

A DEPTH GAUGE

FIELD OF INVENTION

5 The present invention broadly relates to a depth gauge and to use of the depth gauge for measuring a depth of a recess.

BACKGROUND

10 A depth gauge is a measuring device used for determining a depth of a groove or a bore in a machined part. There are mechanical and electronic types of depth gauges readily available in the market and they are used in a wide range of industries. For example, a vernier height gauge, which has a vernier scale (a mechanical height gauge) or a digital readout (an electronic height gauge), can be
15 used obtain the depth of a milled slot in great accuracy (i.e., up to 0.01mm). Often, the term depth gauge and height gauge are inter-changeably used depending on situations.

 A depth gauge typically has a slide assembly attached to a supporting base.
20 The slide assembly further comprises an elongated guide with a straight slot for holding a slidably engaged probe in rod form. The supporting base has a flat surface at the bottom for residing on a surface as reference and the bottom surface is perpendicular to a sliding direction of the probe. To measure the depth of a groove below a surface, the supporting base is placed upon the surface for
25 reference and the probe protrudes out of the guide to reach the groove. The distance of translational sliding movement of the probe can be read out via a scale marked on the guide, as depth.

 In the typical depth gauge, sliding movements of the probe requires
30 substantial amount of length along the guide for wide measurement range. The sufficient lengths of the guide and probe is also important for the guide to hold the probe with sufficient friction and tolerance for depth measurement to be accurate and consistent. However, there are confined places where only a short length is

permitted for a guide assembly of a depth gauge. For example, it is difficult, if not impossible, to measure a depth of a groove on a sidewall of a bore with a diameter of about 30mm or less. In other words, a traditional depth gauge is too large and awkward for applications with some space constraints.

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In other situations where a machined part is much smaller than the base of a depth gauge or a reference surface is inside a confined area preventing the base of a depth gauge to be attached, a conventional depth gauge is unsuitable for obtaining a depth for the machined part.

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To measure depth in a confined place unsuitable for conventional depth gauges, a technician can apply plasticine to a groove in the confined place and take a moulded plasticine part out of the confined place. The depth of the groove is measured outside on the plasticine mould because the moulded plasticine has already been shaped to duplicate the profile of the groove. However, great care needs to be taken to clean off the groove after the plasticine moulding process and the technician also has to re-orientate the removed plasticine mould to ensure correct alignment with respect to the groove inside the confined place. In the process of taking the plasticine mould out of the confined place, extra caution needs to be taken for not disturbing the mould. Furthermore, in the case where many such plasticine moulds are made for multiple grooves inside a confined place, a mix-up of multiple plasticine moulds can result a complete failure in depth measurement. Such failure is unacceptable for measuring some critical components used e.g. in an aircraft because judgement calls have to be made frequently for either replacing or keeping a part in an aircraft structure depending on the depth measured. If a faulty part with an unacceptable depth is not replaced and kept inside the aircraft structure for further flights, crews and passengers' lives are in potential danger.

Despite the fact that a plasticine mould can duplicate a dent with 0.25 mm depth, it is strenuous and generally inaccurate to measure a plasticine mould for duplicating a spherical dent with such a small depth. Therefore, the currently adopted method of using plasticine mould is both imprecise and time consuming.

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A need therefore exists to provide an apparatus and a method to address at least one of the above problems.

SUMMARY

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In accordance with a first aspect of the present invention there is provided a depth gauge comprising first and second elongate members pivotally coupled to each other for relative rotary movement between the first and second members; a reference portion formed on the first member; a tip portion formed on the second member; wherein the tip portion is disposed on the second member such that the tip portion extends substantially tangentially with respect to the relative rotary movement between the first and second members

The first and second members may each comprise first and second elongate material sheet blades respectively.

The reference portion may comprise one long edge of the first blade.

The tip portion may be formed at one end of the second blade, and the second blade is pivotally coupled to the first blade at a pivotal joint at the other end of the second blade.

The gauge may further comprise releasable locking means for locking the first and second members relative to each other.

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The releasable locking means may comprise frictional contact between the blades.

The locking means may comprise a pivotal joint member for the pivotally joining of the first and second members.

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The joint member may comprise a bolt and screw pair or a rivet.

The first and second members may be made from tool steel or stainless steel.

A depth marking may be provided on at least the first or second members.

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In accordance with a second aspect of the present invention there is provided a depth gauge comprising first and second elongate members having substantially a same width and coupled to each other for linear movement between the first and second members; a reference portion formed on the first member; a tip portion
10 formed on the second member; wherein the tip portion is disposed on the second member such that the tip portion extends in a direction substantially parallel to and off-axis from a longitudinal axis of the second member.

The reference portion may be substantially perpendicular to the longitudinal
15 axis of the second member.

The first member may comprise an elongated sheath for receiving the second member therein, and the reference portion comprises an short edge of the sheath at one end of the sheath.

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The sheath may comprise a C-shaped channel.

The second member may comprise an elongated material sheet blade, and the tip portion is formed at one end of the blade.

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The blade may further comprise releasable locking means for locking the first and second members relative to each other.

The releasable locking means may comprise frictional contact between the
30 first and second members.

The first and second members may be made from tool steel of stainless steal.

Co-operating depth markings may be provided on the first and second members respectively.

5 In accordance with a third aspect of the present invention there is provided a use of the depth gauge as defined in the first aspect for measuring a depth of a recess.

10 In accordance with a fourth aspect of the present invention there is provided a use of the depth gauge as defined in the second aspect for measuring a depth of a recess.

The recess may comprise a groove formed on a sidewall of a bore.

15 The bore may be formed in a barrel nut.

BRIEF DESCRIPTION OF THE DRAWINGS

20 Embodiments of the invention will be better understood and readily apparent to one of ordinary skill in the art from the following written description, by way of example only, and in conjunction with the drawings, in which:

Figure 1 shows an embodiment of a rotary depth gauge;

Figure 2 shows the rotary depth gauge measuring a blend-out on an internal sidewall of a barrel nut;

25 Figure 3 shows an embodiment of an edge depth gauge; and

Figure 4 shows the edge depth gauge measuring a blend-out on an internal bottom wall of a barrel nut.

DETAILED DESCRIPTION

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Referring to Fig. 1, a depth gauge (100) has two blades (106, 102) formed by stainless steel plates, which may also be termed as a rotary depth gauge. The two blades (106, 102) take generally elongated rectangular forms and are pivotally joined by a rivet (104) at their ends. The larger blade, which is called guide blade (102), has an

elongated smooth and straight edge (112) at a longer side. The straight edge (112) is used for guiding the gauge (100) when the gauge is pushed against a reference surface for measuring depth. The smaller blade is called point blade (106) which has a pointed tip (110) branched out at a remote end of the pivot joint (104). The pointed tip (110) on the extension (101) serves as a probe for contacting an intended location and it is sharp at its end (110). The sharp end (110) is rounded off for preventing scratching a measured location. The lower edge (107) of the point blade (106) is held above the guide edge (112) when two edges (107, 112) are aligned parallel pointing towards the same direction. This is because the point blade (106) is prevented from touching the reference surface for depth measurement when the guiding edge (112) is already resided on the reference surface. The distance (105) from the pointed tip (110) to the pivot (104) of the point blade (102) is substantially the same as the distance (109) from the remote edge (111) to the pivot (104) of the guide blade (102).

The two blades (106, 102) are permitted to rotate around (108) the pivotal joint (104) in a 360-degree circle and the blades (106, 102) can maintain their respective positions once an external rotational force is removed. This is because the two blades (106, 102) are tightly joined contiguous together at the pivotal location by a rivet (104). As a result, the two blades (106, 102) exert frictional force to each other as their bodies contact and the frictional force prevents any relative movement between the blades (106, 102) unless an external strong rotational force is exerted to the blades (106, 102), such as by a finger's push during measurement or alignment. Alternatively or additionally, releasable locking means in the form of e.g. a screw and bolt pair may be provided as the pivotal joint between the two blades (106, 102).

Referring to Fig. 2, the depth gauge (100) is placed into a bore (203) with 30mm internal diameter of a barrel nut (202) and the central longitudinal axis of the cylindrical barrel nut is indicated by a dash-dot line (204). The barrel nut (202) is sectioned in the middle for exposing measuring conditions of the depth gauge (100). The barrel nut (202) has a dent, termed as blend-out (207) on the internal cylindrical sidewall (208). This type of blend-out is commonly found in barrel nuts for joining horizontal stabilisers of a Boeing's 747 to the aircraft's tail. The blend-out is formed by an electrolysis process during flights in high altitudes because of condensed water collected inside the bore (203) of the barrel nut (202).

To obtain the depth (206) of the blend-out (207), the depth gauge (100) is inserted into the narrow cylindrical chamber (203) and the guiding edge (112) is pushed against the internal wall surface (208). The point blade (106) is further pivoted (108) to reach a nadir of the blend-out (207) by the pointed tip (110). Consequently, the pointed tip (110) shifts and sets below the guiding edge (112) and contacts to the blend-out (207). Subsequently, the depth gauge (100) is taken out of bore (203) and the distance between the pointed tip (110) and the guiding edge (112) is measured by a vernier gauge for obtaining the depth (206) of the blend-out.

If a blend-out is formed at an edge on an internal bottom wall of a barrel nut, another depth gauge (312) is implemented for attaining the depth of the blend-out, which may also be termed as an edge depth gauge. Referring to Fig. 3, an edge depth gauge (312) is provided with two parts (300, 308). In Fig. 3 (a), a first part of the depth gauge (312) is a sheath (300) formed by a piece of stainless steel sheet with two sides (302) folded back in so that a C-shaped channel (307) is provided by the enclosing walls (306, 302). The channel (307) opens at both ends (305, 304) as shown in the side view (b), which corresponds to the front view (a). Two parallel ends (305, 304) of the sheath (300) are made to be direct and even. The C-shaped channel (307) is substantially perpendicular to both the ends (305, 304).

A second component of the edge depth gauge (312) is an edge blade (308) as shown in Fig. 3 (c) which has a pointed head (310) at an end of the elongated edge blade (308). Fig. 3 (c) shows a front view of the edge blade (308) made from a stainless steel sheet and Fig. 3 (d) shows a corresponding side view of the edge blade (308). The edge blade has a substantially same width as the width of the channel (307) such that the edge blade (308) is only permitted to move longitudinally inside the channel (307).

To assemble the sheath (300) and the edge blade (308), the edge blade (308) is inserted into the C-shaped channel (307) from an open end (305) of the sheath (300) and is held tightly inside the sheath (300) as shown in Fig. 3 (e). The C-shaped channel (307) clutches the edge blade (308) tightly so that the edge blade (308) is enabled to slide (314) inside the sheath (300) with some frictional resistance. The frictional resistance comes from the clutching walls' contact (302, 306) against the inserted edge

blade (308). Referring to Fig. 3 (f), gaps between the sheath (300) and the edge blade (308) are provided for clearer illustration and there is adjoining contact between the sheath (300) and the edge blade (308) in the actual edge depth gauge (312).

5 Referring to Fig. 4, the edge depth gauge (312) is inserted into a bore of a barrel nut (402) to measure the depth (406) of a blend-out (408) on an internal bottom wall surface (410) at a corner. The bore of the barrel nut (402) has a diameter (404) of 30mm. Before reaching the bottom wall surface (410), the probe blade (308) is retracted into the sheath (300) so that only the direct and even guiding edge (304) of the sheath
 10 (300) touch the bottom surface (410). The end surface (304) is pushed against the bottom surface (410) of the barrel nut (410). The pointed tip (310) of the probe blade (308) is then pushed forward to protrude beyond the end surface (304) for reaching a nadir of the blend-out (408). A proper position of the depth gauge (312) is attained when the end surface (304) stands on the bottom surface (410) seamlessly which makes the
 15 edge blade (308) substantially vertical with respect to the bottom surface (410) to set a reference for depth measurement. Subsequently, the edge blade (308) is pushed from the other end (305) to touch the nadir at the pointed head (310). Upon proper contact, the edge depth gauge (312) is taken out of the bore (402) and the distance between the pointed head (310) and the end surface (304) is measured by a vernier calliper. The
 20 reading is taken as the depth (406) of the blend-out (408).

An additional function is provided to further facilitate the convenience of depth measurement in constrained places. Referring back to Fig. 1, scale markings (105) are provided on the guide blade (102) for depth reading without the need of an additional
 25 ruler, such as a vernier calliper. A crossing point at two edges (107, 112) of the blades (106, 102) can be used to indicate the depth reading based on these markings (104).

A similar function is also provided to the edge depth gauge (312). Referring back to Fig. 3, scale markings are provided on both the sheath (300) and the edge blade (308). On the sheath (300), there is a plurality discrete scale markings (303) for depth
 30 indication. On the edge blade (308), only a single line marking (309) is made available for indicating a relative position of the edge blade (308) with respect to the sheath (300) when assembled. As the edge blade (308) moves to a particular position during depth measurement, the respective positions between the markings (303, 309) give the depth

readings. As a result, no external ruler is needed which prevents further measurement error and keeps consistency of the measurements.

5 It will be understood that both the rotary depth gauge (100) and the edge depth gauge (312) do not require using plasticine for moulding a blend-out. Therefore, technicians do not have clean up a bore after depth measuring using these gauges (100, 312). These gauges (100, 312) can be inserted into and removed from a bore quickly which saves time for operations, especially for repetitive routine checking. There is little danger of damaging the profile of a blend-out with these gauges (100, 312) because the
10 pointed tip/head (110, 310) are rounded off. More reliable and consistent depth readings are made possible in confined places, with or without scale markings on the gauges (100, 312). A direct depth measuring (without using plasticine moulds) avoids potential confusions caused by multiple plasticine moulds.

15 It will be appreciated by a person skilled in the art that numerous variations and/or modifications may be made to the present invention as shown in the specific embodiments without departing from the spirit or scope of the invention as broadly described. The present embodiments are, therefore, to be considered in all respects to be illustrative and not restrictive.

CLAIMS

1. A depth gauge comprising:
first and second elongate members pivotally coupled to each other for
5 relative rotary movement between the first and second members;
a reference portion formed on the first member;
a tip portion formed on the second member;
wherein the tip portion is disposed on the second member such that the tip
portion extends substantially tangentially with respect to the relative rotary
10 movement between the first and second members
2. The depth gauge according to claim 1, wherein the first and second members
each comprise first and second elongate material sheet blades respectively.
- 15 3. The depth gauge according to claim 2, wherein the reference portion
comprises one long edge of the first blade.
4. The depth gauge according to any one of the preceding claims, wherein the
tip portion is formed at one end of the second blade, and the second blade is
20 pivotally coupled to the first blade at a pivotal joint at the other end of the second
blade.
5. The depth gauge according to any of the preceding claims, the gauge further
comprising releasable locking means for locking the first and second members
25 relative to each other.
6. The depth gauge according to claim 5, wherein the releasable locking means
comprises frictional contact between the blades.
- 30 7. The depth gauge according to claims 5 or 6, wherein the locking means
comprises a pivotal joint member for the pivotally joining of the first and second
members.

8. The depth gauge according to claim 7, wherein the joint member comprises a bolt and screw pair or a rivet.

9. The depth gauge according to any one of the preceding claims, wherein the first and second members are made from tool steel or stainless steel.

10. The depth gauge according to any one of the preceding claims, wherein a depth marking is provided on at least the first or second members.

11. A depth gauge comprising:
first and second elongate members having substantially a same width and coupled to each other for linear movement between the first and second members;
a reference portion formed on the first member;
a tip portion formed on the second member;
wherein the tip portion is disposed on the second member such that the tip portion extends in a direction substantially parallel to and off-axis from a longitudinal axis of the second member.

12. The depth gauge according to claim 11, wherein the reference portion is substantially perpendicular to the longitudinal axis of the second member.

13. The depth gauge according to claim 12, wherein the first member comprises an elongated sheath for receiving the second member therein, and the reference portion comprises an short edge of the sheath at one end of the sheath.

14. The depth gauge according to claim 13, wherein the sheath comprises a C-shaped channel.

15. The depth gauge according to any of the claims 11 to 14, wherein the second member comprises an elongated material sheet blade, and the tip portion is formed at one end of the blade.

16. The blade according to any of the claims 11 to 15, further comprising releasable locking means for locking the first and second members relative to each other.

5 17. The depth gauge according to claim 16, wherein the releasable locking means comprises frictional contact between the first and second members.

18. The depth gauge according to any of claims 11 to 17, wherein the first and second members are made from tool steel or stainless steel.

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19. The depth gauge according to claim 11 and 18, wherein co-operating depth markings are provided on the first and second members respectively.

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20. The use of the depth gauge according to any one of claims 1 to 10 for measuring a depth of a recess.

21. The use of the depth gauge according to any one of claims 11 to 19 for measuring a depth of a recess.

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22. The use according to claims 20 or 21, wherein the recess comprises a groove formed on a sidewall of a bore.

23. The use according to claim 22, wherein the bore is formed in a barrel nut.

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