

SPECIFICATION Thread Gauge

This invention relates to gauges for the accurate measurement of relatively large screw threads and particularly to a gauging tool for measuring pipe threads which may have progressively varying pitches and widths along their helical lengths.

Most present day pipes are provided with a tapered "V-type" thread externally cut on each end of the pipe for mating with an identical but internal thread in a pipe coupling or "box end" of an adjacent pipe. While adequate for conveying most common fluids at relatively low pressures, pipes, having V-threads are not particularly practical when it becomes necessary to thoroughly seal each joint against high internal pressures because the V-threads, when tightened to seal against leakage, create banding forces which tend to shrink the pin end having the external thread and to expand the box end having the internal thread. The pipe joint is thus forced open and the high internal pressures may force the contained fluids through the joint, thereby resulting in failure of the pipe joint.

U.S. patent no: 3,989,284 discloses an improved pipe connection which employs threads having a dovetail cross section with a greater width at the outside diameter of the thread than at its root so that when inter-engaged threads are tightened, the box member with the internal thread is hoop-compressed and the pin member is forced into hoop tension, thus providing a rigid, sealed connection. To produce such a dovetail inter-lock between internal and external threads and to further improve the inter-locking capabilities of the joint, each thread is carefully cut with a gradual taper along its helical length. During the joining operation, the junction of the two pipe members will be quite loose until the mating threads tightly inter-connect by the action of both the transversely dovetailed and longitudinally-tapered thread wall profiles. The rigid seal connection of the described threads thereby renders pipes so equipped suitable for use as well casing or for transporting high pressure, dangerous fluids which may result in serious damage if permitted to leak into the environment.

It is apparent that the above-described threads must be accurately cut and it therefore follows that the varying pitch dovetail threads must be precisely gauged during the quality control step of production. It is a simple operation to measure accurately the dovetail angle between the root diameter and the thread flank wall. The accurate measurement of thread width and pitch distance along the axial length is a more complex measurement, and to make this measurement accurately within the 0.0001 inch tolerances required, it has heretofore been necessary to hand gauge the threads, a very slow and costly production step.

According to the present invention, a tool for gauging thread pitch and width at a succession of

turns of a screw thread in the end of a pipe comprises a base element provided with a clamping arrangement for clamping the element to the pipe in such a way that a flat guide surface on the element is parallel with the longitudinal axis of the pipe and is spaced from the threaded surface of the pipe, a slidable member co-operating with the guide surface so as to be capable of movement in a direction parallel with the longitudinal axis of the pipe, the slidable member carrying an arm of which one end is pivoted to the member and which is fitted with a gauge pin so located in relation to the pivot of the arm as to overlie the thread in the pipe and be capable of insertion within said thread and measuring means for measuring the relative displacement between the base element and the slidable member. Such a tool permits accurate measurement of thread pitches and widths which vary along the helical length of a square or dovetail pipe thread.

Examples of thread gauge in accordance with the invention will now be described with reference to the accompanying drawings, in which:—

Figure 1 is a perspective view illustrating a thread gauge in position to measure external pipe threads;

Figure 2 is a longitudinal sectional view of the thread gauge and pipe illustrated in Figure 1;

Figure 3 is a perspective view illustrating a second form of gauge for measuring internal pipe threads; and

Figure 4 is a graph representing a typical pipe thread "unwrapped" from the circumference of the pipe.

The thread gauge 10 shown in Figure 1 is clamped to the externally threaded end 28 of a pipe 12. Thread gauge 10 includes a toggle clamp 14 which is locked by squeezing together the manually operated handles 16 and released with an unlocking trigger 18. The upper jaw of the clamp 14 is welded to a U-shaped end stop 20 having a flat surface 22 which is perpendicular to the axis of the pipe 12 and which provides a locating surface against which the threaded end of pipe 12 is registered. Upper arms in the end stop 20 rigidly support a pair of cylinders 24 and 26 which locate the gauge relative to the axial centre line of the threaded portion 28 of the pipe 12. The clamping member is provided by a cushioned spindle 30 positioned in the end of the lower jaw 32 of the clamp 14 and located opposite cylinders 24 and 26. This spindle can be adapted to various pipe diameters by means of adjustment nut 34.

Cylinders 24 and 26 each have a length which is slightly less than the length of the thread 28 and, if necessary, may be replaced with longer or shorter pairs of cylinders by removal of bolts 36 which fasten the cylinders to the end stop 20. Bolts 36 extend through the axis of the cylinders 24 and 26 to fix a slide base 38 to the ends of cylinders 24 and 26. Slide base 38 includes an inverted U-shaped member 40 which receives the bolts 36, and has a centre portion which is

relieved to clear the pipe 12 and threads 28 in order to permit the cylinders 24 and 26 to make proper contact. Slide base 38 lies adjacent to but not touching the surface of pipe 12 and in a plane parallel to the longitudinal axis of the pipe.

A linear slide assembly 46 runs in a dovetail track in the slide base 38 in a plane parallel to the longitudinal axis of the pipe 12 and has, on the end furthest from the pipe end, a pivot block 48. The slide assembly 46 supports an arm 50 which is pivoted to the pivot block 48 at one end and carries at its opposite end a handle 52 containing spring-actuated triggers 54 and 55 and, as best illustrated in Figure 2, a gauging pin 56 which protrudes from the lower surface of the arm 50 to engage the threads in the end of pipe 12 and is preferably in the form of a flattened sphere.

A linear encoder 59 is mounted to the slide base 38 and positioned to measure the longitudinal travel of the linear slide assembly 46. This provides input data to an associated computer, not part of the illustrated construction, when appropriately signalled by the triggers 54 or 55 as will be subsequently explained. If desired, the encoder 59 may be enclosed with a suitable cover 57 shown in dashed lines.

Figure 2 is a sectional elevation view of the pipe 12 and the mounted gauge 10 illustrated in Figure 1. Surface 22 of the end stop 20 is positioned as shown against the end of pipe 12 and slide base 38, in close proximity to the surface of the pipe 12, is supported by the cylinder 26. Located within the slide base 38 is the linear slide assembly 46 shown at its position for measuring the thread closest to the end of pipe 12. The pivoted arm 50 is connected to the pivot block 48 on the linear slide assembly 46 by a pivot pin 58 which permits the arm to be raised or lowered as needed so that the gauging pin 56 protruding from the lower surface of the arm 50 may engage the threads in the threaded section 28. The pair of triggers 54 and 55 within the handles 52 are forced apart by springs 60. Electrical switches 64 and 65 are positioned so as to be actuated by the depression of the triggers 54 and 55, respectively.

Figure 3 is a perspective view illustrating an alternative arrangement for measuring internal threads of the type described. The gauge assembly of Figure 3 is similar to that described in connection with Figures 1 and 2 and includes an end stop 62 containing a surface 63 which contacts the end of the pipe 66 and which supports cylinders 68 and 70 and a slide base 72 containing a linear ball slide 74. It will be noted that the cylinders 68 and 70 are located within the bore of pipe 66 so that they contact the machined surface of the threaded portion to thereby accurately locate the gauge. In the arrangement illustrated in Figure 3, the linear ball slide assembly 74 which is similar to that illustrated in Figures 1 and 2, supports a pivoted arm 76 which extends into the bore of the pipe 66. Mounted near the end of the arm 76 and

within the pipe 66 is a gauge pin 78 which, as in the previous arrangement, is preferably in the form of a flattened sphere protruding from the surface of the arm 76. As with the external thread gauge described above, the pivoted arm 76 also carries a handle 80 so that the gauge pin 78 can be manually located within each of the threads to be gauged. Handle 80 contains a pair of triggers 82 and 84 which perform the same functions as triggers 54 and 55 in handle 52. As with the arrangement of Figure 1, a linear encoder 83 is mounted on the slide base 72 to measure relative movement between the base 72 and the linear slide assembly 74.

In operation, the thread gauge of Figures 1 and 2 is clamped to the end of the pipe with the surface 22 of the end stop 20 in contact therewith. The handle 52 is lifted so that arm 50 pivots about the pin 58 and the linear ball slide assembly 46 is appropriately positioned for measuring the threads at any position along the pipe 12. Handle 52 is then positioned so that the gauging pin 56 is located within the first thread space to be gauged and trigger 54 is pulled toward the operator so that the gauging pin 56 will come in tight contact with the left or forward flank wall of the first thread. When sufficient force has been exerted against the trigger 54, the springs 60 will compress to the point where the switch 64 will close, thereby transmitting a signal to the associated computer, instructing it to sample the linear encoder 59. Thereafter, the operator exerts force in the opposite direction against trigger 55 so that gauging pin 56 is forced against the right or rear flank of the first thread being measured. As before, when sufficient force is exerted, the switch 65 will transmit the sampling signal to the computer which is appropriately programmed to correct for the geometrical effects of using a spherical gauging pin 56 so as to render an accurate indication of the width of the thread space of the first thread being gauged. If it is desired that the bottom surface of the gauging pin 56 be held from contacting the floor or root diameter of the thread, a spacer pad 44 may be inserted between the upper surface of the linear slide assembly 46 and the adjacent lower surface of the arm 50, as illustrated in Figure 1.

The operation of the internal thread gauge of Figure 3 is similar. The gauge assembly is clamped to the end of the pipe 66 with the arm 76 entering the bore of the pipe 66 and the slide assembly 74 appropriately positioned so that the gauge pin 78 can enter the first thread space to be measured. The operator thereupon applies a downward pressure to the outer end of arm 76 so that gauge pin 78 will enter the thread space. Thereupon the operator applies force to either handle 82 or 84 in the handle 80 so that the gauging pin 76 will contact first the left or forward flank and then the right or rear flank of the internal thread space. As above, the positional information from the linear ball slide assembly 76 is read into the computer when the operator

applies appropriate force to the triggers 82 or 84.

The described operation of triggers 54 and 55 of Figure 2 or triggers 82 and 84 of Figure 3 by the operator will produce linear encoder output signals which may be plotted as illustrated in Figure 4, in which the point 85 represents the encoder reading of the thread space wall closest to the end of the pipe, and point 86 represents the reading of the opposite thread space wall in the same thread position. Similarly, the thread space next adjacent to the pipe end may be read and plotted at points 88 and 90 and the third thread space read and plotted at points 92 and 94. These encoder readings for each tooth flank are suitably corrected in the computer for the effects of the gauge pin diameter and the resulting plot shown in Figure 4 may be mathematically shifted within the computer until it coincides with a similar pair of straight lines established by the gauge points and dimensions given in the thread specification. This will determine the phase relationship (or angle) about the pipe axis between the gauge points and the points actually measured. Once this relationship is known, the actual thread errors can be computed.

Dovetail threads of the type described herein are occasionally cut with varying diameters or spiroid diameters as described in the aforementioned US patent no: 3,989,284. To gauge this type of thread, similar fixtures are employed, the main differences being that stepped or conical locators are used and a crowned end is given to the gauging pin so that it can locate vertically against the thread root. This arrangement requires that a second linear encoder be mounted at right angles to the first to monitor the vertical movement of the pivoted arm. The thread error calculations, while more complex than those outlined herein, are similar in nature.

Claims

1. A tool for gauging thread pitch and width as a succession of turns of a screw thread in the end of a pipe, the tool comprising a base element provided with a clamping arrangement for clamping the element to the pipe in such a way that a flat guide surface on the element is parallel with the longitudinal axis of the pipe and is spaced from the threaded surface of the pipe, a slidable member co-operating with the guide surface so as to be capable of movement in a direction parallel with the longitudinal axis of the pipe, the slidable member carrying an arm of which one end is pivoted to the member and which is fitted with a gauge pin so located in relation to the pivot of the arm as to overlie the thread in the pipe and be capable of insertion within said thread and measuring means for measuring the relative

displacement between the base element and the slidable member.

2. A tool as claimed in claim 1 and including a handle mounted on the arm for inserting and positioning the gauge pin in the threads.

3. A tool as claimed in claim 2 wherein the gauge pin is part spherical with a flat surface opposite its point of attachment to the arm.

4. A tool as claimed in claim 2 or claim 3 wherein the handle includes at least one spring loaded trigger controlling a switch for interrogating the measuring means when a predetermined force is exerted against the trigger.

5. The tool claimed in claim 4 wherein the handle also contains a second spring loaded trigger, one trigger being for actuation by a predetermined pulling force and the other for actuation by a predetermined pushing force.

6. A tool as claimed in any one of the preceding claims wherein the measuring means is a linear encoder for providing electrical input signals to an external computer.

7. A tool as claimed in any one of the preceding claims wherein the slidable member runs in a dovetail track in the flat guide surface of the element.

8. A tool as claimed in any one of the preceding claims wherein the arm is pivoted to the slidable member by means of a pivot pin passing through a pivot block on the flat guiding surface of the member.

9. A tool as claimed in any one of the preceding claims wherein the clamping arrangement includes two positioning cylinders for engagement with the surface of the thread and having axes parallel with the flat guide surface of the slidable member.

10. A tool as claimed in claim 9 wherein said cylinders are spaced for location on the outer surface of the pipe.

11. A tool as claimed in claim 9 or claim 10 wherein the clamping arrangement also includes an adjustable cushioned spindle for engagement with the surface of the pipe substantially opposite to a point midway between the cylinders, so as to provide a third clamping point for the tool on the pipe.

12. A tool as claimed in claim 9 wherein the cylinders are spaced for location within the bore of the pipe and on the internal thread in the end of the pipe.

13. A tool as claimed in claim 12 wherein the arm is located for insertion within the bore of the pipe.

14. A tool for gauging thread pitch and width at a succession of turns of a screw thread in the end of a pipe substantially as described and as illustrated with reference to Figures 1 and 2 or Figure 3 of the accompanying drawings.



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14. A tool for gauging thread pitch and width at a succession of turns of a screw thread in the end of a pipe substantially as described and as illustrated with reference to Figures 1 and 2 or Figure 3 of the accompanying drawings.