May 16, 1961

F. L. CURTIS

2,984,555

MOUNTED POINTS

Filed April 9, 1958

Fig. 4

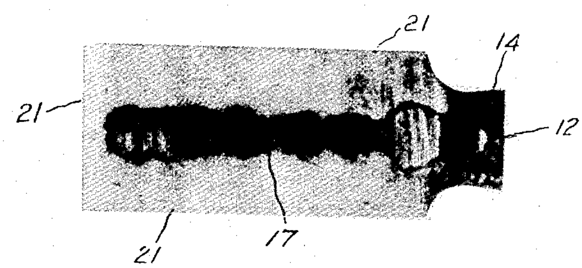


Fig. 1

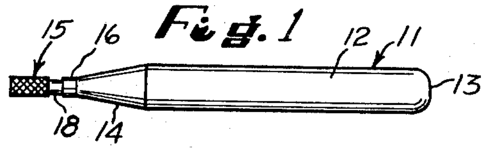


Fig. 2

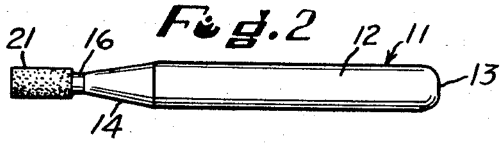
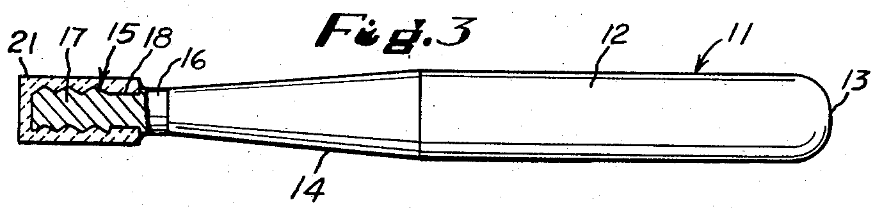


Fig. 3



INVENTOR
FRED L. CURTIS
BY [signature]
ATTORNEY

United States Patent Office

2,984,555

Patented May 16, 1961

1

2,984,555

MOUNTED POINTS

Fred L. Curtis, Worcester, Mass., assignor to Norton Company, Worcester, Mass., a corporation of Massachusetts

Filed Apr. 9, 1958, Ser. No. 727,397

2 Claims. (Cl. 51—309)

The invention relates to mounted points. This application is a continuation-in-part of my co-pending application Ser. No. 628,692, filed December 17, 1956, now abandoned.

One object of the invention is to provide a mounted point for grinding very small bores. Another object of the invention is to provide a grinding wheel for the grinding, lapping, or finishing of small bores and small holes. Another object is to provide a grinding wheel of the type indicated which is inexpensive to manufacture. Another object is to provide a tiny grinding wheel of adequate strength.

Another object is to provide a grinding wheel of the character indicated which holds its size very well. Another object is to provide a small grinding wheel which is satisfactorily efficient in grinding. Another object is to provide such a grinding wheel in the form of a mounted point which gives a good finish to the part ground.

Other objects will be in part obvious or in part pointed out hereinafter.

In the accompanying drawings illustrating my mounted point and the manufacture thereof,

Figure 1 is an elevation of a steel spindle.

Figure 2 is an elevation of the spindle of Figure 1 after the tool portion has been coated in accordance with this invention to produce the completed mounted point,

Figure 3 is an elevation on an enlarged scale of the mounted point of Figure 2 showing the tool portion and its coating in section, and

Figure 4 is a photographic enlargement of a section through the tool end of a mounted point according to the invention.

The term "mounted point" has now for a long time designated a grinding wheel which can be but does not have to be cylindrical and which is mounted on one end of a spindle the shank of which can be clamped in a chuck of a power hand tool such as an electric motor driven hand tool or an air motor driven hand tool. Such mounted points have also for a long time now been used in internal grinding machines by clamping the shank of the spindle in a chuck which is part of the wheel head and is rotated at high speed. These internal grinding machines are precision machine tools. The foregoing explains what I mean by mounted points.

Referring now to Figures 1, 2 and 3, the mounted point comprises a metal spindle **11** having illustratively a straight shank portion **12** with a rounded end **13** for convenient mounting in the chuck of a wheel head or of a power hand tool and, integral therewith, a tapered portion **14**, connecting the straight part of the shank **12** to a tool portion **15** and, as a matter of choice, there may be an intervening portion such as the portion **16** herein shown in Figures 1, 2 and 3 as straight, that is cylindrical.

In an illustrative embodiment of the invention as shown in Figures 1, 2 and 3 the tool portion **15** consists of an originally cylindrical but knurled head **17** and a reduced diameter straight cylindrical portion **18**. All these

2

details can be widely varied so long as the spindle has a shank portion and a tool portion. All portions of the spindle should be rigid with each other and ease of manufacture dictates integrality of structure but interfitting of the shank **11** and the tool portion **17** is not precluded provided a rigid spindle results. Other metals can be used, the requirement of strength and rigidity making steel the preferred metal and the requirement of rigidity as well as the desirability that the spindles shall not readily rust makes the stainless steels preferred. These are nationally identified by numbers and I now prefer No. 410 stainless steel which has been and for some time on a large scale used for mounted point spindles.

Whether or not the tool portion **15** includes a portion **18** of reduced diameter is a matter of choice, although it will be seen that a very fine interlock is provided thereby. It is highly desirable, however, to have, as part of the tool portion **15**, a knurled head **17**. Conventional knurling consists of crisscross threads producing pyramidal elevations and this is highly satisfactory. The knurling operation swages some of the metal outwardly and this is the reason for the reduced diameter portion **18** since the knurling was done on the outer part of the tool portion **15**, but it results in the aforesaid advantageous feature. Equally well, however, the entire tool portion **15** might be knurled. While conventional knurling is highly satisfactory any other substantial deformation of the tool portion as by cutting, stamping, pressing might be adopted.

I also find it advantageous to blast the tool portion **15**. This makes a roughened surface with which the coating **21** hereinafter described can interlock microscopically as it interlocks macroscopically with the knurls. A macroscopically roughened surface is one in which the individual elevations and depressions can be seen with the naked eye. A microscopically roughened surface is one in which they cannot be so seen. Surface blasting produces a surface of the latter kind. As an example of surface blasting I have used with satisfaction No. 25 steel shot ejected from a blast nozzle with compressed air, a process now well known. Another material for blasting which would be very satisfactory is silicon carbide for example of No. 16 grit size, although finer grit sizes could be used and in some cases coarser grit sizes would be satisfactory. A surface having been roughened in this manner will be referred to as a blasted surface.

To the tool portion **15** I now apply a coating of fused abrasive material the major portion by weight of which is fused crystalline metal oxide having a sharp melting point, said metal oxide being metal oxide selected from the group consisting of aluminum oxide, zirconium oxide, titanium oxide and mixtures thereof, which abrasive material is flame sprayed in situ on the tool portion. This coating may be applied in accordance with U.S. Patent No. 2,707,691 granted May 3, 1955, on application of my colleague W. M. Wheildon, Jr. which describes a flame spraying gun for the purpose. Complete information for producing a coating as above defined is set forth in the Wheildon patent. The material is supplied to the gun in the form of rods. These flame spraying guns are on the market and can be procured, for example, from Metallizing Co. of America, Chicago 24, Illinois.

I prefer to use aluminum oxide, Al_2O_3, as the material for the coating **21**. Fused zirconia has recently been found to be an effective abrasive material, see U.S. Patent No. 2,769,699 granted on application of my colleague F. J. Polch on November 6, 1956. This also may be used. Fused zirconia-titania has also been found to be an effective abrasive material, see U.S. Patent No. 2,653,107 granted on application of W. B. Blumenthal on September 22, 1953. Therefore it is certain that fused titanium oxide also can be used. These three oxides are compatible in fact regular grade fused aluminum oxide contains quite a good proportion of titanium oxide. Therefore mixtures of the three or of any two in any proportion can be used.

The rods can be entirely of crystalline metal oxide and thus can be sintered rods of only the oxide or mixtures in question, without any substantial amount of lower melting point material as bond, such as fired clay or glass. On the other hand in order to produce a free cutting wheel, for the portion 21 is a grinding wheel and may have substantial depth as shown, a considerable proportion of clay or glassy bond may be included in the rod resulting in a wheel 21 which has some of the characteristics of vitrified bonded fused alumina wheels. Alumina is synonymous with aluminum oxide, zirconia with zirconium oxide and titania with titanium oxide.

Instead of using a rod spraying gun I may use a powder spraying gun, such as a Metco Thermo Spray Gun manufactured and sold by Metallizing Engineering Company, Inc., Westbury, Long Island, New York. I am not aware of any patent so cannot cite one. This gun sprays ceramic powders of many different kinds, including alumina base, titania base, and zirconia base powders. For many grinding operations a large portion of silicate materials is desirable in the abrasive coating to make it free cutting by erosion of the silicate material, and any abrasive composition which has been found to be useful in the vitrified abrasive art can be applied as a coating with one or the other of the flame spraying guns herein identified. This silicate material can be any of kaolin, ball clay, mixtures of these, glassy frits of any kind and mixtures too, and with the kaolin or ball clay or both and with or without the addition of feldspar, which is a flux or flint which is a hardener. The coating is fused abrasive material which means that it has been fused. Silicates don't have any sharp melting point, but in the guns they are fused to a free flowing condition.

The pure metal oxide material has a sharp melting point and it also is fused in the gun. At least a major portion by weight of the metal oxide component must function as an abrasive, and the test of this is does it have a sharp melting point. Having a major portion by weight of such metal oxide as defined herein the coating is abrasive and can cut metals including hard steels if the harder metal oxides are used such as those mentioned. In most cases aluminum oxide will be preferred except for the grinding of titanium and zirconium and similar metals where zirconium oxide may be preferred, or titanium oxide or mixtures.

A mounted point according to this invention the abrasive of which was substantially pure fused alumina, and which was sixty-five one-thousandths of an inch (65 mils) in diameter was used to grind a hole in a piece of steel which was only of slightly larger diameter. Heretofore a mounted point could not be made with a diameter less than about one hundred one-thousandths of an inch (100 mils). This mounted point was rotated at the high rate of 100,000 r.p.m. This job simply could not be done at all prior to my invention. The grinding rate was quite satisfactory and in a job such as this, a wide variation in grinding time is of little consequence, as the grinding operation only takes a few seconds and setting up time takes a matter of several minutes. And a simple calculation shows that the grinding was done at a surface speed of 1,700 surface feet per minute, which is very slow (6,500 is normal) and a material which will grind at all at this speed had to be a very good abrasive material.

The coating according to this invention is fused abrasive material, as it has been fused in the gun. Flame spraying fuses the material of the rod or it fuses the powder.

As explained in the Wheildon patent aluminum oxide when it becomes the coating 21, is gamma type aluminum oxide. This has not heretofore been known as having high abrasive properties but I have found that it does. The abrasive of the mounted point of Figure 4 is gamma type aluminum oxide without any silicate bonding material. As can be seen from Figure 4 it is dense and would hardly be considered to be a good abrasive material because a good abrasive material was supposed to be necessarily porous. It has heretofore been considered that a monophase non porous material could not be a good abrasive. According to the Wheildon patent the porosity of flame sprayed pure alumina is from 8% to 11% open pores and up to 1% closed pores. This has been considered insufficient for a good abrasive material and therefore it is surprising that the mounted point of this invention should be a good abrasive material. The mounted point which was used in the grinding operation above described was the same as that shown in Figure 4 only smaller. The mounted point of Figure 4 and any made in accordance with the invention has all of the advantageous features mentioned in the objects.

Zirconia as commercially available always contains a minor proportion of hafnia and obviously I use the commercially available material. I have used zirconia stabilized with about 5% of lime. This material, was crystallographically, partly monoclinic and partly cubic, but surprisingly the coatings were found to be 100% cubic. The advantage of stabilized zirconia is that it can be subjected to repeated cycles of heating and cooling without cracking. Zirconia having merely sufficient lime to stabilize it is still referred to as zirconia and where in the claims it is stated that the abrasive material is entirely fused crystalline cubic zirconium oxide, this material is included and the phrase includes the normal variety having a minor portion of hafnia.

Titania (titanium oxide) has been used for flame spraying according to the Wheildon patent. X-ray examination of the titania rods used showed only the crystalline phase rutile. X-ray examination of the coating produced by flame spraying these rutile rods showed three broad lines which identified the material as a hitherto unknown form of titania. This has been christened by the scientists of the manufacturer of rods for flame spraying as gamma titania (gamma titanium oxide). It is nearly amorphous as shown by the broadness of the X-ray lines. It is a good abrasive material, especially when a fine finish is wanted. It is quite compatible with gamma alumina and with cubic zirconia as they are with each other. So also are alpha alumina, monoclinic zirconia and rutile in the rods. It is within the scope of this invention to provide grinding wheels bonded with vitrified bonding material, or with organic bonding material or metallic bond in which the abrasive is gamma alumina or gamma titania, neither ever having been used as abrasive material prior to my invention, and also in such wheels to provide abrasive made out of a mixture of the oxides of aluminum, zirconium and titanium which mixture was never used as an abrasive material before my invention.

A calculation was made to determine the factor of safety of the mounted point whose abrasive portion was .065 inch in diameter. The diameter of the tool portion of the spindle was not known to the calculator, so this was ignored and makes the result a little high but not too much so as centrifugal force increases with the radius. The problem was done in feet and pounds and seconds for centrifugal force and in cubic inches for the mass.

$V^2=Gr$ (centrifugal force equation)

V=velocity in feet per second=1700/60

G=centrifugal force in feet per second at periphery

r=radius of body in feet

Constant of gravity to convert to gravitational units, $g=32$

Then $G=V^2/r$ in feet per second

$G=V^2/32r$ in gravitational units

$G=1700/60\times 1700/60\times 1/32\times 12/.0325$

$G=9{,}260$ in gravitational units g

But this G is the centrifugal force unit in terms of the gravitational unit at the periphery and at the center of the wheel it is zero, so the true multiplier becomes half of the above value which is 4,630.

In calculating tangential stress a diametral band of the material of unit width is taken, of length the same as the diameter, of thickness the same as the radius. The specific gravity of the abrasive material was believed to be 3, and the weight of a cubic inch of water is .036 pound. A cubic inch of this material weighs .108 pound.

But the width of the material (unit) and the thickness of the material cancel out since pounds per square inch tangential stress T is wanted, so the equation becomes:

T=specific gravity $3\times$water factor $.036\times$length $.065$ $\times$multiplier

T=pounds per square inch tangential compressive stress $=32.5$

This is the result that is a little high and the true figure is substantially below 32 pounds per square inch.

The tensile strength of the all aluminum oxide coating has been tested and found to be 800 pounds per square inch. The factor of safety was therefore, in this particular wheel, over 25 to 1 at the speed of 100,000 r.p.m. Obviously much larger mounted points can be made and operated at even higher speeds. The limiting factor will be the grinding stresses rather than the centrifugal force.

It will thus be seen that there has been provided by this invention mounted points in which the various objects hereinabove set forth together with many thoroughly practical advantages are successfully achieved. As many possible embodiments may be made of the above invention and as many changes might be made in the embodiment above set forth, it is to be understood that all matter hereinbefore set forth is to be interpreted as illustrative and not in a limiting sense.

I claim:

1. A small sized mounted point comprising a spindle having a shank portion and a roughened tool portion, a homogeneous abrasive grinding tip portion integral with said tool portion, said grinding tip portion forming the sole grinding element of the tool portion and consisting of a flame sprayed coating deposited in situ on said tool portion and forming the entire grinding surface thereof, and said grinding tip having as an abrasive therein a major proportion of fused crystalline gamma aluminum oxide.

2. A small sized mounted point comprising a spindle having a shank portion and a roughened tool portion, a homogeneous abrasive grinding tip portion integral with said tool portion, said grinding tip portion forming the sole grinding element of the tool portion and consisting of a flame sprayed coating deposited in situ on said tool portion and forming the entire grinding surface thereof, and said grinding tip being formed of an abrasive fused crystalline gamma aluminum oxide.

References Cited in the file of this patent

UNITED STATES PATENTS

1,528,639	Tone	Mar. 3, 1925
2,286,292	Mall	June 16, 1942
2,366,767	Brooks	Jan. 9, 1945
2,428,823	Wright	Oct. 14, 1947
2,535,526	Ballard et al.	Dec. 26, 1950
2,562,587	Swearingen	July 31, 1951
2,653,107	Blumenthal	Sept. 22, 1953
2,707,691	Wheildon	May 3, 1955
2,769,699	Polch	Nov. 6, 1956
2,877,105	Smith	Mar. 10, 1959