Diamond Wire Histo-Saw

Owner's Manual

Model 3241

DDK

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DIAMOND WIRE HISTO-SAW

1.0 DESCRIPTION

1.1 SCOPE

This manual describes the installation, operation and maintenance of the DDK Diamond Wire Histo-Saw. It contains detailed instructions, drawings and listings of specifications, parts and accessories.

1.2 PURPOSE

This precision diamond wire saw cuts materials such as bone, ceramics, glass, precious stones, metals, semi-conductor materials, plastics, nitride, carbide, rubber-like materials etc. both individually and when they occur together.

1.3 APPLICATIONS

The Diamond Wire Histo-Saw is used to cut materials in a variety of applications:

- to produce thin sections of tissue (bones, teeth and implants) in the fields of anatomy, histology and pathology.

- to thin section materials as a preliminary step toward creating electron-transparent areas for electron microscopy examination, i.e. to eliminate grinding and polishing prior to dimpling and perforating.

- to part assemblies at the location of a defect in order to perform testing at the defect, e.g. electronic samples.

- to part assemblies to show contents, i.e. for display purposes.

- to part building components for visual inspection in connection with quality assurance.

- to separate profile sections for the determination of shape, wall thickness and spacing.

- to produce metallographic samples, often possible without embedding and polishing.

- to cut defined indents and recesses on specimens for the determination of the strength parameters of certain materials.

- to saw wafers in the field of electronics for the production of prototypes and job-lots of integrated circuits, etc.

Clearly, the saw can be used for a wide range of highly precise sectioning and parting jobs for a diverse range of materials.

1.4 DESCRIPTION

The DDK Diamond Wire Histo-Saw is composed of two assemblies. The first is a stationary base to which the workpiece is mounted. The second is a movable chassis which rests on the base and carries the motorized diamond wire. Roller bearings under the movable chassis allow it to move by gravity along ways mounted on the base. This motion feeds the moving diamond wire through the stationary workpiece.

The movable chassis holds the wire spool, the wire tensioning device, the variable speed motor, a coolant basin, and electrical controls.

Wire Spool

The wire spool holds 10 m. of diamond wire which moves with a reciprocating motion through the specimen.

Wire Tensioning Device

The wire tensioning device can be fitted in 4 vertical positions, enabling the stability of the diamond wire to be optimally matched to the size of the specimen. The pulley below the drive unit guides the saw wire and also tensions it by means of a weight connected to the pulley. The wire tension can be changed by the removal or addition of weights. If the wire breaks or is excessively extended, the mechanism of the tensioning pulley operates an end switch, which switches off the saw and switches on the "CHECK" signal light.

Variable Speed Motor

The motor speed can be controlled between 0 and 2.5 m. of wire per sec. The drive motor is housed in an anodized aluminum casting and is cooled by a fan. The airstream also prevents impurities from entering the bearings and motor. The motor itself carries the exchangeable wire spool and the guide spindle, which is surface treated to reduce wear.

Coolant Basin

The coolant basin covers the tensioning pulley continuously washing the wire. A stainless steel vessel is supplied as a standard accessory and can be filled with water or other fluid to such a height that the wire is

continually immersed in the fluid. Two spray protection covers prevent the escape of cutting fluid.

Electrical Controls

All electrical control elements are accommodated in one chassis which can be easily removed. The operating voltage is 110 VAC, 60 Hz; the control voltage 24 VAC.

The stationary base holds and orients the specimen with respect to the wire, holds an end-of-cut limit switch and sets the feed force.

Specimen Holder

A grooved table, which is attached to the stationary part of the saw, permits the fastening of any sort of component for holding the specimens. Included with the saw is a micrometer table for precise setting of the specimen thickness or cut location. Coarse setting is possible on the grooved table, with the micrometer table giving a fine setting to within 10 microns. Orientation plates are attached to this table which make it possible to cut the specimen axially or longitudinally. Specimen holders of various types are attached to the plates. These holders are custom-made by Delaware Diamond Knives to suit your specific application and may be in the form of vises, clamps, or dops that grip the specimen or hold it by adhesion (wax or double-sided adhesive strip). This specimen holder assembly can be fastened anywhere on the grooved table - giving plenty of freedom of movement.

Limit Switch

An end-of-cut limit switch is provided for mounting on the grooved table. When actuated, it stops the saw.

Feed Force

The feed pressure is continuously variable by tilting the stationary base. A thumb screw is provided on the front panel which adjusts this tilt to your specification.

1.5 SPECIFICATIONS

Maximum Sample Size:	60 X 85 mm.
Electrical:	110V 60Hz 1ph 5A
Dimensions:	

Saw (b x l x h):	350 x 400 x 44 mm
Net Weight:	22 kg.
Gross Weight:	39 kg.

1.6 PARTS & ACCESSORIES

Each Histo-Saw includes:

micrometer table with vertical bar
mount for axial cutting
mount for longitudinal cutting
spool of wire - 0.30 mm. dia. with 60 micron diamond
post for holding carriage in position during adjustment
110V to 220V transformer with 2 m long power cables
two fuses 800 mA at 250 V (time lag)
24 V telephone bulb
keys for electrical power lock
tool kit

Included accessories:

apparatus for replacing wire on the spool
additional spool of wire
empty wire spools (drums)
specimen holders made to customer's needs
coolant concentrate

Available wire sizes include combinations of:

Wire Diameters 0.13, 0.17, 0.22, 0.30 mm

Diamond Sizes 5, 10, 20, 30, 40, 60 and 80 microns

Standard combinations are:
- 0.17 mm. w/ 30 micron
- 0.22 mm. w/ 30 micron
- 0.30 mm. w/ 40 micron
- 0.30 mm. w/ 60 micron

1.7 THEORY OF OPERATION

The DDK Histo-Saw cuts by moving a wire coated with abrasive diamond particles through a sample. A single strand of wire is used, fastened at each end, with a reciprocal movement. In this way, wire welds are avoided eliminating a weak point in the wire and giving smoother cut surfaces. Gravity is used to

force the wire through the sample through the use of a linear bearing. This applies a constant cutting force throughout the progress of the cut resulting in more predictable cutting times and workpiece temperatures. The tensioning pulley is partially submerged in a water bath providing cooling and cleaning of the cutting wire during use. A micrometer (with 0.010 mm. resolution) moves the sample perpendicular to the direction of cut, providing precise sample location and section thickness control. By varying the wire speed, slope of the saw, and size of diamond wire used, a wide variety of specimen hardnesses can be sectioned as thin as 30 microns.

2.0 INSTALLATION

2.1 UNPACKING & INSPECTION

To remove the shipping container, first remove the eight Phillips head screws around the top of the box. The top of the box can now be lifted off. Remove all the packing material and loose accessories until the box is empty (except for the saw). Grab the saw by both sides and lift out of the box setting it down on its four rubber feet.

Open all envelopes, boxes and packing material and check the parts against the list on the previous page of this manual and the packing list. If anything is missing or you have trouble identifying a part, call Delaware Diamond Knives.

Toss all the packing material back into the shipping container and replace the top using the eight Phillips head screws. If you return the container to DDK we will be able to continue to use it for new saws, repairs and other service for you and our other customers.

2.2 LOCATION SELECTION

The Histo-Saw is a delicate instrument which needs to be handled with care. To insure the best performance, locate the saw on a vibration-free (or as close to vibration-free as possible) table or counter. Bumping the machine or moving the wire while in operation causes problems including wire breakage so try to find a location where traffic is at a minimum.

For best control of feed pressure, the Histo-Saw should be on a level table. The spirit level on top of the instrument is for setting the gravity feed of the saw and is not useful for leveling the instrument. Using a carpenter's level, find a position for the saw where it will be level left-to-right. Use the thumb screw on the front of the saw to level it front-to-back. Now, set the spirit level on the top of the saw to the middle position using the adjusting screw above it.

Many users will place the entire saw in a tray (similar to those used for developing photographic prints) in order to contain any coolant spills or spray.

2.3 POWER REQUIREMENTS

Locate the power cable and make the connection between the female socket on the back of the saw's base and the outlet on the transformer. Plug the transformer into a 110V wall outlet. Locate the keys for the power switch and insert one in the back of the saw's base.

2.4 ASSEMBLY

Two black L-brackets, one on either side of the saw, lift the movable carriage off the linear bearings and clamp the movable carriage to the stationary base during shipping. These bars are removed by loosening the hex-head screws (two on each side) accessible from the top. Save the bars for moving the saw in the future. Leave the hex-head screws accessible from the underside of the saw in place to prevent the sliding carriage from rolling off the bearings to the front or rear or from accidentally falling off the base.

In the tool kit is a cylindrical aluminum part about 1" high. Place this part through the larger hole on the right side of the base of the movable chassis. It will slide into the back groove of the stationary base holding the movable chassis in place. Lifting it slightly will allow the chassis to roll forward for cutting. If you leave it in place, it will drop back into the groove every time you push the movable chassis to the back.

3.0 OPERATION

3.1 LOADING A WIRE SPOOL (DRUM)

The wire is received threaded on a drum ready for use. The wire is wound with a loop of wire for wrapping around the tensioning pulley. Unpack the wire drum carefully to prevent this loop from bending. The two retaining clamps (cotter keys) must initially remain on the drum.

The colored dot on the container for the wire corresponds to the length of the loop provided. The tensioning pulley hinges on bushings located between two bars on the movable chassis. This hinge can be placed in four positions. The shortest position corresponds to the red color, next is yellow, next is green and

the longest is blue. Check that the length of the loop provided matches the position of the hinge. If not, refer to section 3.2.

Remove the covers of the motor and tensioning pulley before installing the wire. Rotate the motor in - first with the motor and then by hand - as far as possible. The drive pin should now be at the top.

Secure the wire drum to the drive motor with the knurled screw until it is tightly clamped. Any wobble of the drum on the end of the motor is unacceptable.

Raise the wire tensioning pulley and thread the wire loop into the groove making sure it is not twisted. Any kinks placed in the wire during this operation make it useless. Gently lower the tensioning pulley until it is supported by the wire loop. Only when the installation is complete can the two retaining clamps be removed.

Now rotate the motor and spool counterclockwise by hand at least three turns away from the mechanical stop. Make sure during this step that the wire unwinds and rewinds into adjoining slots on the spool. If not, use gentle finger pressure to the right or left helping guide the wire into the proper slot. Never raise the tensioning pulley without the retaining clamps in place as the wire will release from the spool becoming hopelessly tangled.

Carefully replace the covers on both the tensioning pulley and spool. Align the slots in such a way that the guards are not cut during the saw's operation. Remember that the front wire will flex as you put pressure on it during cutting.

3.2 CHANGING THE POSITION OF THE TENSIONING PULLEY

Four positions are provided for the tensioning pulley. Optimally, the shortest loop that can accommodate your sample size should be used. Practically, you are limited to the loop sizes that you have in stock and in most cases this will not affect your ability to cut your sample successfully.

Remove the tensioning pulley at its hinge point. Loosen the two locking nuts (one on either end of the hinge) with the socket wrench provided. Remove the two screws about which the hinge pivots with the allen-head screwdriver provided. Remove the cooling tray rest with a flat blade screwdriver.

Select the appropriate position for the tensioning pulley and insert one of the screws. Holding the pulley assembly in place with one hand, insert the other screw in the other side. Now screw them both into place, not tightly. Attach the cooling tray rest (unless you are using the longest loop position) in the position below the tensioning pulley.

Insert the wire loop in the tensioning pulley and follow carefully the alignment instructions in the next section.

3.3 ALIGNING THE TENSIONING PULLEY

When the wire winds and unwinds from the slots on the spool correctly, without binding and without leaving an empty slot, check the alignment of the tensioning pulley. Using a low power hand magnifier, just 2 - 5X, it is easy to check the tensioning pulley alignment. The goal is to be sure that the wire enters and leaves the pulley's slot perfectly vertically.

Visually line up the wire as it enters and leaves the pulley, noting the angle that it makes with the walls of the groove in the pulley. Since the wire will slowly erode the material of the pulley, the object is to have it wear away the center and make the groove deeper. We want to avoid wearing away one of the groove's walls. If the wire enters at an angle, we must move the pulley under the wire.

Loosen the two locknuts, one on either end of the tensioning pulley's hinge, using the socket wrench provided. With the small allen-head screwdriver provided, loosen the screw slightly on the side you want the pulley to move to and tighten the screw on the other side slightly. Recheck the pulley's alignment. Repeat until the wire enters the pulley vertically. The more accurate you can be, the longer your pulley will last.

3.4 MOUNTING YOUR SPECIMEN

While the final method you will use to mount your specimen depends upon what type it is and what your objective is, be sure that it is held firmly. Loose samples can cause the wire to bind and become broken or damaged. Firmly screw the sample to the mounting bars, clamp it in the vise, or wax it to a holder.

Position the micrometer table and clamp it down in such a way that the sample does not interfere with the path of the wire. Raise and lower the sample, twist its mounting and frequently check the clearance until the sample clears both the spool and pulley and will finish cutting before contacting the back length of wire. Be patient until you have it right since an uninterrupted cut is important. While it doesn't matter where the sample first contacts the wire, a location near the pulley or spool is preferred. Position the limit switch on the rightmost end of the table so that it will be activated at the end of the cut (after the wire has completely passed through the sample). Securely tighten all screws and clamps.

Now adjust the micrometer to the end of its range (around 25). Loosen the micrometer table and slide it to the right until the area of the sample you want to cut is in front of the wire. Clamp down the micrometer table once more.

3.5 COOLING TRAY & COOLANT

A coolant is used to remove any heat generated by cutting, to wash away cutting debris and to help keep the wire cutting rapidly. The back wall of the coolant tray fits into a slot under the tensioning pulley hinge and rests against a stop. It is best to fill the tray with coolant after it is in position. Fill only until the bottom of the tensioning pulley is covered and replenish the level as needed when cutting.

Most any fluid can be used as coolant as dictated by compatibility with the sample. Tap water is used most often although various oils (vegetable or synthetic) have been used with water-sensitive samples. A bottle of a typical coolant concentrate is provided and can be used according to the instructions on the bottle.

3.6 POSITIONING THE SAMPLE AND KERF CONSIDERATIONS

The sample position can now be finely adjusted. Keep in mind that the first cut is a facing cut. Now fine-tune the position for your facing cut with the micrometer.

The micrometer is easily read if you keep in mind that each mark on the thimble equals 10 microns. Each mark on the stationary part is equal to one millimeter and two rotations of the thimble make it move by one millimeter.

When sectioning, an amount of material equal to the diameter of the wire (kerf loss) is lost to each cut. In order to get 100 micron thick slices with a 300 micron diameter wire, for example, it is necessary to move the micrometer thimble 40 divisions or 400 microns. Fine tune this movement based upon resulting section thickness measurements as needed.

3.7 SETTING FEED PRESSURE

Lift the retaining pin on the right side of the movable chassis allowing the wire to rest on the sample. Using the thumb screw on the front of the saw, adjust the tilt of the saw until the wire flexes about 1/8” from vertical. This amount of pressure can be increased or decreased based on your experience but best sectioning results are generally obtained with slight pressures.

Push the movable chassis back until the retaining pin drops into place.

3.8 SETTING THE WIRE SPEED

Start the saw by first turning the key in the back. You should hear (and feel) the motor’s cooling fan begin to work. Set the wire speed control to the minimum

position and press the start button. Slowly increase the wire speed control until the wire begins to move. Typically the wire will move more quickly in one direction than in the other. Most cutting can be done with a speed control setting in the 12:00 position. In no case should the motor be run at a speed greater than the 3:00 position.

3.9 STARTING THE CUT

Lift the retaining pin on the right side of the movable chassis allowing the wire to move toward the sample. Control the movement with your hand allowing the wire to rest gently against the sample. After a few moments (30 - 60 seconds), it will be safe to remove your hand and allow the full feed pressure you've set to take affect. This gradual starting of the cut is especially important when sectioning or when entering sloping parts of the sample.

3.10 ENDING THE CUT

The motor will automatically stop when the cut is finished due to the action of the limit switch. If you have cut a thin section, it will normally be attached to the block face by coolant surface tension. Remove it, dry it off, and place it to one side. When pushing the movable chassis back, gently push the wire to the right slightly so that it clears the sample. Move the micrometer the proper distance and direction taking the kerf loss into account. Press the start button and you are ready to start the next cut.

3.11 ENDING A CUTTING SESSION

When finished, turn off the key in the back of the saw to remove power from the motor. Remove your specimen from its mounting. Remove, empty and wipe clean the coolant tray. Wipe up any incidental spills of coolant from on and around the saw.

3.12 REMOVING A WIRE SPOOL

It is usually best to remove the wire if you will not be using it again within a few days. Remove and wipe the splash guards from the spool and tensioning pulley. Turn the spool (motor) completely in clockwise, leaving the drive pin in the vertical position. Place the two retaining clamps on the spool and take the wire out of the tensioning pulley by lifting it slightly. Loosen the spool's knurled screw and the spool will slip off. Keep it safely in the storage tin provided.

4.0 MAINTENANCE

4.1 GENERAL

There are few parts of the Histo-Saw that wear or require frequent maintenance, especially if it is cleaned well between uses. All frequently needed parts are available promptly from DDK and other parts and service are available with minimal delay.

4.2 CLEANING

Cleaning after every cutting session will add to the enjoyment of using the saw and minimize future maintenance problems. Generally, wiping with a clean cloth or paper towels will suffice. If necessary, mild household detergent solutions can be used. Clean the exterior of the saw, the coolant tray, splash guards, mounting hardware and exposed areas of the ways. Cleaning of the wire is not necessary and will help avoid accidental damage (refer to section 4.5). It is not necessary to routinely clean between the saw's sections or inside the motor unless you are working in those areas anyway.

4.3 LUBRICATION

No lubrication of the motor or tensioning pulley is recommended at any time. Unnecessary lubrication will lead to unwanted friction increasing operating temperatures and slowing operating speed. Please don't.

4.4 ELECTRICAL

An Electrical Schematic useful in understanding the operation of the saw and the routing of wires and pin numbers is included in this manual.

While this saw was delivered with a transformer to operate on 115 volts AC as is common in the United States and Canada. This was achieved through the use of a transformer that steps up the voltage inside of the saw to 240 volts AC as is common on the European continent. Therefore be extra careful when servicing this instrument. DISCONNECT THE INSTRUMENT FROM THE POWER SOURCE BEFORE ATTEMPTING SERVICE. Control voltage is a stepped-down 24 volts AC.

The key switch at the rear of the instrument turns on the power. The fan comes on. If the fan is not on:

- examine the fuse block near the key switch. A bad fuse is indicated by a glow of the fuse block cover.

- be sure that the electrical cable plug connecting the motor to the cabinet is properly seated.

Before pressing the on/off button, turn the speed control to zero. Press the on/off button on the top of the instrument and its red indicator will light up. If the "CHECK" light comeson, the motor will not start and the interlocks triggered by end of cut or wire breakage should be examined.

The motor speed control can now be gradually advanced until the motor begins to run. If the motor does not start:

- reset the circuit breaker on top of the instrument

- a loose relay could prevent the motor from starting. They can be reached by removing the four screws of the top panel that contains the speed control, disconnecting the wires from the right side of the chassis and withdrawing the chassis. Be sure that the relays are firmly seated. Relay "RY-1" must be closed before the motor will run.

Relay "RY-2" provides the phase shifting of the motor and logic with the "End of Wire Limit Switches" needed for reversal of the motor's direction.

Fuses are 250V, 2A and can be easily obtained at your local Radio Shack or electronic parts store. We have used up to 5A fuses successfully but fuses with less than 2A capacity should be avoided.

Replacement light bulbs for the three indicators on the top of the movable chassis have been provided in your tool kit. To gain access to the bulb, just remove the lens by pulling it directly up. Replace the bulb and then the lens.

4.5 DIAMOND WIRE

The diamond wire consists of several layers. A high tensile strength stainless steel wire is first coated with copper. Finely graded diamond powder is then mechanically pressed into the copper layer. Finally, several coats of nickel are applied with electroplating to mechanically hold the diamond in place.

No regular maintenance of the wire is required other than care in handling. Kinks in the wire become weak spots and the wire will always break at these points. Have the wire replaced when the cutting rate has slowed noticeably. The life of the wire is difficult to predict because it is dependant upon the hardness of the samples being cut and the care in handling.

If you suspect the wire is losing its effectiveness because the spaces between the sharp diamonds are becoming clogged with debris, the wire can be "dressed" to remove the debris. Take a few cuts of a loose ceramic or "dressing stick" (these can be obtained from DDK) using an excess of coolant. Resume sectioning.

4.6 WAYS

The roller bearings and bars will wear due to contact with cutting debris. Cleaning and/or replacement may be necessary after awhile.

To expose the ways, the movable chassis must be lifted off the stationary base. Start by removing the four hex-head screws from under the chassis. Now lift the chassis and place it behind the base (this allows for the length of electrical wire connecting the two parts).

If cleaning the bars and bearings does not eliminate drag and clicks, they need to be replaced. The bars are press-fit into their grooves. Using a pick or small screwdriver, pry them out from the end. They can then be rotated to expose a fresh area and pressed back into position. Replace with new after one rotation.

The bearings are held in place with a screw and washer and are easily replaced. Once the new ones are in place, the chassis can be lifted back in place on top of the base making sure that the bars are in position between pairs of bearings. Test to be sure that the chassis moves freely on the bars without any hesitation. If hesitation persists, realignment of the bearing might be needed. Two fine screws accessible from the side of the movable chassis align each pair of bearings. Unfortunately, this is a trial-and-error adjustment and so little guidance can be given. Make small adjustments until you notice a change.

4.7 TENSIONING PULLEY

Eventually the groove in the pulley, or one of the pulley walls, will wear sufficiently to need replacement. If the tensioning pulley bounces during operation, replace the pulley.

The old pulley is easily removed by loosening the hex-head set screw in the front of the tensioning pulley holder. The pulley, its bearing and axle are removed and replaced as one piece. Retighten the set screw after replacement. It is especially important that you realign the pulley with respect to the wire after replacement in order to avoid premature wear of your new tensioning pulley.

4.8 BUSHINGS

The pins and bushings that create the tensioning pulley hinge may become damaged during saw movement or worn with use. They should be replaced if the movement of the hinge binds in any way.

Remove the tensioning pulley holder by loosening the lock nuts and pivot screws. Completely remove the screws from the brackets and replace with new.

The bushings in either end of the tensioning pulley holder can be removed with a pick and replaced. Holding the tensioning pulley holder in place with one hand, tighten the pivot screws until they hold it in place. Realign the pulley with respect to the wire.

4.9 MISCELLANEOUS

In this section we have reviewed the most frequent parts needing repair or replacement. Should your needs exceed the remedies offered here, contact DDK for assistance. In many cases, we can talk you through a repair over the phone. In other more serious cases, repair at our shop will be needed. Rest assured that these repairs are given top priority and only in rare cases will we keep your saw for more than one day.

5.0 WARRANTY

Every DDK instrument is warranted to be free from defects in materials and workmanship for a period of one year from the date of delivery. DDK will repair or replace and return free of charge any part which is returned to its factory within said period, transportation prepaid by user, and which is found upon inspection to have been defective in materials or workmanship. This warranty does not include normal wear from use, it does not apply to any instrument or part which has been altered by anyone other than an employee of DDK, nor to any instrument which has been damaged through accident, negligence, failure to follow operating instructions, the use of electric currents or circuits other than those specified on the plate affixed to the instrument, use beyond the specified capacity of the instrument, misuse or abuse.

DDK reserves the right to change, alter, modify or improve any of its instruments without any obligation whatever to make corresponding changes to any instrument previously sold or shipped.

The foregoing obligations are in lieu of all other obligations and liabilities including negligence and all warranties of merchantability or otherwise, expressed or implied in fact or by law, and state our entire and exclusive liability and buyer's exclusive remedy for any claim or damages in connection with the sale or furnishing of goods or parts, their design, suitability for use, installation or operation. DDK will in no event be liable for any special or consequential damages whatsoever, and our liability under no circumstances will exceed the contract price for the goods for which liability is claimed.