Operating and Maintenance Instructions

Infusion / Withdrawal Pumps
12 Speed Gear Box Types

All Models
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General Information

Serial Numbers - All inquiries concerning our product should refer to the serial number of the unit. Serial numbers are located on the rear of the chassis.

Calibrations - All electrical apparatus is calibrated at rated voltage and frequency. While most equipment will operate satisfactorily at slightly different voltages, the calibrations may vary considerably. The device should be operated at specified voltage and frequency listed on the serial number plate.

Warranty - Harvard Apparatus warranties this instrument for a period of one year from date of purchase. At its option, Harvard Apparatus will repair or replace the unit if it is found to be defective as to workmanship or materials. This warranty does not extend to damage resulting from misuse, neglect or abuse, normal wear and tear, or accident.

This warranty extends only to the original consumer purchaser.

IN NO EVENT SHALL HARVARD APPARATUS BE LIABLE FOR INCIDENTAL OR CONSEQUENTIAL DAMAGES. Some states do not allow the exclusion or limitation of incidental or consequential damages so the above limitation or exclusion may not apply to you. THERE ARE NO IMPLIED WARRANTIES OR MERCHANTABILITY, OR FITNESS FOR A PARTICULAR USE, OR OF ANY OTHER NATURE. Some states do not allow this limitation on an implied warranty, so the above limitation may not apply to you.

If a defect arises within the one-year warranty period, promptly contact Harvard Apparatus, 22 Pleasant Street, South Natick, Massachusetts 01760 using our toll free number 1-800-272-2775. Goods will not be accepted for return unless an RMA (returned materials authorization) number has been issued by our Customer Service Department. The customer is responsible for shipping charges. Please allow a reasonable period of time for completion of repairs, replacement and return. If the unit is replaced, the replacement unit is covered only for the remainder of the original warranty period dating from the purchase of the original device.

This warranty gives you specific rights, and you may also have other rights which vary from state to state.

Repair Facilities and Parts - Harvard Apparatus stocks replacement and repair parts. When ordering, please describe parts as completely as possible, preferably using our part numbers. If practical, enclose a sample or drawing. We offer a complete reconditioning service.

CAUTION - This pump is not registered with the FDA and is not for clinical use on human patients.
Basic Description

All of the pumps described are composed of two basic elements:

- A 12-position gear box and motor.
- A pumping/withdrawal mechanism.

The gear box is a planetary type with a "pull and turn" gear selector knob. Position #1 is the fastest speed while #12 is the slowest. The speed range of the gear box is 5000 to 1. In general, power to the pump should be shut off when shifting gears in the first three high speed gear positions 1, 2 and 3. The non-automatic pumps have a switch on the front panel labeled "infusion-withdrawal". This switch changes motor direction and converts the pump from infusion (emptying) to withdrawal (filling). Automatic pumps have this feature built in and there is no infusion withdrawal switch.

A choice of three motors and two basic speed ranges are available:

Synchronous Motors
These are the most precise and their speed is determined by the frequency of the line voltage, usually better than + .01%. However, only 12 ranges are available for any one syringe size.

Variable Speed Motors
These are shunt wound D.C. motors controlled by an SCR motor speed control permitting speed variation over a ten to one range. Thus, between the twelve gear box speeds and the ten to one motor speed control, infinite control of pumping rate over a 50,000 to one is available for each syringe size.

Servo Motors
These are special motors that must be controlled by a special servo amplifier model 2990. A pump and amplifier must be purchased together as a system. A separate instruction book if furnished.

Speed Ranges
Some pumps are designated "hi-speed". In this case a gearing change has been incorporated that increases all speeds by a factor of 3. It is useful where pumping is to be done at high flow rates.
PUMP MECHANISMS

There are a wide variety of pump mechanisms available that can be coupled with the various gear box combinations. In all cases the primary pump mechanism consists of a precisely machined stainless steel rotating lead screw and a bronze nut. This combination converts the rotary motion of the gear box to linear motion to either push or pull the syringe. Two styles of lead screws are used. In those pumps in which the largest size syringe is 50cc the screw is 24 pitch (one revolution advances the pusher 1/24°). In hi-capacity pumps that hold syringes up to 200 or 500ml volume, a 20 pitch screw is used (one revolution advances the pusher 1/20°).

OVERLOAD PROTECTION

All pumps are equipped with an internal overload clutch designed to slip at 25 inch pounds of torque. This is equivalent to 250 lbs. of thrust on the heads of syringes.

The clutch protects the gears in the gear box. The spring loaded clutch produces an audible "click" each time it slips. At the highest rates there will be 120 clicks/minute. At very low rates clicks might occur each 20 minutes or so. When you hear them, check the pump for overloads.

SETTING FLOW RATES

All pumps in this series are calibrated for B-D (Becton-Dickinson) Glass Syringes. (luer lock tip). The delivery rate for each syringe size in ml/minute as a function of gear position number is listed on a rate plate attached to the top of the pump. The rates indicated are those for the motor running at 1800rpm which is the case for synchronous motor or variable speed motors running at top speed. For those pumps equipped with variable speed motors, there is an additional control labeled "% of top speed". It is used to control motor speed. Thus the delivery rate is a function of gear position, syringe size and % of motor speed.

Example:

50cc syringe, gear position 2, % control set at 50%.
Flow rate plate indicates 15.3ml/min, multiplied by 50% on speed control, delivery rate = 15.3 x 50% = 7.65ml/minute. Pumps will accommodate other makes of syringes either glass or plastic. If there is any doubt as to what the actual delivery rate is for a syringe other than B-D glass, then the actual delivery rate should be verified by running the pump for a specific time and collecting the outflow in a graduated container.
HOLDING SYRINGES

With few exceptions all of the pumps hold the syringe at two points, at the tip and at the knob on the plunger. Luer lock tips have two slots that fit into a white U-shaped plastic insert at the end of the pump mechanism. The plastic insert both holds the tip of the syringe securely and provides electrical insulation between the contents of the syringe and the chassis of the pump.

The plunger end of the syringe is held in place by a series of white plastic half round withdrawal adapters. These adapters are supplied with the pump and are labeled from 2cc to 200ml corresponding to the syringe sizes listed on the rate plate for that pump. These withdrawal adapters serve three purposes:

- They hold the syringe.
- They permit withdrawal.
- They prevent syphoning. In certain situations where there is negative pressure in the fluid delivery line, it is possible for syringes to empty by themselves. The withdrawal adapter prevents this.

Withdrawal adapters are fastened to the syringe pusher block by a knurled thumb screw in the pusher. Also, withdrawal adapters have two grooves. The larger one is intended for glass syringes while the smaller is intended for plastic syringes. Due to the variations in the thickness of the plunger knob on glass syringes, the groove is intentionally loose. If this presents a problem then a shim of cardboard can be added between the glass syringe head and the adapter.

LIMIT STOPS

Limit Stops are used to set the limits of excursion of the pusher in either infusion or withdrawal. They can be used to set a specific volume to be delivered or to prevent the plunger from being destroyed by hitting the bottom of the barrel.

There are two types of limit stops used, side rail mounted or lead screw mounted.

Side Rail Mount
These consist of conical rings with thumb screws mounted on the side rails (rods) of the pump. They function by raising the pusher from the lead screw disengaging the half nut of the pusher. Adjust to suit conditions.

Lead Screw Mounted Limit Stops
These consist of two pairs of knurled nuts on the screw, a tapered nut and a check nut. The tapered nut engages a trigger pin on the pusher disengaging the nut, thus, terminating pumping. Adjust to suit conditions.
SYRINGES

A variety of syringes can be used with Harvard pumps - each with advantages and disadvantages.

**Glass Syringes**
Accurate but can become sticky with some solutions. Sometimes exhibit "stiction", jerky motion.

**Plastic Disposable**
Inexpensive, smooth motion, not compatible with all materials, accuracy less than glass.

**Glass With "O" Rings**
Good for pumping gases and "thin" solutions, only available in larger sizes.

**Stainless Steel**
Good for high pressure use. See catalog for details.

PARALLEL - RECIPROCAL OPERATION

Some pumps, particularly the 940 series, are composed of two pump mechanisms driven by a common motor. These pumps are equipped with a gear shift knob located on the opposite side from the main gear shift. Its function is to reverse the direction of one pump so the syringes move in opposite directions but at the same speed. This is useful in procedures where exact equal amounts are required to be added and withdrawn simultaneously. This knurled knob is as pull and turn type and is labelled with a tag. When this feature is not used the pump reverts to parallel operation.
CONTINUOUS AUTOMATIC PUMPS

These are pumps that use 2 or 8 syringes in which each pair of syringes forms a single pumping channel. While one syringe in a pair is filling from a reservoir, the other is emptying. Electrical limit stops operate solenoid valves and reverse the pumping action. These pumps will pump continuously and the volume pumped is not limited to the capacity of the syringe. Examination of these pumps will reveal a sliding rod 1/8"D with adjustable collars and a conical plastic tip that actuates a micro switch that operates the valves and reverses motor direction. An allen wrench is supplied to adjust the position of the collars on the switch rod. The collars should be set to operate reversal when the syringe is filled and when it reaches 5-10% of capacity on the heads of the plunger so they have minimum play in the withdrawal adapter.

Two types of valves are available:
  a. Pinch valve with silicone rubber tubing
  b. Stainless steel valve with stainless steel tubing

Pinch clamp tubing valve
The valve system is composed of silicone rubber tubing and solenoid operated pinch clamps. Please verify that the material to be pumped is compatible with silicone rubber (Silastic). Other tubing can be substituted if needed, but it must be elastic, eg gum rubber.

The solenoid pinch clamp valve consist of a frame work with a moveable stainless steel center section. In the unenergized position, the solenoid operated center bar compresses the two lower 1/4" x 1/8" I.D. Silastic tubes shutting off flow. When energized, the bottom tubes are opened and the top tubes are pinched off.

There are no adjustments for the pinch clamp valve. It is important to use the same size tubing if replacement is needed.

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Pinch Valve Connections

![Diagram of pinch valve connections]

Valve shown de-energized
Stainless steel solenoid valves
Wetted surfaces are 304 S.S. and Viton. Two three way solenoid valves work in conjunction for continuous operation.

The S.S. valves are capable of operating at higher pressures.
ELECTRICAL

All pumps are equipped with a three wire grounded power (mains) cord. Grounding should be kept intact, do not use 3 wire to 2 wire adapters, always use a proper 3 wire grounded A.C. outlet.

A certificate of electrical measurements is included with each pump. Resistance to ground does not exceed .1 ohms while the greatest acceptable leakage current does not exceed 100 micro amperes. All pumps are equipped with the correct size fuse for that pump. NEVER REPLACE WITH LARGER FUSE.

VOLTAGE AND FREQUENCY

All pumps carry a name plate label indicating serial number, model number voltage and frequency. Some pumps are designed for 115-230V, 50-60 Hz operation. A small slide switch located near the line cord selects the proper voltage. VERIFY THAT THIS SWITCH IS SET FOR YOUR VOLTAGE.

Pumps will perform within specification with input voltages between 100-135V and 210-250 volts.

Frequency - Variable speed motors are independent of frequency. Synchronous motors are dependent on frequency. When a synchronous motor is used on 50 Hz its speed will be 5/6 of the speed at 60 Hz. To compensate for this, a special flow rate plate is used on pumps designated 50 Hz.
HIGH PRESSURE PUMP

Many Harvard pumps have been modified to produce high pressures. The major mechanical change is the replacement of the half nut that rests on the lead screw by a solid nut that encircles the lead screw. In all cases the lubrication and maintenance data is the same for the high pressure model as for the model from which it was adapted.

<table>
<thead>
<tr>
<th>High Pressure Model</th>
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In models that use a solid drive nut the carriage containing the nut cannot be moved manually. To position the pusher, the motor must be used in either forward or reverse. Because of the solid nut the usual automatic limit stops found on standard models have been eliminated. An internal clutch will protect both motor and gearing in case of overload.

SYRINGE SELECTION

High pressure pumps can produce pressures in excess of 250 psi if required. Standard glass syringes will burst at internal pressures in excess of 70 psi. If the pump is to be used in a situation where high pressures over 70 psi will be generated then stainless steel syringes should be used. Stainless syringes are available in 20, 50, 100 and 200 cc sizes with and without swage-lock fittings.

PUMPS WITH TWO LEAD SCREWS

Some pumps like model 911, 922, 924, etc. have two lead screws driven by common gearing. Because of solid drive nuts it is not possible to position syringe pushers independently.

To adjust the position of the drive nuts, loosen the set screws (with Allen wrench provided) on the universal joint/coupling at the end of the leadscrew. After loosening the couplings each lead screw can be rotated independently to change the relative position of the pusher blocks.

Retighten the set screws securely.
MULTIPLE SYRINGE PUMPS

Catalog #55-4899 - Model 2265
Catalog #55-4907 - Model 2265A

This multiple syringe pump is derived from the 900 series pumps. All information concerning gear boxes, pump speeds, mainenance, etc. are covered in the general instruction manual covering the 900 series pumps.

Model 2265 is an infusion pump only intended to empty multiple syringes at relatively low back pressures.

The pump will deliver up to 250 pounds of force to the plungers of the syringes. The maximum actual pressure of the liquid in a syringe is expressed as follows:

\[
\text{MAX. PRESSURE PER SYRINGE} = \frac{250}{\text{(No. of syringes)} \times \text{cross sectional area in sq in)}
\]

Example, for a 50cc syringe, the cross sectional area is .9 square inches.

Using 10 syringes:

\[
\frac{250}{10} = 25 \text{ psi}
\]

The greater the number of syringes used and the larger the sizes, less pressure will be produced in each syringe.

ASSEMBLY INSTRUCTIONS

The pump is shipped partially disassembled because of its size.

1. Attach the pusher bar. The pusher bar is a black painted channel about 27” long. It fastens to two 3/8” pusher rods and is held in place by two thumb screws.

2. Select either one of the two syringe holder plates. One holder will hold up to 37 syringes of any size up to 20cc size. The other holder will hold up to 20 syringes up to 50cc size.

   Bolt the syringe holder to the pump base plate using four hex screws provided. There are two sets of tapped holes for exact positioning of either holder. It is not possible to put the holders in the wrong position.

3. Install loaded syringes symmetrically about the center of the pump.

4. Attach spring loaded syringe retainer bar. This bar has a sponge neoprene cushion that rests against the syringes holding them in place. The tension is adjusted by knurled thumb nuts at either end. Just enough tension should be applied to hold the syringes in place without bending the retainer bar.
MOTOR SPEED CONTROL

Variable speed pumps are equipped with an SCR motor speed control part #5153-002, schematic enclosed. The control has 5 trim pots that have been factory set. It is possible for the user to recalibrate the speed of the pump using the two trim pots labelled "min speed" and "max speed".

**Calibration is as follows:**

- Set gear selector to position #1.
- Set % control to 100%.
- Using stop watch, adjust "max speed" control for 60 rpm of lead screw (180 rpm for hi-speed models).
- Set % control to 50%.
- Using stop watch, adjust lead screw to 30 rpm (90 rpm for high-speed models).
- Since controls interact with each other, this procedure must be repeated two or more times until desired results are obtained.
MAINTENANCE

Harvard pumps are well built of quality materials intended to give years of trouble free performance. However, even the best of equipment needs some maintenance. Each pump is shipped with a small bottle of oil (SAE 10 automobile engine oil), and "Magna lube" grease.

Every three months of continuous operation

Apply grease lightly to lead screw.
If pusher block has an oil hole, add 2-3 drops of oil.
If pump has bronze bushings at either end of lead screw, apply 1-2 drops of oil.

Each year

Turn pump upside down, remove bottom plate held in place by two rubber feet and two screws to expose gear box. One drop of oil should be applied to toothed face of each gear. DO NOT OIL MOTOR.
Keep pumps clean and dry, wiping up any liquid spills.

SPARE PARTS COMMONLY ASKED FOR

<table>
<thead>
<tr>
<th>PART NO.</th>
<th>DESCRIPTION</th>
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<tbody>
<tr>
<td>2370-001</td>
<td>Set of withdrawal adapters 5cc-50cc, set of 6.</td>
</tr>
<tr>
<td>2380-001</td>
<td>Set of withdrawal adapters 50-200cc, set of 6, 2 ea</td>
</tr>
<tr>
<td>0900-056</td>
<td>Replacement saddle half nut assembly.</td>
</tr>
<tr>
<td>0930-026</td>
<td>Replacement half nut for series 930.</td>
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<tr>
<td>2200-025</td>
<td>Replacement half nut for 2200 series high capacity pump.</td>
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<tr>
<td>0900-058</td>
<td>Replacement syringe body clamp for 5-50cc syringe</td>
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<tr>
<td>0900-157</td>
<td>Molding insulator</td>
</tr>
<tr>
<td>5091-001</td>
<td>Pull and Turn knob</td>
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<tr>
<td>5090-001</td>
<td>Rubber foot</td>
</tr>
<tr>
<td>0905-025</td>
<td>Bronze half nut for 905 and 915 series</td>
</tr>
<tr>
<td>5153-002</td>
<td>SCR speed control</td>
</tr>
<tr>
<td>5123-006</td>
<td>D.C. motor for above</td>
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<tr>
<td>5123-007</td>
<td>Synchronous motor</td>
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HALFNUT
Part #2200-025
(HI Capacity Pumps)

HALFNUT
Part #0930-026
(Series 930 Pumps)

SYRINGE BODY CLAMP
Part #0900-058

MOULDING INSULATOR
Part #0900-157

SADDLE
Part #0900-056