5500

Compact Mini Bench Top Reactors

Operating Instruction Manual



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PREFACE

Scope

These instructions describe the installation, operation and maintenance of Series 5500 Compact Mini Bench Top Reactors offered in sizes from 100 mL to 600 mL. 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 that 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.

Related Instructions

The following publications are also available to further your understanding of this instrument and its component parts:

No.	Description
201M	*Limited Warranty*
230M	*Safety Precautions to be observed when operating Pressure Reaction Equipment*
231M	*Operating Instructions for Safety Rupture Discs*
323M	*Operating Instructions for Pressure Relief Valves*
441M	*Operating Instructions for the A3040HC Compact Magnetic Drive*
548M	*Operating Instructions for 4848 Reactor Controllers*
FX004	*Health & Safety Assurance Certification*

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.

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 100 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 instrument is intended to be used indoors.



Caution!
Do not use in hazardous atmospheres.

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: 0 to 2000 meters above sea level.

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

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 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.

Provisions for Lifting and Carrying

The reactor and its 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.

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.

There are no user serviceable parts inside the product other than what is specifically called out and discussed in this manual. Advanced troubleshooting instructions beyond the scope of this manual can be obtained by calling Company in order to determine which part(s) may be replaced or serviced.



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

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. Company 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, Company 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 by Company.

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.

INSTALLATION

Flat PTFE Gasket

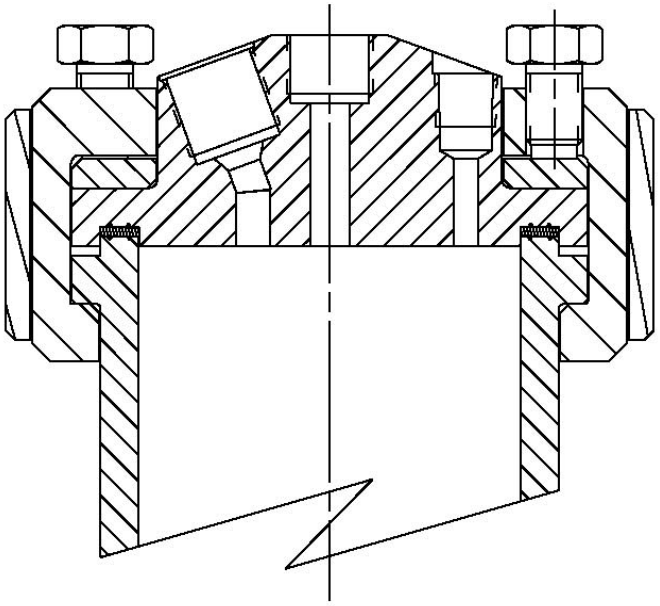
The flat gasket is held in a recess in the vessel head and a machine pilot on the cylinder closes the recess to completely contain the gasket. The split ring closure used with this gasket has six cap screws which must be tightened to develop the loading on the gasket.

The flat PTFE gasket can be used to operating temperatures as high as 350 °C.

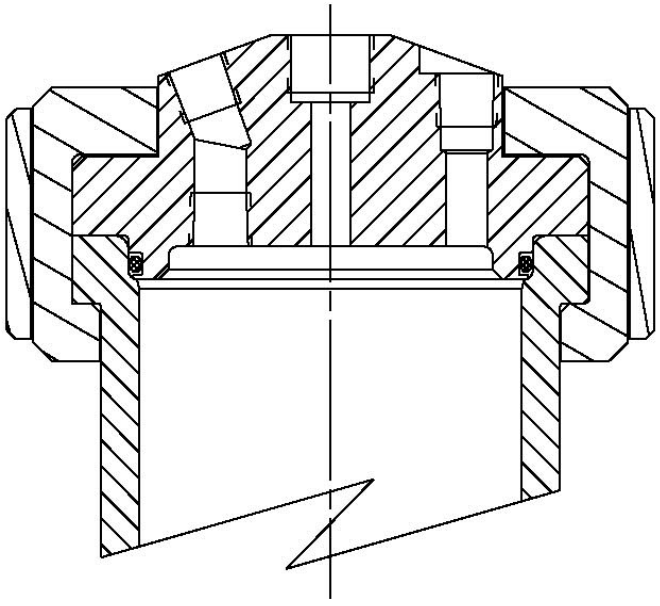
Self Sealing O-Ring Closure

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 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.



Moveable Head with PTFE Gasket



Moveable Head with O-ring Seal & Easy Close Split Ring

Pressure and Temperature Limits

Working pressures up to 3000 psig (200 bar) maximum are permissible in these Mini Reactors when constructed of Type 316 Stainless Steel and equipped with a magnetic stirrer drive. Pressure limits for reactors made of materials other than Type 316 Stainless Steel can be obtained from customer service. No attempt should be made to increase these limits by making alterations or by substituting components which are not recommended by 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 such vessels will be determined by the physical characteristics of the material of construction and will be prescribed on an individual basis.

Working temperatures up to 350 °C are permissible in Mini Reactors equipped with a standard, flat gasket, No. 457HC2, made of PTFE fluoropolymer resin. A PTFE gasket is the recommended choice for most applications since the PTFE resin is inert to most chemicals and it will provide good seals under repeated opening and closing if the gasket temperature does not exceed 350 °C. The service life of a PTFE gasket will, however, be reduced considerably if used at temperatures above 300 °C. For better service in the 300 °C to 350 °C operating range recommends a flexible graphite gasket, No. 457HC3KL.

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.

Working temperatures up to 225 °C are permissible in mini reactors equipped with fluoroelastomer (FKM) O-ring seals. The higher the operating temperature above 200 °C, the shorter the life of the O-ring will be. Perfluoroelastomer (FFKM) O-ring seals have a broad chemical resistance and can be used to temperatures up to 300 °C. Unfortunately they are very expensive and will generally be reserved for unique applications. Ethylene-propylene (EP)
O-rings can be used to 170 °C and are recommended for applications such as ethers, ammonia and amines which will rapidly destroy fluoroelastomer O-rings.

Pressure and Temperature Limits

The working pressure and temperature in these 100 mL thru 600 mL reactors must not exceed the following maximum limits:

Vessel Material	Maximum Pressure	Maximum Temperature
T316SS	3000 psig	350 °C PTFE Flat Gasket
T316SS	3000 psig	225 °C FKM O-Ring
T316SS	3000 psig	300 °C FFKM O-Ring

Assemble The Reactor

These reactors require at least 3 sq. ft. of work space on a sturdy bench or table in a well ventilated area with convenient access to an electric outlet, running water, and a drain. If the tabletop is not heat resistant it would be ideal to provide an insulated pad on which to set the vessel when it is hot.

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 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.

> ***Note:*** *Do not make connections to a Variac, Powerstat or the like to attempt to control the heating output. The heavy inductive load on the primary side of such devices can destroy the internal sold state relay located in the 4848 controller.*

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

2. Connect the heater cord from the heater into the heater socket on the rear panel of the Series 4848 Reactor Controller.
3. 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.

4. 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.
5. 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.
6. Connect cooling water to the magnetic drive. See Instruction Manual No. 441M.
7. Connect tubing to the rupture disc outlet and run to a safely vented area. See Instruction Manual 231M.
8. 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.
9. 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.

Motor Coupling Connection/Operation

Connect the motor to the stirrer by lifting the motor/overrarm approximately 1/2 inch and rotating it into position above the reactor's center. Then slowly move the motor/overrarm downward until the two halves of the coupling connect. Up to 45 degrees manual rotation of the coupling halves relative to each other may be necessary in order to mesh them properly.

IDENTIFY THE VALVES

Gas Inlet Valve

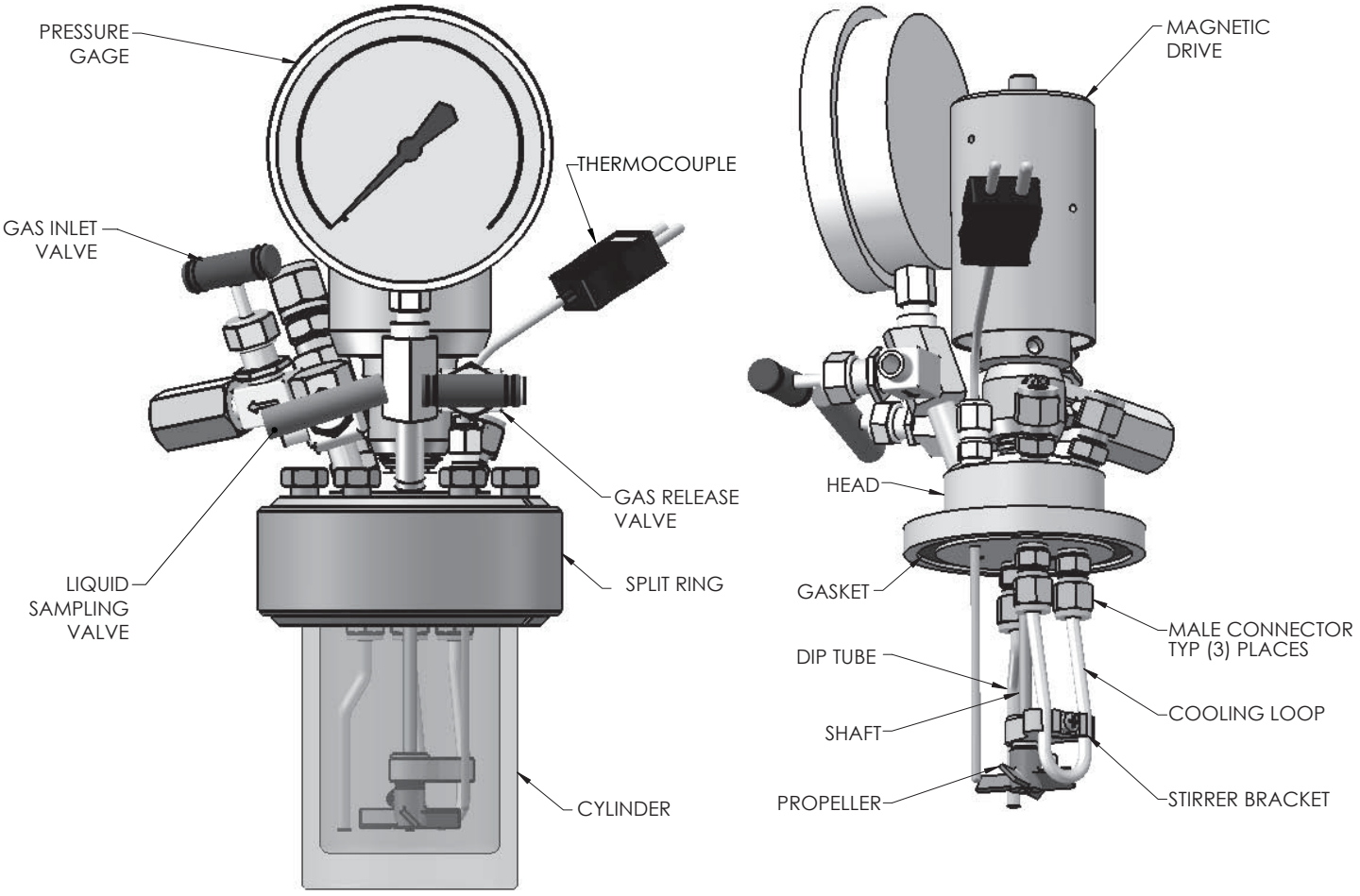
The gas inlet valve is easily identified when the vessel is open by noting that it is connected to a dip tube which extends to a point near the bottom of the cylinder. With this arrangement, incoming gas is always introduced below the surface of the liquid. This valve includes a coupling with an "A" socket connection for attachment of the pressure hose.

Gas Release Valve

The gas release valve is typically connected to a side opening on the gage adapter. Gas released from this valve will be drawn from the top of the reactor.

Liquid Sampling Valve

The liquid sampling valve is attached to the same fitting as the gas inlet valve and connected to the same dip tube. This provides the operator 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 dip tube back into the reactor before withdrawing a sample from the sampling 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 Operating Instruction 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 materials 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 in a 1/8" diameter Stainless steel sheath is installed in each reactor. In reactors made of alloys other than stainless steel, the stainless thermocouple is installed in a thermowell made of the same alloy as the vessel. Connect the thermocouple to the 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 meet 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.

ACCESSORIES

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 PTFE liner will slow the heat transfer rate into the vessel, and it may be necessary to adjust the temperature control method to prevent overheating.

Fits ID	Cylinder Size	Glass Liner	PTFE Liner
2.06"	100 mL	762HC7	762HC7HA
2.5"	160 mL	762HC8	762HC8HA
2.5″	300 mL	762HC	762HC4HA
2.5"	450 mL	762HC2	762HC5HA
2.5"	600 mL	762HC3	762HC6HA

Spare Parts Kit

Spare parts kits are available for these reactors. The kits will provide a reserve supply of parts and tools sufficient to handle most normal replacements and emergency repairs during a year of heavy usage. The kits contain small perishable items required for continuous operation including gaskets, bushings, rupture discs and seals. 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. It is most advantageous to provide the complete vessel serial number from the head or cylinder. *(See Technical Support section on page 15 for more info)*.

HOW TO USE THE VESSEL

To open the Vessel

Open the gas release valve to discharge any internal pressure. For the bolted closure, loosen the six cap screws in the split ring sections. Loosen the cone pointed screw in the outer band and lower the band to rest on the table. The ring sections can now be removed, and the head with all attached fittings is free to be lifted from the cylinder. Handle the head carefully so as not to damage the stirring shaft and other internals when they are outside of the cylinder.

Before Closing the Vessel

Examine the head gasket or o-ring carefully to be sure that it is in good condition. After considerable use, some of the PTFE gasket may extrude into a thin, ragged edge around the inside and outside diameters. This does not necessarily mean that the gasket must be replaced, but the extruded portion should be removed with a sharp knife. Examine the mating surfaces on the cylinder and head to be sure they are clean and free from burrs; then set the head on the cylinder.

Sealing Vessels with PTFE Gaskets

Initially tighten the cap screws to 15 ft-lbs then increase to 20-25 ft-lbs. Tightening should proceed in a criss-cross pattern rather than progressively around the circle. Let the vessel stand for about five minutes after the initial tightening; then tighten the cap screws again. This will compensate for any tendency of the PTFE gasket to flow under the loading pressure.

Sealing with Flexible Graphite Gaskets

Initially tighten the cap screws to 15 ft-lbs then increase to 20-25 ft-lbs. Tightening should proceed in a criss-cross pattern rather than progressively around the circle.

Flexible graphite gaskets tend to be somewhat flakey. To extend the useful life of these gaskets, first rough up the sealing surface of the cylinder with 120 grit sand paper to ensure the gasket remains in the head groove and does not stick to the cylinder. Secondly, coat both sealing surfaces with a silicone lubricant. This process will aid in compressing the gasket so it does not break apart after one use.

Recommended Bolt Torque		
PTFE or Flexible Graphite	0-3000 psig (0-200 bar)	20-25 ft-lbs

O-ring Closures

The split rings used with an o-ring seal do not include any compression bolts.

With the easy close split ring, the o-ring is attached to the pilot on the underside of the head. When closing the vessel, set the head on the cylinder and press down on the head until the bottom of the head meets with the cylinder flange. Then install the two split ring halves and attach the outer drop band.

Gas Connections

For a gas connection to the vessel, use the A495HC pressure hose furnished with the reactor. Attach the hose to a pressure regulator or flow control valve on a commercial gas cylinder using PTFE tape or other thread sealant on the 1/8" NPT male nipple and on the 1/4" NPT bushing, if used. Then screw the Type A coned pressure fitting into the adapter attached to the gas inlet valve and tighten the compression nut firmly. Do not use any thread dope or tape on the coned fitting. The A495HC pressure hose is made of reinforced Nylon which can be used for all non-corrosive gases at pressures up to 2500 psig. For operations involving corrosive gases, this hose should be replaced with an A490HC hose (optional) which has a PTFE lining and a braided stainless steel outer covering. These hoses have the same fittings as in the A495HC.

Pressurizing the Vessel

Check all valves carefully before admitting gas into the system. The liquid sampling valve must remain closed throughout the charging procedure. The gas release valve must also be closed unless the vessel is to be purged, or unless there is to be a continuous flow through the reactor during a run. Always make certain that the pressure in the gas tank is greater than the pressure in the vessel; otherwise liquid will be forced out of the vessel and into the gas tank when the inlet valve is opened. If there is any possibility that the tank pressure might not be high enough to force gas into the reactor, install a one way check valve (optional) in the gas line to prevent any reverse flow.

With the inlet valve open and the flow control valve on the gas tank closed, open the main valve on the gas tank only about one-quarter turn; then use the flow control valve or the valve on a pressure regulator to control the flow of gas into the vessel. After the desired pressure has been reached, close the tank valves and the vessel inlet valve and disconnect the hose at the vessel end.

Do Not Overfill the Vessel

Always watch the pressure gage closely when admitting gas so as not to exceed the maximum working limit. Remember that any subsequent increase in temperature will raise the pressure. Also, be sure that the amount of liquid placed in the vessel is carefully controlled. 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 development of dangerous pressures if sufficient space is not provided for expansion when the liquid is heated. This hazard is explained in greater detail in a warning statement included in the Instruction Manual No. 230M.

Releasing Pressure

Use the gas release valve to reduce the pressure in the vessel if the reactor is accidentally overcharged when filling. Use this valve also to release any excess pressure during a run and to exhaust the vessel at the end of a run. If the discharge gases are flammable or toxic, discharge to an exhaust hood or to any other safe release point.

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.

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 150 °C while checking the apparatus for leaks and observing the performance of the temperature controller.

Internal Cooling Loop

Each Mini Reactor (except the 100 and 160 mL sizes) has a single loop cooling coil installed in the vessel with compression fittings on the head for connecting 1/4" copper or plastic tubing to the loop. (Special 1/8" OD spiral coils can be furnished for 100 mL & 160 mL if required. Due to internal space limitations these coils are attached with male connectors on the top side of the head thereby making the coil captive.) A slow, continuous flow of cold water through a cooling loop proves a very effective means for controlling temperature overshoot in these reactors, particularly when operating at temperatures below 150 °C. Water flow through the loop can be controlled automatically using a solenoid valve in the cold water line, and connected to the cooling socket on the rear panel of the Temperature Controller. With this arrangement, cold water will be admitted to the cooling loop whenever the controller calls for cooling.

If internal cooling is not desired, the cooling loop can be removed and the opening in the head can be closed with No. 79HW, 1/8" NPT plugs. Optionally, other 1/8" NPT threaded fittings can also be installed in the coil openings.

MAINTENANCE

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. 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.

5. Do not use oil or anti-seize lubricant on threads or fittings if the vessel is to be used with oxygen.

6. 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.

7. 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 electrical power should be disconnected when cleaning.

8. 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 (No. 424HC2) before this happens.

9. If servicing assistance is needed, contact Instrument Company directly at the address shown on the back of these instructions.

Periodic Pressure Tests

Each cylinder used in a stirred reactor is tested under hydrostatic pressure to the higher of 1.43 times the rated working pressure at room temperature or 1.30 times the rated working pressure corrected for temperature 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.

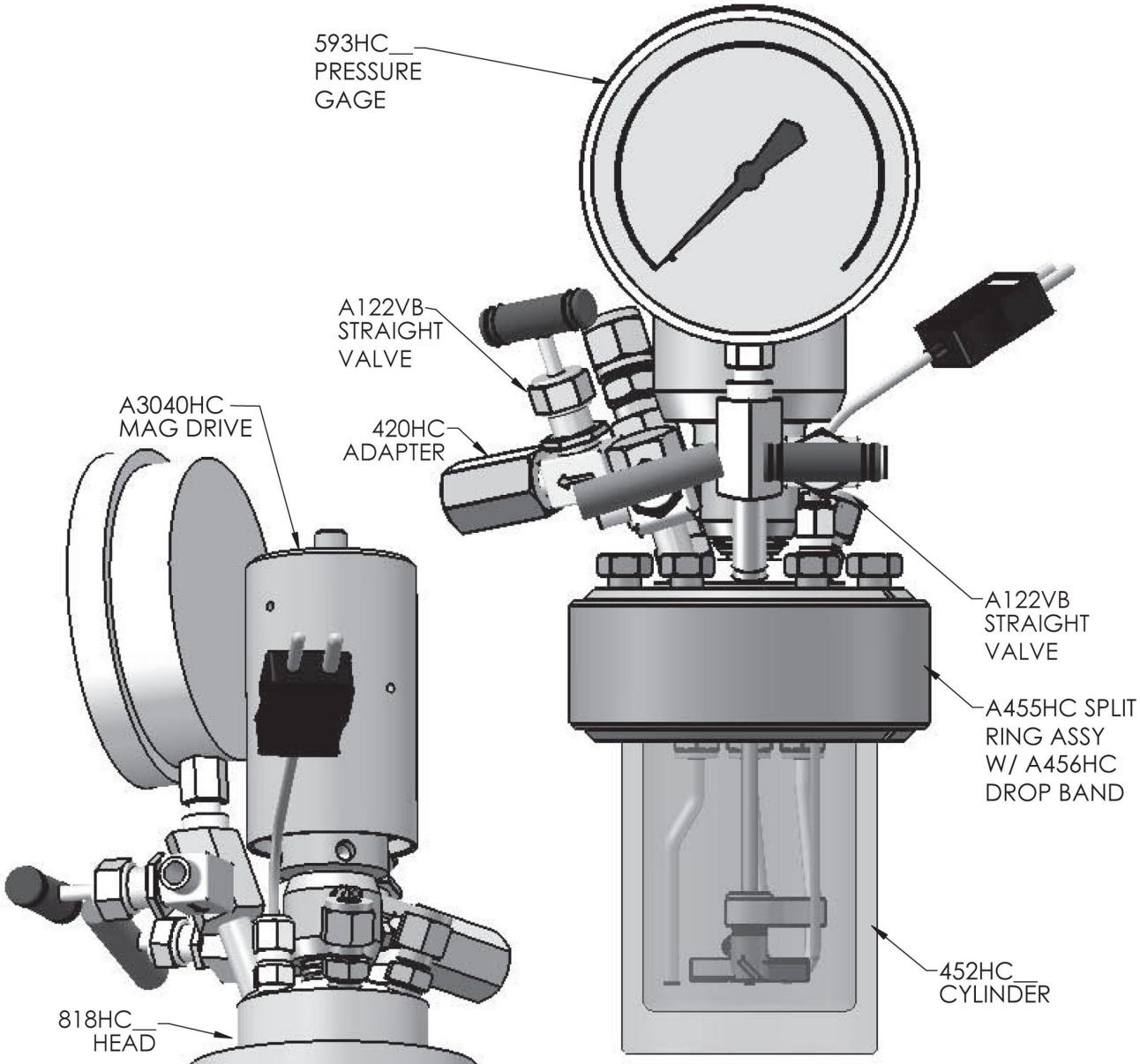
Users who do not have pressure test facilities can return any pressure vessel to the factory for hydrostatic testing and overhaul. This should be done whenever the metal shows excessive damage from corrosion or whenever an over-pressure or other unusual occurrence raises any safety questions.

To return a vessel for repair, contact Company for a return authorization number (RMA).

Technical Support

Company strives to provide our customers with world class support. When contacting Company for technical support, please provide the complete serial number etched on the side of the cylinder. Serial numbers are a long string of letters and numbers. See highlighted text in figure below for an example of a complete serial number.

PARTS LISTS



Vessel Closure and Standard External Parts

Vessel Closure and Standard Internal Parts

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:

OR – O-ring
SS –T316 Stainless Steel
FG – Flat Gasket
SP – Special Alloy

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

CM - Alloy 400
CT - Alloy 600
CG - Alloy B-2
CH - Alloy C-276
CC - Alloy 20Cb3
CA - Titanium G2 or G4
CX - Zirconium

*Cylinder**

Part No.	Description	Code
452HC	Cylinder 300 mL	FG
452HC2	Cylinder 450 mL	FG
452HC3	Cylinder 600 mL	FG
452HC8	Cylinder 100 mL	FG
452HC9	Cylinder 160 mL	FG
2342HC	Cylinder 300 mL	OR
2342HC2	Cylinder 450 mL	OR
2342HC3	Cylinder 600 mL	OR
2342HC4	Cylinder 100 mL	OR
2342HC5	Cylinder 160 mL	OR

*Heads**

Part No.	Description	Code
818HC	Head, for thermocouple	FG
818HC2*	Head, for thermowell	FG
2340HC	Head, for thermocouple	OR
2340HC2*	Head, for thermowell	OR

Internal Fittings*

Dip Tubes

Part No.	Description	Code
832HC	Dip Tube for 300 mL	SS
832HC4*	Dip Tube with nut, 300 mL	SP
832HC2	Dip Tube, 450 mL	SS
832HC5*	Dip Tube with nut, 450 mL	SP
832HC3	Dip Tube, 600 mL	SS
832HC6*	Dip Tube with nut, 600 mL	SP
832HC19*	Dip Tube with nut, 100 mL/160 mL	SS/SP

Male Connectors

Part No.	Description	Code
A833HC	Male Connector, T/C, 1/8 NPTM x 1/8T	SS
A834HC	Male Connector, Cooling Coil, 1/8 NPTM x 3/16T	SS
A92HW*	Male Connector, Cooling Coil, 1/8 NPTM x 1/4T	SS
A138CA	Male Connector,1/8 NPTM X 1/4T Thermowell	SP

Cooling Loop

Part No.	Description	Code
831HC	Cooling Loop for 300 mL	SS
831HC6*	Cooling Loop for 300 mL	SP
831HC2	Cooling Loop for 450 mL	SS
831HC7*	Cooling Loop for 450 mL	SP
831HC3	Cooling Loop for 600 mL	SS
831HC8*	Cooling Loop for 600 mL	SP

Stirrer Support Bracket

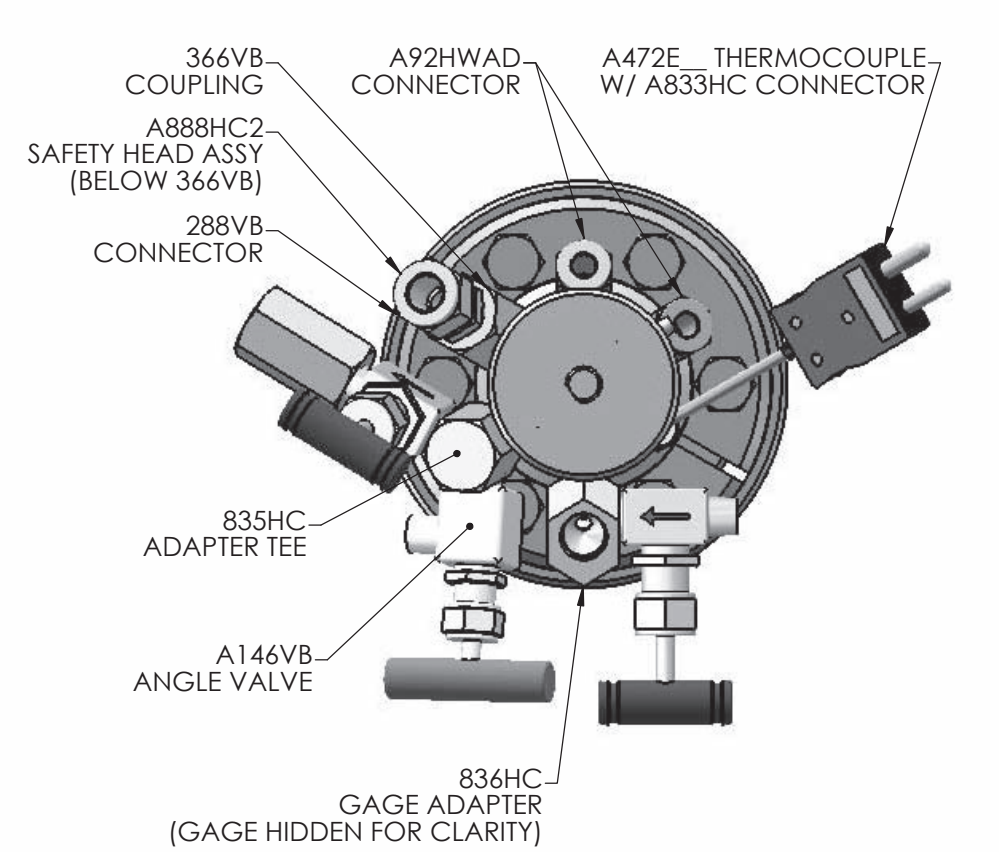
(450 mL and 600 mL only)

Part No.	Description	Code
A1260HC	Stirrer Bracket w/o bushing	SS
A1260HC2*	Stirrer Bracket w/o bushing	SP
1261HC	Stirrer Bracket Bushing	

*Stirrer Shafts**

Part No.	Description
822HC15	Shaft, 300 mL
822HC16	Shaft, 450 mL
822HC17	Shaft, 600 mL
822HC18	Shaft, 100 mL
822HC18	Shaft, 160 mL

** Denotes Special Materials Available*



Mini Head External Fittings

External Fittings

Part No.	Description
79HW*	Plug, 1/8" NPTM
A122VB	Valve, straight 1/8" NPTM
A146VB	Valve, angle 1/8" NPTM
420HC	Adapter, 1/8" NPTF x "A" Socket
835HC	Valve adapter tee
836HC	Gage and valve adapter
A92HWAD	Male Connector 1/8 NPTMx1/4T (T316SS for top of cooling loop)
A92HW*	Internal Connector, cooling loop*
217VB*	Nut for A92HW* ¼" T
218VB*	Ferrule Set for A92HW* ¼" T
366VBD	Hex Coupling, 1/4 NPTF
288VBAD	Male Connector, 3/8" T-1/4" NPTM
A833HC	Male connector, 1/8 NPT(M) X 1/8T for thermocouple
A1453HC*	Thermowell
A138CA	Male Connector, 1/8NPT(M) X 1/4T for thermowell

Part No.	Description
A472E	Thermocouple, Grounded 300mL Type J, 7-1/2
A472E2	Thermocouple, Grounded 450mL Type J, 9-1/2
A472E3	Thermocouple, Grounded 600mL Type J, 11-1/2
A472E4	Thermocouple, Grounded 100/160mL Type J, 5-1/2
A490E	Thermocouple, Dual, Grd, 7-1/2
A490E2	Thermocouple, Dual, Grd, 9-1/2
A490E3	Thermocouple, Dual, Grd, 11-1/2
A2685HC	Cooling Sleeve assembly
424HC2	Anti-Seize Lubricant
A888HC2	Rupture disc assembly
49HC2*	Orifice Cone for rupture disc assembly
527HC	Orifice Ring for rupture disc assembly

(Refer to manual 231M for more information on Safety Rupture discs.)

** Denotes Special Materials Available*

Impellers*

Part No.	Description
A837HC	Impeller with screw

Gaskets & Seals

Part No.	Description	Code
457HC2	Head Gasket, PTFE	FG
457HC3KL	Head Gasket, Flexible Graphite	FG
2341HCJV	O-ring FKM	OR
2341HCJK	O-ring FFKM	OR
48HC	Gasket, silver; for A3040HC	
48HCFG	Gasket, gold plated; for A3040HC	

Split Rings and Accessories

Part No.	Description	Code
A455HC	Split Ring Assembly with bolts	FG
454HC	Compression Ring, Head	FG
A456HC	Drop Band	FG
232HCF	Bolts, split ring 3/8-24 9/16" Hex	FG
2195HC	Split Ring, pair	OR
372HC2	Wrench, 9/16"	

A3040HC Magnetic Drive Parts List

(Refer to manual 441M for more information)

Part No.	Description
1132HC	(2) Upper Thrust Washer
2721HC*	Body
A3035HC*	Rotor Assembly
1133HC	(3) Bushing
827HC	O-Ring NBR
2683HC	Cooling sleeve
2714HC	Hose, Conn. Barbed
825HC	Snap Ring
1137HCHA	O-ring PFTE (Standard)
1137HCJK	O-Ring FFKM (Optional)
1137HCJV	O-Ring, FKM (Optional)
1137HCJE	O-Ring, EP (Optional)
1137HCJB	O-Ring, NBR (Optional)
48HC	Gasket, Fine Silver
48HCFG	Gasket, Gold Faced (Special Mat'l)
A3075HC	Bearing/End Cap Assembly
A3077HC	Outer Magnetic Housing Assembly
3047HC	Drive Adapter

** Denotes Special Materials Available*

Gages

Part No.	Description
593HCPD	Pressure gage, 3-1/2", 1000 psi/bar
593HCPF	Pressure gage, 3-1/2", 2000 psi/bar
593HCPG	Pressure gage, 3-1/2", 3000 psi/bar
593HCP1AD	Pressure gage, 3-1/2", 100 psi/bar
593HCP2AD	Pressure gage, 3-1/2", 200 psi/bar
593HCP6AD	Pressure gage, 3-1/2", 600 psi/bar

Vessel Heaters Parts List

The 100 - 600 mL Mini Reactors are equipped with aluminum block heaters designed to provide uniform heat distribution to the walls and bottoms of these vessels.

Heater Assemblies

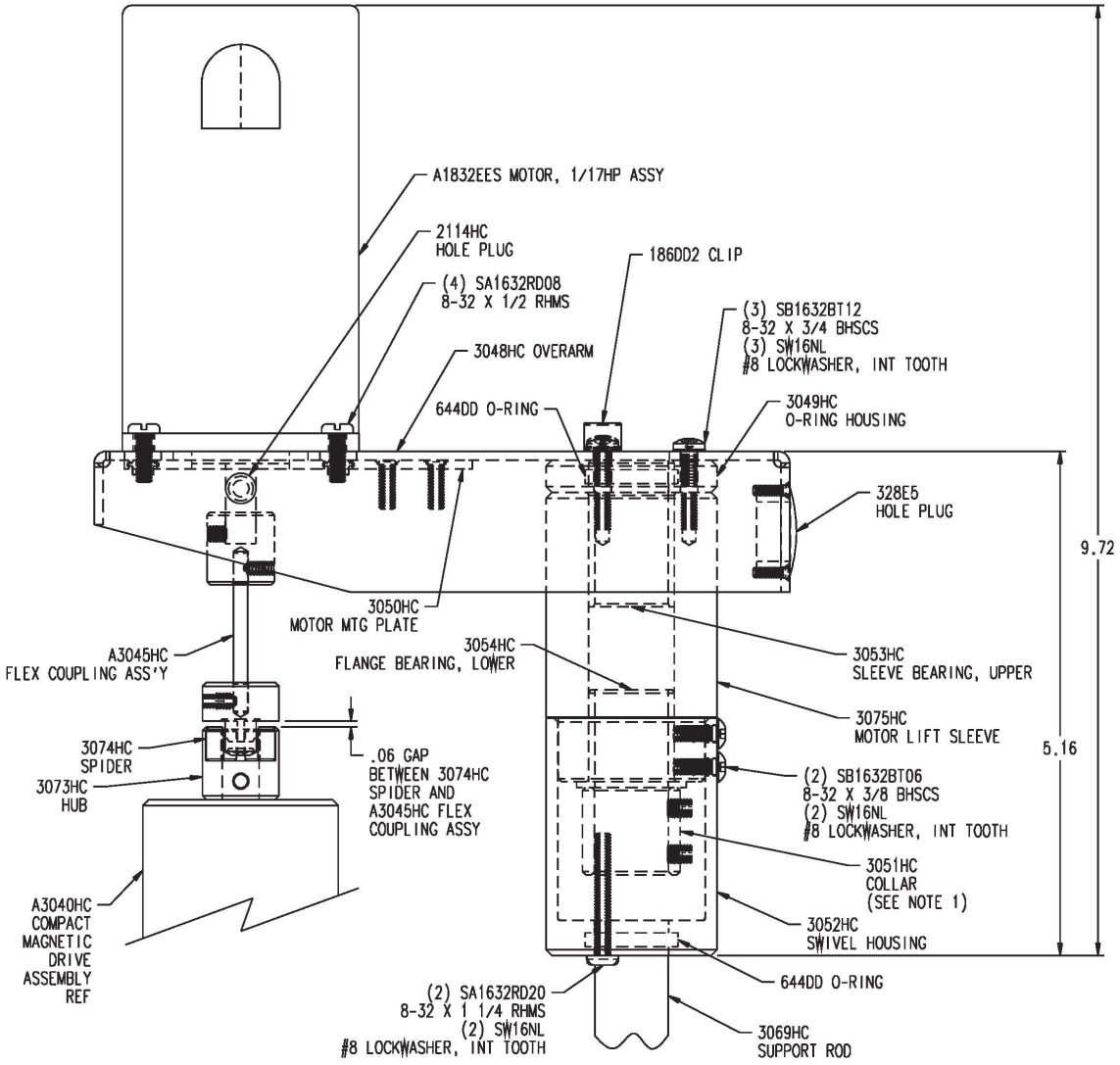
Part No.	Description
For use with 100, 160 & 300 mL Vessels:	
A3061HCEB	Heater Assy., 700W 115V
A3061HCEE	Heater Assembly, 700W 230V
A3061HC4EB	Heater assy w/ cooling, 700W 115V
A3061HC4EE	Heater assy w/ cooling, 700W 230V
For use with 450 mL Vessels:	
A3061HC2EB	Heater Assembly, 1000W 115V
A3061HC2EE	Heater Assembly, 1000W 230V
A3061HC5EB	Heater assy w/ cooling, 1000W 115V
A3061HC5EE	Heater assy w/ cooling, 1000W 230V
For use with 600 mL Vessels:	
A3061H3EB	Heater Assembly, 1000W 115V
A3061HC3EE	Heater Assembly, 1000W 230V
A3061HC6EB	Heater assy w/ cooling, 1000W 115V
A3061HC6EE	Heater assy w/ cooling, 1000W 230V

Replacement Heating Elements Parts List

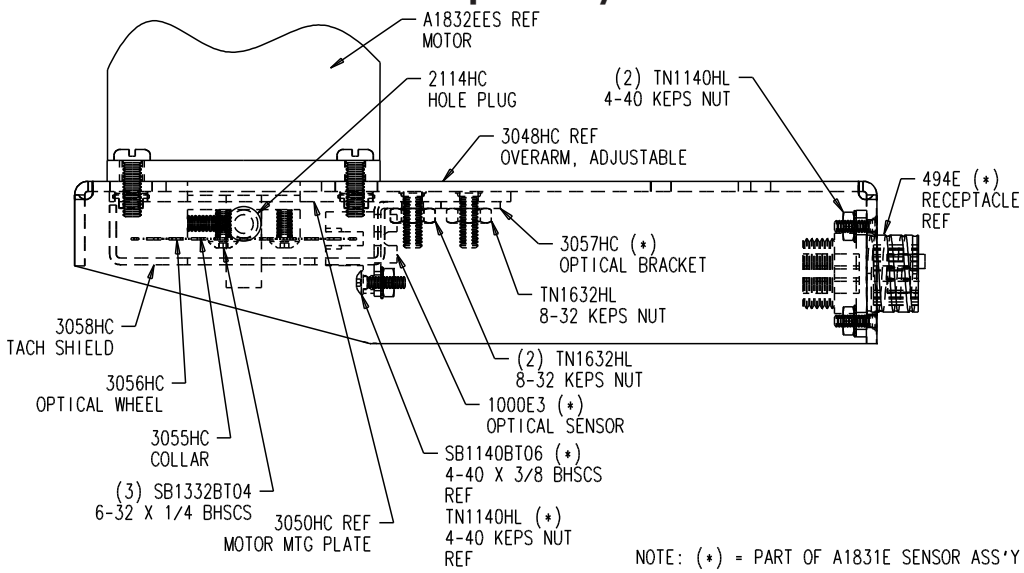
Part No.	Description
For use with Heaters for 100, 160 & 300 mL Vessels:	
1666E4EB	Heating Element, 350W 115V
1666E4EE	Heating Element, 350W 230V
For use with Heaters for 450 mL Vessels:	
1666E5EB	Heating Element, 500W 115V
1666E5EE	Heating Element, 500W 230V
For use with Heaters for 600 mL Vessels:	
1666E6EB	Heating Element, 500W 115V
1666E6EE	Heating Element, 500W 230V

DRAWINGS

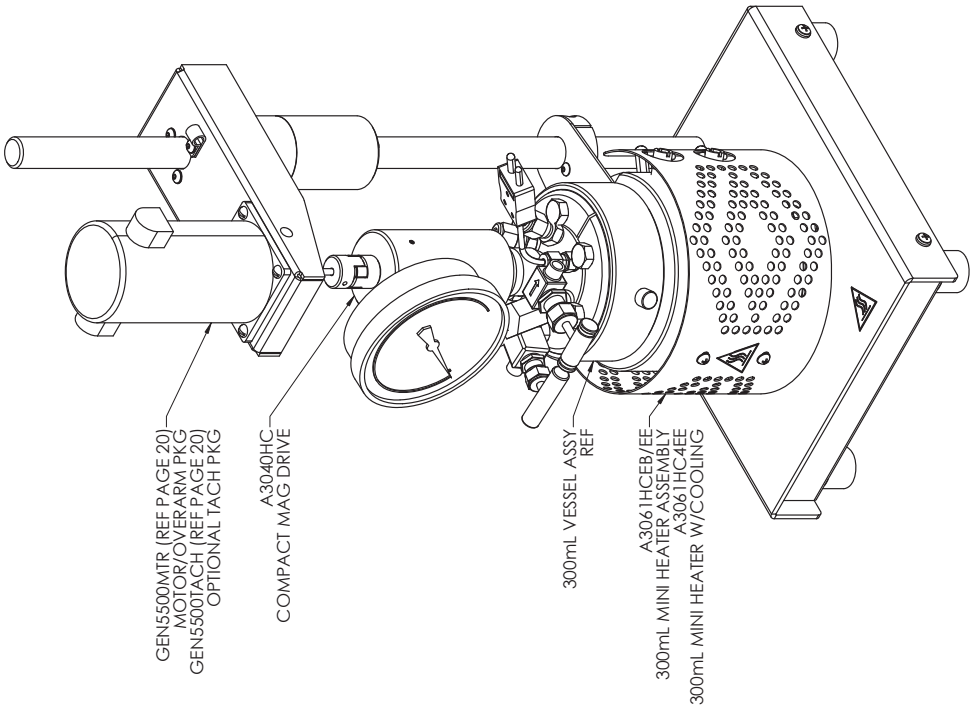
Motor/Overarm Layout

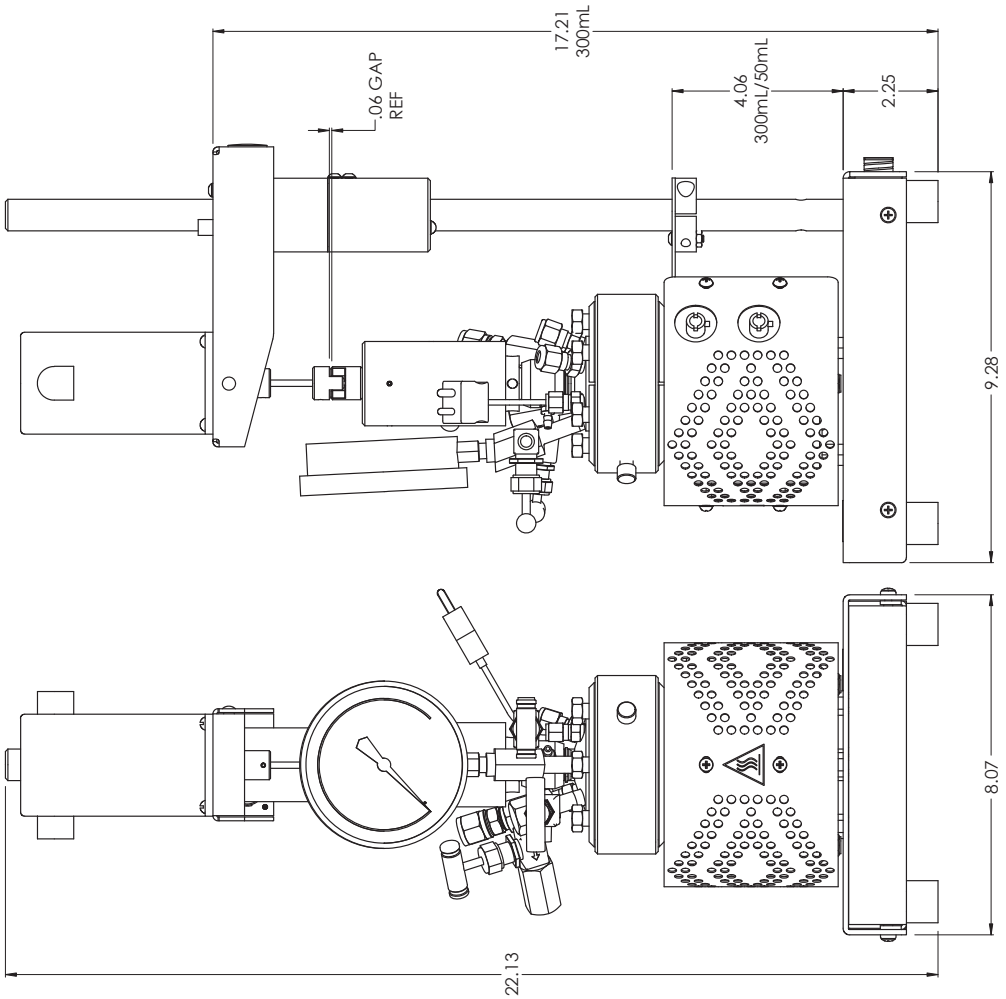


Tach Option Layout

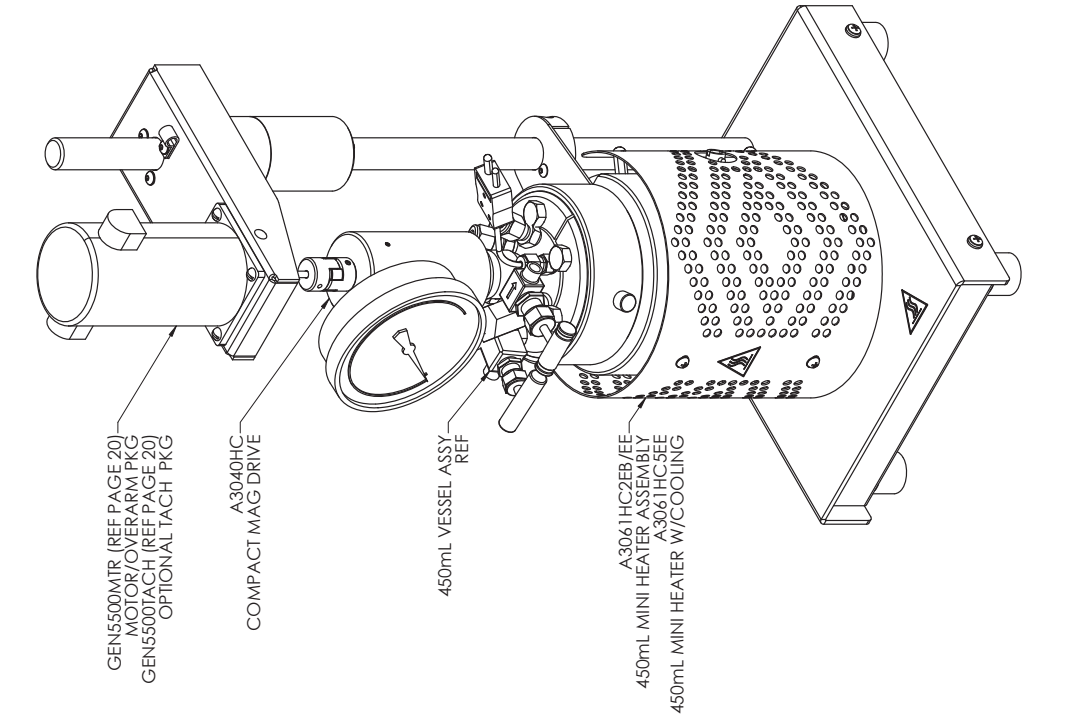


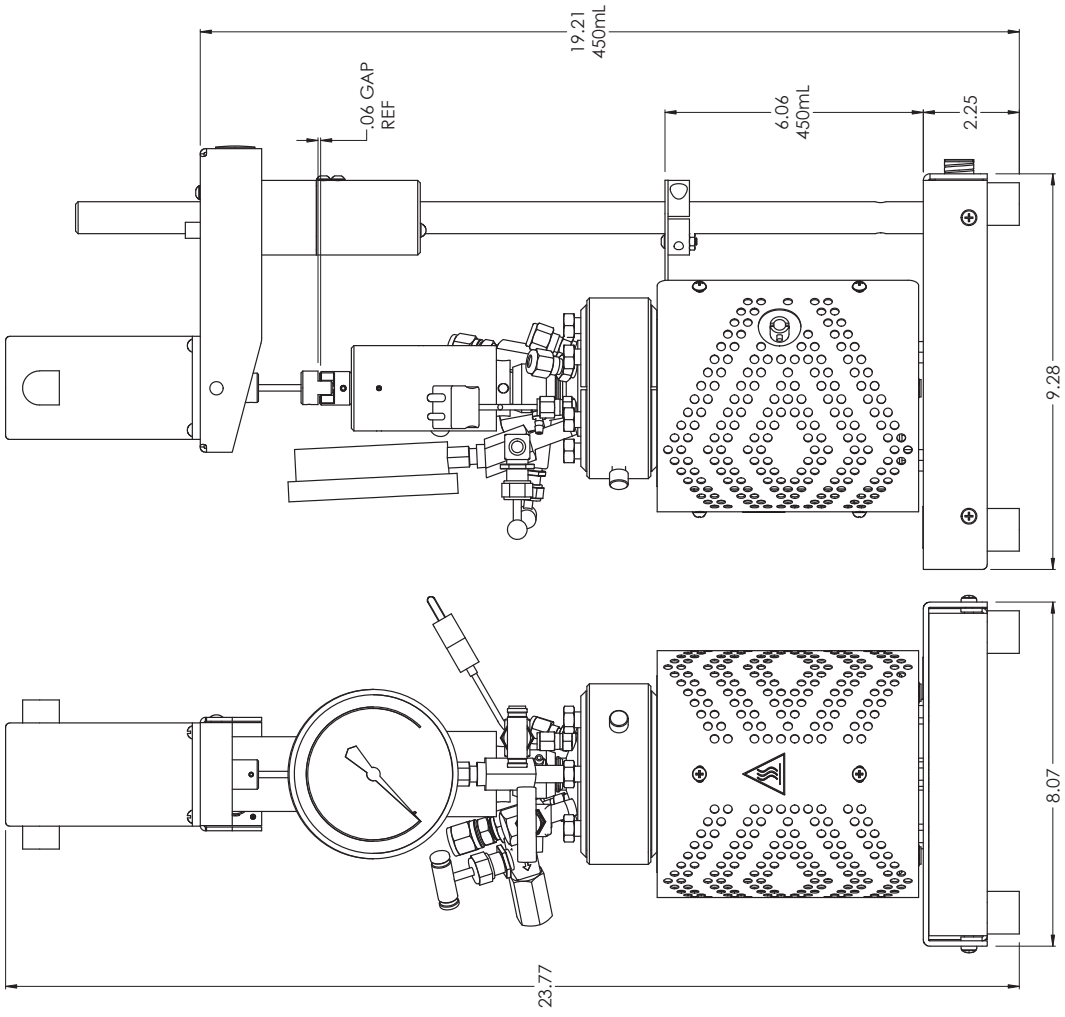
100, 160, 300 mL Mini Compact Reactor





450 mL Mini Compact Reactor





600 mL Mini Compact Reactor

