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F. FROMHOLT

2,554,901

DIAMOND INDENTER FOR TESTING THE HARDNESS OF METALS

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Fig. 1



Fig. 2

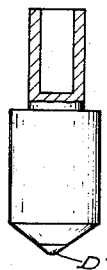


Fig. 3

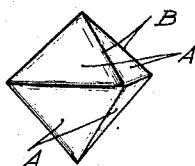


Fig. 4

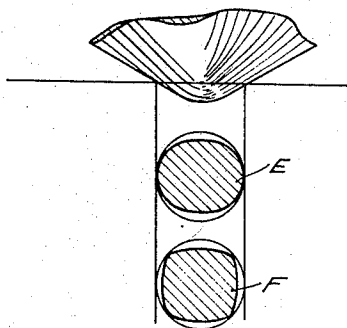


Fig. 5

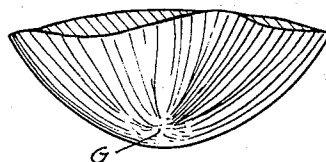


Fig. 6

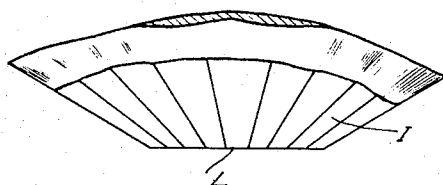
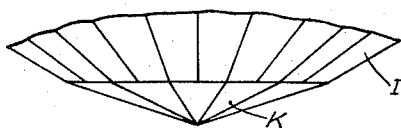


Fig. 7



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DIAMOND INDENTER FOR TESTING THE
HARDNESS OF METALS

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The present invention relates to a new type of diamond indenter for testing the hardness of metals and adapted to be mounted in various known machines utilising such diamond indenters, the hardness being read on a dial, or by micrometric measurements of the diameter of the indentation, according to the particular kind of machine.

The invention is ascertained hereunder with reference to the drawings in which:

Fig. 1 is an elevational view of a known diamond indenter of pyramidal shape.

Fig. 2 is an elevational view of another known diamond indenter of conical shape.

Fig. 3 is an elevational view of a diamond

crystal.

Fig. 4 is an elevational view with the corresponding sectional views of a known diamond indenter.

Fig. 5 are elevational views showing the deformities of known diamond indenters.

Fig. 6 is an elevational view of a first type of indenter according to the invention.

Fig. 7 is an elevational view of a second type of indenter according to the invention.

Diamond indenters hitherto utilised have variable characteristics according to the types of machines and can be divided into two categories: those having the form of a pointed pyramid with a square base, for example as shown in Fig. 1, the diametrically opposite faces of which come at a precise angle, and those of conical form, for example as shown in Fig. 2, with the apex rounded, the angle of the cone as well as the radius varying according to particular circumstances.

In the first case, this indenter, being brittle, is very fragile owing to its pointed and sharp-edged formation, due to the extreme hardness of the diamond. When it is accurately shaped its sensitivity is very great and it enables extremely precise measurements to be effected (especially for metallurgical investigation), on the types of machines for which it is intended, but it can only be utilised with slight loads and requires extreme care and delicate manipulation in operation.

In the second case, the indenter, although brittle, is less fragile but it is very difficult to form the ideally perfect shape.

Actually, a diamond cone can only be formed by a preliminary roughing (turning by abrasion with the aid of another diamond) and then by polishing (metal lap lined with diamond powder). These working conditions are abnormal for the

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reasons hereinafter set forth, but are however the only possible.

This fundamental error may have arisen from the fact that the adaptors of the known steel ball-testing process, who wished to work with a diamond, sought for an ideal geometric form without taking into account the practical possibilities for "working" the diamond.

The process for the rough-forming of this diamond cone at present in use presents the following drawbacks:

(1) The only rough diamond formation possible to which the process is applicable is the formation known as the octahedron or four-pointed, as shown in Fig. 3. Now, this crystal form resists the diamond used for the "roughing," or the polishing disc, when the diamond is turned on its quaternary axis in the roughing and polishing operations, by its alternate comparatively hard parts A and comparatively soft parts B, as a function of the direction of the cleavage planes.

(2) The roughing operation shapes the diamond in circular rotation by the attack of another diamond, without taking account of the direction of the crystal axes which inevitably imparts to the diamond being shaped, independently of a coarse and irregular shaping, flaws or cracks which, though superficial, are so many sources of weakness, ready to break when the load is applied to the indenter.

From these facts, there likewise results, apart from the increased fragility of the diamond, which may result in the breaking of the latter by cleavage at the moment of the compression effort, a lack of precision due to the departure from the theoretically perfect form, produced by the process described and manifested by oval or elliptical sections E, or curvilinear squared sections F (Fig. 4), ogival form G, or flattened, round or other deformity of the point H (Fig. 5).

Local touching-up of the diamond can enable a correct reading for a standard of given hardness to be obtained, but it is very difficult to give rigorously accurate indications to cover the whole range of different hardnesses.

The present invention has for its object to remedy the above-mentioned drawbacks and depends on a new combination of known means and parts, this combination giving a better and more complete result in comparison with diamond indenters of conical types at present utilised.

The invention realises a new type of diamond indenter of an absolutely novel form, this form

being given by utilising the cutting method universally employed which takes into consideration the directions of the crystal axes of the diamond, thus forming a tool of perfect sensitivity and precision, which greatly increases its useful life under normal working conditions.

It is known that to obtain a regular and polished surface a diamond must be cut to take into account the directions of the crystal axes. Now, roughing can only give a coarse and irregular shaping, injuring the crystallisation of the diamond, by the creation of flaws which constitute so many potential breaking points and which polishing cannot remove. It is therefore necessary, to avoid these drawbacks, to proceed by cutting alone and to do away with roughing and circular polishing; however, normal cutting only allows plane facets to be obtained.

Thus, coming between the known case of the acute apex of the pyramid having four faces with sharp edges and forming a fragile whole, necessitating precautions in use and slight loads and the further known case having the rounded point of a polished cone presenting all the irregularities and defects resulting both from the shaping process and the structure of the diamond, according to the present invention a cone, or a regular polyhedral pyramid I is formed (Fig. 6) the extremity of which, and this is the essential characteristic of the invention, instead of having a radius, is formed by a truncation L, so disposed and dimensioned that it will give the same indications in the hardness scales as indenters previously utilised.

The "cone" may be formed by any process or be practically manufactured as a regular polyhedral pyramid, the diametrically opposite faces of which have the required included angle. It may have so many faces that its final form is substantially that of a cone. This form is shown by way of example only in Fig. 6.

The truncation L may be simple (Fig. 6) or complex. The latter is formed by a secondary "cone" K (Fig. 7) having regular faces (regular polyhedral pyramid) with a desired included angle greater than that of the main pyramid.

The diamond thus cut forms a perfectly polished point the indentation of which will take place with little effort in the metal under test by a steady sliding, whence a very high sensitivity.

Irregularities in form, inevitable by roughing and polishing methods, are thus avoided, provided that the cutting is carried out with regularity and precision. The precision of the readings given in the whole range of hardnesses will be a function of the possible exactness of the

shaping. The life of indenters according to the invention will, moreover, be increased by the fact that the diamonds from which they are formed have been cut in the natural directions of the crystal axes and no injury, even superficial, will tend to split the diamond by cleavage at the time the load is applied.

What I claim and desire to secure by Letters Patent of the United States of America is:

1. A diamond indenter for testing the hardness of metals, the operative part of which comprises a diamond cut to the form of a regular polygonal pyramid of comparatively small apex angle and the apex of which is truncated, and a smaller regular polygonal pyramid with a larger apex angle, the base of which matches the truncation of the first pyramid, the axes of the two pyramids coinciding and lying perpendicularly to the plane of truncation of the first pyramid.

2. A diamond indenter for testing the hardness of metals, the operative part of which comprises a diamond cut out to the form of a regular polygonal pyramid of comparatively small apex angle and the apex of which is truncated, and a smaller regular polygonal pyramid with a larger apex angle, the base of which matches the truncation of the first pyramid, the axes of the two pyramids coinciding and lying perpendicularly to the plane of truncation of the first pyramid, the number of sides of the polygonal bases of the pyramids being high enough to produce a substantially conical depression in the metal surface to be tested.

3. A diamond indenter for testing the hardness of metals, the operative part of which comprises a diamond cut to the form of a regular polygonal pyramid of comparatively small apex angle and the apex of which is truncated, and a smaller regular polygonal pyramid with a larger apex angle, the base of which matches the truncation of the first pyramid, the apex of the two pyramids coinciding and lying perpendicularly to the plane of truncation of the first pyramid, the outer cut surfaces of both pyramids being unroughened and unpolished.

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