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PENETRATOR

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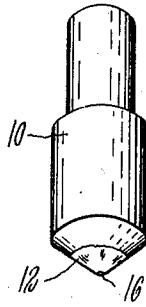
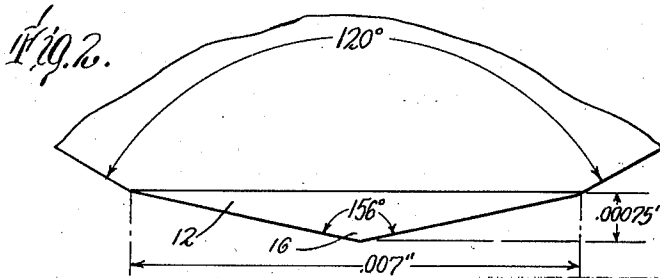


Fig. 1.



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PENETRATOR

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Original application June 10, 1939, Serial No. 278,522. Divided and this application August 7, 1940, Serial No. 351,713

2 Claims. (Cl. 265—12)

This application is a division of my co-pending application Serial No. 278,522, filed June 10, 1939, for "Penetrator." The invention relates to penetrators such as are used to test the hardness of hard materials such as steel. Penetrators of this type consist of a diamond mounted in a holder or stem, the exposed portion of the diamond being shaped as desired to form a suitable penetrating apex. In using a penetrator of this kind, a prescribed pressure is exerted on the holder when the apex of the diamond is in contact with the face of the object under test. The distance of penetration is then measured with great accuracy to determine the hardness of the material in accordance with calculations based on the shape of the penetrating apex. Diamonds with an apex having an angle of 120° have been largely used for this kind of testing as such an angle offers advantageous mathematical results in deriving a chart of progressive hardness numbers.

When such points are used for testing very hard substances such as case-hardened steel or tungsten-carbide, the points are liable to be crushed by the pressures required for sufficient penetration. This difficulty has heretofore been met by rounding the extreme tip of the penetrator or by flattening the tip to a plane face of small area. Penetrators of these kinds could be used on the standard machines with only simple adjustments of the machines being necessary. Such tips, however, have proved unreliable, especially with the very hard materials for which they are particularly designed, as the rounded or flat tips tend to crush rather than to separate the surface particles of case-hardened steel so that the distance of penetration is uncertain and the results are not dependable.

It is the theory of leading metallurgists that hardness is measured by the internal friction of metals during the displacement of deformation of the crystals produced by the penetration of the diamond; in other words, the indent left by the penetrator is referred to as the depth or deformation permitted by the sidewise flow of crystals under pressure. To make an accurate penetration, the flow should start as near the center as possible. This is provided for in my new form of diamond.

According to the present invention, a penetrator is provided that is durable and rugged so that it can be used on the hardest materials, can be used on existing machines with little or no adjustment thereof, and can be used for testing moderately hard materials as well as very hard

materials. To this end the diamond is shaped to form a cone of 120° , but the extreme tip is modified to form a cone of about 156° . This double cone is comparatively rugged, but presents a point to the work for proper penetration.

The most obvious physical process which meets the eye when an indentation is made in a hardness test is the piling up of the material around the edges of the indent. This process is revealed on a ball-pointed cone when the penetration is sufficiently deep and actually takes place only when penetrating "soft" steel or ordinary hardened steel. The depth of penetration, however, is insufficient on extremely hard metals such as tungsten carbide or nitrited surfaces to drive the flow of metal beyond the limits of contact with the ball. On the other hand, such a sidewise and upward flow of metal begins at the point of the 156° cone. In other words, the sidewise flow on the ball point does not occur on a superficial indentation. Hence the pointed 156° cone is far more reliable in determining the hardness of very hard materials.

For a more complete understanding of the invention, reference may be had to the following description thereof, and to the drawing of which Figure 1 is an isometric view of a penetrator embodying the invention.

Figure 2 is an enlarged side elevation of the tip of the penetrator shown in Figure 1.

In testing the hardness of very hard materials such as tungsten-carbide, case-hardened steel or the like, a diamond point is pressed against a surface of the object and the depth of penetration is measured by fine micrometers of high accuracy. For convenience in manipulation, the diamond is embedded in a steel holder which in turn may be removably mounted in suitable apparatus by which force may be applied to press the diamond point against the surface to be tested. A strong support must be provided for the object to be tested to hold it against the impressed force behind the penetrator. Objects to be tested are introduced between the support and the penetrator from the side, whereupon the penetrator is moved down into contact with the object, and pressure is applied. In measuring the surface hardness of the case-hardened object, the penetration must be slight or the accuracy of the measurement will be vitiated by the relatively softer material underlying the hard surface. For this purpose a pointed tip is necessary since a rounded tip tends to crush the hard surface layer and gives unreliable results. Heretofore, pointed tips have been subject to

damage by chipping resulting from the forces imposed on the penetrator when it is in use and by being struck from the side by carelessly inserted work.

According to the present invention, the penetrating tip is shaped in the form of a double cone, the extreme end of the tip having a relatively large angle at the apex. Figure 1 shows a penetrator consisting of a holder 10 in which is embedded a pointed diamond 12. The exposed portion of the latter is shaped to form a 120-degree cone, having at its extremity a second cone 16 with an apex angle of approximately 156°. This flatter cone at the extremity is preferably small, having a base 18 with a diameter of substantially .007 inch. The point end results in proper penetration and the wide angle materially reduces the liability to damage. The small size of the end cone—having a base only about .007 inch in diameter—makes a penetrator available for testing such metals as soft steel or other metals into which the penetrator may be pushed further than the height of the end cone, without recalibration of machines now generally used for hardness testing.

While the preferred angularity of the end cone is 156°, reasonably satisfactory results may be had with end cones with angles varying from 146° to 165°. In other words, the base diameter of the end cone should be at least six times its height, and preferably nine or ten times its height. The resistance to penetration of hard materials depends on the difficulty of pushing granules which compose the material to one side and getting them out of the way of the penetrator. Hardness seems to rest upon the inter-atomic and inter-molecular forces which hold these particles together in a solid. So far as we

know, these are common forces and the overcoming of them is a measure of hardness.

In employing conical penetrators with rounded points, as practiced in the prior art, it was assumed that for all practical purposes the spherical tip could be ignored in so far as it acted as a compressor. As soon, however, as superficial testing came into the field, penetration was limited to a depth so shallow that only a small part of the ball entered, such part having so small an area as to approximate a flat. Nitrited surfaces, when subjected to contact with a ball-point penetrator, tend to develop fine cracks with the result that the surface layer is weakened by these fine cracks and the hardness numbers for the weakened surface are not the same as for the undistributed surface. This condition is minimized by the 156° penetrator by virtue of its sharp point.

It is evident that various modifications and changes may be made in the embodiment of the invention herein shown and described without departing from the spirit or scope thereof as defined in the following claims.

I claim:

1. In a penetrator, a diamond tip shaped to form a double cone comprising a main cone having an angularity of approximately 120° and an end cone at the extremity of the tip having an angularity of about 156° and a base diameter of approximately .007 inch.

2. In a penetrator, a diamond tip shaped to form a double cone, comprising a main cone having an angularity of about 120° and an end cone at the extremity of the tip having an angularity of from 146° to 165° and a base diameter of approximately .007 inch.

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