GraverMax[®] GraverMate[®]



Operation and Maintenance Manual



Glendo Corporation



IMPORTANT

Read This First

Your success with your new GraverMax / GraverMate will depend on how well you understand its operation. Please read this entire manual carefully.

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SCHEMATIC / PARTS GraverMax



BASIC MACHINE SET-UP

Remove the machine and accessories from the carton.

1. CONNECT AIR SUPPLY

Each GraverMax / GraverMate requires 1.4 CFM (40 liters/min.) at a minimum 45 psi (3.1 bar). Maximum input is 125 psi (8.6 bar). The compressed air must be reasonably clean and dry. The built-in filter on each unit is a final filter and not capable of removing large amounts of water or contaminants. If the air

> supply has excessive water or contaminants, an additional filter/water trap should be installed ahead of the unit. Be

sure to clean/purge all filters and water traps regularly.

IMPORTANT: Never add oil

compressor uses oil inside, be

sure oil does not contaminate

to the compressed air for

GraverMate. Oil can foul internal parts and cause erratic handpiece operation. If your

any GraverMax /

your compressed air.



Purge moisture from filter by pushing up on the valve located at the bottom of the filter bowl.

2. CONNECT THROTTLE AND HANDPIECE

Insert the 1/4" (6,35mm) handpiece or throttle hose end through the brass nut with plastic liner until at least 1/16" (1,5mm) extends past the plastic liner. Wetting the hose slightly will help. Slide the hose over the machine fitting and tighten the brass nut. Handpiece and throttle connections should only be snug. Normally finger tight is enough; if you use a wrench do NOT overtighten.

3. SET AIR PRESSURE AND STROKE SPEED

Find your handpiece model on the Handpiece Tuning Chart on page 6. Adjust your GraverMax / GraverMate air regulator to the

"Recommended Initial Setting" air pressure for this handpiece.





per minute knob to the recommended initial setting also shown in the tuning chart. If your handpiece model is not listed, use 23 psi (1.6 bar) and 1800 strokes per minute.

4. Plug in electrical connection and turn machine "ON".

5. Make sure the handpiece selector knob (on GraverMax only) is correctly switched to the handpiece you want to use. Depress the foot control; the handpiece should impact. IMPORTANT: Proper "Tuning" of air pressure and strokes per minute affects handpiece performance considerably. Refer to Page 6 for details.

GraverMax

GraverMate





1. CONNECT AIR SUPPLY (use joint tape or sealant on pipe fittings)





2. CONNECT HANDPIECE HOSES (do not overtighten)





The machine is now ready for operation, but please familiarize yourself with all sections of this manual, and keep it handy for future references.

WARRANTY

Each GraverMax and GraverMate, including handpieces and foot control, carries a full 2-year warranty covering parts and labor.

These units are designed for reliable operation using most sources of compressed air. However, some air supplies contain excessive water, oil, dirt, rust or other contaminants. The unit's built-in filter is a final filter to protect against normal dirt and water. If your compressed air has excessive contaminants, you should install the necessary filter(s) and water trap(s) ahead of your unit.

Oil contamination can be gradual and subtle. If you notice an oil residue (usually a yellow to brown colored sticky or liquid residue) in the unit's filter bowl or handpiece / throttle hose, you probably have an oil problem in your compressed air. Older oil-lubricated and "silent" compressors that use internal oil are more likely to cause oil contamination. If this occurs, install a Coalescing Oil Filter (GRS #004-579 or equivalent).

NOTE: Damage caused by contaminated compressed air is not covered by the warranty.



Introduction

The GraverMax/GraverMate fulfills the need for a machine capable of allowing rapid but precise cutting and carving of metal, stone, wood and ivory, and many other materials. The precise impact control feature of the machine also makes it an ideal tool for stone setting, stippling, matte finishing on jewelry, stipple engraving on crystals, etc. Most anyone with certain natural skills can easily learn to properly operate a GraverMax/GraverMate.

The GraverMax / GraverMate acts on the principle of an air-powered hammer capable of delivering controlled impacts at speeds of 400 to 4,000 strokes per minute. A foot pedal controls the impact power in much the same way the gas pedal works on a car.

The large range of power available and precise control allows delicate cuts to be combined with heavy material-removal for the desired effects. To realize the full capability of the GraverMax/GraverMate you need to become familiar with both the operation and routine maintenance of your machine.

It is also important to become familiar with various proven techniques for use of the GraverMax/GraverMate and the wide selection of tools used to produce a range of desired effects. Tool geometry and proper sharpening are as important as the skillful use of the GraverMax /GraverMate. The first section of this manual is intended to help you avoid many of the difficulties others have experienced in achieving the desired result with their machine. This section is worthy of frequent review until you master both the machine and the proper preparation of the tool, or graver, that does the work.



Strokes per Minute

GraverMax ONLY

Stroke speed setting is a matter of personal preference and experience. Generally speaking, lower speed settings are preferred for some stippling, matting or staking functions. Try mid-range settings for tasks requiring maximum power. Higher speeds work best for

fine, delicate cuts and to obtain the best finish.

The GraverMax shows a range of 400 to 4,000 strokes per minute. The calibrations on the dial are only



approximate. When comparing one GraverMax to another, or reading your operating manual, please remember that each machine may "tune" slightly differently. Each model of handpiece has a normal range of strokes per minute. Operating outside this range can produce erratic operation at times.

GraverMate

The GraverMate has no speed adjustment; it operates at about 2300 strokes per minute.

How to TUNE the GraverMax/GraverMate

By "tuning" your machine, we mean adjusting the strokes per minute and air pressure for optimum performance. TUNING YOUR MACHINE PROPERLY IS THE SINGLE MOST IMPORTANT OPERATION THAT YOU SHOULD LEARN.

1. *Refer to the chart below.* Set the Strokes per Minute to the Recommended Initial Setting for the handpiece you are using.

(Stroke setting does not apply to GraverMate)



2. *Refer to the chart below.*

Set the air pressure by adjusting the regulator knob, located on top of the machine, to the MIDDLE of the Normal Air Pressure Range for the handpiece you are using.

3. Without depressing the foot control, hold the handpiece horizontally in one hand. (Note: Be sure the handpiece selector knob is turned to the handpiece you are using!) Now, slowly turn the regulator knob (air pressure) counterclockwise to reduce the air pressure by about 2 to 6 psi (0.1-0.4

6						
Handpiece Type		Normal Operating Range Strokes Per Minute	Normal Air Pressure Range <i>psi (bar)</i>	Recommen Strokes Per Minute	ded Initial Setting Air Pressure psi (bar)	
004-506 Large		800 - 2400	20 - 30 psi (1.4 - 2.1 bar)	1400	24 psi (1.6 bar)	
004-508 Standard		1000 - 2800	18 - 23 psi (1.2 - 1.6 bar)	2000	20 psi (1.4 bar)	
004-563 Bulino		1600 - 4000	19 - 23 psi (1.3 - 1.6 bar)	3000	20 psi (1.4 bar)	
004-610 / 609 Hammer		1000 - 2700	20 - 25 psi (1.4 - 1.7 bar)	1800	22 psi (1.5 bar)	
004-710 Hammer		1000 - 2700	20 - 25 psi (1.4 - 1.7 bar)	1800	22 psi (1.5 bar)	
004-801 / 810		1800 - 4000	21 - 25 psi (1.5 - 1.7 bar)	3000	22 psi (1.5 bar)	
004-720 Heavy-Duty		800 - 2400	20 - 30 psi (1.4 - 2.1 bar)	1400	24 psi (1.6 bar)	
004-901 / 910	Standard Spring	1400 - 3400	18 - 22 psi (1.2 - 1.5 bar)	2700	19 psi (1.3 bar)	
	Fine Spring	1600 - 3600	12 - 15 psi (0.8 - 1.0 bar)	3000	13 psi (0.9 bar)	
004-921 Monarch		2400 - 4000	11 - 14 psi (0.7 - 0.9 bar)	3600	12 psi (0.8 bar)	

HANDPIECE Tuning Chart

bar) until the handpiece vibrates very slightly in your hand. Next, increase the air pressure slowly until this vibration barely stops. Then, increase the air pressure about 1 psi (0.1 bar) more. The goal is to use the least air pressure possible that will properly operate the handpiece.

Remember, if the handpiece vibrates without depressing the foot control, the air pressure is probably too low. If the handpiece fades out at full throttle, the air pressure is probably too low, or the strokes per minute is too high for that handpiece. The handpiece should start to operate within 3/8" (9.525mm) of depression of the foot control... if it doesn't, the air pressure is probably too high. Always make small adjustments in air pressure or strokes per minute, not large ones, until you are very familiar with your machine.

If you have "tuned" your machine properly, the handpiece will operate smoothly and predictably. New operators often use too much air pressure or the incorrect strokes per minute range. This can make your machine difficult to control for fine work. Both the GraverMax and GraverMate have extremely fine control for the smallest stone setting and the finest engraving. But, you must learn to "tune" the machine correctly to achieve this fine control! After a while, you can experiment with variations in air pressure and stroke speed to suit your work preference.

How to Hold Your Handpiece

Normally, you should hold your handpiece like a table knife, not like a pencil. A few exceptions are hammering and stippling. Resist the urge to grip your handpiece tightly. Train yourself to hold the handpiece as softly as you can. When you grip it tightly or push hard with your hand, you lessen the impact power and create more work for yourself! So, relax and let the machine do the work while you concentrate on the design you are working on. When you are doing heavy work, try this: Partially release your grip on the handpiece as you add more power with the foot control. You



will be amazed at how much more power you have! If you slip with the graver, you are not operating your handpiece properly, and probably pushing too hard with your hand.

Hammering is a special situation. When hammering you usually hold the handpiece like a pencil. If you are hammer setting, be sure to press the hammer tip down firmly on the work BEFORE using the foot



control to start hammering. Also, do NOT operate the hammer by holding the tip slightly above the work as with many flexible-shaft hammers. Do NOT allow the hammer tip to "bounce" against the work. Use just enough downward pressure to keep the hammer from jumping off the work. GRS handpieces have tremendous power. Use just enough power to do the work...take it easy at first!

How to Use the FOOT THROTTLE

The GraverMax / GraverMate foot throttle is operated like an automobile accelerator and NOT like a flexible-shaft foot control. You should put the tool in position BEFORE depressing the foot control. Never depress the foot throttle and then try to bring a stroking handpiece to the work!

If you need more power when cutting deeper, push more on the foot throttle to increase the handpiece power. You will soon learn to coordinate your foot action with



the need for more power as you work. A beginner will push the foot control down a set amount and try to do the rest by pushing harder, while never changing foot position. This is wrong and not safe. At the start of the cut, increase power in a smooth fashion. If you need more power, press more with your foot. As the cut tapers to the end, reduce the foot pressure gradually as your hand tilts the graver up and out. With a little practice, this hand/ foot coordination will become as natural as driving a car.

EFFECTIVE TIPS

The GraverMax / GraverMate provides an effective, unique method for performing a variety of functions in many materials. You may not achieve effective results with the machine at first. In fact, your initial attempts may be disappointing or downright discouraging! Begin by expecting a learning period - whether you have had experience engraving by another method, or are a novice. This claim is also made: After the initial learning period, the results and the satisfaction derived from use of the machine are fantastic! It takes a little practice, some learning, and perhaps some re-learning.

It may seem awkward and ineffective at first - like your first attempt to ride a bicycle... remember?

The easiest and most productive way to learn quickly is to work with someone accomplished in the use of the GraverMax/GraverMate. If this is not possible, the information contained in these "TIPS" will be helpful. A most valuable and useful information source is James B. Meek's book, *THE ART OF ENGRAVING*. We recommend it highly.

Most of the information in this section is directed toward the task of metal engraving. Even if your purpose for using the machine differs, this information is relevant and helpful. The engraving of metal, especially steel, is most difficult and demanding. When the principles of metal engraving are understood, then other uses will be less demanding. We have never known a person who could effectively carve a deep relief scene that could not easily set a stone, florentine or engrave a ring, matte finish a piece of jewelry, carve wood, or prepare a fossil.

Here are some reasons why you may not achieve effective results at first:

- The concept of variable power applied to the handpiece seems strange at first.
- Coordination of power and tool cutting action with the foot throttle might feel awkward, but after a small amount of practice it will become natural.
- It seems strange and different at first but extremely effective when mastered. Again, remember how easy it was to ride a bicycle after you learned how. Successful cutting requires just the right amount of forward pressure on the handpiece, and proper manipulation of the throttle.

Try these techniques then review results and try them again:

• Turn the machine ON, hold the handpiece in your hand, and work the foot throttle to get the feel of the power variation from light, short strokes to heavy, long strokes. You will begin to anticipate the foot throttle position for the various power settings desired.

• Be sure the tool is tight in the chuck. Work the throttle while tightening or loosening the chuck. The handpiece action at full throttle will aid in tightening the chuck, and is especially helpful in opening the chuck to remove the tool.

• When cutting or engraving, hold the handpiece as you would a table knife - not a pencil. Place your index finger on the graver or chisel as you would on a knife blade to exert slight downward pressure. Hold it like a pencil only when stippling, background matting, chipping, etc.

• Place the tool cutting point on the work piece BEFORE applying power with the throttle. Attempting to enter the cut with the power ON and the handpiece stroking will quickly dull or damage the tool point.

• Apply power with the throttle only AFTER positioning the tool on the work. Use slight forward pressure to keep the tool point moving forward into the cut. Both tool angle and downward pressure control the depth of cut. Avoid using too much downward pressure; it's tiring and often indicates the need for better tool sharpening or a more relaxed technique.

• Vary the power input with the throttle to control the speed and depth of cut. Do not let the cutting action get ahead of your ability to guide the tool. Stop the throttle action to reposition the work. Leave the tool point in the cut.

• Overcome the tendency to let the handpiece continue to stroke when not actually cutting (by failing to take your foot of the throttle.) With practice, control of the throttle becomes an automatic response.

• Use a stable vise or heavy engraver's block to hold the work. If the work is not held solidly, vibration will decrease effectiveness of the tool's power and will quickly dull or chip the point. A GRS engraving block is a most effective work-holding device.

• Don't push hard! If your hand become tired or cramped, you aren't using the power of the machine to do the work - or you may not have the tool properly sharpened or heeled.

• Keep the tool sharp and properly heeled. Sharpen frequently - before you lose the point entirely. With practice you will begin to "feel" when the point is beginning to dull. At this time, only a slight amount of sharpening is necessary to bring it back to the desired sharpness. Hardness of the material you are cutting will greatly affect tool life.

• There should be no noticeable vibration of the tool point in the cut. If the point is allowed to vibrate in the cut, the point will dull quickly.

IMPORTANT TOOL SHARPENING TECHNIQUES

While the GraverMax/GraverMate is a tremendous aid in solving the most difficult task in engraving or carving, it does not help in another important area - the task of tool sharpening. In fact, it perhaps even emphasizes that problem. You will be cutting faster and deeper, and the need for proper point geometry and condition will soon become apparent. Be prepared to go through a learning period in the tool sharpening task. Here too, a few minutes spent with someone who knows how to sharpen tools properly can save hours of frustrating experimentation. A word of caution though! BE SURE YOUR ADVISOR REALLY KNOWS.

If a session with someone versed in tool sharpening is not possible, read the following information - and practice. In the end, you must learn an effective technique so that when you put the tool into the work, you know the result will be as you planned.

Various types of gravers are used for different types and styles of cutting, but the square and point (Onglette) are the most important in metal

cutting. Once you master the sharpening techniques for them, you should have little difficulty with others. POINT or ONGLETTE

In his book, *THE ART OF ENGRAVING*, Mr. Meek's excellent illustration and discussion of the importance of proper tool sharpening technique and geometry is especially helpful. He relates to this subject in chapters 2, 4 and 7. This subject is of utmost importance, and this reference material is most helpful.

Gravers should be ground on the face first. An approximate 45-degree angle should be maintained. Keep the graver in the handpiece for free hand sharpening. First, this will save time. Second, the additional length provided is an aid in maintaining the proper angle on the stone. A considerable amount of care and practice is required to maintain the proper angle while sweeping the tool point across the stone.

For good results, the graver must be heeled, or set-up. This task takes some experimentation and practice to produce satisfactory results. The finish of the engraved cut is greatly affected by the finish of the graver heel. For a bright cut, finish the heel using polishing paper or a ceramic lap. Here is what the heel accomplishes:

- A. It raises the working angle of the graver to a convenient height from the work surface.
- B. It provides depth control.
- C. It gives clearance when working on irregular surfaces and prevents the bottom surface of the graver from dragging on the edges of the cut when making curved cuts.
- D. It improves the quality and appearance of the cut.

Usually a heel angle of 15 degrees is used. Only a small amount of material need be removed. A few light strokes on a fine, hard stone is

sufficient. Don't be confused by the tremendous number and variety of gravers available in the supply catalogs; virtually all work can be accomplished with a small variety of points.



GRS sharpening equipment is a most valuable aid in tool sharpening. It is especially helpful for beginners in the art of engraving, and has been readily accepted by accomplished engravers who have found that it is faster and produces more consistent results.



The combination of the GRS Power Hone® and the Sharpening Fixture provides the ideal sharpening system. The Sharpening Fixture is designed specifically for use with the Power Hone. With this combination, you can sharpen repeatedly with consistent results time after time. It is easy to learn - you merely follow the instructions. A square graver can also be "heeled" with the fixture.

Tips For Practice Sessions

Start with simple cuts. Using a square or point (onglette) graver, begin by cutting straight lines - then simple curves. Practice depth control, cutting both fine shallow lines and deep cuts. It is good practice to master the technique of varying the depth of cut to produce a pleasing shaded effect. These practice sessions will help you acquire the necessary skills in both tool control and tool sharpening techniques.

After you have mastered the basic skills, you can concentrate on learning the more difficult and intricate designs. With confidence in your ability to control the tool, you will be able to execute progressively more difficult patterns with varying depth of cut and subtle shading and finally on curved or irregular surfaces.

Simple exercises like those sketched below are good beginning practice designs as they are relatively simple. It is easy to determine the progression of the cuts to generate the design, and they do not require a large amount of rotation or manipulation of the work piece. This type of design is also good practice for the beginning woodcarver.



OPERATION

CONTROL UNIT

The control unit contains the air and electrical system components. Air components are: filter regulator, rotary valve, gauge, manual valves, tubing, etc. Electrical components are: D.C. motor, speed control, fuse, switch, etc.

FILTER / REGULATOR

This component is designed to provide clean regulated air to the system. Operating pressure is indicated by the gauge reading.

The filter is designed to remove moisture, compressor oil, etc. from the air supply. The bowl has a manual drain which should be checked and emptied as frequently as necessary. Check at least daily.

If large amounts of water or contaminants are in the air supply, more frequent attention must be given to the unit filter. The bowl must be drained frequently to prevent water from entering the operating components, and the filter element must be cleaned and/or replaced frequently. Use a filtered air source.

AIR PRESSURE CONTROL

The air pressure control is used to "fine tune" the impact action through a wide range of stroke speeds ("Fine Tune" - see page 6).

To adjust for optimum performance, set desired stroke speed and while operating the throttle, adjust air pressure between 20-35 psi (1.3 - 2.4 bar). With some combinations of pressure and stroke speed settings, an erratic or reduced stroke action may be noted. This condition may be corrected by a slight change in stroke speed, pressure setting, or both.

IMPORTANT: Adjust air pressure setting as low as possible for most sensitive stroke control. This also eliminates throttle pre-travel.

Impact action may "fade" at higher stroke speed settings due to piston inertia. Decreased air pressure setting will correct this condition.

ROTARY VALVE

The rotary valve is lubricated by the air passing through it. DO NOT RUN ELECTRICAL SYSTEM EXTENSIVELY UNLESS AIR SYSTEM IS ON.

ELECTRICAL SYSTEM

The electrical system is composed of a D.C. motor, speed control, fuse, switch, etc., to drive the rotary valve at a selected speed. The strokes per minute dial on the GraverMax allows the speed of the rotary valve to be changed. The GraverMate has no speed adjustments.

THROTTLE

The throttle controls the impact power. The more the throttle is depressed, the greater the stroke speed.

The throttle is essentially an air valve. Depressing the throttle progressively opens the valve and increases the power of the impact strokes.

NOTE: The throttle is set to bleed a small amount of air in the "off" position. This is necessary for optimum throttle sensitivity and to eliminate pre-travel.

OPERATING TECHNIQUES

The ability to exercise precise control under all operating conditions is the most important feature of the GraverMax/GraverMate. Coordination of the throttle and handpiece is very similar to steering your car while depressing the gas pedal.

Place the cutting point of the tool in position before depressing the throttle. Stop the stroking action before repositioning the tool, or at the end of a cut.

Use sufficient impact force to perform the cutting with a minimum of hand pressure. If your hand or arm becomes tired quickly, you are pushing the tool. Use only enough hand pressure to maintain complete control over the cutting action. If the tool point slips out of position and gouges your work, you are using too much hand pressure, or the point is improperly sharpened.

IMPACT HANDPIECE

The handpiece acts as an air-driven hammer. Several handpieces are available. The smaller handpieces are most universally used for engraving, fine mold finishing, jewelry manufacturing, etc. The larger handpieces are used for heavier material removal requirements, woodcarving, fossil preparation, etc.

The handpiece chucks and Quick Change chucks are designed to hold a wide variety of gravers, chisels, etc. Maximum tool diameter opening for most handpiece chucks is 1/8" diameter (3.17mm). See tool modification below.

Piston, spring, and bore of the handpiece must be clean for proper operation. If operation becomes sluggish, erratic, or fails to operate, cleaning is indicated. (See MAINTENANCE page 14).

INSTALLING TOOLS

When inserting the desired tool into the chuck, it is not necessary that it be aligned perfectly; however, it must be firmly seated inside the chuck, on the face of the chuck, or on the ledge provided in the chuck jaws.

Standard gravers normally used with wood handles (point, knife, liners, etc.) may be used in all handpieces. The tang (or shank) end must be modified by grinding to fit the chuck properly.

The following sketch shows how the graver should be modified.

CAUTION - Do NOT use tools bits with a

Do not use tool bits with a taper larger than the chuck will easily accept. If the tool bit shank is so large that it will not "bottom out", the impact during use will wedge the tool into the chuck so tight that it may damage it.



MORE ABOUT MODIFYING TOOLS

Removing the top/front of the engraver tip will allow a better view of the area being cut and will permit faster sharpening as there is less surface to be sharpened.

NOTE: When grinding a tool on a wheel, do not let the tool tip get too hot and burn. Burning means the tool metal will turn blue, which takes the temper or hardness out of the tool and it will not hold a cutting edge. To avoid burning the tool, do not press too hard against the wheel; take your time. Have a container of water that you frequently dip the tool into before it gets warm in your hand.

Always be sure that the tool point is sharp. Refer to the TIPS section for sharpening technique.





ROTARY HANDPIECE

The rotary handpiece delivers high horsepower, but low torque. Feather touch or brushing techniques remove the most material

possible. With this method, you will have a superior tool for fine, delicate, intricate, and exciting work. The Rotary Handpiece is a precision instrument that can be easily damaged if misused or improperly maintained.

Your rotary handpiece is engineered for quality and manufactured for long life. To use, attach handpiece to auxiliary air output on your GraverMax or GraverMate and adjust air flow and pressure until desired speed is achieved. The handpiece is designed to operate at a maximum of 35 psi (2.4 bar).

NOTE: Stop the rotary handpiece by turning the auxiliary knob until the air is OFF. For frequent ON/OFF usage, we recommend adding a GRS foot

switch in the air line. This will facilitate your work.



IMPORTANT: Do not operate a rotary handpiece until you are thoroughly familiar with proper operating procedure. READ THE INSTRUCTIONS THAT COME WITH THE ROTARY HANDPIECE CAREFULLY.

ROTARY HANDPIECE SAFETY

- 1. Use safety glasses or goggles. Also use face or dust mask if cutting operation is dusty or if working on glass. (NOTE: When working on glass put water on the surface to help keep the dust down.)
- 2. Keep work area clean and uncluttered.
- 3. All visitors should be kept at a safe distance.
- 4. Do not force tool. It will do a safer and beter job at the rate it was designed for.
- 5. Use the correct burs. Do not force bur to do the job of a heavier duty tool.
- 6. Use clamps or vise to secure work.
- 7. Avoid accidental starting. Turn tool OFF immediately after use.
- 8. Do not depress bur ejector while running -possible damage to tool may occur.
- 9. Do not operate tool without a bur.
- 10. Use 35 psi (2.4 bar) or less air pressure.

WORK HOLDING

The workpiece must be held as firmly as possible. If it is not, much of the power and cutting capability of the tool is lost. Use either an engraver's ball vise or a vise which can be rotated with your free hand to position the work as the cut progresses. GRS offers a selection of vises to fit different tasks.



MAINTENANCE

IMPACT HANDPIECE

The impact handpiece must be kept clean for proper operation. If operation becomes sluggish, erratic, or fails to operate, cleaning is indicated. (See - CLEANING - Back Cover) TO CLEAN HANDPIECE:

- 1. Remove hose connector, piston and spring.
- 2. Clean all parts thoroughly with oilless solvent. Alcohol based solvents are recommended.
- 3. Reassemble and test.

NOTE: DO NOT LUBRICATE PISTON, SPRING OR BORE.

Oiling - occasionally place a drop of synthetic oil or light grease on the handpiece chuck threads / jaws or Quick Change chuck. This will extend useful life, and improve operation.

ROTARY HANDPIECE

Refer to the operating instructions for operation and routine maintenance of the rotary handpiece.

THROTTLE

The throttle should require little maintenance. It should be cleaned periodically.

Oiling - Periodically place a drop of oil on the throttle hinges and on the bleed valve.

CONTROL UNIT

The Control Unit contains both air and electrical system components. Each system will require maintenance attention.

AIR SYSTEM

The air system is composed of: filter / regulator, rotary valve, gauge, manual valves, tubing and connectors.

If large amounts of water and contaminants are in the air supply to the unit, more frequent attention must be given to the unit filter. The bowl must be drained frequently to prevent water from entering the rotary valve, hoses, handpiece, etc. In addition, the filter element must be cleaned and / or replaced frequently.

If moisture is noted in the handpiece or throttle hoses, shut the unit down immediately and drain the filter bowl. Then proceed as follows:

- 1. Disassemble and clean handpiece(s).
- 2. Reduce pressure setting to 10 psi
- 3. Turn unit ON to purge moisture from valves, hoses, etc.
- 4. Reassemble handpiece.

ROTARY VALVE

The Rotary Valve is lubricated by air passing through it. Additional lubrication is not required or recommended.



HOSES AND FITTINGS

Inspect and replace hoses, etc. whenever evidence of wear is noted.

To replace handpiece hose:

NOTE: Refer to the instruction that came with the handpiece.

- 1. Disassemble handpiece.
- 2. Cut hose flush with handpiece connector and push out retaining bushing.
- Insert hose through handpiece connector or knob (depending on type of handpiece) so it protrudes.
- 4. Insert retaining bushing into hose.
- 5. Pull hose and bushing into location in the handpiece connector.

ELECTRICAL SYSTEM

The electrical system is composed of a D.C. permanent magnet motor, speed control, fuse and switch, etc.

If unit fails to operate, check and replace fuse if necessary. Proper fuse is 1.5 amp for the 115 Volt unit and .75 amp for the 230 Volt unit.

See ROTARY CLEANING, page 15, if you are replacing the fuse often.

WARNING: ALWAYS UNPLUG POWER CORD BEFORE REMOVING COVER.

If unit remains inoperable after you have performed these routine steps, please contact the GRS Tools factory or your local dealer.

ROTARY VALVE CLEANING

SYMPTOM - Chirping Noise or Fuse Keeps Blowing

Contaminants in the compressed air may cause residue to build up on the ROTARY VALVE and BUSHINGS. If this happens you will hear a chirping noise at first: this will later overheat the motor and blow the fuse. Instructions are provided below to assist you in cleaning the valve assembly.

Should you find an oily or watery residue when cleaning this valve, you must also address the source of the contamination. Almost all air powered engraving systems need clean, dry, oil-free air to operate correctly.

If you are using an oil-less compressor and are getting contamination, check to see the water trap on the regulator located in the rear of the GraverMax/GraverMate units is drained. Be sure to drain the air tank on your compressor periodically as well.

If you are using an oil type compressor, you MUST have a coalescing oil filter in the air supply line to remove this contamination. These are available from GRS or any paint supply house which deals in spray painting equipment. These are essential to use for long term reliability of your equipment.



Follow these steps to solve the problem:

IMPORTANT: Disconnect electrical and air supply first.

1. Remove the shell by removing the four screws located on the bottom. (See Fig. A) Slide the shell off. (See Fig. B - arrow is pointing at rotary valve for the GraveMax) *The Rotary Valve on the GraverMate is vertical and located in the top center.*

2. Loosen the two set screws located in the ROTARY FLYWHEEL at the back of the rotary valve with a hex wrench (See Fig C. - arrows are pointing at set screws).

3. After loosening the set screws, pull the ROTOR out of the valve. (See Fig. D) Clean the rotor with a NON-RESIDUE solvent (ie: acetone, denatured alcohol, etc.) Dry thoroughly - make sure NO moisture is on the rotary. (See Fig. E)

4. Clean the BUSHINGS inside of the valve with a cotton tipped swab and NON-RESIDUE solvent. (See Fig. F) MAKE SURE IT IS COMPLETELY DRY inside the valve before replacing the rotor.

5. Place the ROTOR into the VALVE. Align the ROTARY FLYWHEEL on it. **IMPORTANT:** Before tightening the set screws, the rotor must be spaced for free movement. It will need approximately .003" play. If you do not have a .003" shim, use a piece of writing or copy paper (20#). One layer of 20# paper is about .003". Inset the paper between the rotary washer and the valve. (See Fig. G) Hold the rotor and flywheel together with the paper spacing and tighten the set screws. Check to see that the flywheel turns freely by hand. Reassemble the shell and connect the air supply and electricity.



GraverMax

1	002-334	Filter / Regulator Complete	
2	002-364	5 Micron Filter	
3	002-417	Drain Bowl	
4	022-135	Fuse Holder - VDE	
5	022-138	Fuse - VDE/GDE 1.6 amp - 115	volt
	022-139	Fuse - VDE/GDB 0.8 amp - 230	volt
6	004-520	Circuit Board Assembly	
7	004-595	Transformer - 230 volt ONLY	28-
8	004-513	Power Cord - 115 volt	20
	004-651	Power Cord - 230 volt	27
9	002-336	Controller	
10	002-341	Knob - (Strokes Per Minute)	
11	002-340	Knob - (Handpiece Selector)	
12	002-339	Knob - (Auxiliary Air)	31
13	002-615	Air Gauge	
14	004-291	Air Gauge Bracket	32
15	004-501	Valve Assembly, 2 way	02
16	002-766	Wire Hose Clamp, Corbin A-45	
17	002-229	Cord Retainer	
18	002-326	1/4" X 1/16" Male Connector	
19	002-331	1/4" Connector (Bulkhead Union))
20	011-210	Rubber Foot	
21	002-337	Switch - 115 Volt	
	002-738	Switch - 230 Volt	
22	004-001	Cover	
23	050-002X6	Urethane Tubing .170" I.D.	
24	050-002X8	Urethane Tubing .170" I.D.	
25	002-328	1/4" X 1/8" Male Elbow	
26	002-971	Disc (Sintered)	
27	002-386	1/4" X 1/8" Male Connector	
28	002-385	Adapter	
29	002-338	Button (neon display)	
30	002-361	1/8" NPR X 1/4" Barb Fitting	
31	004-587	Valve Assembly	
32	002-335	Motor	
33	002-749	O-Ring Drive	

004-677 Motor / Valve Kit - ready to drop in -

For Foot Control schematic see page 18



The ROTARY VALVE is lubricated by the air passing through it. DO NOT RUN ELECTRICAL SYSTEM UNLESS AIR SYSTEM IS ON.



GraverMate



GraverMax / GraverMate FOOT THROTTLE

ASSEMBLY # 004-519

1	004-006	Throttle Base
2	004-007	Hinge Plate
3	004-010	Pivot Shaft
4	004-011	Bleed Shaft
5	022-170	1/4-40 X 3/16" SHSS
6	002-073	1/4-28 Nut (2)
7	011-210	Rubber Foot Assy. 8-32 X 3/8" (4)
8	002-527	10-32 X 3/4" RHMS
9	002-526	Spring Retainer
10	002-204	10-32 Hex Whiz Loc Nut
11	001-028	Throttle Hinge Nut (2)
12	004-009	Spacer (2)
13	004-012	Outlet
14	002-517	1/8" NPT X .170 Barb Fitting
15	004-031	Throttle Outlet Spring
16	004-008	Spring Retainer
17	002-065	10-32 X 3/8" RHMS (2)
18	001-036	Throttle Spring



SERIAL NUMBER ON **GRAVERMAX** EXAMPLE: MA02075

MA = Machine Model

- 02 = Year Built
- 075 = 75th machine built that year

SERIAL NUMBER ON GRAVERMATE

EXAMPLE: AA02088

AA = Machine Model

- 02 = Year Built
- 088 = 88th machine built that year

GRS Adjustable Power Limiter Valve for GraverMax or GraverMate



This valve restricts the amount of escaping air, creating a control setting which limits the amount of impacts produced by the handpiece. *It works like a governor.* When depressing the foot control, the action of the handpiece will "max-out" at the desired setting of the Power Limiter Valve. This allows for more control for finer engraving work. The valve is positioned in the air line to the foot control on any GraverMax or GraverMate system.

> **Kit includes:** Adjustable Power Limiter Valve, extra air hose, coupler, screws and instructions.

Order #004-808



Air Filter / Oil-Removal Kit Removes dirt and oil contamination from compressed air.

Order #004-579

Quick Disconnect Kit

Allows quick switching of air handpieces. Includes one main body and two connectors.



Order #004-615

GRS Ultra 850 High-Speed ROTARY Handpiece

This rotary handpiece turns between 300,000 and 400,00 RPM for effortless engraving, decorating and grinding of wood, metal, shell, plastic, glass, stone... almost

any material.

Includes handpiece, tubing, connectors, carbide bur and instructions.

Requires 1.3 cfm at 30-35 psi (38 liters per minute at 2-2.5 bar) Connects directly to GraverMax, GraverMate or any regulated air supply.

Order #004-850

REQUIRES **NO**

Quick Reference SEE PAGE 6 FOR MORE DETAIL HANDPIECE Tuning Chart for GraverMax

	Normal Normal		Recommended Initial Setting	
Handpiece Type	Operating Range Strokes Per Minute	Air Pressure Range	Strokes	Air Pressure
		por (our)	Ter Philate	psi (bur)
004-506 Large	800 - 2400	20 - 30 psi (1.4 - 2.1 bar)	1400	24 psi (1.6 bar)
004-508 Standard	1000 - 2800	18 - 23 psi (1.2 - 1.6 bar)	2000	20 psi (1.4 bar)
004-563 Bulino	1600 - 4000	19 - 23 psi (1.3 - 1.6 bar)	3000	20 psi (1.4 bar)
004-610 / 609 Hammer	1000 - 2700	20 - 25 psi (1.4 - 1.7 bar)	1800	22 psi (1.5 bar)
004-710 Hammer	1000 - 2700	20 - 25 psi (1.4 - 1.7 bar)	1800	22 psi (1.5 bar)
004-801 / 810	1800 - 4000	21 - 25 psi (1.5 - 1.7 bar)	3000	22 psi (1.5 bar)
004-720 Heavy-Duty	800 - 2400	20 - 30 psi (1.4 - 2.1 bar)	1400	24 psi (1.6 bar)
Standard Spring	1400 - 3400	18 - 22 psi (1.2 - 1.5 bar)	2700	19 psi (1.3 bar)
Fine Spring	1600 - 3600	12 - 15 psi (0.8 - 1.0 bar)	3000	13 psi (0.9 bar)
004-921 Monarch	2400 - 4000	11 - 14 psi (0.7 - 0.9 bar)	3600	12 psi (0.8 bar)





HANDPIECE CLEANING

Remove piston & spring from handpiece. Take each, one at a time, and place in a sheet of WRITING or COPIER paper (DO NOT USE paper towel, tissue, or newsprint). Holding it between your fingers (see left) "buff & polish" off any dirt or residue. Folding the paper, use the edge to clean between the piston grooves and the spaces between the spring.

To clean the handpiece inside, take the WRITING or COPIER paper and twist it to a point (see left). Insert the paper point into the handpiece and rotate paper and handpiece against each other. This will "buff & polish" the inside clean.

NOTE: DO NOT LUBRICATE PISTON, SPRING OR BORE.



900 Overlander Road P.O. Box 1153 Emporia, KS 66801 USA

Phone: 1-800-835-3519 Fax: 620-343-9640 Tel: 620-343-1084 e-mail: GRS@GrsTools.com website: www.GrsTools.com

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