From G.E. Research Lab memo ~1952

11.1

A NEW METHOD OF MAKING DIAMOND TOOLS

H. Tracy Hall

It has been found that diamond can be bonded to metal in the same manner that ceramics are bonded to metal. If the diamond is painted with a suspension of fine titanium hydride powder, almost any solder will be caused to wet the diamond. The soldering operation must be carried out in a vacuum or an inert gas.

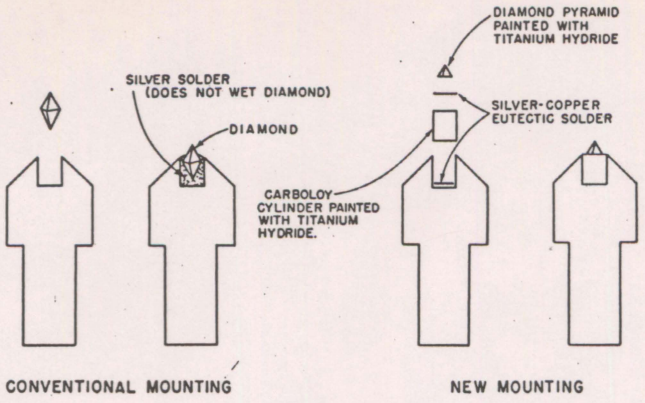

Fig. 1

Several diamond tools have been constructed in the Laboratory, with silver-copper eutectic solder and titanium hydride used to bond the diamond to the shank. One such tool is shown at the right in Fig. 1, for comparison with a conventionally mounted diamond at the left. The conventionally mounted diamond weighs 0.38 carat, a carat being 0.200 gram. The flush-mounted diamond tip weighs only 0.19 carat, yet exposes much more working surface than the diamond in the conventional tool.

Diamond, the hardest known substance, nas the highest unit price of all marketed materials. One-half ton leaves the mines each year to grace ladies' fingers or gentlemen's tie-pins; two tons leave the mines each year to be lost in the world's industrial machines. In industry there are four main fields of application for diamonds: 1) bearings, wear plates, dies, and the like; 2) testing points in measuring and precision instruments; 3) tools for cutting and grinding; 4) tools for the readjustment of tools made from other materials.

Under (4) in this list comes the diamond-pointed grinding-wheel dresser. This tool is used to produce and maintain a desired contour on precision grinding wheels. Some of these machines automatically produce such items as valves and wrist pins for today's automobile engines. The method ordinarily used to fasten diamonds in wheel-dressing tools is purely mechanical in nature. A cylindrical hole is drilled in the tool shank to receive the diamond. Then silver solder or some other metal is melted or sintered in place around the stone. About 80 per cent of the diamond must be buried in the tool to provide a "root" that will mount the diamond securely and also to give adequate heat transfer from the diamond to the metal shank. A phantom view of a diamond octahedron mounted in conventional fashion is shown at the left in Fig. 2. The drawing at the right in Fig. 2 shows the saving that results if just the tip of the diamond is bonded to the shank.

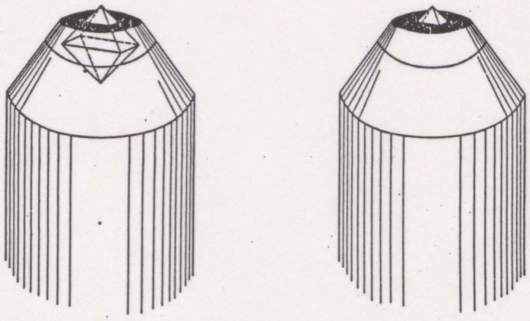

Fig. 2 Phantom view of a conventional mounting of a diamond octahedron (left), and a new mounting of just a diamond tip (right).

Such wheel-dressing tools, with a small 0.20-carat diamond soldered to the tip (cost of the diamond, $3.00), have been tested on the Cincinnati Centerless Grinder in the Laboratory machine shop. The grinding wheel used was 20 inches in diameter and had a four-inch face. The grit was a hard-bond vitreous silicon carbide (Norton 37C54M5V). To dress this wheel, a 3.00-carat

diamond costing at least $150.00 is required when the diamond is mounted in the usual way. A 0.20-carat diamond in conventional mounting is immediately torn from the mount on application to this wheel. The diamond mounted with titanium hydride, however, remains firmly bonded to the shank.

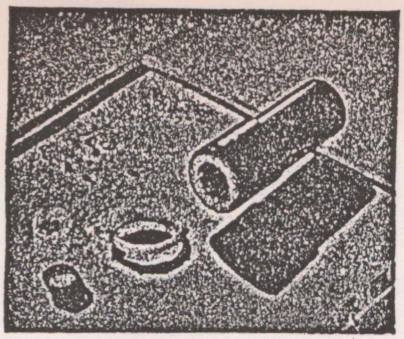

Fig. 3 A coring drill, with diamond grit bonded to the steel, easily cuts through plate glass in one minute.

Another type of tool that has been made is a coring drill, shown in Fig. 3. Diamond grit (200 micron) has been bonded to the steel of the drill with silver solder and titanium hydride. Grit could be bonded to a cutoff wheel or to almost any other surface in the same fashion. Although the wheel-dressing tool and the coring drill are the only two types of tools that have been made in the Laboratory, the use of titanium hydride in mounting diamonds could be extended to any of the many kinds of diamond tools.

The advantages obtained by mounting diamonds with titanium hydride may be listed as follows:

1) Diamonds much smaller than those used in a conventional mounting may be used to give the same size of working tip. Since diamonds increase in price exponentially with size, this means a great saving in diamond costs.

2) The solder wets the diamond. There is an actual metal-to-diamond bond, and the diamond cannot work loose.

3) There is more efficient heat transfer from diamond to holder. Excessive heat damages diamonds. Good heat transfer means a cooler working diamond.