17).
11. Position adjustor (item 18) with attached coupling in place on top of the counter base plate (item 15) and secure with screws (item 21).

**NOTE: The Model 4000 Adjustor requires a gasket (item 22).**

12. Replace the accessories and counter.

## Section 5 TROUBLESHOOTING

### 5-1 General

Table 5-1 has been provided to aid in basic troubleshooting. Disassembly procedures are covered in Section 4 - Maintenance. If trouble occurs, determine the probable cause in an effort to pinpoint the source of the trouble, i.e., if a counter does not register at all, first make certain that there is flow through the meter.

If the flowmeter is found to be in need of repair, it is recommended the user contact the nearest Service or Sales Office.

It is important that servicing be performed by trained and qualified service personnel.

## SECTION 6 PARTS LIST

### 6-1 General

This section contains the necessary parts required to make up any standard unit that is covered in this bulletin. Each parts list also contains the recommended spare and replacement parts denoted by an asterisk. For items that are not listed, or additional information, consult factory. When ordering, the following information must be furnished.

1. Part number and description
2. Model number of flowmeter
3. Serial number of flowmeter
4. Quantity required

When ordering items of a material or special construction not indicated in the Parts List, furnish the following information so that the part number of the item can be determined.

1. Item number and description
2. Specific material of item
3. Model number of flowmeter
4. Serial number of flowmeter
5. Quantity required

**TABLE 5-1 TROUBLESHOOTING**

| SYMPTOM | POSSIBLE CAUSE | REMEDY |
|---|---|---|
| Meter runs but counter does not register between Counter Base Plate and Adjustor | Broken Coupling P/N W-4125 | Replace Coupling |
| | Faulty Adjustor | Replace Adjustor |
| | Faulty Register | Replace Register |
| Meter runs but is noisy | Meter is not properly timed | Retime Meter |
| | Damaged Rotors | Service or replace rotors |
| | Worn bearings | Replace ball bearings |
| | Bad gears in Counter Base Plate Assembly | Replace Counter Base Plate Assembly |
| Meter runs but only very slowly, not noisy, low delivery rate | Strainer screen clogged | Remove and clean strainer screen |

**Figure 6-1 Complete Meter Assembly**

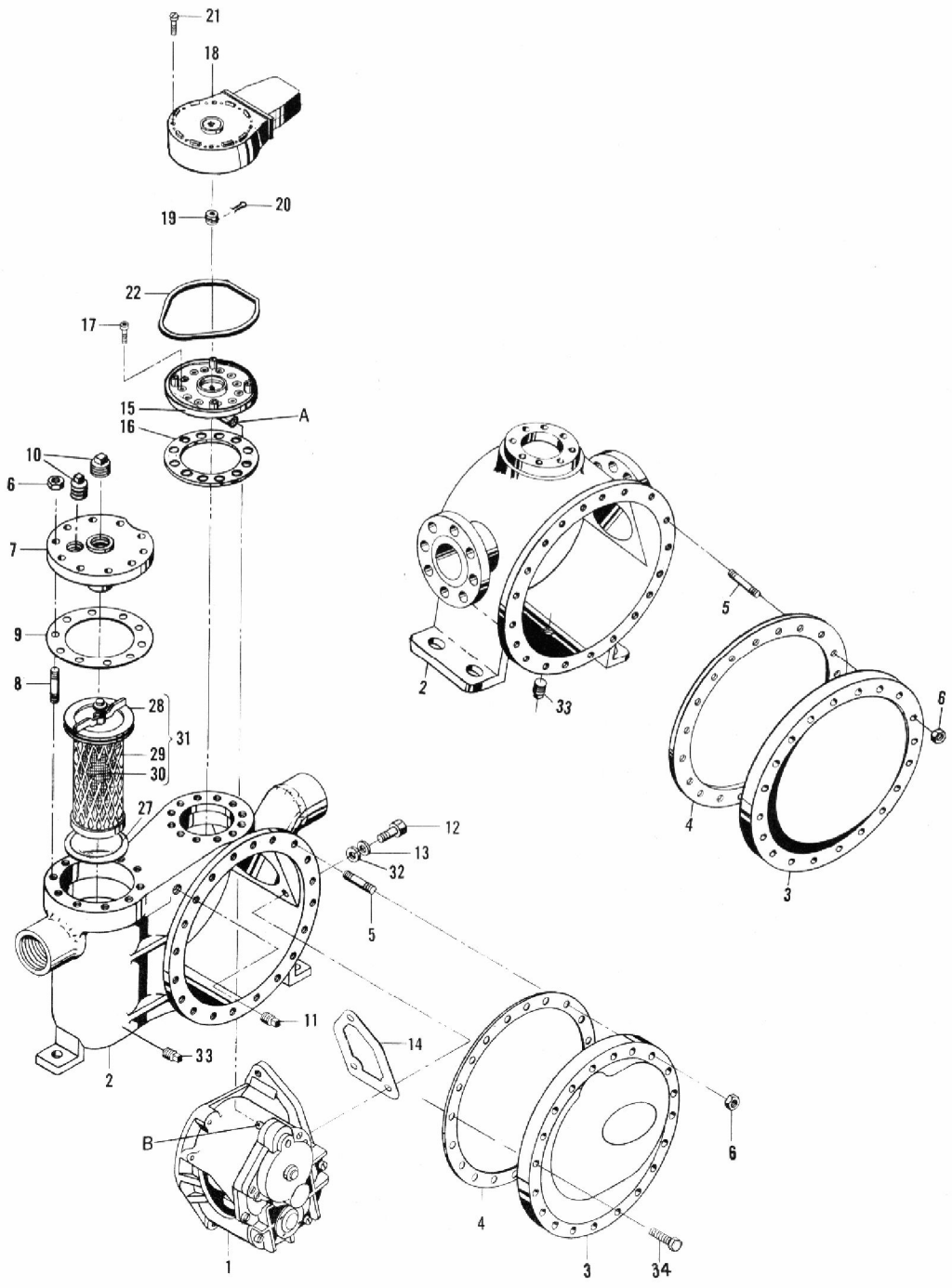


**TABLE 6-1 COMPLETE METER PARTS LIST (REFERENCE FIGURE 6-1)**

| ITEM NO. | DESCRIPTION | NO REQ | B-43 PART NUMBER | NO REQ | B-43H PART NUMBER | NO REQ | B-53 PART NUMBER | NO REQ | B-53H PART NUMBER | NO REQ | B-53HF PART NUMBER | NO REQ | B-54 PART NUMBER | NO REQ | B-55 PART NUMBER |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | Measuring Unit (Standard) | 1 | 43105 | 1 | 43105 | 1 | 53105-002 | 1 | 53105-002 | 1 | 53105401 | 1 | 53105-002 | 1 | 53105-002 |
| | (HTT-325°F) | 1 | 43105-300 | 1 | 43105-300 | 1 | | 1 | 53105-302 | 1 | | 1 | 53105-302 | 1 | 53105-302 |
| | (HTT-450F) | 1 | N/A | 1 | N/A | 1 | 53105402 | 1 | 53105402 | 1 | 53105402 | 1 | | 1 | |
| 2 | Housing | 1 | 43375 | 1 | 43875 | 1 | 53375 | 1 | 53875 | 1 | 53915 | 1 | 54415 | 1 | 55415 |
| 3 | Cover | 1 | 43145 | 1 | 43145 | 1 | 53390 | 1 | 53390 | 1 | 53390 | 1 | 54431 | 1 | 55431 |
| *4 | Gasket | 1 | 43384 | 1 | 43384 | 1 | 53384 | 1 | 53384 | 1 | 53384 | 1 | 54434 | 1 | 54434 |
| 5 | Stud | 18 | 151083 | 18 | 1 51083 | 20 | 151083 | 20 | 151083 | 20 | 151083 | 16 | 1 51389 | 20 | 151391 |
| 6 | Nut | 10 | 151589 | 10 | 151589 | 10 | 151589 | 10 | 151589 | 10 | 151589 | 16 | 151551 | 20 | 151558 |
| 7 | Strainer Cover | 1 | 43430 | 1 | 43430 | 1 | 43430 | 1 | 434+) | 1 | 43430 | | | | |
| 8 | Stud | 10 | 151316 | 10 | 151316 | 10 | 151316 | 10 | 151316 | 10 | 151316 | | | | |
| *9 | Gasket | 1 | 43421 | 1 | 43421 | 1 | 43421 | 1 | 43421 | 1 | 43421 | | | | |
| 10 | Pipe Plug | 2 | 154704 | 2 | 154704 | 2 | 154704 | 2 | 154704 | 2 | 154704 | | | | |
| 11 | Pipe Plug | 1 | 154783 | 1 | 154783 | 1 | 154721 | 1 | 154721 | 1 | 154721 | | | | |
| 12 | Screw | 3 | 151017 | 3 | 151017 | 4 | 151041 | 4 | 151041 | 4 | 151041 | 4 | 151045 | 4 | 151045 |
| *13 | Washer | 3 | 151882 | 3 | 151882 | 4 | 151863 | 4 | 151863 | 4 | 151863 | 4 | 151863 | 4 | 151863 |
| *14 | Gasket | 1 | 42383 | 1 | 42382 | 1 | 52383 | 1 | 52383 | 1 | 52383 | 1 | 52383 | 1 | 52382 |
| 15 | Counter Base Plate Assembly (Standard) | 1 | 43750 | 1 | 43750 | 1 | 43750 | 1 | 43750 | 1 | 44755 | 1 | 44750 | 1 | 44750 |
| | (HTT - 325°F) | 1 | 43750-300 | 1 | 43750-300 | | | 1 | 43750-300 | 1 | | 1 | 44755 | 1 | 44755 |
| | (HTT - 450 F) | 1 | | 1 | | | 44755-005 | 1 | 44755-005 | 1 | 44755-005 | 1 | | | |
| *16 | Counter Base Plate Gasket | 1 | 53156 | 1 | 53156 | 1 | 53156 | 1 | 53156 | 1 | 53156 | 1 | 53156 | 1 | 53156 |
| 17 | Screw | 12 | 151015 | 12 | 151015 | 12 | 151015 | 12 | 151015 | 12 | 151015 | 12 | 151015 | 12 | 151015 |
| 18 | Adjustor (Incl. Item 19) | 1 | W4000 | 1 | W4000 | 1 | W4200 | 1 | W4200 | 1 | W4200 | 1 | W4200 | 1 | W4200 |
| 19 | Coupling (Incl. item 20) | 1 | W4125 | 1 | W4125 | 1 | W4125 | 1 | W4125 | 1 | W4125 | 1 | W4125 | 1 | W4125 |
| 20 | Cotter Pin | 1 | 153905 | 1 | 153905 | 1 | 153905 | 1 | 153905 | 1 | 153905 | 1 | 153905 | 1 | 153905 |
| 21 | Screw | 4 | 150565 | 4 | 150565 | 4 | 150565 | 4 | 150565 | 4 | 150565 | 4 | 150565 | 4 | 150565 |
| *22 | Gasket | 1 | 52146 | 1 | 52146 | | | | | | | | | | |
| *27 | Gasket | 1 | 175114 | 1 | 175114 | 1 | 175314 | 1 | 175314 | 1 | 175314 | | | | |
| 28 | Top Ring | 1 | 175180 | 1 | 175180 | 1 | 175380 | 1 | 175380 | 1 | 175380 | | | | |
| 29 | Outer Frame | 1 | 175170 | 1 | 175170 | 1 | 175370 | 1 | 175370 | 1 | 175370 | | | | |
| *30 | Inner Screen 20 Mesh | 1 | 175100-020 | 1 | 175100-020 | 1 | 175310-020 | 1 | 175310-020 | 1 | 175310-020 | | | | |
| | 40 Mesh | 1 | 175130 | 1 | 175130 | 1 | 175330 | 1 | 175330 | 1 | 175330 | | | | |
| | 80 Mesh | 1 | 175150 | 1 | 175150 | 1 | 175350 | 1 | 175350 | 1 | 175350 | | | | |
| 31 | Complete Strainer 20 Mesh | 1 | 175120 | 1 | 175120 | 1 | 175320 | 1 | 175320 | 1 | 175320 | | | | |
| | Basket 40 Mesh | 1 | 175120 | 1 | 175125 | 1 | 175325 | 1 | 175325 | 1 | 175325 | | | | |
| 32 | Stat o-seal Washer | 3 | 152034 | 3 | 152034 | 4 | 152030 | 4 | 152030 | 4 | 152030 | 4 | 152030 | 4 | 152030 |
| 33 | Pipe Plug | 2 | 54711 024 | 2 | 154711-024 | 2 | 154711 024 | 2 | 154711-024 | 2 | 154711424 | 2 | 154711-024 | 2 | 154711424 |
| 34 | Hex Socket Set | 2 | 151083-024 | 2 | 151033424 | 2 | 151083 024 | 2 | 151083-024 | 2 | 151033424 | | | | |

*RECOMMENDED SPARE PARTS

**Figure 6-2 Measuring Unit Assembly**

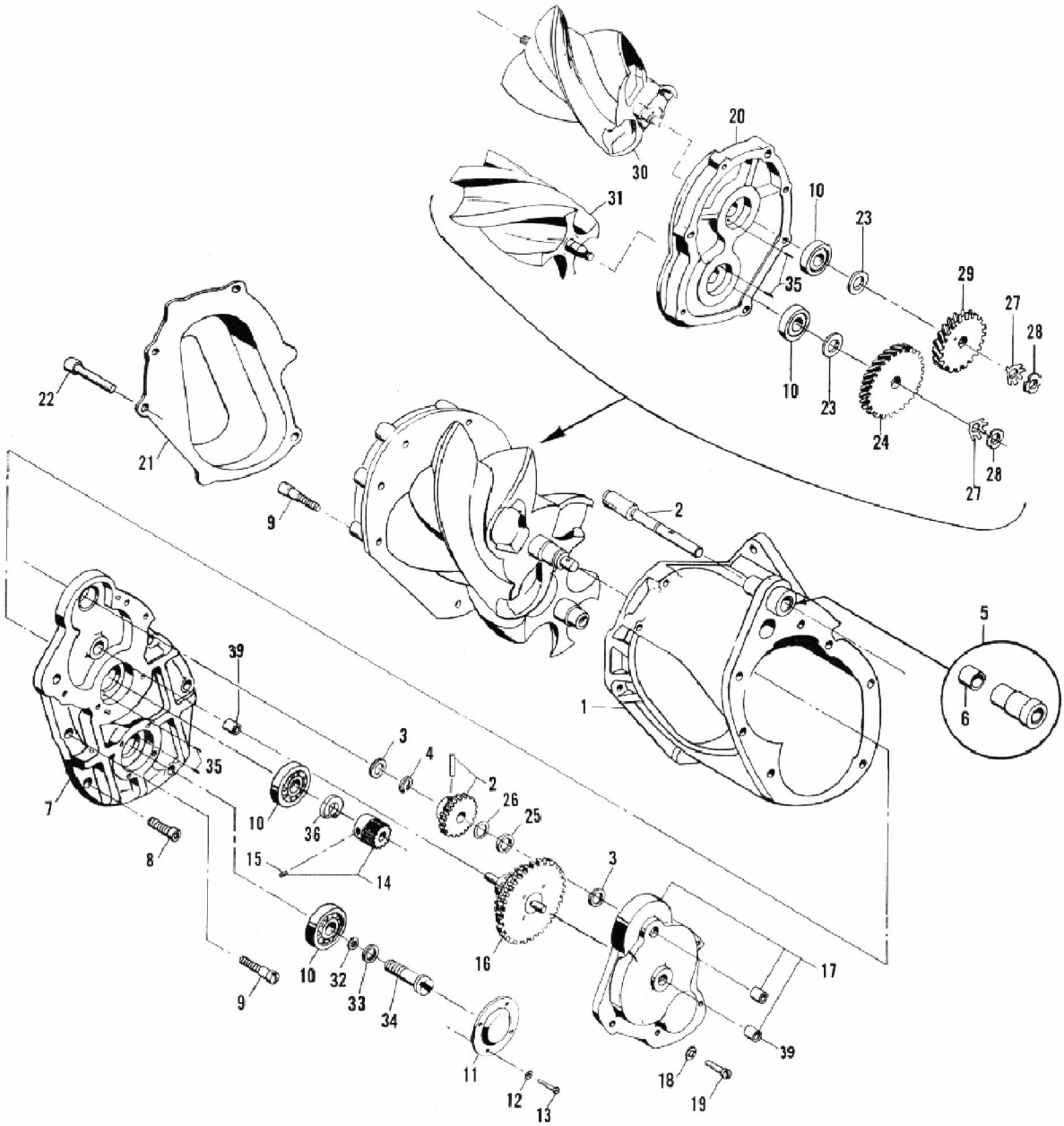


**TABLE 6-2 MEASURING UNIT—PARTS LIST (Reference Figure 6-2)**

| ITEM NO. | DESCRIPTION | NO REQ | 43105 PART NUMBER | NO REQ | 43105-300 PART NUMBER | NO REQ | 53105-001 PART NUMBER | NO REQ | 53105-002 PART NUMBER | NO REQ | 53105-302 PART NUMBER | NO REQ | 53105-402 PART NUMBER |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | Measuring Unit Body | 1 | 43511 | 1 | 43511 | 1 | 53511 | 1 | 53511 | 1 | 53511 | 1 | 53511 |
| *2 | Gear and Shaft Assembly | 1 | 43125 (27T) | 1 | 43125 (27T) | 1 | 53125 (19T) | 1 | 53125 (19T) | 1 | 53125 (19T) | 1 | 53125 (19T) |
| 3 | Washer | 2 | 151856 | 2 | 151856 | 2 | 151856 | 2 | 151856 | 2 | 151853 | 2 | 151856 |
| 4 | Spring Clip | 1 | 153943 | 1 | 1 53943 | 1 | 153943 | 1 | 153943 | 1 | 153943 | 1 | 153943 |
| 5 | Bearing Assembly | 1 | 43110 | 1 | 43110 | 1 | 43110 | 1 | 43110 | 1 | 43110 | 1 | 43110 |
| 6 | Bushing | 1 | 155169 | 1 | 155169 | 1 | 155169 | 1 | 155169 | 1 | 155169 | 1 | 155169 |
| 7 | Front End Cover Assembly | 1 | 43130 | 1 | 43130 | 1 | 53130 | 1 | 53130 | 1 | 53130 | 1 | 53130 |
| 8 | Socket Head Screw | 4 | 151010 | 4 | 151010 | 7 | 151010 | 7 | 151010 | 7 | 151010 | 7 | 15101 0 |
| 9 | Dowel Screw | 4 | 51567 | 4 | 51567 | 4 | 51567 | 4 | 51567 | 4 | 51567 | 4 | 51537 |
| *10 | Ball Bearing | 4 | 155184 | 4 | 1 55184 | 4 | 155184 | 4 | 155184 | 4 | 155184 | 4 | 1551 84 |
| 11 | Bearing Retainer | 1 | 40539 | 1 | 40539 | 1 | 40539 | 1 | 40539 | 1 | 40539 | 1 | 40539 |
| 12 | Lockwasher | 4 | 152253 | 4 | 152253 | 4 | 152253 | 4 | 155253 | 4 | 152253 | 4 | 152253 |
| 13 | Socket Head Screw | 4 | 150103 | 4 | 150103 | 4 | 150103 | 4 | 150103 | 4 | 150103 | 4 | 150103 |
| *14 | Gear Assembly | 1 | 72235 (13T) | 1 | 72235 (13T) | 1 | 53117 (18T) | 4 | 53117 (18T) | 1 | 53117 (18T) | 1 | 53117 (18T) |
| 15 | Socket Head Set Screw | 2 | 150975 | 2 | 150975 | 2 | 150975 | 2 | 150975 | 2 | 150975 | 2 | 150975 |
| *16 | Compound Idler Assembly | 1 | 43120-002 (42T-52T) | 1 | 43120 (42T-52T) | 1 | 53120-003 (38T-49T) | 1 | 53120-003 (38T-49T) | 1 | 53120-004 (38T-49T) | 1 | 53120-004 (38T-49T) |
| 17 | Bearing Plate Assembly | 1 | 43140 | 1 | 43140 | 1 | 53140 | 1 | 53140 | 1 | 53140 | 1 | 53140 |
| 18 | Lockwasher | 5 | 152257 | 5 | 152257 | 3 | 152257 | 3 | 152257 | 3 | 152257 | 3 | 152257 |
| 19 | Screw | 5 | 150527 | 5 | 150527 | 3 | 150527 | 3 | 150527 | 3 | 150527 | 3 | 150527 |
| 20 | Rear End Cover | 1 | 40266 | 1 | 40266 | 1 | 50266 | 1 | 50266 | 1 | 50266 | 1 | 50266 |
| 21 | Gear Cover | 1 | 41601 | 1 | 41601 | 1 | 51601 | 1 | 51601 | 1 | 51601 | 1 | 51601 |
| 22 | Socket Head Screws | 6 | 151032 | 6 | 151032 | 8 | 151033 | 8 | 151033 | 8 | 151033 | 8 | 151033 |
| 23 | Spacer Key | 2 | 40294 | 2 | 40294 | 2 | 40294 | 2 | 40294 | 2 | 40294 | 2 | 40294 |
| **24 | Timing Gear(4T) | 1 | 40596 | 1 | 40596 | 1 | 50596 | 1 | 50596 | 1 | 50596 | 1 | 50596 |
| 25 | Washer | 1 | 151901 | 1 | 151901 | | | | | | | | |
| 26 | Shim | A/R | 152537 | A/R | 152537 | A/R | 152537 | A/R | 152537 | A/R | 152537 | A/R | 152537 |
| 27 | Lockwasher | 2 | 41593 | 2 | 41593 | 2 | 41593 | 2 | 41593 | 2 | 41593 | 2 | 41593 |
| 28 | Locknut | 2 | 40592 | 2 | 40592 | 2 | 40592 | 2 | 40592 | 2 | 40592 | 2 | 40592 |
| **29 | Timing Gear(3T) | 1 | 40591 | 1 | 40591 | 1 | 50591 | 1 | 50591 | 1 | 50591 | 1 | 50591 |
| **30 | 3T Rotor | 1 | 40276 | 1 | 40276-300 | 1 | 50276 001 | 1 | 50276 | 1 | 50276-300 | 1 | 50276401 |
| **31 | 4T Rotor | 1 | 40586 | 1 | 40586-300 | 1 | 50586-001 | 1 | 50586 | 1 | 50586-300 | 1 | 50586401 |
| 32 | Bearing Key | 2 | 50238 | 2 | 50238 | 2 | 50238 | 2 | 50238 | 2 | 50238 | 2 | 50238 |
| 33 | Lockwasher | 1 | 152119 | 1 | 152119 | 1 | 152119 | 1 | 152119 | 1 | 152119 | 1 | 152119 |
| 34 | Screw | 1 | 150156 | 1 | 150156 | 1 | 150156 | 1 | 150156 | 1 | 150156 | 1 | 1 50156 |
| 35 | Roll P in | 4 | 153547 | 4 | 153547 | 4 | 153547 | 4 | 153547 | 4 | 153547 | 4 | 153547 |
| 36 | Retaining Ring | 1 | 153953 | 1 | 153953 | 1 | 153953 | 1 | 153953 | 1 | 153953 | 1 | 153953 |
| 37 | Stub Shaft | 1 | 51579 | 1 | 51579 | 1 | 51579 | 1 | 51579 | 1 | 51579 | 1 | 51579 |
| 38 | Groove Pin | 1 | 153636-019 | 1 | 153636-019 | 1 | 153636-019 | 1 | 153636-019 | 1 | 153636-019 | 1 | 153636 019 |
| 39 | Bushing | 3 | 40541 | 3 | 40541 | 3 | 40541 | 3 | 40541 | 3 | 40541 | 3 | 40541 |

***Recommended Spare Parts**

**Items 24 and 29 are supplied as a set
Items 30 and 31 are supplied as a set.

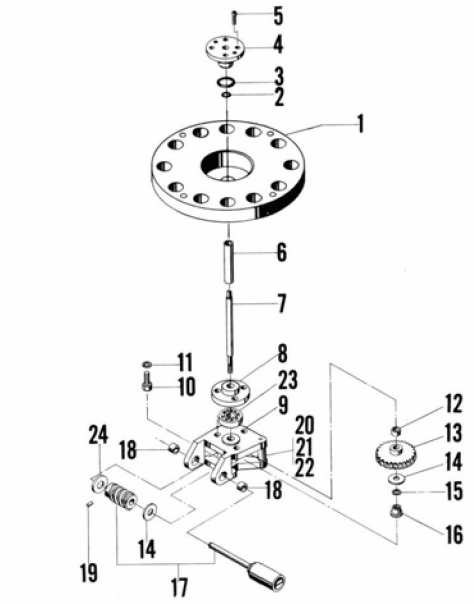



**Figure 6-3 Counter Base Plate Assembly**

**Table 6-3 Parts List—Counter Base Plate Assembly (Reference Figure 6-3)**

| ITEM NO. | DESCRIPTION | NO. REQ | PART NUMBER |
|---|---|---|---|
| 1 | Counter Base Plate | 1 | 53151 |
| *2 | O-Ring (All Models except 44755-005) | 1 | 1 52064-022 |
| | Teflon Bal Seal (44755-005) | 1 | 270-00-027-00 |
| *3 | O-Ring | 1 | 152070-022 |
| 4 | Gland Assembly | 1 | 43175 |
| 5 | Screw | 4 | 151029 |
| 6 | Spacer | 1 | 53163 |
| | Packing Shaft | 1 | 53164 |
| 8 | Bearing Housing | 1 | 74177 |
| 9 | Bracket (43750 & 43750-300) | 1 | 53161 |
| | (44750, 44755 & 44755-005) | 1 | 74161 |
| 10 | Screw | 3 | 150713 |
| 11 | Lockwasher | 3 | 152259 |
| 12 | Spacer | 1 | 4166 |
| **13 | Worm Wheel (43750 & 44750) | 1 | 73786-002 |
| | (43750-300 & 44755) | 1 | 73786-003 |
| 14 | Thrust Washer | 1 | 51163 |
| 15 | Lockwasher | 1 | 152257 |
| 16 | Nut | 1 | 151704 |
| **17 | Worm & Shaft Assembly(43750 & 44750) | 1 | 43765-002 |
| | (43750-300, 44755 & 44755-005) | 1 | 43765-003 |
| 18 | Bushing | 2 | 155151 |
| 19 | Pin | 1 | 153549 |
| 20 | Spacer | 1 | 52159 |
| 21 | Screw | 1 | 150511 |
| 22 | Lockwasher | 1 | 152255 |
| *23 | Ball Bearing | 1 | 155195 |
| 24 | Washer | 1 | 151907 |

*** Recommended Spare Parts**
**** NOTE: Items 13 and 17 must be replaced in sets.**

**†Specifications subject to change without notice**

**LIMITED WARRANTY**

Seller warrants that the Goods manufactured by Seller will be free from defects in materials or workmanship under normal use and service until the expiration of the earlier of twelve (12) months from the date of initial installation or eighteen (18) months from the date of shipment by Seller. Consumables, including, without limitation, glass parts and electrodes, membranes, liquid junctions, electrolytes and reagents, o-rings, plastic tubing, etc. are warranted to be free from defects in material and workmanship under normal use and service for a period of ninety (90) days from the date of shipment by Seller. If, within thirty (30) days after Buyer's discovery of any warranty defects during the applicable warranty period, Buyer notifies Seller thereof in writing, Seller shall, at its option, promptly correct any errors that are found by Seller to exist in the Software, or repair or replace F.O.B. point of manufacture, that portion of the Goods or Software found by Seller to be defective. All replacements or repairs necessitated by inadequate preventive maintenance, or by normal wear and usage, or by fault of Buyer, or by unsuitable power sources or by attack or deterioration under unsuitable environmental conditions, or by abuse, accident, alteration, misuse, improper installation, modification, repair, storage or handling, or any other cause not the fault of Seller are not covered by this limited warranty, and shall be at Buyer's expense. Seller shall not be obligated to pay any costs or charges incurred by Buyer or any other party except as may be agreed upon in writing in advance by an authorized Seller representative. All costs of dismantling, reinstallation and freight and the time and expenses of Seller's personnel for site travel and diagnosis under this warranty clause shall be borne by Buyer unless accepted in writing by Seller. Goods repaired and parts replaced during the warranty period shall be in warranty for the remainder of the original warranty period or ninety (90) days, whichever is longer. This limited warranty is the only warranty made by Seller and can be amended only in a writing signed by an authorized representative of Seller. There are no representations or warranties of any kind, express or implied, as to merchantability, fitness for particular purpose, or any other matter with respect to any of the goods or software.