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Service Manual **Ingage** **Regulator**

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I. TOOLS, TEST EQUIPMENT AND SERVICE MATERIAL

A. TOOLS

- Screwdriver - (1/4 in. (6 mm) flat blade
- Screwdriver-No.2 Phillips
- Open end wrenches – 7/16 in, 9/16 in, 5/8 in, 11/16 in
- Adjustable wrench-10 in (25) cm
- Hex key wrench-1/16 in
- Internal retaining ring pliers
- Punch-1/8 in (3mm)
- Standard paper clip
- Hammer
- C-Clamp-3 in (8cm)
- Dental Pick (or similar pointed instrument)

B. TEST EQUIPMENT

Test flowmeter with an accuracy of + or – 2% if reading @ 70 degrees F (21 degrees C) and 14.7 psi (101 kPa)

Test pressure gauge with a range of 0-100 psi (0-690 kPa) and accuracy in according to ASME 40.1-1998, Grade “B”, permissible error)+/-% of span):

- lower ¼ of scale (0-25 psig) = +/- 3%;
- middle ½ of scale (25-75 psig) = +/-2%;
- upper ¼ of scale (75-100 psig) = +/- 3%.

Leak detector – Nupro “Snoop” or equivalent (oxygen compatible)

C. SERVICE MATERIALS

- Krytox 240 AC Fluorinated Grease (DuPont)
- Teflon tape – ¼ in (6mm)
- Isopropyl alcohol
- Cloth – lint free
- Oxygen tubing – ¼ in (6mm) I.D.
- Screw – 6-32 UNC
- Service Instructions

II. SPECIFICATIONS

Flotec Ingage™ Regulators are small, lightweight devices that are available in a variety of configurations to meet the various requirements for medical gas delivery. Flotec Ingage™ Regulators can be equipped with a 12 position, detented flow control valve or a variety of designated inlet flow connectors. Units are also available with single or dual high flow DISS outlets. Both small cylinder and large cylinder inlet connections are available on all regulators. The following instructions provide information to assist qualified personnel in the service and repair of Flotec Ingage™ Regulators. It is recommended that the repair technician read this service and repairs instructions thoroughly before servicing Flotec Ingage™ Regulators.

Storage Temperature: -40 degrees F to 140 degrees F
Operating Temperature: -20 degrees F to 150 degrees F
Materials: Brass, Bronze, Anodized Aluminum, Teflon, Neoprene, Silicone, Stainless Steel and Buna N
Filtration: 10 micron High Pressure and 30 micron Low Pressure
Supply Pressure Range: 250 to 3000 psi
Operating Pressure: 50 psi (17, 20, 24, 30, 40, 58, 70, 90, 110 PSI available upon request)
Relief Valve Pressure: 75 PSI or 95 PSI
Inlet Connections: Any CGA inlet connection is available for specific gases and most International applications are available upon request)
Dimensions: Variable depending on type and style specified
Weight: Variable depending on type and style specified
Indicators: Cylinder Contents, Medical Gas Flow Rate
Power take off Outlet Connections: none, 1 or 2 of any combination of the following: DISS check valve, Chemetron QD, Hansen QD, Ohio QD, Puritan Bennett QD, Schrader QD, plugged 1/8" FNPT ports, or plugged 1/4" FNPT ports.
Flowmeter Outlet Connection: DISS fitting or Hose Barb

III. THEORY OF OPERATION

The Flotec Ingage™ Regulator is a single stage piston-type regulator. When it is initially attached to a high-pressure gas cylinder, the internal components are in the position shown in enclosed drawings. With the cylinder off, the spring exerts force against the piston assembly and pushes the piston assembly away from the regulator seat.

When the cylinder valve is opened, high-pressure medical gas (approximately 2000 psi for a full cylinder) passes through the inlet filter and flows through the seat. The gas then flows through the shaft of the piston and exits to the regulated output cavity.

The gas continues to flow into this area until the cavity builds enough pressure to overcome the force of the spring, which occurs at 50 psi. The piston assembly then moves toward the seat and the seal blocks the flow path and prevents the pressure from rising above 50psi. This all occurs in a fraction of a second. When gas is let out of the output cavity through the flow-controlling device, the pressure in the cavity drops. The spring then pushes the piston assembly away from the seat to allow the oxygen to restore the pressure to 50 psi and deliver the flow through the flow-controlling device at the prescribed rate. This too happens in a fraction of a second.

In the unlikely event that the regulator does not regulate properly and should the internal pressure rise above 75 psi or 95 PSI the relief valve will unseat and safely release gas through the vent holes in the side of the body.

NOTE The Flotec Ingage™ adjustable flow regulator is shown in enclosed drawings. The internal regulator components are common to all Flotec Ingage™ Regulators and Pressure Reducers.

IV. DEFINITION OF STATEMENTS

Statements in this manual preceded by the following words are of special significance.

WARNING means there is the possibility of injury or death to you or others.

CAUTION means there is the possibility of damage to the unit or other property.

NOTE indicates points of particular interest for more efficient and convenient operation.

Always disassemble, inspect, clean and repair regulator components in accordance with these instructions. Be aware of all the potential hazards associated with handling and using high-pressure gas equipment. Also, be aware that the possibility of fire exists when the combination of a combustible material, a source of ignition and oxygen is present (Called the Fire Triangle).

WARNING Replacement of parts on high-pressure regulators should be made only by qualified personnel familiar with their operation. Do not remove or install parts with the regulator installed on a cylinder. Use only the proper repair tools and parts. Always wear eye protection when servicing high-pressure regulators.

WARNING Contaminants or hydrocarbons may, in the presence of an ignition source and oxygen may combine and burn violently. Never permit oil, grease or other combustible substances to come in contact with oxygen cylinders, regulator parts or repair tools. Provide a clean; oil free surface on which to place disassembled regulator parts.

WARNING Always open high-pressure oxygen cylinder valves **SLOWLY**. This should always be done in order to allow the heat of gas compression to dissipate. Always verify that the oxygen cylinder valve is fully closed (clockwise) before disconnecting the regulator from the cylinder.

WARNING Do not obstruct the vent holes in the body of the regulator. These holes must be open to atmosphere for proper regulator operation.

NOTE Flotec Ingage™ Regulators with yoke style cylinder connections are equipped with a new permanent O-Ring that eliminates the need for a yoke washer seal yet still provides a hand tight 3000 psi seal. Never remove or replace O-Ring with a non-Flotec O-Ring.

V. PRODUCT CLASSIFICATION DATABASE

Device-	Regulator, Pressure, Gas Cylinder
Device Description-	Pressure regulator
Medical Specialty	Anesthesiology
Product Code	CAN
Regulation Number	FDA #868.2700
Device Class	1
GMP Exempt?	No
510(k) Exempt?	Yes

VI. INSTALLATION INSTRUCTIONS

See Insert Instructions provided with each regulator.

VII. SERVICE AND REPAIR

NOTE Always perform the regulator test procedures in this manual before placing a repaired regulator back in service.

NOTE Refer to the Parts List and Parts Illustration for identification of parts referenced with bold numbers.

A. CLEANING, LUBRICATION AND SEALING

Clean metal parts of the regulator with isopropyl alcohol and thoroughly blow dry with dry, oil free compressed gas. Use a mild solution of soap and water to clean plastic parts. Use a clean lint free cloth with isopropyl alcohol to clean internal parts, being certain to remove any residual fibers.

O-ring seals that have been cleaned or are new replacements should be lubricated with a film of KRYTOX 240AC Fluorinated Grease.

Whenever pipe threaded (NPT) connections must be disassembled, reseal the threads with Teflon tape. When applying teflon tape remove old sealant from the male and female threads and wrap the male threads with Teflon tape in a clockwise direction, starting 1 to 2 threads back from the end.

1. INLET CONNECTIONS

a. REMOVABLE CGA OR INTERNATIONAL CONNECTION

1. Using a strap wrench on the regulator body and an appropriately sized open-end wrench on the nipple, tailpiece, or yoke assembly remove the assembly from the 1/4" female NPT port.
2. Remove old sealant from the male and female threads. **CAUTION** Hold the regulator with the inlet port down so that any particulate matter will fall out of the port.
3. If the inlet filter replacement is required, tap the old filter out of the tailpiece with a rod inserted in the threaded end of the nipple or tailpiece.

b. INSTALLATION CGA OR INTERNATIONAL CONNECTION

1. Install a replacement inlet filter in the nipple, tailpiece, or yoke assembly and secure in place using a 5/16" rod and a light tap of a ball peen hammer.
2. Reseal the male threads on the nipple, tailpiece, or yoke assembly with Teflon tape. Always put Teflon tape after the first full thread of the 1/4" male NPT threads. Use wrenches to tighten the assembly

2. DISS AUXILIARY OUTLETS

a. REMOVAL

1. Using a 5/8" open end wrench, remove the DISS auxiliary outlet from the regulator
2. Remove old sealant from the male and female threads. **CAUTION** Hold the regulator with the DISS auxiliary outlet ports down so that any particulate matter will fall out of the port.

b. SERVICE

1. Disassemble the DISS auxiliary outlet by depressing the check valve plunger until the opposite end containing the o-ring clears the body. Remove the O-ring to gain access to the plunger and spring.
2. Inspect the components for wear or damage and replace as necessary. Reassemble in reverse order.

c. INSTALLATION

1. Reseal the male threads on the DISS auxiliary outlet with Teflon tape.
2. Thread the outlet into the regulator body and tighten.

3. INTERNAL CONTENTS GAUGE

a. RESETTING

1. Align hole in knurled nut or swivel yoke with hole in Ingage™ body.
2. Insert paper clip end into hole and turn knurled nut or swivel yoke until gauge aligns with (-0-) PSI.

b. MAINTENANCE

1. Keep internal contents gauge free of debris and contaminants.
2. Do not use oil or other lubricants with internal contents gauge.

WARNING The Flotec Ingage™ Regulator contains an internal contents gauge, which should only be removed or replaced by a trained Flotec Technician.

4. FLOWMETER

Before attempting to disassemble the flow control valve to resolve a flow related problem, perform the following procedures for back flushing the valve to remove any debris from the valve orifices. **NOTE:** The flow control valve must be removed from the regulator before back flushing.

a. REMOVAL

1. Using a vise on the regulator body and a strap wrench on the flowmeter assembly for Yoke style regulators or two strap wrenches on Nut & Nipple style regulators turn the flowmeter counter clockwise to loosen.

b. SERVICE

1. Backflush all 11 flow positions with a medical gas. Check the screw holding the rotor assembly onto the knob shaft for tightness. **NOTE:** Any other service work must be done by the manufacturer; there are no user serviceable parts in the flowmeter assembly. If the flowmeter needs to be returned to the manufacturer reassemble the flowmeter with the upper body before returning.
2. **CAUTION** The flow control valve is manufactured to exacting tolerances and utilizes a number of extremely small orifices. To prevent improper valve operation due to contaminants, ensure hands, tools and worktable are clean when disassembling and servicing the flow control valve. There are no user serviceable parts in the flowmeter assembly
3. Clean all flow control valve components with isopropyl alcohol and thoroughly blow dry.
4. **CAUTION** Do not allow a lubricant film applied on the rotor face to accumulate in the rotor orifices.
5. **WARNING** Do not interchange rotors and flow control valve bodies. Always assemble rotor with its original flow control valve body.
6. Verify that the valve shaft rotates smoothly and stops at each detented position.

c. INSTALLATION

1. Replace the O-ring on the flowmeter assembly as needed.
2. Thread the flowmeter into the upper body and turn clockwise to tighten. Using a vise on the regulator body and a strap wrench on the flowmeter assembly for Yoke style regulators or two strap wrenches on Nut & Nipple style regulators turn the flowmeter clockwise to tighten to 15 inch pounds.

5. REGULATOR INTERNAL COMPONENTS

a. REMOVAL

1. Remove either the flowmeter or the end cap by following instructions under FLOWMETER removal. **NOTE:** References made to the flow control valve body are also applicable to the regulator end cap.
2. If the regulator has a removable inlet connection, remove the connection from the regulator per INLET CONNECTIONS removable CGA or international connection.

b. SERVICE

1. Remove the large O-ring from the piston for inspection. Clean the piston with isopropyl alcohol and thoroughly blow dry. Inspect both O-rings for wear or damage. Replace as necessary with new O-rings that have been lubricated with a film of Krytox 240AC lubricant. Inspect the seal on the end of the piston for cuts or abrasions. **WARNING** Failure to install the piston seal will render the regulator inoperative and will result in uncontrolled high flows through the relief valve vent ports.
2. Clean the relief valve with isopropyl alcohol and thoroughly blow dry. Inspect the relief valve O-ring for cuts and wear. Replace the O-ring if it is damaged.

3. Clean the inside of the regulator body with isopropyl alcohol and a lint free cloth and thoroughly blow dry. Inspect the seat for damage. Apply a film of Krytox 240 AC lubricant approximately ½” wide to the inner surface of the regulator body.

c. INSTALLATION

1. Install either the flowmeter or the end cap by following instructions under FLOWMETER installation. **NOTE** References made to the flow control valve body are also applicable to the regulator end cap.

VIII. TESTING

Perform the following test procedures after servicing the regulator or to determine if a regulator problem exists.

WARNING If service to the internal components of the regulator has been performed, conduct a preliminary static pressure test per the “STATIC PRESSURE TEST” instructions with a medical gas cylinder pressure of approximately 250 PSI. Conduct the preliminary static pressure test before beginning any functional testing to verify that all regulator internal components have been installed correctly.

NOTE All functional testing should be performed using a full cylinder of gas at 1900 to 2100 PSI.

A. INTERNAL CONTENTS GAUGE TEST

1. With the regulator unpressurized, verify that the contents gauge pointer is at or below the red “REFILL” area.
2. Connect the Medical gas regulator to a full gas cylinder and **SLOWLY** open the cylinder valve.
3. Verify that the contents gauge pointer moves into the green “FULL” area.

B. LEAK TEST

WARNING Do not attempt to repair leaks while the regulator is pressurized.

1. Connect the regulator to an appropriate cylinder.
2. On regulators equipped with a flowmeter, set the flow to the off position.
3. Apply a compatible leak test solution to all outlets and fittings. **WARNING** Do not apply any leak test solution to the internal contents gauge. **SLOWLY** open the cylinder valve. Constant bubbling of the leak test solution denotes the presence of a leak.
4. Tighten fittings as required to eliminate all external leaks. **WARNING** Do not over tighten threaded connections.
5. Close cylinder valve and note the pressure indicated on the contents gauge. This pressure should not decay more than 100 PSI in 90 seconds or less. If the regulator decays more than 100 PSI, return to factory for repair.

C. STATIC PRESSURE TEST

1. Connect the test pressure gauge to the flow control outlet, flowmeter outlet or designated flow connector. Turn the flow control knob or flowmeter knob (where applicable) to the largest flow setting. On emergency oxygen regulators, connect the test pressure gauge to one of the DISS auxiliary outlets.
2. Connect the regulator to a medical gas cylinder and **SLOWLY** open the cylinder valve.
3. Verify that the test gauge pointer stabilizes and becomes steady at between 45 PSI and 65 PSI. **NOTE** “Steady” is defined as no detectable movement of the test gauge pointer for a minimum of 15 seconds.

D. DYNAMIC PRESSURE TEST

1. Connect the test pressure gauge to one of the DISS auxiliary outlets.
2. Connect the regulator to an oxygen cylinder and **SLOWLY** open the cylinder valve.
3. Set a flow on the regulator flow control or flowmeter. On emergency regulator models, slightly depress the second auxiliary outlet check valve plunger to establish a small flow of gas from the outlet.
4. Verify that the pressure test gauge stabilizes at 50 + or - 5 PSI.

E. FLOWRATE TEST

NOTE A number of variables including ambient atmospheric conditions and test instrumentation resolution and accuracy will affect the results of flowrate testing. Compensation must be made for deviation from ambient conditions of 70 degrees F and 29.3 inches HG at the location of the test.

1. Connect the regulator to a full gas cylinder and **SLOWLY** open the cylinder valve.
2. Connect the flow control barbed outlet connector, the designated flow connector or the flowmeter outlet to the test flowmeter using as suitable length of oxygen tubing.
3. Verify that the flows read on the test flowmeter are within + or – 10% of the flow set on the regulator.

IX. REPLACEMENT PARTS LIST FOR DR8xxx-xxxxxx AND DR5xxx-xxxxxx

DESCRIPTION	FLOTEC PART #
DOME HANDLE	DH209
T-HANDLE	114-6316-117
BRASS THREAD INSERT (new)	810-6039-003
THREAD INSERT HELICOIL (old)	810-6428-001
FILTER	810-6033-021
O-RING NEOPRENE	810-6737-301
SPRING	151-0001-001
PISTON BRASS	810-6621-112
CHEMETRON STYLE QD TO 1/8" MNPT	QDC2-12
OHIO STYLE QD TO 1/8" MNPT	QDO2-12
HOSE BARB GREEN	HB12
HOSE BARB SILVER	HB122
HOSE BARB YELLOW	HB124
HOSE BARB BRASS	810-6619-003
DISS 1040 FITTING 1/8" MNPT	DF-1040
DISS 1120 FITTING 1/8" MNPT	DF-1120
DISS 1160 FITTING 1/8" MNPT	DF-1160
DISS 1180 FITTING 1/8" MNPT	DF-1180
DISS 1240 FITTING 1/8" MNPT	DF-1240
DISS 1040 CHECK VALVE 1/8" MNPT	DCV-1040
DISS 1120 CHECK VALVE 1/8" MNPT	DCV-1120
DISS 1160 CHECK VALVE 1/8" MNPT	DCV-1160
DISS 1180 CHECK VALVE 1/8" MNPT	DCV-1180
DISS 1240 CHECK VALVE 1/8" MNPT	DCV-1240

X. TROUBLESHOOTING GUIDE

INTERNAL CONTENTS GAUGE:

SYMPTOM	PROBABLE CAUSE	ACTION
Pointer does not move after cylinder valve is turned on	Cylinder is empty Contents gauge is damaged	Replace cylinder
Reading drops sharply with flow through regulator	Cylinder valve “cracked” open	Fully open cylinder valve

THE REGULATOR LEAKS AT:

Vent holes in body	Particulate matter in regulator	Clean regulator internal components
	Piston O-ring leaks	Replace piston O-rings (2)
	Piston seal leaks Relief valve gasket leaks	Replace piston seal Replace relief valve gasket
Auxiliary DISS outlet	Check valve O-ring leaks	Replace check valve O-ring
Adjustable flow outlet with knob in off position	Flowmeter not functioning properly	Return to Flotec
Designated flow connector	Connector not properly tightened connector	Tighten connector
	O-ring leaks	Replace connector O-ring
Threaded (NPT) connections	Loose connections	Disassemble clean and reseal threads, reassemble and tighten
THERE IS NO FLOW OR INACCURATE FLOW AT THE METERED FLOW OUTLET	Regulator inlet filter is blocked	Replace inlet filter
	Flowmeter/flow control is turned off	Turn flowmeter/flow control to desired setting
	Flowmeter not functioning properly	Refer to Flowmeter service Instructions
	Flow control valve is obstructed	Remove flow control valve from regulator and backflush
	Flow control knob is incorrectly positioned on shaft	Align knob set screw with flat on shaft and tighten securely

	Designated flow connector filter screen dirty	Backflush connector replace connector
THERE IS NO FLOW AT THE	Cylinder is empty Regulator inlet filter is blocked	Replace Cylinder AUXILIARY DISS OUTLETS Replace inlet filter
	Hose connector not properly engaged	Re-engage and tighten hose connector

