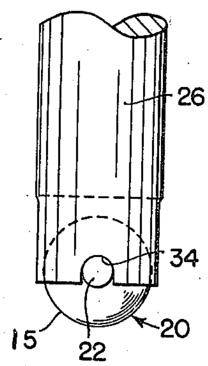
Feb. 24, 1948. C. V. KENT 2,436,435

HARDNESS PENETRATOR

Filed Feb. 26, 1945

FIG. 5



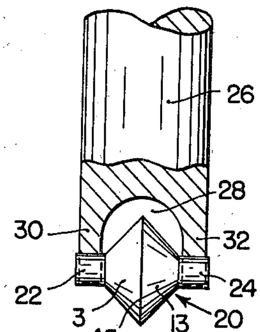


FIG. 4

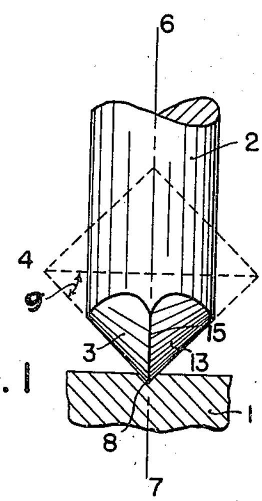


FIG. 1

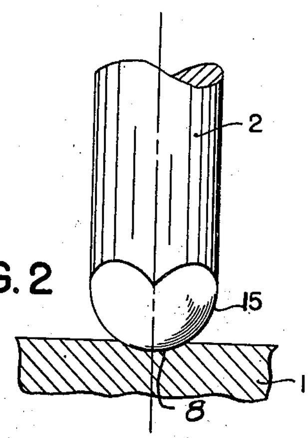


FIG. 2

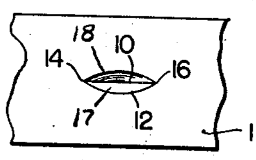


FIG. 3

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HARDNESS PENETRATOR

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1 Claim. (Cl. 73—85)

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This invention relates to the testing of the hardness of materials and more particularly to penetrators or indenters used in the machines by which the hardness of a specimen is tested. Generally a test load of a given magnitude is used to force such a penetrator or indenter against the surface of the specimen whose hardness is to be determined. A dimension of the resulting impression is utilized as an indication of the hardness of the specimen.

Sometimes the depth of the impression made by the penetrator is measured, but more commonly a surface dimension of the impression is used as the basis for the computation of the hardness index of the specimen. Among the best known systems for testing hardness are those using a hardened steel ball referred to as a "Brinell" ball; a 4-sided diamond pyramid whose sides are symmetrical with each other and intersect in four cutting edges having the same angle called the "Vickers" pyramid; and a 4-sided pyramid in which two opposite cutting diagonal edges make a large angle with each other while two other cutting edges in a plane perpendicular to that of the first two make a somewhat smaller angle with each other, known as the "Knoop" pyramid.

Both types of pyramid penetrators permit greater accuracy in reading the size of the impression than the Brinell ball. The Knoop pyramid particularly has certain advantages over the other types of impression, specifically:

1. For the same area of impression the length of the longer diagonal of the impression created by the Knoop pyramid is greater than the length of the diagonal in the Vickers impression. Therefore there will be a relatively smaller observational error in reading the Knoop impression.

2. With some materials the material displaced by the indenter causes a rounded ridge around the impression which makes it hard to secure a correct reading. No such ridge is formed adjacent to the apexes of the angles forming the ends of the longer diagonal of the impression.

3. In materials where the impression contracts after the removal of the penetrator, no contraction takes place on the long diagonal of the impression of a Knoop indenter.

It is an object of the present invention to provide a penetrator for testing machine which retains the aforementioned advantages of the Knoop pyramid but is easier and cheaper to produce than the pyramidal penetrator. To make the readings of pyramidal penetrators conform to an existing standard it is necessary that the four planes be cut to form an exactly defined angle

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between each pair of planes and all the planes must pass through a single point. By contrast there is only a single curved cutting edge, easily generated by existing mechanical equipment, in the penetrator which forms the subject of this invention.

More specifically, the circular cutting edge of the Knoop penetrator may be generated by the intersection of two coaxial cones. In making the test, the common base of the two cones is placed in the line of application of the test load.

In one form of the invention the indenting surface of the penetrator comprises portions of two similar conical surfaces forming parts of two similar coaxial cones, the common axis of the two cones being perpendicular to the direction of the force used to create the impression in a specimen to be tested. Such coaxial conical surfaces can readily be ground by conventional methods on a tool grinder.

It is another object of the invention to provide a penetrator having cutting surfaces of such curved shape as to form a lenticular impression in the specimen to be tested when the penetrator is applied to said specimen.

A further object of the invention is to provide a penetrator having a single circular cutting edge which can be turned about its axis so that successively different arcs of this cutting edge may be brought into play.

A still further object of the invention is to provide a penetrator having a single curved cutting edge which is removably, and preferably turnably, mounted in or on a holder.

Another object of the invention is to provide a penetrator of hardened material which is magnetically supported in a holder of a different composition.

Still another object of the invention is to provide a penetrator which is particularly well suited for performing hardness tests on plastics.

Other objects, features, and advantages of the invention will appear as the description proceeds, reference being had to the accompanying drawings in which:

Fig. 1 shows a front view of the invention.

Fig. 2 is a side view of the penetrator shown in Fig. 1.

Fig. 3 is a plan view of the impression left in the specimen by the penetrator shown in Figs. 1 and 2. The modified form of penetrator shown in Figs. 4 and 5 leaves the same impression.

Fig. 4 is a front view, partly in section, of a modified penetrator.

Fig. 5 is a side view of the modified form of the penetrator shown in Fig. 4.

In Figs. 1 to 3 the numeral 1 denotes a specimen whose hardness is to be determined. 2 is a bar having its lower end ground so as to form two conical surfaces 3 and 13, each of these conical surfaces being part of a cone whose axis 4—5 extends perpendicularly to the axis 6—7 of the penetrator. Since hardness impressions are normally made with the penetrator at right angles to the surface of the specimen, the axis 4—5 will ordinarily be parallel to the surface of the specimen 1. The two conical surfaces 3, 13 meet in an arc 15 which forms the single cutting edge of the penetrator. Cones 3, 13 may be formed with any one of several angles 9, depending upon the angle most suitable for indenting the particular type of material. In Figure 1 this angle 9 is shown as approximately 45° but it may be selected to suit the hardness and characteristics of particular types of specimens to be tested. In general, the softer the specimens, the larger will be the angle chosen.

As will be seen from the drawing, the penetrator has two planes of symmetry, one being defined by the axes 4—5 and 6—7 and the other being perpendicular thereto and containing axis 6—7. There is no cutting edge in the first-named plane of symmetry, the only cutting edge 15 being situated in said second plane perpendicular to the axis 4—5. The shape of the cutting edge 15 is that of an arc of a circle. Any section taken through the active (conically ground) portion of the penetrator parallel to said last-named plane of symmetry is delimited by a circular curve having its center on the axis 4—5. The section taken through the other plane of symmetry, that is, the plane containing axis 4—5 as well as axis 6—7 is of V-shape with the sides of the V straight lines.

If the penetrator shown in Figs. 1 and 2 is forced against the specimen 1 so that the cutting edge 15 penetrates the specimen as shown at 8, the impression made will be of lenticular shape. The lenticular figure 12 shown in Fig. 3 is bisected by the longitudinal line 10 created by the cutting edge 15 and the side walls 17 and 18 of this impression are curved surfaces corresponding to small portions of the conical surfaces 3 and 13 of the penetrator. At each of the two ends 14 and 16 of the lenticular figure 12 the sides of the latter and the line 10 join in a single point which can be readily observed, such as by a microscope. The distance between the points 14 and 16 will be used as index of the hardness of the particular specimen tested.

It has been found that the hardness readings obtained by the use of the double-cone penetrator described bear in fixed relation to the readings secured by other penetrator systems, in particular by the systems using pyramidal penetrators. This permits the use of a conversion factor that permits the comparison of readings obtained under this system with those obtained under other systems.

The body on which the conical surfaces 3, 13 are formed may consist of hardened steel. In some cases it may be advisable to tip the steel bar 2 with a particularly hard material, such as "Carboloy," and to grind the conical surfaces 3, 13 thereon.

In the modification shown in Figs. 4 and 5 the penetrator proper, generally indicated at 20, is again of double conical shape, but instead of being formed in one piece with the shaft 2 as in the example of Figs. 1 and 2, it is in the form of a roller which is mounted on a separate holder 26. The roller 20 of double frusto-conical shape presents again the two conical surfaces 3, 13 and the single circular cutting edge 15 in which these two surfaces meet. While the roller 20 may be supported in the holder 26 in any desired manner, it is preferably rotatably mounted in or on said holder. In the example shown the roller 20 carries two studs 22, 24 which extend on both sides of the roller coaxially with the common axis of the two cones 3, 13. The holder 26 is fork-shaped having two downwardly extending prongs 30, 32 in which the studs 22, 24 find their bearings and which leave between themselves an opening 28, into which the roller 20 projects. With this arrangement the roller 20 may be rotated from time to time to bring into play new indenting surfaces corresponding to a new section of the cutting edge 15, whereby the useful life of the penetrator may be greatly prolonged.

It will be obvious that, if only a rotatable mounting of the roller 20 relative to the holder 26 is desired, this may be achieved also in various manners different from the one shown in Figs. 4 and 5, such as by proviidng the roller 20 with one or more axial bores and have this roller supported by two studs or by a shaft formed integral with, or secured to, the holder 26 so that the wheel may turn on said studs or on said shaft. The arrangement shown in Figs. 4 and 5, however, wherein the studs 22, 24 form part of the roller 20 and the holder 26 has two slots 34 which are open at their lower end so that the studs may be slipped into these slots from below, is very convenient for the reason that it lends itself readily to holding the penetrator in place solely by magnetic means without the necessity of any mechanical retaining members. If the holder 26 is magnetized and of the penetrator at least the studs 22, 24 are of magnetizable material, the latter will be attracted magnetically into the slots 34 and retained therein as soon as the studs 22, 24 of the roller 20 are brought reasonably close to and below the slots 34 in the holder 26.

A further advantage of this arrangement is that one penetrator can readily be exchanged for another having a different angle and the substitution of the one penetrator for the other in the holder is only a matter of seconds.

Roller 20 may be of hardened steel, its symmetrical form lending itself readily to hardening.

One of the advantages of this system is that it permits the selection of the proper size of roller and the proper cone angle that is best adapted to the general type of specimen that is to be tested. In particular it has been found that a double-cone penetrator of the proper size and angle gives better results in the testing of plastics than those systems of hardness testing that were primarily developed for use on metals. The chief reason for the superior performance of the double-cone penetrator is believed to be the reduced tendency to distortion and recovery of a lenticular impression which has curved walls. Especially near the two end points 14 and 16 of the curved line 10 in Fig. 3 the distortion does not exist while the material is distorted by the flat sides and numerous angles of the other indenters.

What I claim is:

A penetrator for hardness testing machines adapted to make a lenticular impression, comprising, in combination, a hardened piece whose cutting edge is formed by the intersection of two conical surfaces, means for loading any part of said circular cutting edge, said means including bearings on the axis of said cones and a shank having bearing surfaces so spaced as to transmit an axial load from the shaft axis to the specimen along a diameter of the circular cutting edge which is normal to the specimen.

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