4520
Bench Top Reactors
Operating Instruction Manual





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Related Instructions

The following publications can be ordered to further your understanding of this instrument and its component parts:

No.	Description
230M	Safety Precautions to be observed when operating Pressure Reaction Equipment
231M	Operating Instructions for Safety Rupture Discs
548M	Operating Instructions for 4848 Reactor Controllers
234M	Operating and Maintenance Instructions for Magnetic Drives
323M	Operating Instructions for Pressure Relief Valves
201M	Limited Warranty
F0042	Health & Safety Assurance Certification

PREFACE

Scope

These instructions describe the installation, operation and maintenance of Series 4520 Bench Top Reactors offered in one and two liter sizes. They cover the basic steps to be followed for installing these reactors and describe the function of all standard components. They are intended to be used in conjunction with several related instruction sheets listed on the previous page. This information describes several components which are common to most pressure reaction equipment and includes safety precautions and other related information applicable to all reaction laboratories. The users should study all of these instructions carefully before starting to use these vessels so that they will fully understand the capabilities and limitations of the equipment.

Safety Information

To avoid electrical shock, always:

1. Use a properly grounded electrical outlet of correct voltage and current handling capability.
2. Ensure that the equipment is connected to electrical service according to local national electrical codes. Failure to properly connect may create a fire or shock hazard.
3. For continued protection against possible hazard, replace fuses with same type and rating of fuse.
4. Disconnect from the power supply before maintenance or servicing.

To avoid personal injury:

1. Do not use in the presence of flammable or combustible materials; fire or explosion may result. This device contains components which may ignite such material.
2. Refer servicing to qualified personnel.

General Specifications

Electrical Ratings

Controller ratings are found in the Operating Instructions for the controller supplied with your reactor and on the controller data plate.

Before connecting a controller to an electrical outlet, the user must be certain that the electrical outlet has an earth ground connection and that the line, load and other characteristics of the installation do not exceed the following limits:

Voltage: Fluctuations in the line voltage should not exceed 10% of the rated nominal voltage shown on the data plate.

Frequency: Controllers can be operated from either a 50 or 60 Hertz power supply without affecting their operation or calibration.

Current: The total current drawn should not exceed the rating shown on the data plate on the controller by more than 10 percent.

Thermocouple: Unless otherwise specified, all Series 4848 Controllers operate with a Type J (iron-constantan) thermocouple. The total resistance of the thermocouple and the lead wires should not exceed 20 ohms. If the resistance of the thermocouple circuit is higher, it will reduce the sensitivity of the control system.

Explanation of Symbols

II	On Position, full power heater switch
I	On Position, half power heater switch
O	Off Position
~	Alternating Current (AC)
	This **CAUTION** symbol may be present on the Product Instrumentation and literature. If present on the product, the user must consult the appropriate part of the accompanying product literature for more information.
	This **CAUTION** symbol indicates that the surface may be hot.
	**Protective Earth (PE) terminal**. Provided for connection of the Protective Earth (green or green/yellow) supply system conductor.

Environmental Conditions

This apparatus is to be used indoors. Operating: 15 °C to 35 °C; maximum relative humidity of 80% non-condensing. Installation Category II (overvoltage) in accordance with IEC 664. Pollution degree 2 in accordance with IEC 664.

Altitude Limit: 2,000 meters.

Storage: -25 °C and 65 °C; 10% to 85% relative humidity.

Provisions for Lifting and Carrying

The Series 4520 Bench Top Reactors and their components are very heavy. Before moving ensure all cables are disconnected. Use proper and safe lifting techniques when installing or moving the reactor and/or its components.



Caution!
Do not use in hazardous atmospheres.

Cleaning & Maintenance

Periodic cleaning may be performed on the exterior surfaces of the instrument with a lightly dampened cloth containing mild soap solution. All power should be disconnected when cleaning the instrument.



Ensure that any hot surfaces have had adequate time to cool before cleaning or maintaining the reactor and/or its components.

Intended Usage

This system has been designed for use as a high pressure reactor system. It has been designed, built, and tested to strict physical and electrical standards. However, it is the user's responsibility to install and operate it in conformance with local pressure and electrical codes. If this equipment is used in a manner beyond its intended usage, the protection provided by the equipment may be impaired.

User's Responsibility

All reactors and pressure vessels are designed and manufactured with great care to assure safe operation when used within their prescribed temperature and pressure limits. But . . . the basic responsibility for safety when using this equipment rests entirely with the user; who must:

1. **Select a reactor or pressure vessel** that has the capability, pressure rating, corrosion resistance, and design features that are suitable for its intended use. Engineers will be glad to discuss available equipment and material options with prospective users, but the final responsibility for selecting a reactor or pressure vessel that will perform to the user's satisfaction in any particular reaction or test must rest with the user .

   In exercising the responsibility for the selection of pressure equipment, the prospective user is often faced with the choice between over-or under-designed equipment. The hazards introduced by under-designed pressure vessels are readily apparent, but the penalties that must be paid for over-designed apparatus are often overlooked. Recognizing these criteria, reactors and pressure vessels are offered in several different styles, each designed for convenient use in daily operation within certain temperature and pressure limits, using gaskets, closures, and other elements carefully selected for safe operation within the limits specified for that design. But in order to preserve the validity of these designs, all temperature and pressure limits must be observed, and no attempt should be made to increase these limits by making alterations or by substituting components which are not recommended

2. **Install and operate** the equipment within a suitable barricade, if required, with appropriate safety accessories and in full compliance with local safety codes and rules.

   All standard pressure vessels are provided with either a suitable relief device or a means to attach one (typically in the form of a plugged opening). When a pressure vessel is delivered without a pressure venting device, it is the customer's responsibility to provide pressure relief in order to protect the operator and the equipment from destructive high pressures. If you need more information or need help in selecting a proper relief device, please contact Company.
3. **Establish training procedures** to ensure that any person handling the equipment knows how to use it properly.
4. **Maintain the equipment** in good condition and establish procedures for periodic testing to be sure the vessel remains structurally sound.

Unpack Carefully

Unpack the equipment carefully and check all the parts against the packing list. If shipping damage is discovered, report it immediately to the delivering carriers. The vessel, motor, heater, and temperature controller may be packed separately for convenience in shipping, but these parts are easily reassembled. Examine the components closely for any loose parts or shipping damage and be sure to check all layers of packing materials thoroughly so as not to overlook any parts which might otherwise be discarded.

INSTALLATION

Pressure and Temperature Limits

The working pressure and temperature at which any reactor or pressure vessel can be used will depend upon the design of the vessel and the materials used in its construction. Since all materials lose strength at elevated temperatures, any pressure rating must be stated in terms of the temperature at which it applies. The standard material of construction for Company is Type 316 Stainless Steel.

Limits for vessels made of other materials and for other operating temperatures can be obtained from Customer Service. No attempt should be made to increase these limits by making alterations or by substituting components that are not recommended by the Company. It must also be understood that lower pressure and temperature limits may be required for modified reactors and for vessels made of special alloys.

Limits for vessels will be determined by the physical characteristics of the vessel material and will be prescribed on an individual basis.

The maximum working pressure and temperature for any vessel is governed by the design of the vessel and the strength of the material from which it is constructed. There is also a close relationship between working pressure and temperature since the strength of any material will normally fall off as the temperature is increased. Temperature and pressure limits are also affected by the physical properties and temperature limits of the gaskets and seals used in the vessel, and by any valves, gages or other fittings attached to the vessel. Obviously, the safe operating pressure of any system can be no higher than that of its lowest rated component.

All reactors show the maximum safe operating pressure and temperature imprinted on the cylinder.

The working pressure and temperature in these one and two liter reactors must not exceed the following maximum limits:

Pressure and Temperature Limits		
Vessel Material	**Maximum Pressure**	**Maximum Temperature**
T316SS	1900 psig	350 °C PTFE Flat Gasket
T316SS	1900 psig	225 °C FKM O-ring
T316SS	1900 psig	275 °C FFKM O-ring

ASSEMBLE THE REACTOR

These reactors require at least 10 sq. ft. of workspace in a well-ventilated area with convenient access to an electric outlet, running water, air and a drain.

1. Set the Temperature Controller near the reactor, leaving a space of at least six inches between the controller and the base of the reactor so that the controller will not be unduly affected by radiant heat. Connect the reactor to the controller using information contained in its Instruction Manual No. 548M or follow the steps below.

Labeled connections are provided on the rear panel of the controller.



Cooling Only:

The **Cooling** output connector is to be used only with Company cooling solenoid valve assemblies supplied with the appropriate cooling power cord.



Heating Only:

The **Heating** output connector is to be used only with Company heater assemblies supplied with the appropriate heater power cord.



Motor:
Secure the clamp on motor cord to the controller with the provided screw next to the motor socket for safety purposes.

The **Motor** output connector is to be used only with Company motor assemblies supplied with the appropriate motor power cord.

2. For Fixed Head Reactors



Bolt the stand to the bench, table, or floor using the holes in the base plate.

3. The support and heater are shipped fully assembled. The heater raises and lowers on its support rod to permit the vessel or cylinder to be removed. Lower the heater, open the hinged retainer on the front of the support and slide the vessel into its support. Fixed head vessels have a square lip which fits into a matching groove in the support plate. Removable vessels are supported by the split rings which rest on the support plate. The stirrer drive connector lifts by rotating and lifting the knob above the belt guard. The universal joint contains a cross pin that slips into the groove on top of the magnetic drive.

4. Connect the heater cord from the heater into the heater socket on the rear panel of the Series 4848 Reactor Controller.

5. Plug the motor cord into the motor socket on the rear of the controller.



Secure the clamp on the motor cord with the provided screw next to the motor socket for safety purposes.

6. Connect the thermocouple and extension wire to both the thermocouple and to the controller in the “Primary Temp Input” position on the rear panel. Insert the thermocouple in the thermowell.

7. Connect leads from accessory packages such as tachometer, pressure transducer and high temp cut-off to the designated positions on the back panel of the 4848 Controller.

8. Connect cooling water to the magnetic drive. See Instruction Manual No. 234M.

9. Connect tubing to the rupture disc outlet and run to a safely vented area. See Instruction Manual 231M.

10. Note the voltage and amperage requirement stamped on the controller data plate, and then plug the power cord into an appropriate outlet. Power for these reactors should be drawn from a grounded outlet capable of carrying up to the full current rating of the reactor.

11. If an electric stirrer motor is supplied, turn the speed control knob fully counterclockwise on the Reactor Controller, turn on the motor switch and slightly increase the speed for a short run to check the stirrer drive system but do not turn on the heater, put heater toggle switch in center position (OFF). There must always be a vessel in the heater when it is turned on, and the vessel and heater sizes must match. If the heater is operated without proper size vessel in contact with the mantle, the mantle may overheat and fail.

Series 4520 1 & 2 Liter Reactors are furnished with two structural options in addition to the size, pressure range, stirrer motor, controller and similar options. These are:

Fixed Head or Removable Head Vessel Design

In the fixed head design, the head of the vessel may remain fixed in the reactor support stand. All attachments to the head, gas and liquid feed and discharge lines, cooling water, vapor take-off and condenser, thermocouple, and any electrical leads can remain permanently in place. The reactor is opened by removing the cover clamp sections and lowering the cylinder away from the head.

In the removable vessel design, the entire vessel must be removed from the support stand for charging, product recovery, and cleaning.

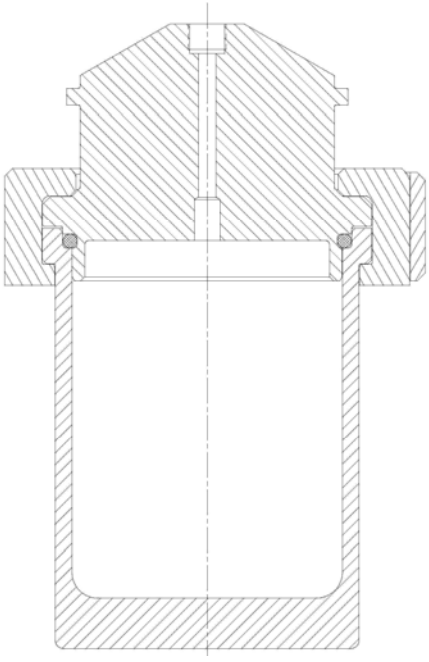
There is no difference in the pressure or temperature limits or basic operating instructions based upon the fixed head or movable vessel options. There are differences in the design of the stand components which adapt the vessels to the support system.

Flat PTFE Gasket or Self Sealing O-ring Closure

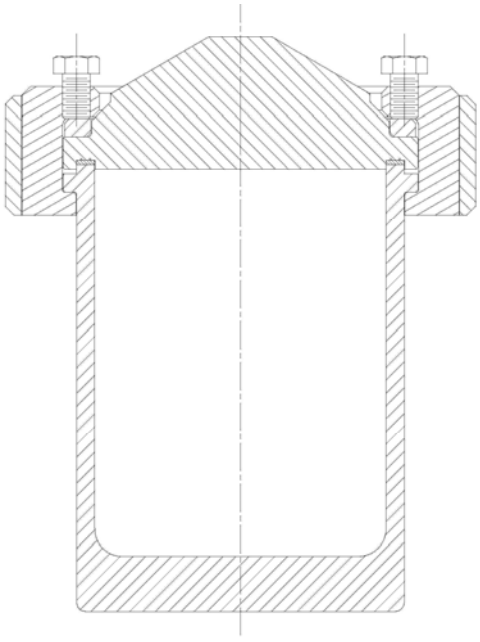
The flat gasket is held in a recess in the vessel head and a machine pilot on the cylinder closes the recess to completely contain the gasket. The split ring closure used with this gasket has six cap screws which must be tightened to develop the loading on the gasket.

The self sealing design features an O-ring retained in a groove on the vessel head. This design is self sealing and the split ring used with this sealing system does not require nor have the cap screws used with the flat gasket.

The flat PTFE gasket can be used to operating temperatures as high as 350 °C. The maximum temperature of the vessels equipped with O-ring seals depends upon the material used for the O-ring. The most common material is a fluoroelastomer (FKM) which has a 225 °C maximum operating temperature limit.



Fixed Head with O-ring



Moveable Head with Flat Gasket

IDENTIFY THE VALVES

Gas Release Valve

The gas release valve is mounted on an extension in a 1/8" NPT port. This valve is open to the gas head space of the cylinder.

This position also includes a 1/8" NPT thread on the underside of the head which may be used for a second dip tube or an alternate accessory such as a catalyst addition device.

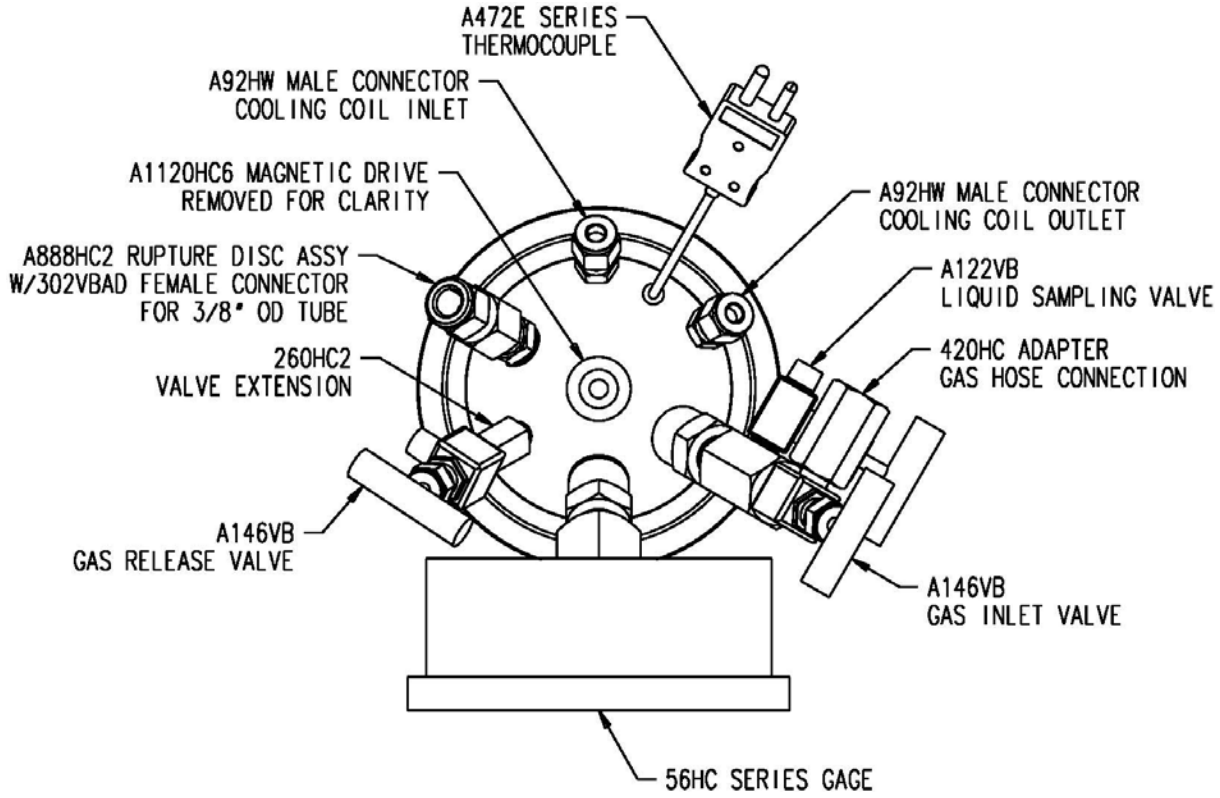
Note: If a fitting is added to the underside of the head in this location it will be necessary to install an additional valve on the gage adapter open to the gas space of the vessel for pressure release.

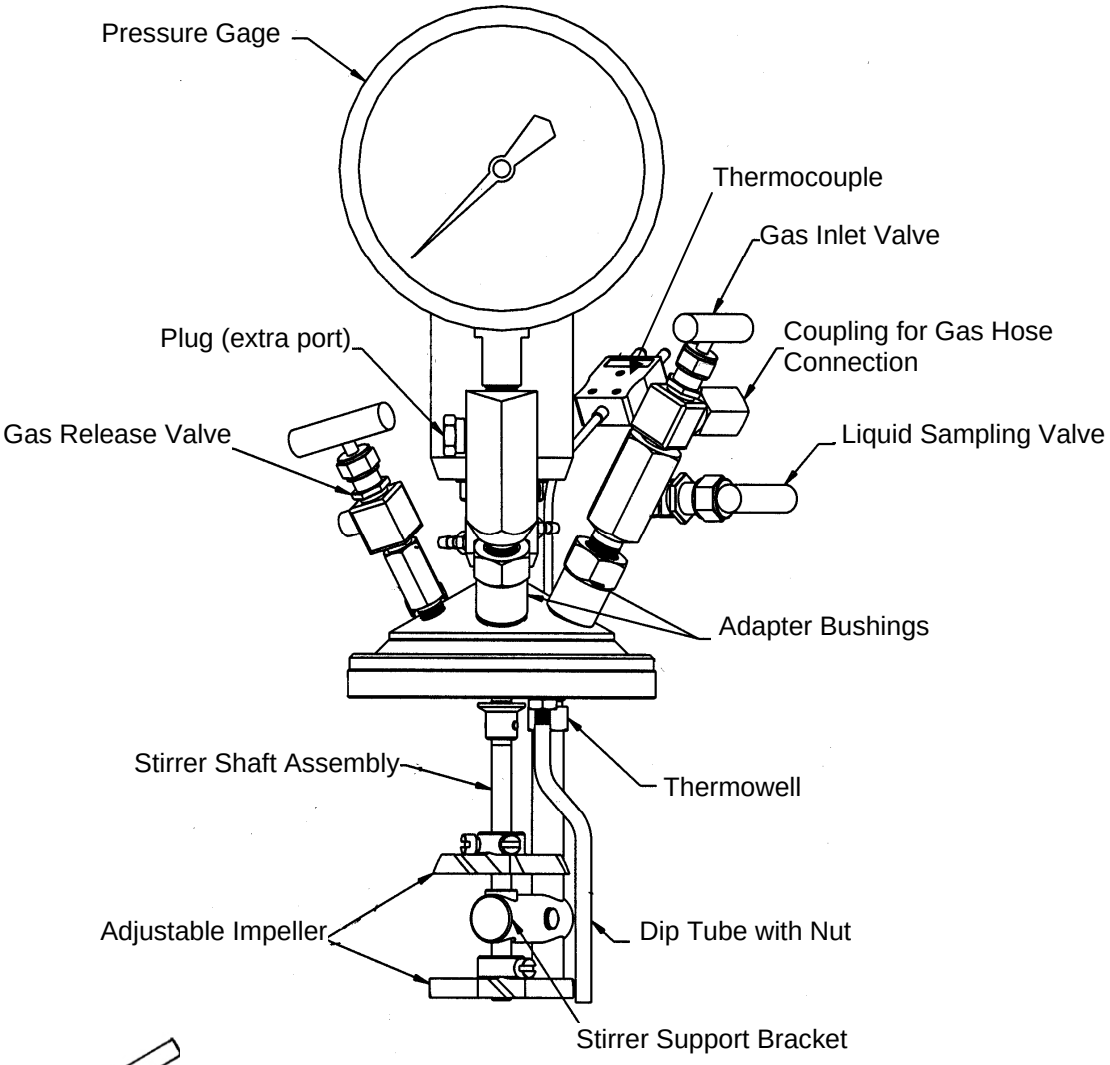
Gas Inlet Valves

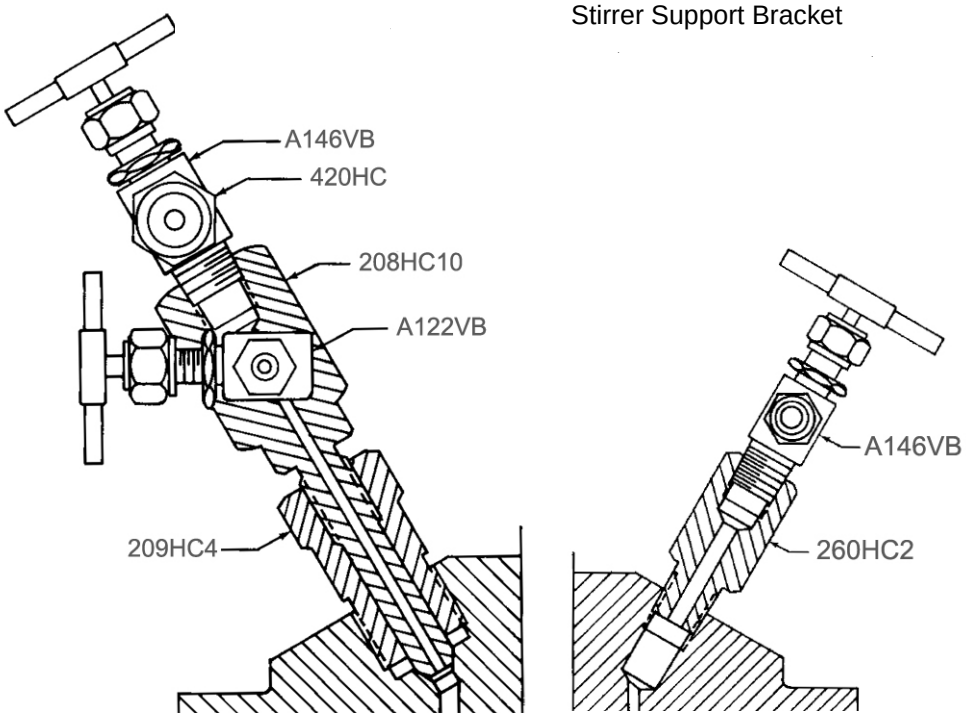
The gas inlet valve is easily identified when the vessel is open by noting that it is connected to a dip tube which extends to a point near the bottom of the cylinder. This is an angle pattern valve with an attached coupling which provides a socket for attaching the A495HC gas hose furnished with the reactor.

Liquid Sampling Valve

The liquid sampling valve is attached to the same adapter as the gas inlet valve combined with the dip tube. With this arrangement, incoming gas is always introduced below the surface of the liquid and the operator is provided with a means for clearing the dip tube to be sure that any sample taken during a run will be representative of the charge. This can be done by opening the gas valve momentarily to force any liquid in the tube back into the reactor before withdrawing a sample from the sampling valve.







Inlet Sampling Valve **Gas Release Valve**

OTHER VESSEL HEAD FITTINGS

Safety Rupture Disc

There is a safety rupture disc attached to the head which is intended to rupture and release the pressure before it reaches a dangerous level. A metal tag wired to the safety head identifies the burst pressure at room temperature for that particular disc. A similar tag is furnished with each replacement disc. This tag must remain with the apparatus at all times so that both present and future operators will be aware of the disc rating. Users should read the discussion of rupture discs given in the Instruction Sheet No. 231M for a complete description of the characteristics of rupture discs and the precautions to be observed when operating pressure equipment protected by this type of safety device.

A typical pre-bulged disc can be used to 90% of the rating on the tag. For additional protection, the user should install an adequate and safe venting system for removing any toxic, flammable or volatile material which would be released if the rupture disc should burst. A connector for attaching 3/8" OD tubing to the discharge port of the rupture disc is provided for this purpose.

Type J Thermocouple

A Type J thermocouple with a 1/8" dia. Stainless steel sheath is furnished with the reactor. Insert this thermocouple into the thermowell and connect it to the thermocouple socket on the rear panel of the temperature controller using the A470E2 extension wire furnished with the reactor.

Pressure Gage

The pressure gage furnished with this reactor has a T316 Stainless Steel Bourdon tube. Gages are furnished in a variety of ranges to met individual needs. Typically, the gage and the rupture disc are furnished as matched ranges. For applications where a gage is selected with a range under 1000 psi, a relief valve is added and set to protect the gage. A 1000 psi rupture disc is installed as the fail-safe vessel protection.

For highly corrosive applications where the vapor phase might corrode the stainless Bourdon tube, offers isolator assemblies in a variety of materials. These isolators with their internal piston isolate the vapors from the gage.

The gage adapter includes a ¼" NPT side port with a plug installed. This position may be used for a variety of fittings such as a needle valve, pressure transducer or relief valve.

Gage and Valve Adapters

The pressure gage and the combined gas inlet and sampling valves are attached to the head with an adapter which allows these fittings to be drawn up tightly when facing in any direction. To attach these fittings to the head, screw the gage or valves firmly into the adapter, then run the 209HC4 bushing onto the threaded stem as far as it will go. Screw this assembly into the head until the nose of the adapter is seated; then back it off until the valve or gage is facing in the desired direction. Now hold the fitting firmly in place and close the joint by tightening the 209HC4 bushing. This connection can be made and broken repeatedly without destroying the sealing faces. A light coating of thread lubricant, such as No. 424HC2 High Temperature Anti-Seize Lube, applied to the threads and to the nose of the adapter will help to obtain a tight joint.

Note: Do not use PTFE tape on the straight thread connections of the coned adapters and mating bushings. PTFE tape should only be used on the (NPT) threads such as the needle valves or gage connection.

HOW TO USE THE VESSEL

PTFE Gasket or O-ring Seal

It is important to examine the main seal of the head and cylinder before running any experiments. Make certain that the gasket or O-ring are in good condition. The seal should not have any nicks or be hardened, discolored or deformed. Examine the mating surfaces of both the head and cylinder to be sure they are clean and free from burrs.

Fixed Head Vessel Installation

Lower the heater assembly and swing it to the left for clearance while installing the vessel assembly. Open the hinged retainer bar and slide the square lip of the head into the support plate. Close the hinged retainer bar. Place the cylinder in the lift cup and raise the cylinder up to the head. Place the split rings around the head and cylinder and close the split ring latches. Follow the bolt tightening procedure below.

Moveable Head Vessel Installation

Lower the heater assembly and swing it to the left for clearance while installing the vessel assembly. With the vessel on the countertop, mount the head on the cylinder. Place the split rings around the head and cylinder. Raise the drop band around the split ring. Tighten the drop band bolt finger tight. Follow the bolt tightening procedure below before installing the vessel assembly into the support frame. The split ring closure rests on the top of the support plate

Sealing Vessels with PTFE Gaskets

First, hand tighten the six bolts. Then using the open-ended wrench supplied with the system. Proceed in a criss-cross pattern to tighten the bolts to 25 ft/lbs. This can be achieved by applying a firm but hard pull to each bolt. Allow the vessel to stand for about five minutes after the initial tightening procedure to allow for the flow of the PTFE gasket under load, then retighten the bolts.

Sealing Vessels with O-ring Seals

Moveable head vessels with O-ring seals include a split ring and a drop band. Place the split rings around the head and cylinder. Raise the drop band around the split ring placing the band so that the bolt will tighten into the dimple on the split ring. Tighten the drop band bolt finger tight.

Fixed head vessels with O-ring seals include a split ring with latches. Place the split rings around the head and cylinder. Close the latches.

Gas Inlet / Liquid Sampling Valves

These reactors include a double valve assembly with a common dip tube. This arrangement allows the introduction of gas into the liquid level as well as the ability to take samples while the vessel is under pressure. The A146VB angle pattern valve at the top is the gas inlet position. The A122VB straight needle valve mounted on the side of the 208HC10 adapter is the liquid sampling valve.

Gas Connections

The A495HC pressure hose is made of reinforced Nylon which can be used at ambient temperature for all non-corrosive gases at pressures up to 2500 psig. This hose is furnished with a male “A” socket connection which will attach to the 420HC coupling installed on the gas inlet valve above the internal dip tube. The other end includes a ¼” NPT male bushing with a alternate 1/8” NPT male thread underneath for attachment to the gas tank valve.

To attach the hose, pull back the nut, rotate the sleeve back as far as it will go toward the nut, insert it into the coupling and then tighten the compression nut firmly.

Note: This assembly acts like a pipe union, allowing the hose to remain stationary while the joint is tightened.

HOW TO USE THE VESSEL *(Continued)*

For applications involving corrosive gases the nylon hose should be replaced with the A490HC hose which includes a PTFE lining and a braided stainless steel outer covering. The A506HC hose is constructed of T316 stainless steel (or other corrosion resistant materials) is also available for severe conditions.

Pressurizing the Vessel

Check all of the needle valves before introducing gas to the vessel. The A122VB liquid sampling valve must be in the closed position throughout the charging procedure. The gas release valve should also be in the closed position unless it is to be used to purge the vessel or run in a continuous mode of operation.

It is important to make certain that the pressure in the gas tank is greater than the pressure in the vessel. If the vessel pressure is greater than the gas tank , liquid will be forced out of the vessel and into the gas supply when the inlet valve is open. If there is any possibility that the gas tank pressure might not be sufficient, install a one way check valve in the gas line to prevent any reverse flow. (Hoses with check valves are available upon request) After the desired pressure has been reached, close the valves and disconnect the hose assembly at the vessel side.

Do Not Overfill the Vessel

Monitor the pressure gage of the vessel when admitting gas. Be aware of the maximum pressure limits of the vessel and allow for expansion as a result of the heating process.

As a general rule, the liquid charge should not exceed two-thirds of the capacity of the cylinder. Too much liquid in the vessel can lead to the development of dangerous pressures if sufficient space is not available for expansion when the material is heated. See the Safety Instruction Manual No. 230M for additional details and potential hazards.

Withdrawing Liquid Samples

Liquid samples may be withdrawn from the sampling valve attached to the same adapter as the gas inlet valve whenever the vessel is pressurized. Always close the inlet valve before withdrawing a liquid sample and open the sampling valve cautiously because liquid will be discharged with considerable force. Be particularly careful if the temperature of the sample is above its boiling point at atmospheric pressure. If so, it will “flash” and be lost as soon as it is released from the vessel. This problem can be avoided by connecting an optional 4351 Sample Collection Vessel to the sampling valve to collect the liquid into an appropriate receiver. The addition of a small amount of gas can be used to clear the dip tube between liquid samples so that the next sample drawn through the tube will truly be representative of the mixture.

Releasing Pressure

The gas release valve is used to reduce the pressure in the vessel if the system is accidentally overcharged when filling. It is also used to release any excess pressure during a run and to exhaust the vessel at the end of a test.

If the discharge gases are flammable or toxic, a line should be added to the valve to discharge into an appropriate containment or exhaust system.

HOW TO USE THE VESSEL
(Continued)

To Open the Vessel at Completion of a Test

Fixed Head Units: Lower the heater and swing it out of the way. Raise the cylinder support to the cylinder bottom. Open the gas release valve to discharge any internal pressure. The split ring closure may now be removed by unscrewing the bolts or opening the latches. The head with all of the attached fittings may remain in the support plate. The cylinder can be lowered away. Care should be taken when removing the cylinder so damage will not occur to the internal fittings.

Moveable Head Units: Lower the heater and swing it out of the way. Open the gas release valve to discharge any internal pressure. Remove the complete vessel assembly from the support stand and place it on a countertop. The split ring closure may now be removed by unscrewing the bolts or opening the latches. Care should be taken when lifting the head from the cylinder so damage will not occur to the internal fittings.

Initial Operating Test

Read all operating instructions carefully so as to be well acquainted with the correct procedures for handling the vessel and for operating the controller and other accessories. An initial operating test should be made, with only water, to check the apparatus before starting the first experimental runs. For this initial test, fill the cylinder not more than half full of water and run the temperature up to 150ºC while checking the apparatus for leaks and observing the performance of the temperature controller.

Variable Speed Electric Motor

Reactors are normally equipped with a DC variable speed motor supplied and controlled through the Series 4848 Controller. Instructions for connecting and operating these motors are included in the controller instruction sheet No. 548M. This motor is usually installed in a drive system designed to produce stirring speeds from 0 to 600 rpm. Higher speeds (1000 or 1700 rpm) can be obtained by substituting larger diameter motor drive pulleys.

ACCESSORIES

Internal Cooling Coils

Cooling coils may be installed in any of these reactors. The heads of the one and two liter vessels are drilled with 1/8" NPT connections on the top and underside of the head. These openings will have plugs installed if a cooling coil was not required when the system was furnished.

The standard cooling coil is a serpentine configuration. These coils provide an effective cooling area and may be used with either a Pyrex or PTFE liner. An optional spiral coil is available which offers a larger surface area for cooling but it is more difficult to clean. The spiral coil can not be used with an internal liner and it may not coordinate with other optional internal fittings.

The A160HW3 solenoid valve package is recommended for use with the internal cooling coil. This package includes the solenoid valve, a metering valve and the parts required to automate and control the cooling process. This assembly will connect to the cold water line, the cooling coil and to the temperature control. Cooling will then be admitted to the coil whenever cooling is called for by the temperature control. This system is particularly advantageous when holding fixed temperatures below 150 °C or to control exothermic reactions.

Alternate plugs are available to close these ports when the coil is removed.

The replacement of a cooling coil will require new nuts and ferrules for installation. Align the replacement coil with the internal fittings before tightening the nuts. Once the nuts are tightened it may be necessary to manually squeeze or slightly adjust the serpentine loops of the coil to position it properly for clearance.

If an internal cooling coil is not required these two ports may be used for alternate fittings such as an additional valve with a second dip tube.

Liners

Glass or PTFE liners can be furnished to fit most reactors. These liners slide into the cylinder. Although they will not keep corrosive vapors from reaching the surfaces of the cylinder and head, they make it much easier to add and remove liquid reactants, and they give some protection to the cylinder when working with corrosive solutions. It must be noted, however, that adding a liner will slow the heat transfer rate into the vessel, and it may be necessary to adjust the temperature control method to prevent overheating.

Liner Part Numbers

Fits ID	Cylinder Size	Glass Liner	PTFE Liner
4"	1000 mL	398HC	398HCHA
4"	2000 mL	399HC	399HCHA

Spare Parts Kit

Can furnish spare parts kits for these reactors which will provide a reserve supply of parts and tools sufficient to handle most normal replacements and emergency repairs during a year of heavy usage.

These kits contain replacement gaskets, packing, O-rings, shafts, bearings, and rupture discs. They can be ordered from any Dealer or direct from the Company. The order must specify the reactor size and indicate type of rupture disc, stirrer drive and whether it has a flat-gasket or O-ring closure. Always provide the reactor serial number (stamped on head and cylinder) to assure receipt of proper replacement parts.

Air Motor

Variable speeds from 100 to 2000 rpm can be obtained by replacing the standard motor with an A1393HC air motor assembly. This motor operates on compressed air which must be supplied at 40 psig minimum pressure with at least 10 CFM available at that pressure. It is furnished with a speed control valve and oiler, all assembled on a mounting bracket.

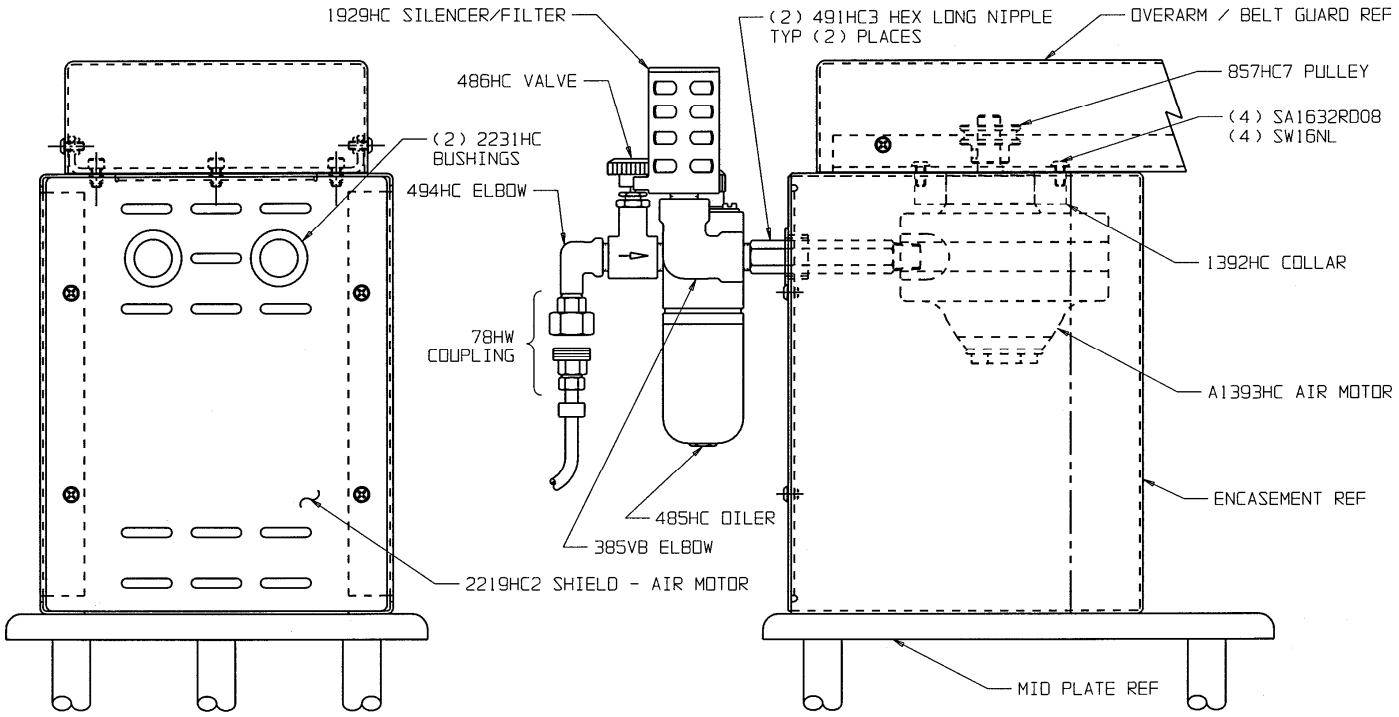
To operate reactors equipped with an air motor, mount the assembly firmly on the stand and connect the air hose to a compressed air line. For best torque and speed control the piping to the motor should be at least 1/4" IPS or larger. Fill the oiler with SAE 10 oil and adjust the oiler to feed one drop per minute into the air stream. For long continuous runs at high speeds the oiling rate should be increased to three drops per minute.

If the motor becomes sluggish, flush it with a non-flammable solvent in a well ventilated area. Disconnect the air line and muffler and pour a small amount of solvent into the inlet port. Rotate the shaft by hand in both directions for a few minutes; then connect the air line and run the motor until there is no further trace of solvent in the exhaust.

If the muffler felts are dirty, wash them in solvent or replace them.
Re-lubricate the motor with a squirt of oil into the chamber and reassemble.

If it becomes necessary to disassemble the motor to replace the vanes, follow the directions given in the instruction sheet published by the Gast Manufacturing Corporation, Benton Harbor, Michigan.

Air Motor Option





EXPLOSION PROOF OPERATION

If the local safety code requires that equipment installed in the user's laboratory must be explosion proof, there are four possible ignition hazards to be considered:

1. **The Motor**

   The standard adjustable speed motor is not explosion proof, yet these motors are not unduly hazardous if operated in a well ventilated location where care is taken to prevent the accumulation of explosive gases or vapors. To eliminate any possible spark hazard originating at the motor, can furnish an air motor as described previously, or the reactor can be equipped with a variable speed, explosion proof motor that is approved for use in Class 1, Groups C & D, and Class 2, Groups E, F, & G atmospheres. Explosion proof motors are furnished with a temporary power cord and plug which are not explosion proof. The user should remove this temporary wiring and replace it with an explosion proof switch and wiring which will comply with the local electrical code.

2. **The Temperature Controller**

   The Series 4848 Temperature Controllers furnished with these reactors contain switches and other elements that are not explosion proof. The minimal spark hazard associated with these units can be resolved by installing the controller in a remote location outside of the hazardous area or by enclosing it in an approved explosion proof housing. If enclosed within a positive pressure, clean air housing, the discharge from the housing must be directed into a safe area. If requested, will furnish the long lead wires needed to mount the controller in a remote location. If the controller is to be installed in an explosion proof housing, the user must provide the necessary housing and installation.

3. **The Heater**

   The elements in the heater could be dangerous in an explosive atmosphere if the surface temperature of the element becomes high enough to ignite flammable vapors. This hazard must be evaluated for each individual installation since major modifications are required if the heater must be isolated from the surrounding atmosphere. Users who consider this a significant hazard are urged to contact the Company for further discussion and suggestions that might be helpful.

4. **The Wiring**

   The wiring provided with the standard reactor systems does not meet the standards prescribed for explosion proof operation. Optional, intrinsically safe barriers are available.

PERIODIC PRESSURE TESTS

Each cylinder used in a stirred reactor is tested under hydrostatic pressure to 1.3 times its maximum rating before it is released from the factory. Micrometer caliper measurements are taken during this test to check the deflection of the walls under pressure. Excessive deflection or failure of the metal to resume its original dimensions after pressure is released indicates that a cylinder is potentially unsafe and it will be rejected. Similar tests should be made at regular intervals during the life of each cylinder, and particularly whenever the user suspects that the equipment has been over-stressed or damaged.

Some laboratories maintain hydraulic test facilities and make it a rule that all pressure vessels must be tested at regular intervals. Records are kept of deflections at specific test pressures so that any increase in deflection becomes a warning that the metal has lost strength. Any cylinder that fails to return to its original dimensions after application of the prescribed hydrostatic test should be discarded as unsafe for further use.

Users who do not have pressure test facilities can return any pressure vessel to the factory for hydrostatic testing and overhaul. This should be done whenever the metal shows excessive damage from corrosion or whenever an over-pressure or other unusual occurrence raises any safety questions. To return a vessel for repair contact Company for a return authorization number. Apparatus returned for testing and overhaul should be shipped prepaid to the Company, 211-53rd Street, Moline, Illinois 61265. An order or letter of instructions should be mailed to the same address, as no repair work will be started without specific instructions and a Health & Safety Assurance Certification form (F0042) signed by a responsible user.

GENERAL MAINTENANCE NOTES

1. Periodically inspect all electrical wiring and pressure connections for excessive corrosion. Suspect parts should be replaced by components only supplied by Company.
2. Always use appropriate wrenches on all fittings and valves. Never use pliers or pipe wrenches.
3. Head and cylinder service fixtures are available for convenience and protection of components during maintenance of your reactor.
4. To reinstall straight thread (NPS) fittings to the head, screw the gage or valves firmly into the adapter.
   Run the bushing onto the threaded stem as far as it will go. Screw this assembly into the head until the nose of the adapter is seated; then back it off until the valve or gage is facing in the desired direction (no more than one full turn). Hold the fitting firmly in place and close the joint by tightening the bushing. This connection can be made and broken repeatedly without destroying the sealing surfaces. A light coating of thread lubricant, such as High Temperature Anti-Seize Lubricant, applied to the straight threads and to the nose of the adapter will help to obtain a tight joint.
   Note: PTFE tape should not be used on this joint.
5. NPT (National Pipe Taper) threads should not be disassembled any more than necessary. It will become increasingly difficult to maintain a tight seal with these tapered threads if the joint is made and broken repeatedly. Grafoil tape or PTFE tape (if temp allows) should be used on all NPT threads.
6. Do not use oil or anti-seize lubricant on threads or fittings if the vessel is to be used with oxygen.
7. If your vessel is equipped with a loose compression ring be sure that it is in place on the head before attaching any head fittings. The compression ring cannot be installed after fittings have been screwed into the head.
8. Clean all threads and gas passages thoroughly and remove all tape fragments when overhauling a vessel. An ultrasonic bath is excellent for cleaning metal parts, but do not place a thermocouple probe, pressure gage, face seals or ball bearings in an ultrasonic bath. Periodic cleaning may be performed on the exterior surfaces of the reactor stand with a lightly dampened cloth containing mild soap solution. All power should be disconnected when cleaning.
9. Routinely inspect cap screws on split ring closure for lubrication and cleanliness. These screws should not be allowed to dry because the threads will seize. Regularly apply High Temperature Anti-Seize Lubricant before this happens.
10. To operate reactors equipped with an air motor, connect air hose to a compressed air line. For best torque and speed control the piping to the motor should be at least 3/8” IPS or larger. Fill the oiler with SAE 10 oil and adjust the oiler feed one drop per minute into the air stream. For long continuous runs at high speeds, the oiling rate should be increased to three drops per minute. If the motor becomes sluggish, flush it with a non-flammable solvent in a well ventilated area.
    Disconnect the air line and muffler and pour a small amount of solvent into the inlet port. Rotate the shaft by hand in both directions for a few minutes; then connect the air line and run the motor until there is not further trace of solvent in the exhaust. If the muffler is dirty, replace it. Relubricate the motor with a squirt of oil into the chamber and reassemble.
11. If servicing assistance is needed, contact Company directly at the address shown on the back of these instructions.

PARTS LISTS

Reaction Vessel Parts List

Consult the itemized list for your reactor provided along with this manual. For purpose of reactor identification, the following abbreviation/codes are used**:**

FH -	Fixed Head	**LD -**	Light Duty
RV -	Removable Head	**HD -**	Heavy Duty
FG -	Flat Gasket	**OS -**	O-ring Seal

Part No.	Description	Code
Cylinders		
236HC10	Cylinder, 1000 mL	FG
236HC20	Cylinder, 2000 mL	FG
2742HC10	Cylinder, 1000 mL	OS
2742HC20	Cylinder, 2000 mL	OS
HEADS		
1370HC20	Head	RVFG(LD)
2252HC20	Head	FHFG(LD)
2740HC20	Head	RVOS(LD)
2750HC20	Head	FHOS(LD)
2259HC20	Head	FHFG(HD)
2758HC20	Head	FHOS(HD)
755HC50	Head	RVFG(HD)
INTERNAL FITTINGS		
THERMOWELL		
265HC7	Thermowell 1000ml	FH
265HC12	Thermowell 2000ml	FH
STIRRER SUPPORT BRACKET		
A380HC	Stirring Bracket Assembly	FG
A1404HC	Stirrer Bracket Assembly	OS
380HCF	Cap screw for A380HC/ A1404HC bracket	
299HC	Bushing PTFE for A380HC/ A1404HC bracket	
299HCKF	Bushing, graphite for A380HC/ A1404HC bracket	
DIP TUBE		
257HC26	Dip Tube with nut, 1000 mL	
257HC27	Dip Tube with nut, 2000 mL	

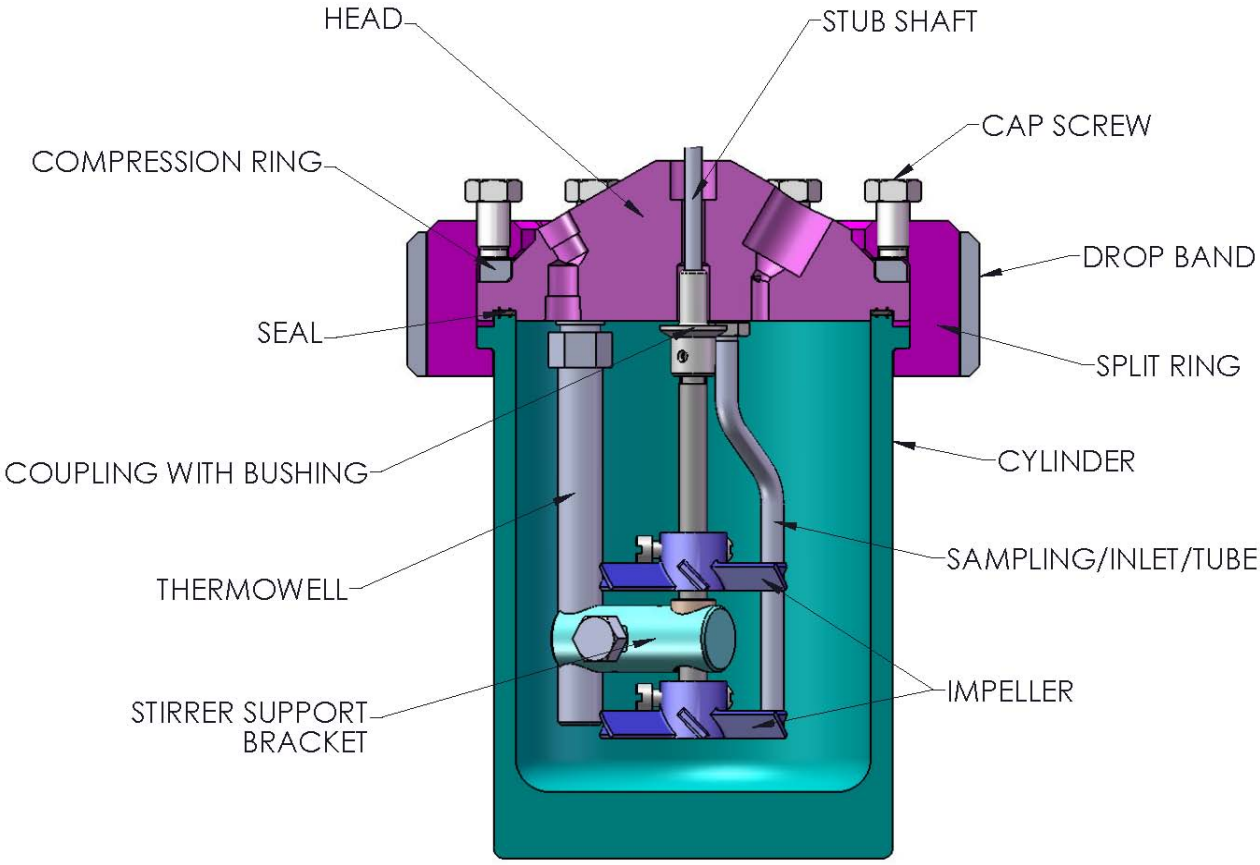
For parts made from alternate materials use the codes shown below as a suffix to the standard part number.

CM -	Alloy 400	**CC -**	Alloy 20Cb3
CT -	Alloy 600	**CAD -**	Titanium G2
CG -	Alloy B-2	**CAA -**	Titanium G4
CXA	Zirconium G702	**CH -**	Alloy C-276
CXB	Zirconium G705		

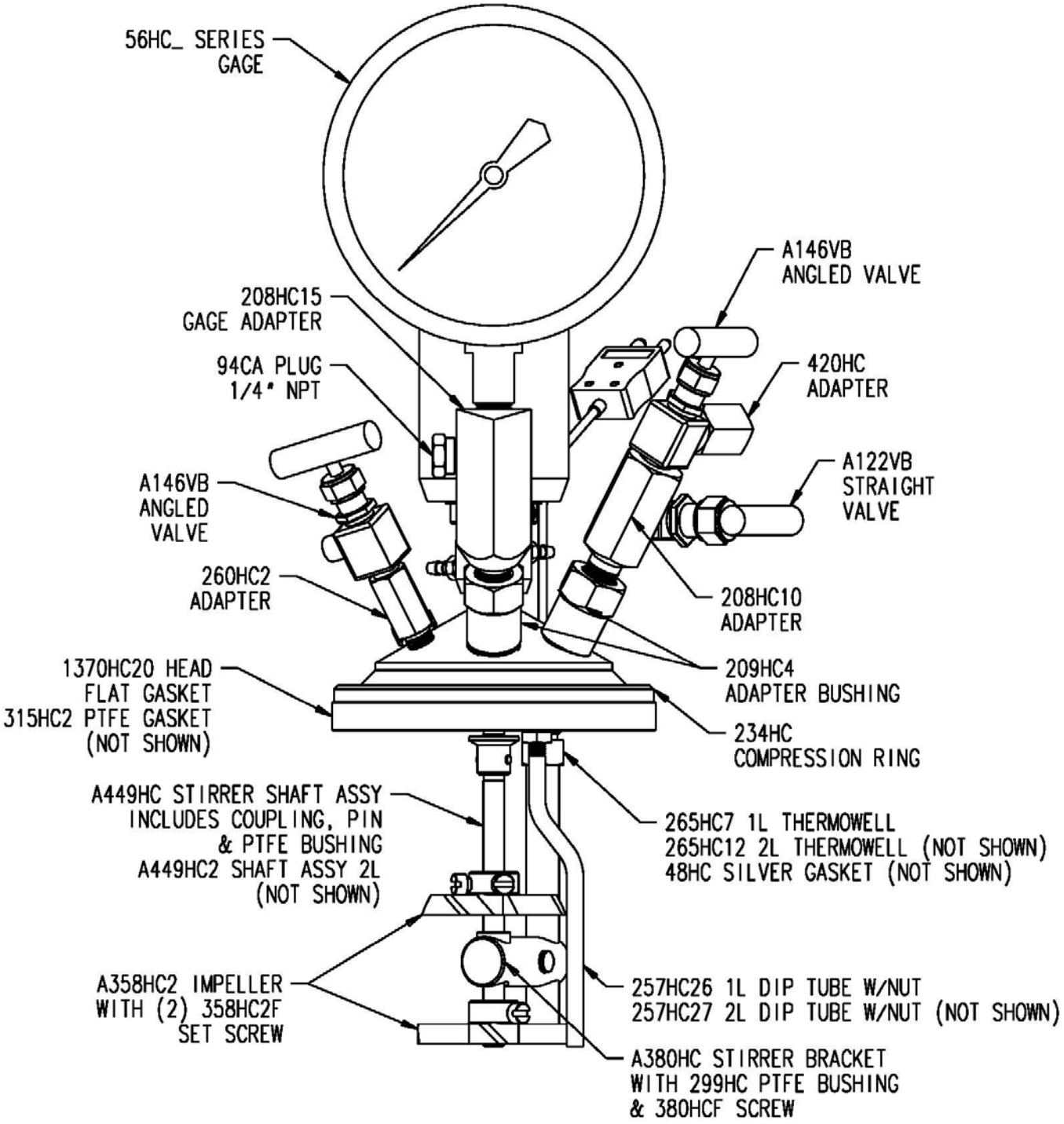
Part No.	Description	Code
SHAFTS		
352HC6	Stub shaft, A1120HC6, 2.56”	RV(LD)
352HC9	Stub shaft, A1120HC6 , 3.98”	FH(LD)
1025HC39	Stub shaft, A1180HC4, 5.76”	FH(HD)
1025HC14	Stub shaft, A1180HC4, 4.12”	RV(HD)
A449HC	Shaft assembly with coupling, 1000 mL	(LD)
A449HC2	Shaft assembly with coupling, 2000 mL	(LD)
A1030HC	Shaft assembly with coupling, 1000 mL	(HD)
A1030HC2	Shaft assembly with coupling, 2000 mL	(HD)
378HC	Coupling, stirring shaft	(LD)
379HC	Pin, shaft, coupling	(LD)
1028HC	Coupling, stirrer shaft	(HD)
1029HC	Pin, shaft, coupling	(HD)
447HC	Shaft bushing, PTFE	(LD)
1027HC	Shaft, bushing, PTFE	(HD)
448HC	Shaft with 447HC bushing, 1000 mL	(LD)
448HC2	Shaft with 447HC bushing, 2000 mL	(LD)
1025HC	Shaft with 1027HC bushing, 1000 mL	(HD)
1025HC2	Shaft with 1027HC bushing, 2000 mL	(HD)
A358HC2	Impeller with set screws, 2.28” dia	
A358HC5	Impeller with set screws, 2” dia	
358HC2F	Set screws for impeller	
GASKETS & SEALS		
48HC	Gasket, silver; thermowell and LD drive	
48HCFG	Gasket, gold plated; thermowell and LD drive	
315HC2	Head Gasket, PTFE	FG
2741HCJV	O-ring FKM	OS
2741HCJK	O-ring FFKM	OS

Part No.	Description	Code
EXTERNAL FITTINGS		
94CAAD	Plug, 1/4" NPTM	
A122VB	Needle Valve, 1/8" NPTM (Gas Sample)	
A146VB	Needle Valve, angled 1/8" NPTM (Gas Release/Inlet)	
208HC10	Valve adapter, two 1/8" NPTF	
208HC15	Gage adapter, angled, two 1/4" NPTF	
234HC	Compression Ring	
209HC4	Bushing	
260HC2	Valve extension, 1/8" NPT (Gas Release)	
288VBAD	Male Connector, 3/8 T-1/4" NPTM	
396HC3	Stirrer Plug	(LD)
35HC	Compression Nut, for plug	(LD)
420HC	Adapter, 1/8" NPTF to A socket (Gas Inlet)	
A472E2	Thermocouple, 1000 mL	
A472E6	Thermocouple, 2000 mL	
A888HC2	Safety Rupture Disc assembly without disc (see 231M)	
A2685HC	Cooling Sleeve assembly	(LD)
A740HC	Cooling Sleeve assembly	(HD)
A1120HC6	Magnetic Drive assembly	(LD)
A1180HC4	Magnetic Drive assembly	(HD)
663HC	Olive, drive seal	(HD)
664HC	Nut, Gland, drive seal	(HD)

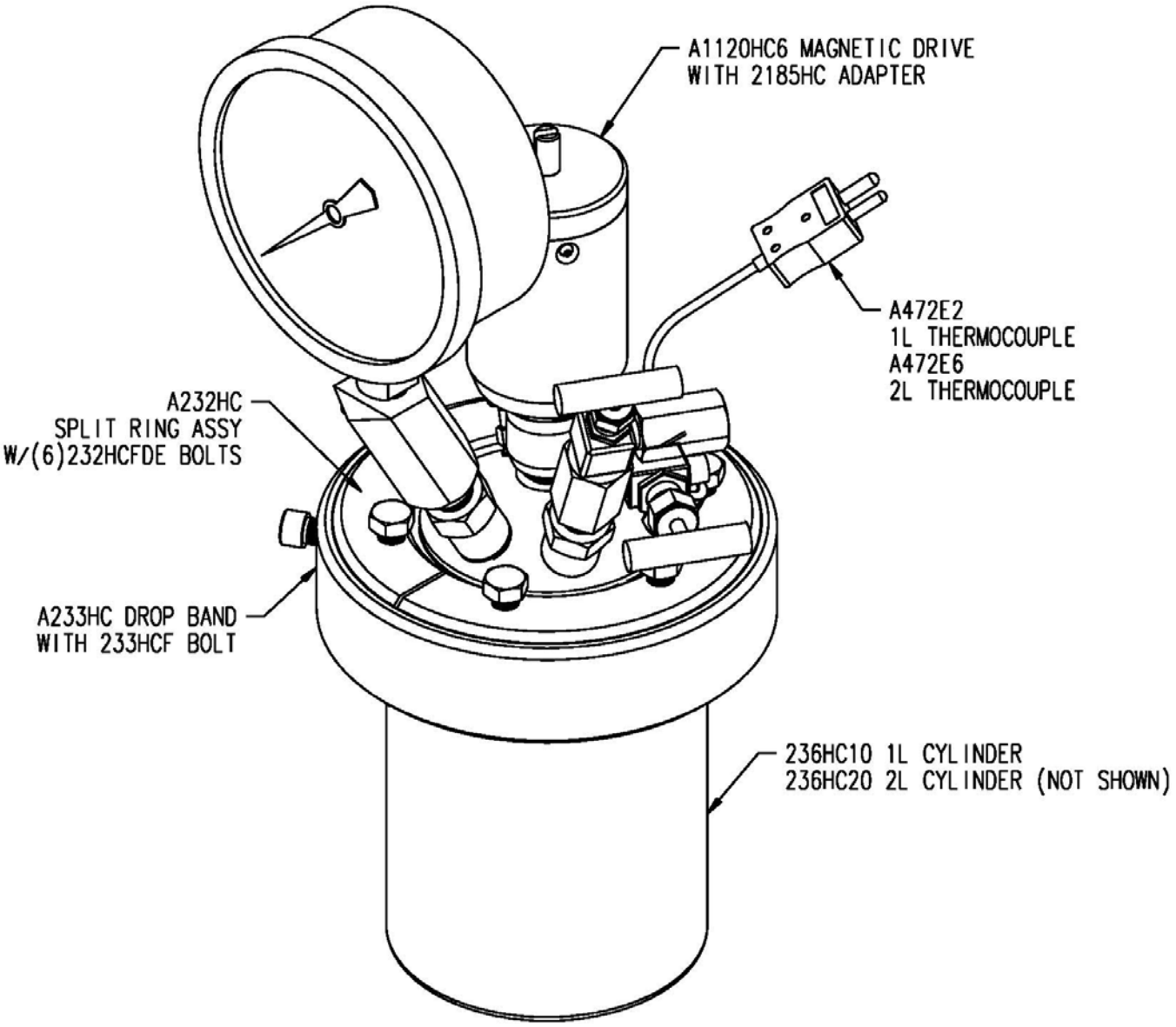
Part No.	Description	Code
SPLIT RINGS AND ACCESSORIES		
A232HC	Split ring pair with cap screws	RVFG
A2255HC3	Split ring pair with cap screws, latches	FHFG
232HCFDE	Cap screw, for A232HC and A2255HC3	
2245HC	Split ring, pair	RVOS
A2243HC	Split ring, pair, with latches	FHOS
A233HC	Drop band with screw	RV
GAGES		
56HCPC	Pressure gage, 4-1/2", 0-600 psi	
56HCPD	Pressure gage, 4-1/2", 0-1000 psi	
56HCPF	Pressure gage, 4-1/2", 0-2000 psi	



Removable Head Style Parts Lists

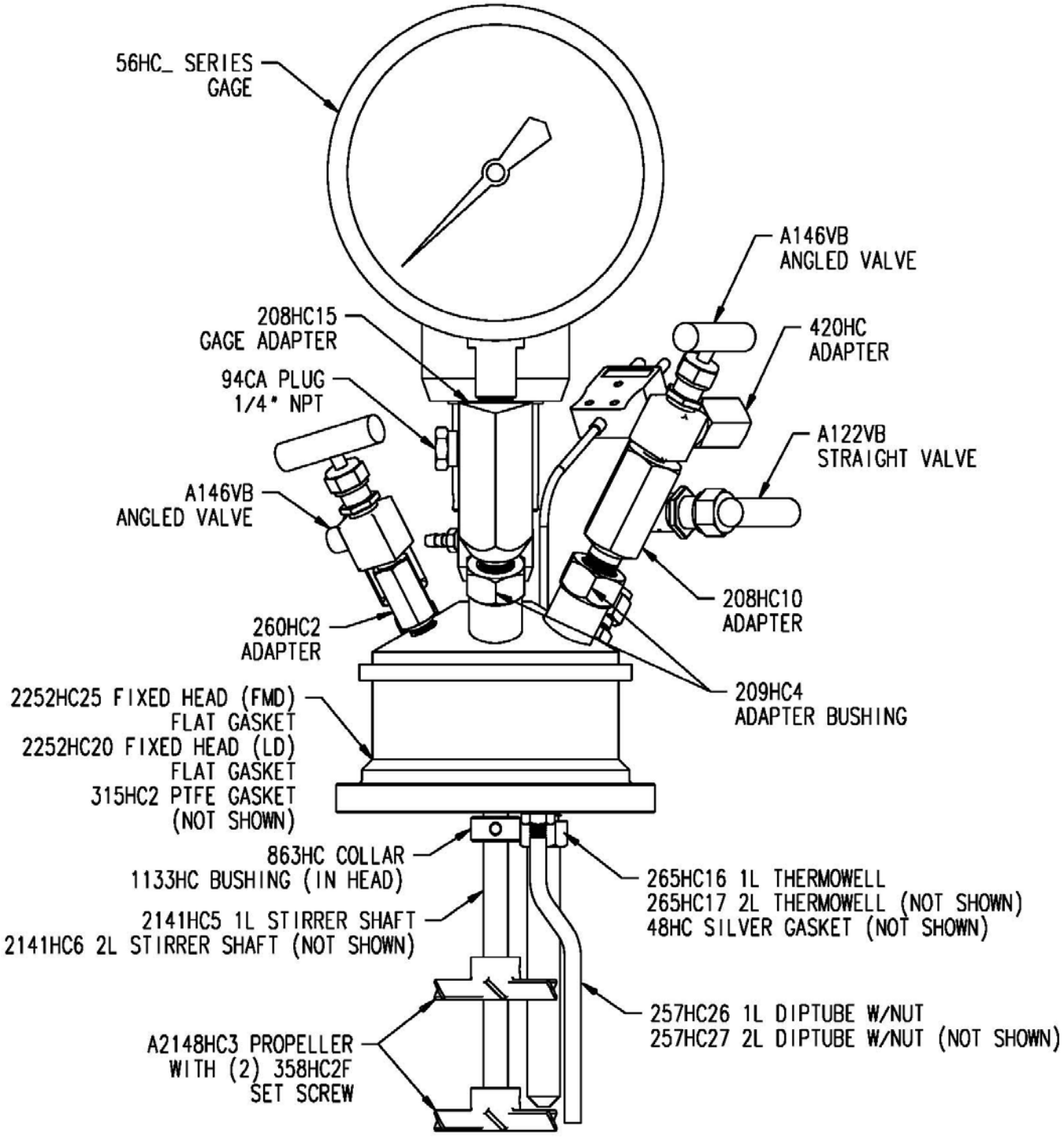


Front View
Removable Head Flat Gasket

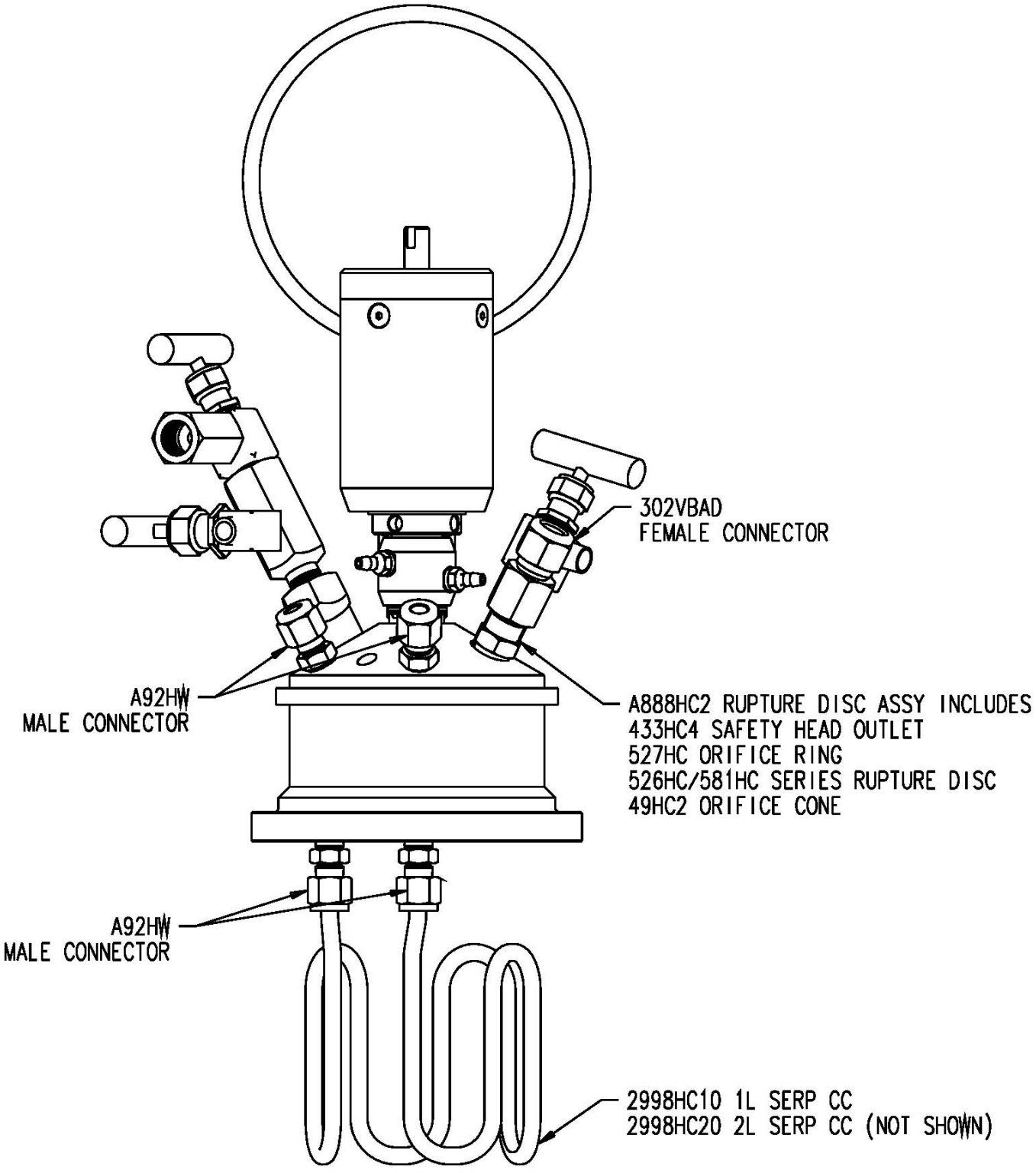


Removable Head Flat Gasket

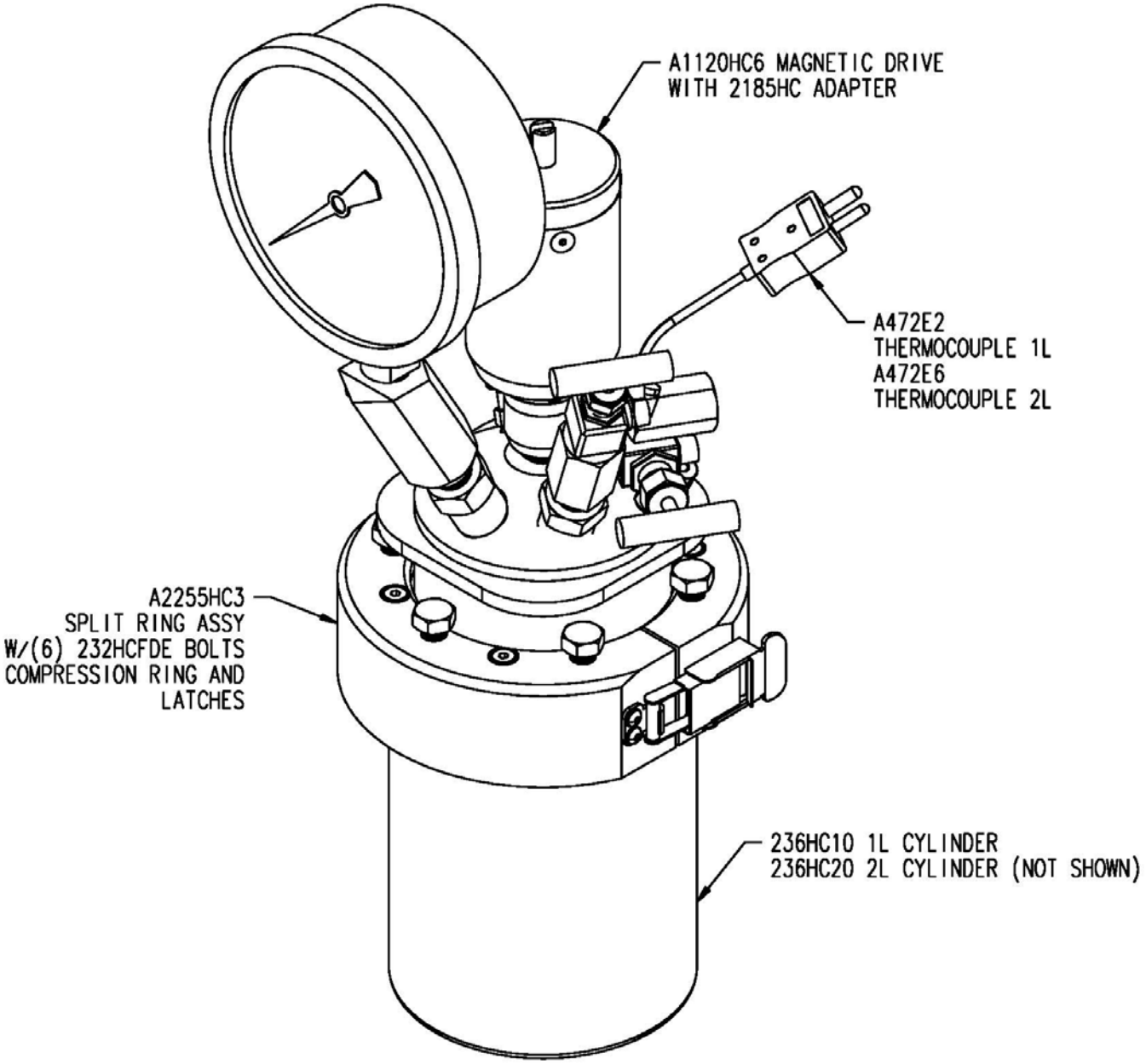
Fixed Head Style Parts Lists



Front View
Fixed Head Flat Gasket
Light Duty Footless Mag Drive



Back View
Fixed Head Flat Gasket



Fixed Head Flat Gasket

Overarm Parts List

Part No.	Description	Code
MOTOR		
1355EES	Motor VS/PM130VDC 1/8 HP	LD
A1554EES	Motor VS/PM 130VDC 1/8 HP with EMC filter	LD
A1393HC	Air Motor	LD
A388E6	Air Motor	HD
A388EES	Motor 1/4 HP VS 90 VDC	HD
A388E2ES	Motor 1/2 HP VS 90VDC	HD
A388EEQ	Motor 1/4 HP EXP VS 90 VDC	HD
A388E2ET	Motor 1/2 HP VS 180 VDC	HD
A388EER	Motor 1/4 HP EXP VS 180 VDC	HD
A388EET	Motor 1/4 HP VS 180 VDC	HD
DRIVEN PULLEY ASSEMBLY		
A2179HC	Driven Pulley Assembly	LD
839HC	Ball Bearing	LD
841HC	Snap Ring, External .693"	LD
842HC	Snap Ring, 1.804"	LD
858HC2	Pulley, Driven	LD
862HC	Support Hub	LD
299HC2	Bushing, PTFE	LD
A2519HC	Driven Pulley Assembly	HD
706HC2	Pulley, Driven	HD
725HC	Support Hub	HD
730HC	Ball Bearing	HD
731HC	Snap Ring Internal 2"	HD
732HC	Snap Ring External 1"	HD
2429HC	Bushing PTFE	HD
UPPER DRIVE SHAFTS		
A2562HC	Upper Drive Shaft , A1120HC	LD
A2562HC2	Upper Drive Shaft, A2140HC	LD
A2564HC	Upper Drive Shaft, A1120HC6, ¼ hp motor	LD
A2564HC2	Upper Drive Shaft , 1/4 -1/2 hp, A1180HC	HD

Part No.	Description	Code
SHAFT COUPLINGS		
2075HC	Shaft Coupling .38, Universal	(LD)
2352HC	Shaft Coupling .50, Universal	(HD)
RELEASE KNOBS		
845HC2	Release Knob, .38 Shaft	LD
726HC	Release Knob, .50 Shaft	HD
DRIVE PULLEYS (MOTOR)		
857HC	Pulley 600 RPM	LD
857HC3	Pulley 800 RPM	LD
857HC4	Pulley 1000 RPM	LD
857HC5	Pulley 1700 RPM	LD
695HC5	Pulley 800 RPM .62	HD
695HC3	Pulley 1000 RPM .62	HD
695HC2	Pulley 1700 RPM .62	HD

PULLEY BELT COMBINATIONS (LD DRIVE)

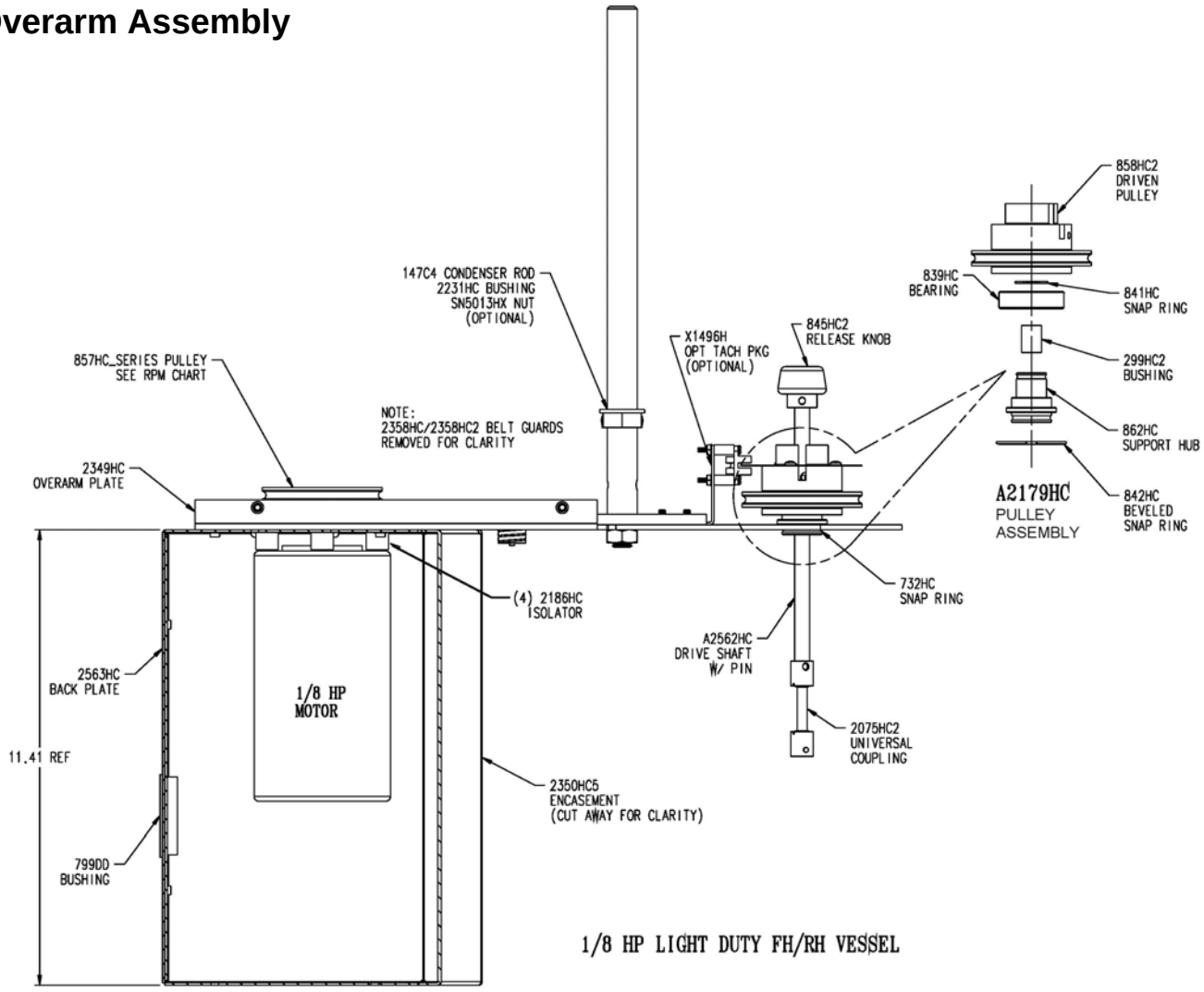
LD Pulley	Belt
857HC	847HC9
857HC3	847HC9
857HC4	847HC9
857HC5	847HC10

PULLEY BELT COMBINATIONS (HD DRIVE)

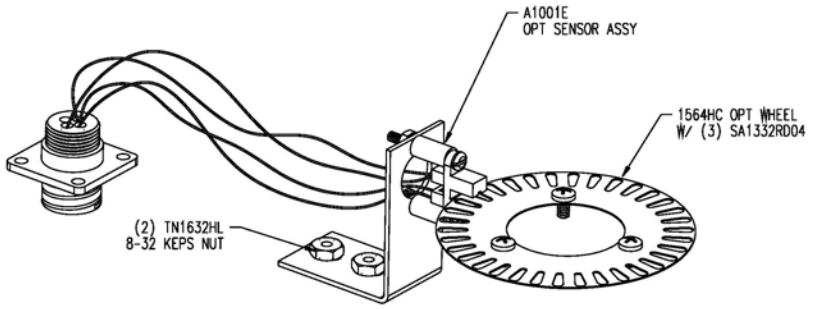
HD Pulley	Belt
695HC5	728HC5
695HC3	728HC5
695HC2	728HC6

OPTIONAL TACH PARTS		
1564HC	Optical Wheel	
A1001E	Tach Sensor Assembly (9.0"L)	
A1001E2	Tach Sensor Assembly (5.5"L)	

Overarm Assembly



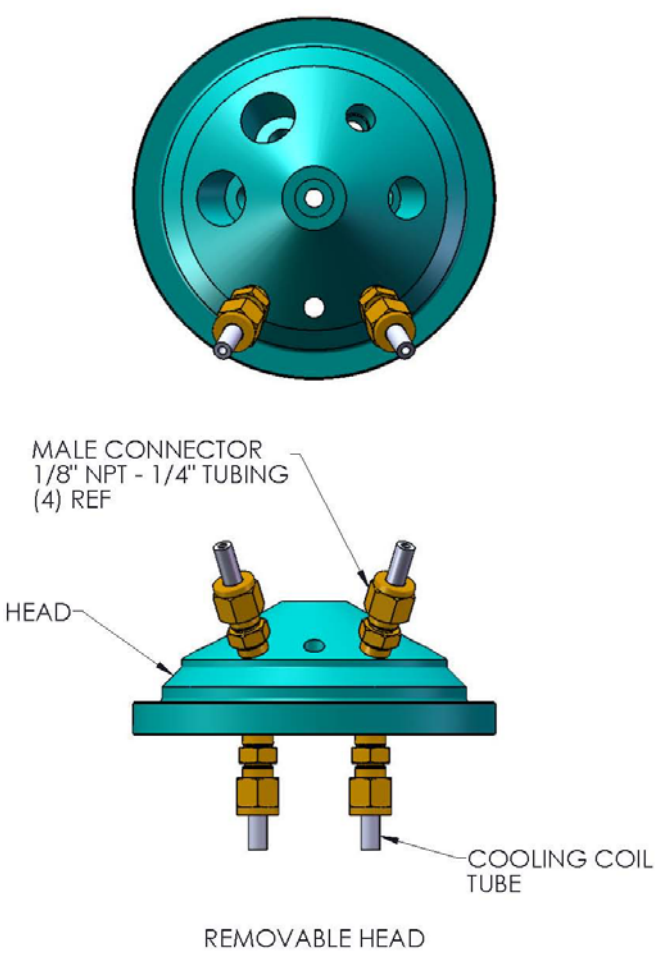
RPM TABLE			
RPM	PULLEY	DIA.	BELT
600 RPM	857HC	ø1.19	847HC9
1000 RPM	857HC4	ø1.85	847HC9
1700 RPM	857HC5	ø3.00	847HC10



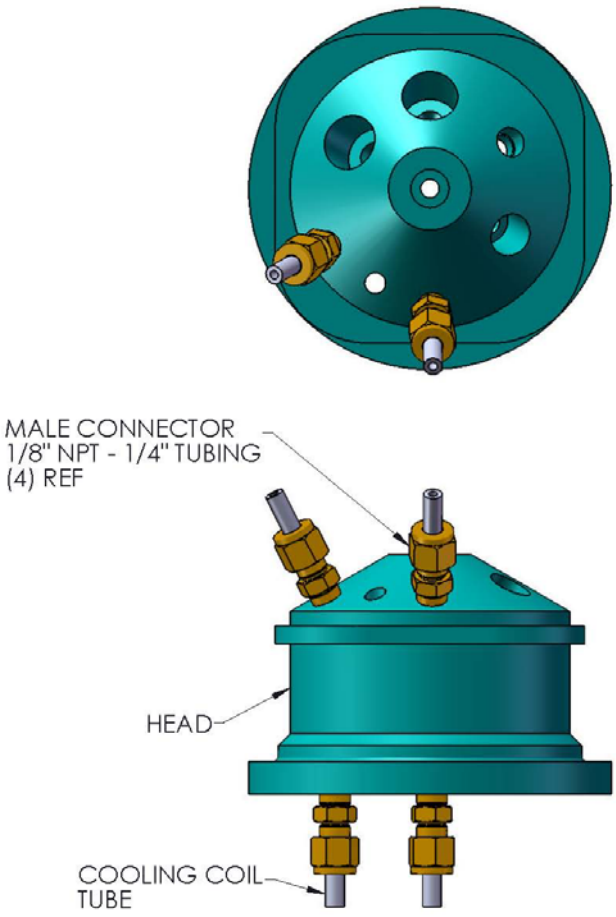
Cooling Coil Parts List

Part No.	Description
2998HC10	Cooling Coil, Serpentine 1L
2998HC20	Cooling Coil, Serpentine 2L
A92HWAD	Male Connector, T316SS*
217VBAD	Nut for tube 1/4", T316SS*
218VBAD	Ferrule for tube 1/4", T316SS*
885HC2	Plug, 1/4" T Cap & Nut

* Used in both top and bottom on the head. Change to appropriate material suffix for special alloy vessels for internal connection.



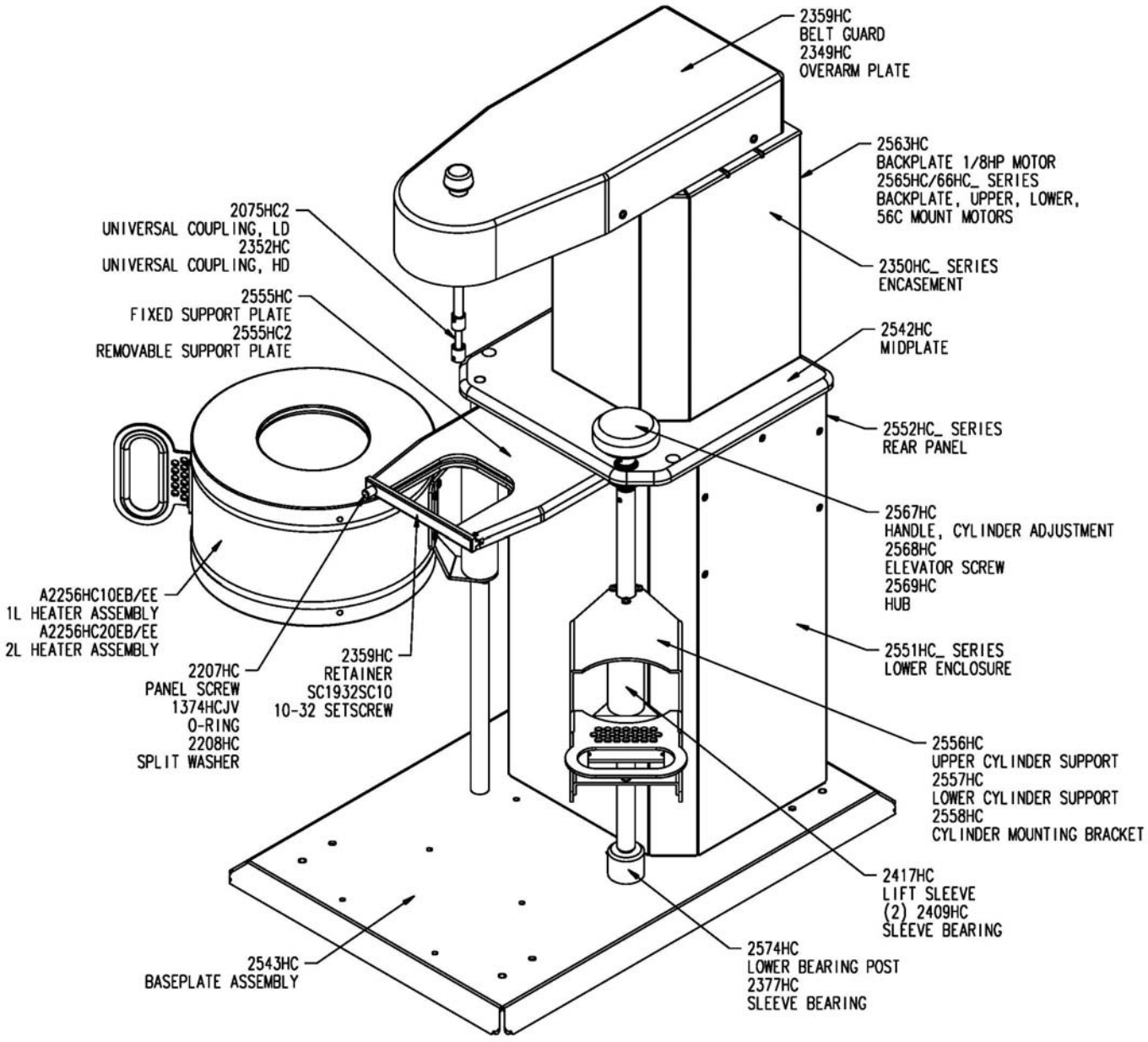
REMOVABLE HEAD



FIXED HEAD

Vessel Heaters Parts List

Part No.	Description
FOR FIXED HEAD VESSELS	
A2256HC10EB	Heater Assembly 1000W 115V 1L
A2256HC10EE	Heater Assembly 1000W 230V 1L
A2256HC12EB	Heater Assembly 1000W 115V 1L w/ thermowell
A2256HC12EE	Heater Assembly 1000W 230V 1L w/ thermowell
A2256HC20EB	Heater Assembly 1500W 115V 2L
A2256HC20EE	Heater Assembly 1500W 230V 2L
A2256HC22EB	Heater Assembly 1500W 115V 2L w/ thermowell
A2256HC22EE	Heater Assembly 1500W 230V 1L w/ thermowell



Benchtop Stand Arrangement