Sept 10, 1957 M. E. STECZYNSKI 2,805,487

GAUGE FOR THREADS

Filed July 30, 1953 3 Sheets-Sheet 1

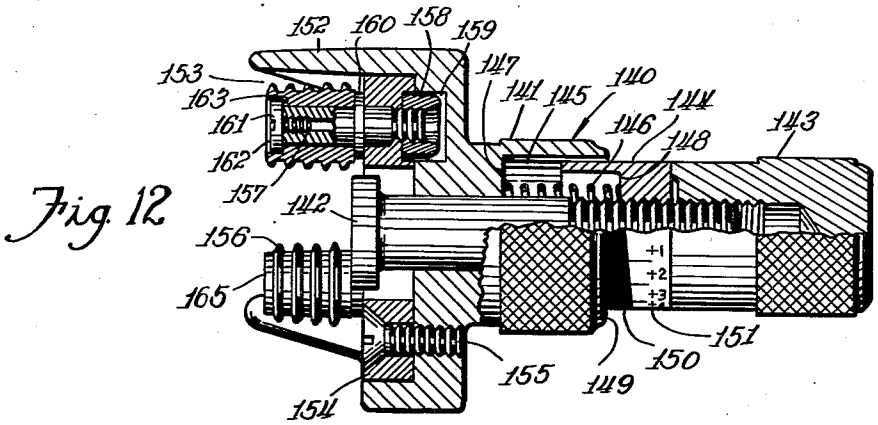


Fig. 12

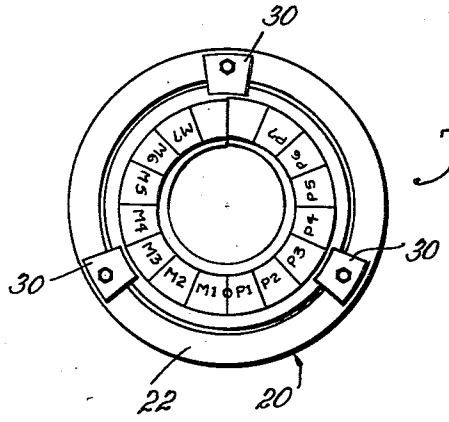


Fig. 1

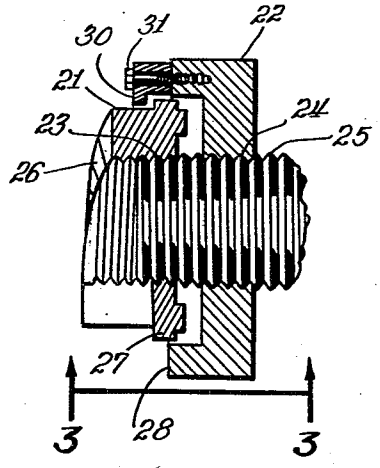


Fig. 2

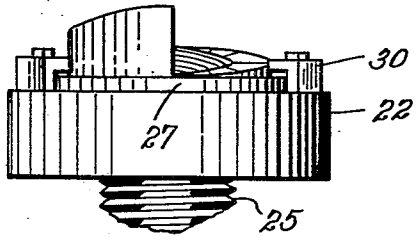


Fig. 3

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GAUGE FOR THREADS

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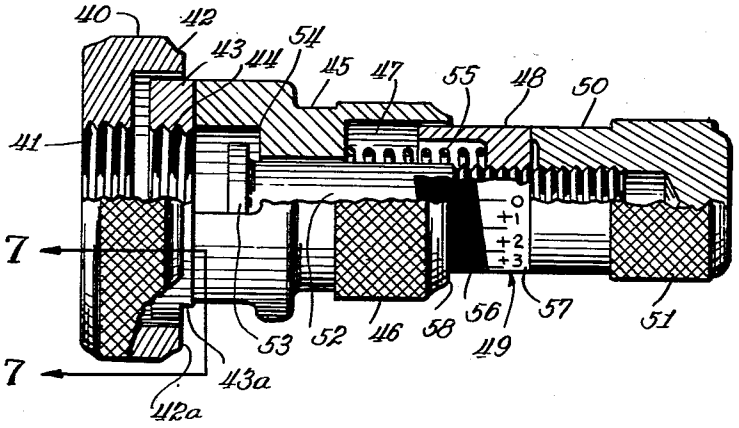


Fig. 4

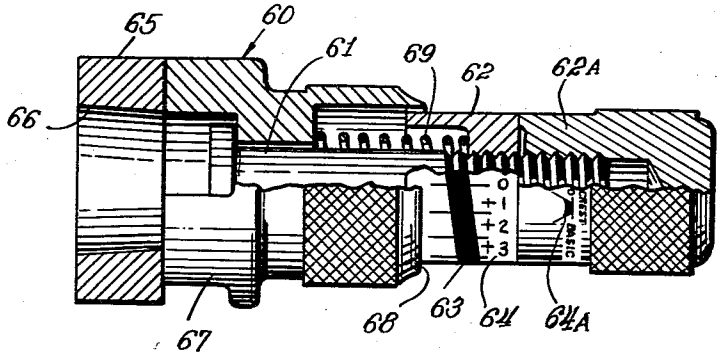


Fig. 5

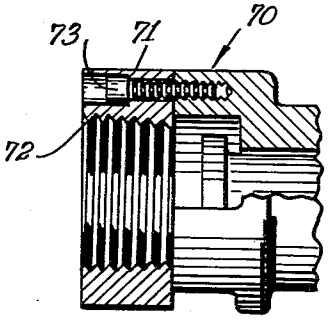


Fig. 6

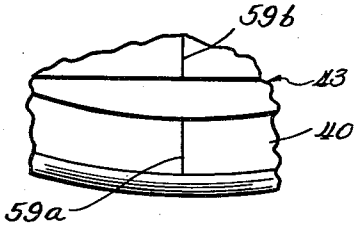


Fig. 7

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GAUGE FOR THREADS

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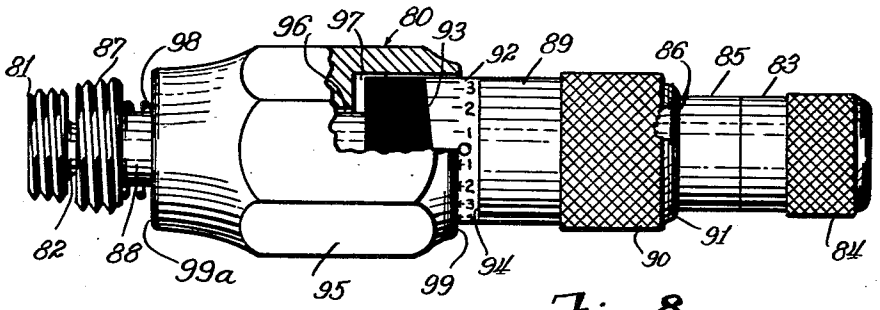


Fig. 8

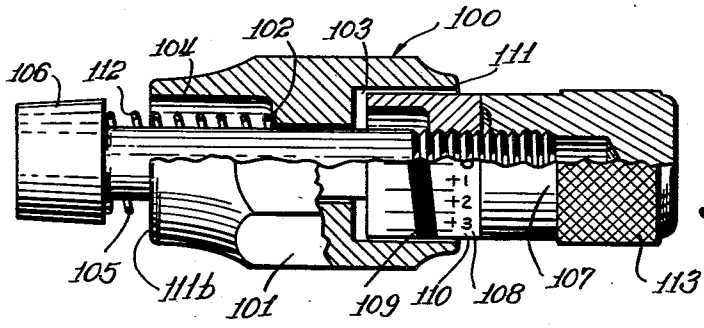


Fig. 9

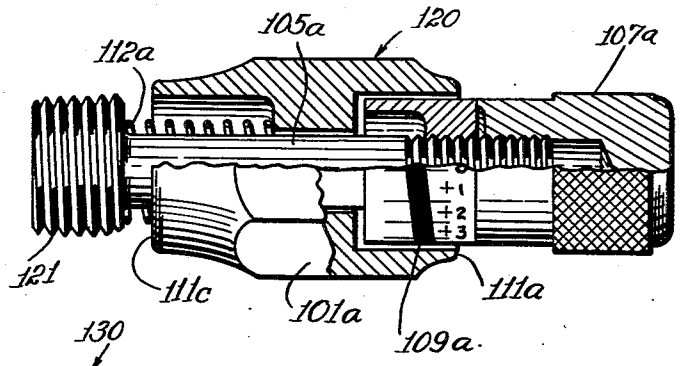


Fig. 11

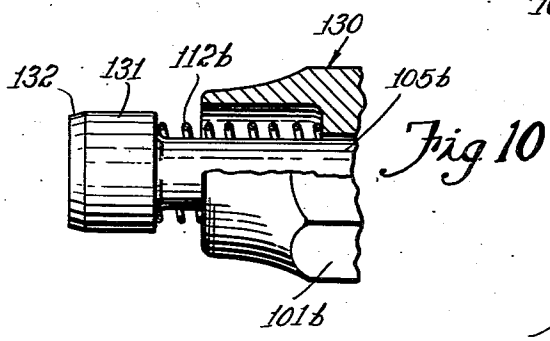


Fig 10

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United States Patent Office 2,805,487 Patented Sept. 10, 1957

2,805,487

GAUGE FOR THREADS

Myron E. Steczynski, Chicago, Ill.

Application July 30, 1953, Serial No. 371,228

25 Claims. (Cl. 33—199)

This invention relates to thread gauges and more particularly to gauge sets for gauging both male and female threads. The gauge sets embodying my invention are particularly useful in gauging tapered pipe threads and will be described herein with reference thereto. The present application is a continuation-in-part of my copending application Serial No. 144,869 entitled Pipe Thread Gauges and having a filing date of February 18, 1950, now Patent No. 2,680,301.

Mating pipe threads are frequently required to effect a fluid tight seal and to insure such a seal, must make sealing contact with each other at both the root and the crest of a thread as well as at the intermediate side portion. To aid in effecting a seal almost all pipe threads are tapered so that the threads are forced into secure contact when the thread elements are tightened together throughout a major portion of their length.

To seal the root and crest portions of the thread the usual procedure has been to employ a luting compound which fills these spaces when the elements are threaded together. However, luting compounds are not satisfactory where high temperatures and pressures are involved, or where the fluid either affects the luting compound or is of such nature as to be contaminated thereby.

For use in such cases, threads such as the NPTF (Dryseal) have been developed in which the roots and crests of mating threads make positive and substantially coincident metal-to-metal contact. In the "Dryseal" thread the thread crest is purposely made sharper than the mating root so that the root actually flattens the crest when the joint is tightened to form a seal. In this "Dryseal" thread, much closer tolerances at the roots and crests must be observed, but heretofore no effective gauging means or method has been available for designating these critical tolerances.

The development and adaptation of metal-to-metal sealing threads has been impeded because the available gauging methods and guages which are suitable to standard pipe threads are not adapted to indicate with sufficient accuracy the tolerances necessary to provide close fit threads in which the root and crest forms are critical.

The gauges of this invention may be used with considerable advantage in gauging conventional pipe threads, but they are particularly well adapted for the newer metal-to-metal contact threads, for an accurate indication of root and crest condition as related to the sides of the thread is achieved with these gauges and this relationship is essential if the threads are to mate properly. Moreover, the gauging of threads can be accomplished with my gauges by unskilled personnel who are able to follow the most simple instructions.

In gauging pipe threads the fullness of the root, or root truncation, as well as the flatness of the crest, or crest truncation, are critical values and must bear the proper relationship to the pitch diameter along the entire mating length of the thread. In other words, the profile of the thread should be the same over its entire length and it

should have a predetermined shape with respect to the profile of the mating thread.

The fact that pipe threads are tapered makes determination of the root and crest shapes or truncation measurement difficult because both the root and crest of a tapered thread define cones, and a direct measurement of a diameter is of no value unless it is made at the same point as measurements of other diameters. Thus accurate gauging of tapered pipe threads must involve a correlation between the minor diameter, the pitch diameter and the major diameter of the thread at any particular point and at all points along its length. Actually the term "diameter" used in connection with tapered pipe threads is somewhat of a misnomer. Radius would be more apt, for the radii of a diametral line are not exactly the same since a root is always directly opposite a crest, and corresponding measurements on opposite sides of the thread axis are slightly displaced axially on a conical figure. Furthermore the sides are not the same from root to crest. The term "diameter," however, will be used herein, for it is the accepted term, having been carried over from non-tapering screw thread terminology where all diameters are constant over the length of the thread.

The conventional method of gauging "Dryseal" threads has been to employ a set of three plugs or rings, depending upon whether a male or female thread is to be gauged. The first plug or ring gauge checks the end portion of the thread with respect to a particular pitch diameter to determine whether the basic pitch diameter is correct and spaced from the end of the thread within limits of one turn in either direction, three stepped markings usually being provided on the gauge to show the depth of hand engagement of the gauge and thread. The second gauge is like the first but is of such size as to gauge the three wrenching threads beyond those engaged by the first gauge. Steps may also be provided to indicate whether the pitch diameters of these threads are oversize or undersize. This gauge should engage within one-half turn of the first gauge if the thread is correct. The third gauge has an unthreaded conical surface which engages only the crest of the thread, and three sets of two indicating markings are provided which show the basic as well as the limiting diameters of the thread crest. The choice of crest diameter limits is determined by referring back to the orginial measurement and the proper pair of limit steps which corresponds to first reading of the pitch diameter at hand engagement. These are difficult operations because no provision for direct reading is provided. Everything is based upon interpolation of word markings. Suppose, for example, that the first gauge indicates that the critical pitch diameter of the thread is one-half turn small from basic. The inspector then has to decide which of the pairs of steps on the last gauge is to be employed as limits. He has a choice between the pair which corresponds to basic threads or the pair which applies to minimum size threads. The human factor in such a procedure is too variable to give reliable results. Some bad threads are passed and some good threads are rejected.

Furthermore, no adequate determination of the root condition is possible by the above outlined procedure and no means of gauging such has been provided heretofore.

Other arrangements for gauging such threads, such as the projection method where a shadow of the thread form is compared with a standard profile, are cumbersome to use and are subject to error in not catching irregularities shielded from view or not brought into the viewing plane. For further discussion of this subject matter reference and incorporation herein is made to my article "Tighter pipe threads through proper gauging," published in the 33rd Annual Report of the Compressed Gas Manufacturers Association, page 72.

Accordingly, one object of this invention is to provide a set of gauges and method for gauging tapered pipe threads which check not only the sides of the thread to be gauged but also in direct relationship therewith the root and the crest thereof to determine whether the significant thread characteristics are correct to form an acceptable seal.

Another object is to provide a gauging apparatus which in direct relationship with exact positions takes into account the fact that a thread whose effective pitch diameter or side portions are oversized or undersized should also have uniformly and standard oversized or undersized root and crest diameters respectively in order to provide proper thread form for sealing.

Another object is to provide a gauging apparatus which will give a ready indication of any critical thread defect and degree thereof in the case of unacceptable threads so that the piece may be either scrapped or ear-marked for reworking, and which may be used to classify acceptable threads as to basic pitch diameter for later use with mating threads having the same effective pitch diameter.

Another object is to provide sets of gauges which are simple and easy to use, requiring a minimum of human judgment in the gauging operation, and which can be readily and relatively inexpensively manufactured and maintained.

Another object is to provide a gauge for tapered threads which will readily indicate the exact position of the critical pitch diameter of the thread being gauged without the necessity of the operator keeping track of the number of turns of the gauge, the indicating means on the gauge extending the range to more than two turns of the thread, yet confining the operator to only one reading in any gauging position of the gauge.

A further object is to provide a gauge for determining the location of the basic pitch diameters of tapering threads by axial depth of threaded engagement, a surface on the end of the gauging element being inclined so as to indicate relative depth to which the threaded part is engaged in the full range and beyond of acceptable limits of the thread.

A further object is to provide a gauge having a continuous indicating surface which may be readily shifted from the usual basic standard without any machining whatsoever, to provide product sizes either somewhat oversize or somewhat undersize from basic, as desired.

A further object of the invention is to provide a tapered thread gauge construction in which the gauge can be easily provided with a characteristic gauging element for specific gauge purposes, and any point on a continuous scale thereon can be selected and marked by symbol as the basic criterion for the position of the proper thread diameter in the thread to be gauged without further work being done on the gauging element.

Another object of the invention is to provide a gauge construction in which the waste due to rejects in manufacturing is eliminated.

Another object of the invention is to provide a gauge construction whereby a damaged or worn gauge need only have the gauging element reworked or else the basic zero point can be re-set to a standard master gauge without any machining whatsoever so as to read correctly and directly on the continuous scale to accommodate for wear or error of the gauging thread.

Another object of the invention is to provide a taper thread gauge in which no tolerance for wear need be provided between the function and the reading of the gauge, but the indicating scale can be shifted or re-set to a standard master from time to time as the gauge wears.

Yet another object of the invention is to provide a set of gauges for gauging the root, crest, and pitch diameters of tapered pipe threads wherein each gauge in the set has a depressible element and the determination

of whether the threads are acceptable is made by depressing the element to engage the end of the threaded workpiece and then referring to the position of the scale provided by the gauge relative to a witness member; the scale being so arranged that the permissible thread tolerances are incorporated into the scale reading and at a glance the acceptability of the thread is determined.

Yet a further object of the invention is to provide a set of four gauges for gauging tapered male threads and a complementary set of gauges for gauging tapered female threads; all of the gauges employing movable elements that are depressed upon proper insertion of the gauges into the threads, or about the threads as the case may be, and the determination of whether the threads fall within permissible limits is readily ascertained by noting or selecting the position of a scale relative to a witness member after the movable elements have been depressed; the gauges and scales carried thereby being interrelated so that comparative gauging of the pitch, root, and crest diameters is provided.

Other objects and advantages of this invention will present themselves to those familiar with the art on reading the following specification in conjunction with the drawings and the appended claims:

A fundamental idea of this invention is to provide a set of gauges for each thread to be gauged, one gauge of the set engaging the sides of the thread to determine the basic pitch diameter of the thread which in threads is a function of the distance the gauge may be threaded onto the work piece, or vice versa. A scale is provided which gives a ready, convenient to remember, indication of the critical pitch diameter within one range of the scale of less than one turn for two or more relative turns of the thread. Another gauge of the set is constructed to engage only the root portion of the thread and is provided with a pair of axially spaced scale margins which indicate at a glance the tolerance in critical root diameter position corresponding to pitch diameter readings appearing on the first gauge. A further gauge in the set is constructed to engage only the crest portion of the thread and is provided with axially spaced scale margins to determine at a glance the critical crest diameter tolerance corresponding to pitch diameter readings appearing on the first gauge.

It appears that when a threaded joint is tightened, except in cases of extreme interference, the sides of the two threads will be in contact, and a gauging procedure wherein the crest and root diameters are referred back to the pitch diameter results in extremely accurate determination and fit because even the sets of gauges employed for male and female threads can be cross-checked with master setting gauges for wear and deviations at any time according to specified stand-off limits.

Embodiments of my invention are illustrated in the accompanying drawing in which:

Fig. 1 is a top plan view of one form of gauge embodying my invention and that is useful for gauging a tapered male thread;

Fig. 2 is a longitudinal sectional view of the gauge shown in Fig. 1 and in which a tapered male thread is shown in position within the gauge;

Fig. 3 is a side view in elevation of the gauge;

Fig. 4 is a longitudinal sectional view, partly in elevation, of a modified form of gauge that is useful in gauging the pitch diameter, taper and length of a tapered male thread;

Fig. 5 is a longitudinal sectional view, partly in elevation, of a gauge used for gauging the crest diameter of a tapered male thread and that is designed for use with the gauge illustrated in Fig. 4;

Fig. 6 is a broken longitudinal sectional view, partly in elevation, showing a gauge for gauging the root diameter of a tapered male thread and that is designed for use with the gauges illustrated in Figs. 4 and 5;

Fig. 7 is a broken sectional view taken on the line 7—7 of Fig. 4;

Figs. 8–10 show a gauge set for use in gauging tapered female threads and in which Fig. 8 is a side view in elevation, with parts thereof in section, of a gauge for checking the pitch diameter, taper and length of a tapered female thread;

Fig. 9 is a longitudinal sectional view, partly in elevation, showing the gauge used to check the crest diameter or crest truncation;

Fig. 10 is a longitudinal sectional view, partly in elevation, showing the gauge used to check the crest diameter or crest truncation at the innermost threads, also to check the maximum bore of the tapped hole;

Fig. 11 is a broken side view in elevation, with parts thereof shown in section, of a gauge for gauging the root diameter or root truncation of a female thread; and

Fig. 12 is a longitudinal sectional view, partly in elevation, of a modified form of gauge.

In my copending application Serial No. 144,869, hereinbefore referred to, advantages are described in detail of a gauge set for gauging the pitch, root, and crest diameters of tapered male pipe threads. Attention is directed particularly to Figs. 7–11 of that application which illustrate the gauge set referred to. In that application the gauge set described for gauging male threads consists of three separate ring gauges each used separately in the gauging operations. One gauge is provided respectively, for testing each of the pitch, root, and crest diameters. I have provided an improvement over that gauge set and have combined the separate pitch and root diameter gauges into a single gauge that indicates the pitch and root diameters in a single gauge operation. This improved gauge is illustrated in Figs. 1–3 of the drawings and reference will be made now thereto in describing the combined gauge in detail.

The gauge is indicated generally by the numeral **20** and comprises a pair of circular rings **21** and **22** having internal threads **23** and **24** respectively. The smaller ring **21** gauges the pitch diameter and the thread **23** thereof is undercut and truncated so as to engage only the sides of the thread **25** to be gauged. The thread **24** of the other ring **22** is relieved at the sides so that it engages only the root of the thread **25** to be gauged.

The face of the ring **21** is machined to have an inclined surface **26** for indicating the location of the basic pitch diameter of the gauged thread **25**. It should be noted that determining the pitch diameter is the basic gauging operation and all of the subsequent gauging determinations wherein the root and crest diameters are gauged will be referred to the basic pitch diameter to ascertain whether the root and crest diameters are within permissible relative tolerances. The top surface **26** of the gauge **20** is machined to a helical shape, the pitch of the helix being four times that of the thread pitch. The resulting surface is inscribed and has a labeled area thereon corresponding to the effective pitch diameter of the threads to be gauged. On the side of the ring **21** a flange **27** is provided which serves not only as a retainer to hold the two gauge rings **21** and **22** together, but also as a surface for indicating the root truncation tolerances. The ring **22** has an integral projecting rim **28** thereabout having three circumferentially spaced lugs **30** attached thereto which project inwardly beyond the edge of the flange **27** to hold the two rings together. Actually the gauge functions if the lugs **30** are eliminated but to make it easier to handle the gauge, the lugs **30** are provided and may be held in place by cap screws **31**.

The gauge **20** is used as follows: the work-piece thread **25** is first threaded into the large ring **22** and given a few turns. The thread **25** then engages the thread **23** of the small ring **21** and the two rings are rotated until such time as the thread **24** engages the root portion of the thread **25**. The smaller ring **21** is then rotated until hand tight. In some instances the small ring **21** will

come to a stop first and the procedure is reversed, but in any event the rings are turned until snug.

The operator then looks at the end surface **26** on the smaller ring to determine whether the basic pitch diameter lies within the predescribed limits. This determination is made by noting the point or area on the helical surface **26** which is level with the top of the work piece bearing the threads **25** and that is received within the threads **23** of the ring **21**. It is noted by referring to Fig. 1 that the helical surface **26** is divided into areas designated P_1, P_2, P_3, etc. and M_1, M_2, M_3, etc. The line between the adjacent areas P_1 and M_1 is designated with a 0 and this is the basic reference area on the gauge. "P" indicates plus or large while "M" designates minus or small, and the numerals represent the amount of largeness or smallness. Each of the numerals indicates one quarter of a turn deviation from the 0 line.

In the area designated P_1 is level with the top of the member being gauged and having the threads **25**, the pitch diameter is within one quarter turn on the large side of being basic and if any other area is level with the end of the work piece (with the exception of the zero line), the pitch diameter is greater or smaller than basic, as the case may be, by the number of quarter turns indicated by the numerical designation.

The root truncation is checked by looking at the side of the gauge **20** along the edge of the rim **28**. If this edge lies within the height of flange **27** the root diameter is correct. Thus the height of the flange **27** corresponds to the root truncation tolerance and if this tolerance is within one-half a turn in either direction from basic for a given pitch diameter, the height of the flange will be equal to the thread pitch. It will be obvious that a pair of subscribed lines may be used to define the truncation tolerance instead of the height of the flange if desired. This would perhaps be desirable where the tolerance was so small that the flange **28** would not have sufficient strength.

In my copending application Serial No. 144,869 which has been referred to I also disclose a gauge set for gauging tapered female threads. In this gauge set a separate plug gauge is used for gauging each of the pitch, root, and crest diameters. It will be appreciated that the gauges illustrated in Figs. 1–3 and described above could be modified so as to provide a single gauge for gauging female threads wherein the pitch and root diameters are checked in a single gauging operation.

A set of gauges for gauging the pitch, root and crest diameters of male pipe threads is illustrated in Figs. 4–7 inclusive of the drawings. In describing these gauges reference will be made then to these figures. The gauge shown in Fig. 4 is used to check the pitch diameter and at the same time the taper and length of the thread. In effect then the gauge of Fig. 4 is really a gauging structure wherein three gauging determinations are made in a single operation; namely, the pitch diameter of the thread is gauged and at the same time the taper of the thread as well as the length of the thread are gauged.

The gauge illustrated in Fig. 4 includes an outer or large ring gauge **40** equipped internally thereof with threads **41**. The ring **40** is free to rotate and may be threadedly received upon the tapered male threads of a work-piece such as a pipe or other threaded structure. It is seen that the ring **40** has an annular flange portion **42** and rotatably received therein is a smaller inner ring **43** that is also internally threaded and provides threads **44** that are adapted to receive therein a threaded pipe or other threaded work-piece. The ring **40** provides a finished witness or gauging surface **42*a*** adapted to be used in conjunction with a gauging step **43*a*** provided by the ring **43** in a manner hereinafter described.

The ring **43** is rigidly secured to a sleeve **45** having at the rear end thereof a knurled nut portion **46**. Any suitable means may be employed for securing the ring **43** to the member **45** so that rotation of the sleeve **45**

is effective to rotate ring **43**. The end portion of the member **45** has an annular chamber **47** therein that slidably receives an intermediate plunger portion **48** carrying a scale thereon designated generally with the numeral **49**. The gauge also provides an end plunger portion **50** equipped with peripheral knurling **51** to facilitate gripping thereof. The end **50** and the intermediate scale portion **48** of the plunger are provided with a longitudinally extending bore therein that is threaded and threadedly receives the rear end portion of a plunger element **52** therein. The plunger element **52** extends forwardly through a bore provided in the member **45** and is freely slidable therein. At its forward end the plunger element is equipped with an annular flange **53** adapted to engage the shoulder **54** to prevent the plunger unit comprising the members **52**, **48** and **50**, from moving rearwardly and out of the member **45** under the biasing influence of the coil spring **55**.

The scale **49** consists of a helical line **56** having a numbered scale portion **57** arranged therewith. The helical scale **56** is frequently referred to as a ramp scale. Preferably the pitch of the ramp scale **56** is four times the pitch of the threads **41** and **44** and the numerical designations are calibrated to read in quarters of a turn so that the 0 mark is basic, plus one equals one-quarter of a turn large, plus two equals one-half a turn large, etc., while the minus numerical designations, which are not shown in Fig. 4, will indicate quarter turns small.

It is noted that the ramp scale **56** is carried by the movable plunger and its relative position is compared to a stationary witness surface **58**. In the position of the plunger shown in Fig. 4, the upper surface **58** of the member **45** is shown for convenience somewhat away from the ramp scale **56** which is the approximate position of the plunger before being depressed. The point at which the witness surface **58** crosses the ramp scale **56** is important in ascertaining the pitch diameter of the work-piece being gauged as well as in establishing a basis of reference for a subsequent gauging operation and the importance will be described later when the operation of the gauge is set out.

The sectional view in Fig. 7 is taken of the pitch diameter gauge illustrated in Fig. 4 and is intended to show the witness marks **59***a* and **59***b* carried respectively by the outer ring **40** and inner ring **43**. The purpose of the witness marks **59***a* and **59***b* will be brought out in a discussion of the operation of this gauge.

The gauge illustrated in Fig. 5 is designed to gauge the crest truncation of a tapered male thread. This crest truncation gauge is designated generally with the numeral **60** and it is clear from the drawing that it is substantially identical to the gauge shown in Fig. 4 except for the ring portions **40** and **43** of that gauge which are used for checking the pitch diameter, thread length and thread taper, and except for the ramp scale **63** which is a band to denote crest truncation tolerance, and not a line to denote pitch diameter. The crest gauge **60** will then be described only generally for it is believed that a detailed description will not be necessary to a complete understanding of the invention.

The gauge **60** in Fig. 5 includes a plunger **61** having an end portion **62***a* and an intermediate scale portion **62** with a helical ramp scale **63** thereon equipped with a numerical scale portion **64**. Instead of a threaded ring **43** with which the gauge in Fig. 4 is equipped, the crest gauge **60** has a ring **65** equipped with a tapered bore **66** therethrough. The ring **65** may be secured to the body portion **67** of the gauge in any suitable manner and for example the ring may be secured in place by screws or dowels, if desired. The tapered bore **66** is adapted to receive a taper threaded part therein and the plunger **61** is adapted to be depressed to bring the enlarged forward flange portion of the plunger element into engagement with the end of the part. The sleeve or body portion **67** is provided with a witness surface **68** that cooperates with the helical scale **63** as will be subsequently described. It is seen that a coil spring **69** urges the plunger rearwardly. Since the gauge **60** is so similar to the pitch gauge described already in detail, a further description of crest gauge **60** is believed unnecessary.

The gauge illustrated in part in Fig. 6 is designed for gauging the root truncation of a tapered male thread and this root truncation gauge is designated generally with numeral **70**. The gauge **70** is identical to the crest gauge shown in Fig. 5 except for the ring portion **71** which instead of having a plain tapered or frusto-conical bore **66** therethrough is equipped with threads **72**. Any suitable means may be employed for rigidly securing the ring **71** to the gauge body and, as illustrated, cap screws **73** may be employed.

Since the root gauge **70** is intended to gauge the root of a male thread with the crests on its own thread **72**, the threaded bore of the ring **71** is relieved at the root (major diameter) of the thread **72** and also along the sides of the threads so that engagement with the male thread being gauged occurs substantially only at the root of the gauged thread.

The operation of the gauge set shown in Figs. 4–7 inclusive will now be set out. The pitch diameter is the basic gauging operation and the determinations made during this gauging procedure are employed subsequently as a reference in the gauging operations wherein the root and crest truncation are gauged. As has been indicated before, the pitch gauge also is used to determine whether the taper of the thread being gauged is within prescribed tolerances. Generally the taper of a thread is three-quarters of an inch per foot on the diameter and to prevent great variation from this, which might result in leakage, etc., in a fluid pressure system, the taper should be gauged.

The first step in the gauging operation is to thread the large ring **40** (Fig. 4) onto the tapered pipe thread and thereafter thread the inner ring member **43** onto the same male thread. Each of the rings **40** and **43** should be hand tightened and should not be turned onto the thread by wrenches etc. Care should be taken to make sure that both the ring **40** and the ring **43** are engaged to about the same tightness.

It is important to observe the relationship between the ring **40** and ring **43** when both are tightened upon the thread being engaged. It is noted that the ring **40** has a finished rear surface portion **42***a* and that the inner ring **43** is equipped with a gauging step **43***a*. If the taper of the thread being gauged is proper, the face **42***a* of the ring **40** must come within the limits of the gauging step **43***a* provided by the ring **43**. The gauging step **43***a* is equal in height to one turn on the threads in a direction of minus tolerance on the taper. If there is doubt that the taper is proper upon an inspection of the relative positions of surface **42***a* and step **43***a*, whether the taper is within one turn can be determined exactly by referring to and comparing the witness lines **59***a* and **59***b* on the two rings (see Fig. 7).

If the outer ring **40** projects higher than the upper limit of the gauging step **43***a*, it means that the taper on the thread being gauged is too great. Alternatively it could mean that the thread is too short and does not allow the large ring **40** to be turned on far enough. On the other hand if the outer ring **40** stops so that the surface **42***a* thereof is below the lower limit of the gauging step **43***a* it means that the taper on the thread is straighter than the tolerated amount represented by one thread below basic. For the thread to be acceptable at this gauging operation the two rings **40** and **43** must be positioned relatively within the one thread or turn indicated by the step **43***a* and the witness lines **59***a* and **59***b* shown in Fig. 7.

After this determination has been made the plunger is depressed to bring the flange portion **53** thereof into engagement with the upper end of the threaded member

being gauged. With the plunger depressed the helical scale **56** is viewed at the point where it intersects the witness surface **58** provided by the sleeve or gauge body **45** and the plus or minus numerical designation at that point noted. Tapered thread specifications generally call for threads which are within one turn in either direction from the basic which is the 0 reference point on the ramp scale **56**. Therefore, if the surface **58** crosses the ramp scale **56** at a point farther from the 0 reference mark than is permitted for any given tolerance (which in such case would be one turn or between plus four and minus four on the scale) it is known that the pitch diameter of the thread being gauged is either less or greater than the permissible tolerance. For example, if the limits are one-half of a turn in either direction from basic, which is the 0 reference on the scale, and the surface **58** crosses the scale **56** at a point greater than plus two or less than minus two, it means that the pitch diameter deviated more than one-half a turn from basic on the designated pitch diameter.

Although the pitch diameter of the thread being gauged might vary considerably from the reference point it does not mean that the thread is useless and that the pipe or other threaded work-piece must be discarded. On the contrary, it has been found that if a male thread has a pitch diameter that varies from 0 reference or basic by plus four for example that it may be used readily and a fluid tight seal provided, with a female thread that also differs by a plus four from basic if the crest and root truncations are properly related to the plus four pitch diameter. Thus a thread need not be discarded regardless of the pitch diameter variation from the basic 0, but instead the numerical deviation from basic will brand or ear-mark the thread being gauged and if the crest and root diameters correspond to the pitch diameter variation from reference or basic, the thread may be used. It is important then that the point at which the witness surface **58** engages or crosses the helical ramp **56** be remembered and applied to the particular thread since this numerical designation becomes necessary in the root and crest gauging operation that will now be set out.

After the thread taper and pitch diameter or length have been determined by use of the gauge illustrated in Fig. 4, either the crest gauge **60** or the root gauge **70** may be employed in the next gauging operation. The order in which the root and crest gauges are used is of no consequence and they may be employed interchangeably in the second gauging operation. Assume that the crest gauge **60** is next used, the frusto-conical bore **66** is slipped over the male threads and before the ring **65** is pushed on tightly it may be wobbled slightly from side to side in an effort to indicate out-of-roundness or out-of-taper of the crests. If the crests are not out of round or not out of taper, the ring **65** is slipped down tightly upon the threads and the plunger **61** then depressed to bring the enlarged flange portion of the plunger element into engagement with the end surface of the pipe or other workpiece.

When the workpiece was gauged with the pitch and taper gauge of Fig. 4, it was found that upon depressing the plunger that the surface **58** crossed the upper edge of the helical band at some one point of numerical designation on the band. For example, if in using the pitch gauge, the surface **58** crossed the upper edge of the helical band **56** at the plus three point, this plus three determination ear-marked the workpiece and it is used as a reference in the further gauging operations. Therefore, upon depressing the plunger **61** of the crest gauge **60** the surface **68** and the plus three point on the scale should fall between the upper and lower edges of the helical band scale **63** (these edges establish the tolerance).

If the plus three point on the scale band **63** and the edge **68** intersect between the upper and lower limits of the scale band, the crest truncation is then within the allowable tolerances for the plus three thread and the thread is passable. If, however, the surface **68** rides above and conceals the band **63** at the plus three point when the plunger **61** is depressed, it means that the crest of the threads being gauged is too sharp and the ring **65** did not travel far enough onto the threads. On the other hand, if upon depressing the plunger **61** the surface **68** falls below the lower edge of the band **63** at the plus three point thereof, it means that the crests being gauged are too flat and the workpiece entered too far into the conical bore **66** of the ring **65**. In either case the crest of the threads being gauged falls outside of the permissible tolerance for a thread having a plus three pitch diameter and the thread should be rejected.

The root gauge **70** (Fig. 6) is used in substantially the same manner. In the root gauging operation the threads of the workpiece are screwed into the threads **72** of the ring **71** and are brought to a hand tightened position. The ring **71** is then backed off slightly and the gauge is wobbled to ascertain the looseness of the thread being gauged relative to the threaded bore **72**. If the looseness is not excessive, it means that the thread engages the gauge threads throughout the length of the threaded bore **72** and the thread is then all right for further gauging. The gauge **70** is then again tightened onto the workpiece until it is hand tight and the plunger of the gauge is depressed to bring the enlarged flange portion of the plunger element into engagement with the end of the workpiece. In order that the thread root have the proper truncation, the helical band at the plus three marking thereon, when depressed must intersect the edge **68** within the width of the band.

If the helical band is concealed within the body of the gauge at the plus three point, the plunger has gone down too far and the workpiece did not enter far enough into the threaded bore **72**. This would mean that the roots of the thread being gauged are too full, that is, the truncation is too great and the threads are rejected. If though, the plunger does not go down far enough it is an indication that the workpiece entered the ring **71** too far and the roots of the thread being gauged are too sharp or are undercut and the workpiece should be rejected.

It will be appreciated that the specific numerical scale readings set out above are used solely by way of example and that the same procedure is carried out irrespective of particular pitch diameter determination. If the pitch diameter scale reading is minus four, then the root and crest scale readings are made at the minus four point thereon, and so forth.

It seems clear from the above that a tapered male thread is quickly and easily inspected by means of these gauges. In three operations the taper of the thread, the lengths, the pitch diameter, root truncation and crest truncation are all gauged. The pitch diameter gauging operation is the important and basic gauging operation for it ear-marks or designates the workpiece for the subsequent root and crest gauging operations. Even if the thread being gauged falls outside of the permissible tolerance at the pitch diameter, but has proper corresponding crest and root truncations, the thread may still be used, however, if it is subsequently mated with a female thread having substantially the same pitch diameter with corresponding root and crest truncations. These factors are all determined in the same gauging operations and the operator is required to carry but a single plus or minus number through the entire gauging procedure of a single part.

Human error is substantially eliminated in the gauging operations because the gauging is a comparative procedure, no mental calculations are required, and it is necessary for the operator to remember but one figure. The only indicia he must carry in his head during the gauging steps is the simple plus or minus or zero numeral where the surface **58** of the pitch diameter gauge crosses the helical line **56**. This pitch diameter figure is used

as the reference in the subsequent crest and root gauging operations that have been described and by simply depressing the plunger of each of the crest and root gauges it is apparent at a glance whether the gauging or witness surface falls within the limits of the helical band at the numerical reference point. If it does, then the thread is acceptable and if it does not, then the thread is not acceptable.

In Figs. 8–10 a gauge set is illustrated that is used to gauge a tapered female thread. The same gauging operations are carried out through use of these gauges that were performed by the three gauges illustrated and described with reference to Figs. 4–7. In addition, however, a further gauge is illustrated in Fig. 10 and this gauge is employed to determine whether the maximum bore of the thread at the farthermost (smallest) threads thereof has not been exceeded. Those gauges will now be described.

The gauge shown in Fig. 8 is used to gauge the taper depth and pitch diameter of a tapered female thread and is designated generally with the numeral 80. The gauge 80 has a threaded plug 81 that is relieved at both the root and crest and is designed to engage only the flank of the female thread being gauged. The plug 81 is carried on a shaft 82 that extends axially through the gauge and is threaded at the rear end thereof and threadedly receives the end piece 83 having a knurled end 84 thereon that facilitates gripping during the rotation thereof when the plug 81 is turned into the female thread. The threaded rear end of the shaft 82 also threadedly receives or carries an intermediate scale portion 85 hving a circumferential scale band 86 thereon.

The gauge 80 also carries an enlarged tapered plug 87 having threads about the periphery thereof and these threads are also relieved at the root and crest so that they engage the thread being gauged along the sides or flanks thereof. While the plug 81 is intended to penetrate the workpiece and engage the inner wrenching threads, the enlarged plug 87 is designed to penetrate the thread a short distance and engage only the hand-engagement threads just beyond the initial entrance.

The plug 87 is carried by an elongated sleeve 88 that is threaded at its rear end and threadedly receives and carries the intermediate end piece 89 having a knurled end 90 equipped with a finished reference, or witness surface 91. Also threadedly carried by the sleeve 88 is an intermediate scale portion 92 having a helical ramp scale 93 equipped with numerical indicia 94. It is apparent that the enlarged plug 87 and the sleeve 88 have an axially extending bore therethrough that receives the shaft 82 therein and permits free rotation of the shaft 82 relative to the sleeve 88 and the plug 87. Therefore, the end piece 83 and intermediate end piece 89 may be selectively and independently turned or slid, thereby rotating or sliding respectively the small plug 81 and large plug 87.

The gauge 80 also carries a sleeve or collar 95 that in the particular illustration given is hexagonal in shape. The sleeve 95 has an axially extending bore 96 therethrough that communicates with an enlarged chamber 97 at the rear end of the sleeve. The sleeve 95 is slidably received about the elongated sleeve 88 that carries the plug 87 and is free to move axially relative thereto. A coil spring 98 is interposed between the enlarged plug 87 and intermediate surface provided in the sleeve 95 and that forms a seat for the spring. The spring 98 then effectively biases the sleeve 95 in a rearward direction and away from the plug 87. If reference is made to Figs. 9–11 the precise manner in which the seat for the spring is provided by the sleeve 88 will be readily apparent since each of the gauges in this respect is substantially identical. The sleeve 95 also has a finished reference or witness surface 99 that is used in conjunction with the helical ramp scale 93 in a manner that will be subsequently described in detail. On the end opposite the witness surface 99 is the gauging surface 99*a*, which engages or contacts the face of the part with the female thread being gauged, and its application will likewise be subsequently covered.

The gauge illustrated in Fig. 9 is generally similar to the pitch gauge 80 and is used to gauge the crest of a tapered female thread. This gage is designated generally with the numeral 100. The crest gauge 100 has a relieved body or hexagonal sleeve 101 providing an axial bore 102 therethrough communicating with an enlarged rear end chamber 103 and an enlarged forward chamber or spring chamber 104. Slidably mounted within the bore 102 and free to rotate therein is an elongated shaft 105 that carries a frusto-conical crest gauging plug 106 at the forward end thereof.

At its rear end the shaft 105 is threaded and threadedly receives an end portion 107 and an intermediate scale portion 108 having a helical band scale 109 thereon extending about the periphery thereof and which is equipped with the numerical indicia 110. The hexagonal body or sleeve 101 has a finished rear witness or reference surface 111 designed to be used in conjuncton with the scale 109, and a finished front gauging surface 111*b* which contacts the end face of the thread being gauged. A coil spring 112 is interposed between the plug 106 at its forward end and seats at its rear end upon the shoulder provided between the enlarged chambers 104 and 102. The spring is operative to bias the sleeve 101 in the rearward direction and away from the plug 106. If desired, the end portion 107 may be knurled at 113 to facilitate rotation thereof by providing a good finger grip.

The gauge shown in Fig. 11 is for gauging the root truncation of a tapered female thread and is designated by the numeral 120. The gauge 120 is identical with the crest gauge 100 heretofore described and illustrated in Fig. 9 with the exception of the plug 121 which, while frusto-conical in shape, carries peripheral threads that are relieved at their root and sides since the plug 121 is designed to gauge only the root diameter or truncation of female threads. Therefore, the same numerical designations are used in setting out the gauge shown in Fig. 11 since they are all identical with the exception of the root plug 121 as has just been mentioned. The suffix *a* is added to each number, however, for purposes of clarity.

In Fig. 10 is shown a gauge 130 that is used in gauging female threads to ascertain whether the maximum bore diameter thereof at the farthermost (smallest) end is within permissible tolerances. The bore gauge 130 is identical in construction to the root gauge 120 and the crest gauge 100 except for the plug 131 which is cylindrical through substantially its entire length except for an inwardly tapered shoulder 132 that provides a substantially frusto-conical portion, and which is identical with the corresponding end portion of plug 106 on gauge 100. Therefore the numbers applied to the various parts in the Fig. 9 illustration, and similarly applied to the illustration in Fig. 11, are also applied to the portion of the bore gauge 130 that is illustrated except that the letter *b* is added to each number. A further discussion of the structure of the bore gauge shown in Fig. 10 and also of the root gauge shown in Fig. 11 is believed unnecessary to a complete understanding of the gauges and their operation since as has been indicated, these gauges are substantially identical to the crest gauge shown in Fig. 9 with the exception of the plug portions which have been described in detail.

The operations of the gauges shown in Figs. 8, 9 and 11 are very similar to the operation of the gauges shown in Figs. 4–7 with the exception that the workpiece will now be a member having a tapered female thread rather than a tapered male thread. The gauge 80 is first used since this gauge, in addition to checking the thread taper and depth, also indicates the pitch diameter of the threads

and the pitch diameter is the basic gauging element and ear-marks the workpiece for further gauging operations.

The first step is to thread the plug **81** into the thread being gauged and this is accomplished by rotating the end piece **83**. After the plug **81** is inserted a distance sufficient to clear the end of the thread, the enlarged plug **87** is turned into the thread through rotation of the intermediate end portion **89**. Each of the plugs **81** and **87** is then screwed into the thread until each engages the thread to about the same degree of tightness. In each case the plug is hand tightened. Care should be taken in inserting the plugs **81** and **87** to prevent binding therebetween. After the plugs have been inserted to a hand tightened position the gauging surface **91** is viewed with reference to the cylindrical scale **86**. If the surface **91** falls within the upper and lower limits of the band **86**, it means that the thread taper falls within the predetermined tolerances and the further gauging operations should be carried out. If the surface **91** falls either above or below the limits of the band **86** the thread taper is improper and it does not come within the permissible limits.

Next the sleeve **95** is pushed downwardly to engage the end of the workpiece with its surface **99***a* and the point on the helical ramp scale **93** where the reference or witness surface **99** intersects the edge thereof is noted. If the gauging surface **99** intersects the helical scale **93** at the zero mark thereof, the thread has a pitch diameter that is exactly basic. The slope of the helical ramp scale **93** is preferably four times the slope of the threads and each numerical designation indicates one quarter of a turn. Generally the thread has a tolerance of one turn in either direction, and if the surface **99** intersects the helical line **93** anywhere between the plus four and minus four points on the scale, the pitch diameter of the thread is within permissible tolerance and is passable as an acceptable thread. It should be understood that these tolerances may vary from specification to specification and are given for purposes of illustration only.

In the event that the surface **99** intersects the helical line **93** at some point beyond either the plus four or minus four scale marking, the thread may still be useful if it is matched or mated with a male thread having essentially the same pitch diameter designation. Referring back then to the example set out in the discussion of the gauges for testing male threads, if the surface **99** intersects the line **93** at the plus three marking thereof, the female thread being gauged might be properly and desirably used with a male thread having a plus three pitch diameter, provided the crest and root truncations of the female thread fall within the prescribed tolerances.

Notation is made of the point on the scale where the surface **99** intersects the ramp **93** and then either the crest truncation gauge **100** or the root truncation gauge **120** is used in the order desired to check the crest and root truncations of the thread. If the crest gauge **100** is used, the plug **106** is inserted into the thread and it may be carefully rocked or wobbled to determine whether there is any out of roundness or out of taper of the thread. If the thread has the proper roundness and taper, the plug **106** is pushed farther into the thread until it is tight and the sleeve **101** is then depressed. If upon depressing the sleeve **101** to bring its gauging surface **111***b* into engagement with the end of the workpiece, it is found that the reference surface **111** and the plus three point on the scale marking fall within the upper and lower limits of the helical band scale **109**, the crest of the thread comes within the permissible tolerance and the thread is acceptable.

If the surface **111** does not go down far enough to uncover any part of the band **109** at the plus three marking thereon, the plug **106** has penetrated the thread too far and it means that the crests are too flat and should be rejected. On the other hand if the sleeve **101** moves downwardly too far so that there is clearance below the bottom of the scale band at the plus three marking, it means that the plug **106** has not penetrated the thread far enough and the crests are too sharp and should be rejected.

The root gauge **120** is used in a similar manner. The plug **121** is turned into the thread being gauged by rotation of the end piece **107***a* and after it is hand tightened it is backed off slightly and the gauge wobbled to determine the looseness of the thread. If the thread is too loose, as compared with generally acepted threads, it may mean that the gauge stopped at the last incomplete thread. If it is not too loose, the plug **121** is again brought to the hand tightened position and the sleeve **101***a* depressed. If the gauging surface **111***a* thereof falls within the width of the band **109***a* at the plus three mark, the thread is acceptable for the root diameter thereof comes within the prescribed tolerances for a thread having a plus three pitch diameter.

If the sleeve **101***a* does not uncover the band **109***a* at the plus three mark, the plug **121** has penetrated the thread too deep and the thread should be rejected since the root thereof is too sharp or undercut. If upon depressing the sleeve **101***a* it is found that the scale **109***a* is completely uncovered at the plus three mark, then the plug **121** has not penetrated the thread far enough and the root is too flat (filled in) so that rejection of the thread is justified.

The maximum bore gauge **130** is next employed and the plug **131** thereof is inserted into the female thread. This gauge in reality checks the crest of the thread at the end thereof. After insertion of the plug the sleeve **101***b* is depressed and if the reference surface thereof comes within the upper and lower limits of the helical band at the plus three point, the bore of the thread is below the maximum at a depth corresponding to a thread having a plus three pitch diameter and it is acceptable. If on the other hand, the sleeve **101***b* either completely conceals or completely uncovers the band **109***b* at the plus three mark, the diameter of the thread at the farthermost threads thereof is improper and the thread may be rejected.

It will be appreciated that the operation of the gauges illustrated in Figs. 8–11 is substantially identical to the operation of the gauges illustrated in Figs. 4–6, the only difference being that the latter group of gauges is used to gauge the pitch diameter, taper, length, root and crest diameters of tapered male threads, while the set of gauges shown in Figs. 8, 9 and 11 are used to gauge the same diameters of tapered female threads. In addition, the maximum bore diameter gauge of Fig. 10 is used to carry out the additional gauging step of checking the maximum bore of a female thread as covered by specifications. All of the advantages, then, realized through the use of the gauges for checking male threads are also realized in using my gauges for gauging female threads and will not therefore be repeated since they have been brought out hereinbefore.

The gauge illustrated in Fig. 12 is a modification of the gauges hereinbefore described and deviates therefrom primarily in the type of ring provided that is used for receiving a tapered male thread. This gauge is indicated generally with the numeral **140** and includes a body portion **141** having a plunger element **142** slidably mounted within an axially-extending bore provided thereby. The plunger element **142** is threaded at its rear end and threadedly carries an end portion **143** and an intermediate scale portion **144**. The scale portion **144** is freely slidable within an enlarged chamber **145** provided by the body member, and a coil spring **146** seats at one end upon a shoulder **147** provided by the body **141** and at the other end upon a shoulder **148** provided within the intermediate scale portion **144**. A finished gauging or witness surface **149** is provided by the body **141** and this surface cooperates with a helical ramp scale

150 equipped with numerical indica 151 in the gauging operation.

The body 141 is enlarged at its forward end and is equipped with an annular flange 152 providing a chamber 153 therein. A ring mounting member 154 is received within the chamber 153 and engages the inner surface of the enlarged end of the body 141 and is secured in position by screws 155. At least three roller gauge members 165 are employed and, if desired, a greater number may be used. These members are spaced apart and provide threads or ribs 156 adapted to receive a tapered male thread carried by a pipe or other workpiece.

Each of the members 165 is generally frusto-conical and has an axially-extending passage therethrough that receives therein a tubular member 157. The member 157 is threaded at its inner end and threadedly receives a head or nut 158 which seats within a recess provided in the under surface of the ring 154 and extends into a recess 159 provided by the body 141. Thus, upon screwing the tubular member 157 into the head 158 the tube is rigidly supported relative to the ring 154.

The member 165 is received upon the outwardly-extending end of the tubular member 157 and interposed between the ring 154 and member 165 is a shoulder 160. At its outer end the central passage through the tubular member 157 is equipped with threads and it threadedly receives a cap screw 161 having an enlarged head 162 that engages a shoulder portion 163 provided by the outer end of the member 165. Thus, with this assembly the members 165 are rigidly secured in position relative to the ring 154 and flange 152 but are readily removable and may be replaced with other threaded members.

The threaded members 165 serve a function similar to the rings 42, 43 or 71 heretofore described with reference to the male gauging structure shown in Figs. 4 and 6. The spaced members 165 provide a broken ring adapted to be threaded onto a male thread as part of a gauging operation. It will be appreciated that the threads 156 carried by each of the members 165 may be relieved at the crests and roots if the gauge is to be used in a pitch diameter gauging operation, and if the gauge is to be used in a root gauging operation the threads 156 may be relieved at the sides or flanks thereof and at the roots so that these threads engage only the root of a male thread being gauged.

The operation of the gauge is substantially identical to the operation of the gauges shown in Figs. 4–7 and in this gauging operation a male thread is threadedly received within the spaced members 165. When a hand tight fit is obtained, the plunger comprising the plunger element 142, scale portion 144 and end portion 143, is depressed to bring the enlarged flange of the plunger element into engagement with the face of the pipe or workpiece received within the threads of the gauge. The position at which the witness surface 149 crosses the ramp scale 150 is noted and this information is used as has been set out before. This gauge, then, can be used for gauging the pitch, crest and root diameters of a male thread, depending upon the type of threads 156 provided on the members 165. It will be apparent that the threads 156 might be eliminated and smooth-walled frusto-conical rollers provided to replace the members 165, and in such case the gauge could be used for gauging the crest elements of the male thread.

For the purpose of assisting the users in understanding the significance of each gauge and visualizing the actual form of the thread being gauged in relationship to the basic from to which the gauge is set, each gauge is preferably marked with an appropriate sectional representation of one thread as shown at 64*a* in Fig. 5 to orient the basic form or dimension in correct relationship with the movement of the plunger so that the measurement accomplished is understood as a matter of comparison based upon relative width of the band 63 left exposed after the plunger 61 is moved to its testing position. The basic or zero to which the gauge is set is indicated in relation to the basic thread form as outlined by straight lines and deviation therefrom is indicated in the blackened portion of the representation 64*a*. In Fig. 5 the crest is checked of a male thread and when setting the gauge the gauge is "zeroed" at the intersection of the "0" line and the outermost edge of the band 63. Any deviation from basic will permit the test piece to go deeper in the gauge surface 66 and the plunger a less distance inwardly. Zero (0) being at the top of the thread, any deviation therefrom will indicate a thread whose "crest" is not up to "basic." Visualized, this would mean a thread of a height falling within the black portion of 64*a* some place proportional to the width of the band 63 received within the boundary line 68.

While in the foregoing specification embodiments of my invention have been set out in considerable detail for purposes of adequately describing the invention, it will be appreciated by those skilled in the art that change may be made in these details without departing from the spirit and principles of the invention.

I claim:

1. A gauge for gauging male threads, comprising a body portion equipped at one end with a ring adapted to receive therein the male thread of a workpiece, said body portion having an axially-extending bore therein, a plunger mounted within said bore for axial movement relative to said body portion and ring, means for urging said plunger away from contact with a workpiece received within said ring, said plunger being adapted to be moved at will into abutting engagement with a threaded workpiece received within said ring, and a helical scale extending around said plunger operatively arranged with a circular edge on said body for indicating the extent of axial movement of said plunger when the same is brought into engagement with a workpiece received within said ring whereby the extent of penetration of a workpiece into said ring is ascertainable.

2. The structure of claim 1 in which said ring is equipped interiorly with threads undercut at the root and relieved at the crest so as to engage only the sides of a thread being gauged.

3. The structure of claim 1 in which said ring is adapted to receive a tapered male thread said scale comprises two axially spaced edges, and a second ring is provided, said second ring being freely movable axially relative to said first-mentioned ring and being adapted to receive therein the tapered male thread of a workpiece, scale means also being provided and arranged with said rings for indicating the relative positions thereof on a tapered thread to ascertain the taper thereof.

4. The structure of claim 1 wherein said ring is equipped interiorly with threads relieved at the sides and undercut at the root so as to engage only the root of a thread being gauged.

5. The structure of claim 1 in which said ring has a smooth-walled interior so as to engage only the crest of a thread being gauged.

6. In a set of gauges a gauge for gauging tapered male threads, comprising a body portion equipped at one end with a ring adapted to receive therein the tapered male thread of a workpiece, said body portion having an axially-extending bore therein, a plunger mounted within said bore for axial movement relative to said body portion and ring and being adapted to be moved into abutting engagement with a threaded workpiece received within said ring, said ring having an interior surface equipped to engage a tapered male thread in a predetermined relationship therewith whereby the gauging of a particular feature of the thread is provided, and a scale having a helix of a pitch greater than the pitch of the thread to be measured and operatively arranged with said plunger for indicating the extent of movement thereof when the same is brought into engagement with a workpiece, whereby

the particular feature of the thread being gauged, which is a function of the extent of penetration of a workpiece into said ring, is indicated by said scale.

7. The structure of claim 6 in which said scale is carried by said plunger.

8. The structure of claim 6 in which said scale is provided with a spiral band carried by said plunger of a width to determine tolerance variations, the width of said band defining the tolerance of the particular thread feature being gauged.

9. In a set of gauges a gauge for gauging female threads, comprising a shaft equipped at one end with a plug adapted to be received within a female thread of a workpiece, a sleeve mounted upon said shaft for axial movement relative thereto and to said plug and being adapted to be moved into abutting engagement with the end of a workpiece receiving said plug therein, means for urging said sleeve away from said engagement and a helical scale operatively arranged with said sleeve for indicating the basic dimension of a thread being gauged with respect to the extent of axial movement of said sleeve when the same is brought into engagement with a workpiece whereby the extent of penetration of said plug into a workpiece is ascertainable.

10. The structure of claim 9 in which said plug is equipped exteriorly with threads undercut at the root and relieved at the crest so as to engage only the sides of a thread being gauged.

11. The structure of claim 9 in which said plug is equipped exteriorly with threads relieved at the sides and undercut at the root so as to engage only the root of a thread being gauged and said scale is provided with axially spaced lines indicating the tolerance variations for the thread being gauged.

12. The structure of claim 9 wherein said scale is defined by two lines spaced a distance indicating tolerance variations and said plug has a smooth-walled exterior surface so as to engage only the crest of a thread being gauged.

13. The structure of claim 9 wherein said plug is adapted to be received within a tapered female thread, and a second plug is provided by said gauge, said second plug being freely movable axially relative to said first-mentioned plug and being adapted to be received within the tapered female thread of a workpiece, means for urging said plug away from a workpiece, helical scale means being provided for indicating a basic dimension of the thread by the relative positions of said plugs within a tapered thread for ascertaining the taper thereof.

14. The structure of claim 9 in which said plug is tapered over a portion of its reduced end and cylindrical over the remaining portion of its length and is adapted to penetrate a female thread only adjacent the initial threads thereof for gauging the maximum bore thereof.

15. In a set of gauges, a gauge for gauging tapered female threads, comprising a shaft equipped at one end with a plug adapted to be received within the tapered female thread of a workpiece, a sleeve mounted upon said shaft for axial movement relative thereto and to said plug and being adapted to be moved into abutting engagement with the end of a workpiece having tapered threads receiving said plug, means for urging said sleeve away from said engagement said plug having an exterior surface equipped to engage a tapered female thread in a predetermined relationship therewith whereby the gauging of a particular feature of the thread is provided, and a helical scale operatively arranged with said sleeve for indicating the extent of movement thereof when the same is brought into engagement with a workpiece receiving said plug, whereby the particular feature as a basic dimension of the thread being gauged, which is a function of the extent of penetration of said plug into the thread, is indicated by said scale.

16. The structure of claim 15 in which said scale is carried on said shaft and has a helical pitch greater than the pitch of the thread being gauged.

17. The structure of claim 15 in which said scale is provided with a spiral band carried by said shaft, the axial width of said band defining the tolerance variation of the particular thread feature being gauged.

18. In a set of gauges for tapered pipe threads, a gauge comprising a body having a tapered thread adapted to engage the side portions of a male thread and configured to gauge pitch diameter, a surface at the end of the lesser radius of said thread and provided by said body and having an edge defininig a helix, indicia on said surface for indicating tolerance variations with respect to the pitch diameter of the thread being gauged, a movable element supported on said body and having a relieved thread for engaging the root portions of the thread being gauged, and means for indicating the relative axial position of said element with respect to said body whereby the condition of root truncation of the thread being gauged is indicated.

19. A gauge for gauging tapered male threads, comprising a body portion equipped at one end with a ring adapted to receive therein the tapered male thread of a workpiece, said ring being broken and provided by a plurality of circumferentially spaced thread-receiving members adapted to receive a tapered male thread therebetween, said body portion having an axially-extending bore therein, a plunger mounted within said bore for axial movement relative to said body portion and ring and being adapted to be moved into abutting engagement with a threaded workpiece received within said ring, means for urging said plunger out of said engagement, said ring having an interior surface equipped to engage a tapered male thread in a predetermined relationship therewith whereby the gauging of a particular feature of the thread is provided, and a helical scale operatively arranged with said plunger for indicating the extent of movement thereof when the same is brought into engagement with a workpiece, whereby a basic dimension of the thread being gauged, which is a function of the extent of penetration of a workpiece into said ring is indicated by said inclined scale.

20. A gauge for gauging threads, comprising a support member equipped at one end with a thread-engaging element, a movable member supported by said support member for axial movement relative thereto and to said element, means for urging said member away from said element, said member being adapted to be moved into engagement with a workpiece having a thread thereof engaged by said element, means having a helically disposed scale thereon operatively arranged with said movable member for indicating the extent of axial movement thereof when the same is brought into engagement with a workpiece having threads engaged by said element, whereby the extent of axial engagement of said element with the threads of a workpiece is indicated and means for locating said last means in a predetermined position with respect to said movable member.

21. The structure of claim 20 in which said scale is provided with a spiral band around said second named means, the width of said band defining the permissible tolerance of the particular thread feature being gauged.

22. A set of gauges for gauging a tapered thread, comprising a gauge having a tapered thread thereon undercut at the root and relieved at the crest so as to engage only the sides of a predetermined thread to be gauged, a second gauge having a tapered thread thereon undercut at the root and relieved at the sides so as to engage only the root of a predetermined thread to be gauged, and a third gauge having a tapered surface thereon for engaging only the crest of a predetermined thread to be gauged, each of said gauges being equipped with a movable member adapted to be moved into abutting engagement with a workpiece having a tapered thread being gauged, and each of said gauges being provided with an

inclined scale operatively arranged with said movable member for indicating the extent of axial movement thereof when the same is brought into engagement with a workpiece having a tapered thread being gauged, whereby the axial position of the gauge thread relative to the thread of the workpiece being gauged is represented on said scale.

23. In a set of gauges, a gauge having a body equipped with at least one element defining an annular bore configured to engage a portion of a thread whereby the gauging of a particular feature of the thread is provided, a second element having an annular bore engaging another portion of the thread and cooperating with the first element to determine another feature of the thread, said first element providing the measuring position of the second element by mechanical cooperation therewith, and a helical scale provided by said gauge and equipped with indicia for indicating tolerance variations with respect to the first particular feature to be gauged and with respect to said other feature.

24. In a set of gauges for tapered pipe threads a gauge comprising two members having tapered threads thereon, said members being so constructed and arranged that they partially telescope with each other to a position limited by a thread to be gauged, one of said members having its threads formed to contact the roots of the thread being gauged and the other member having indicia associated

therewith defining a helix, said indicia indicating tolerance variations with respect to a predetermined pitch diameter of the thread being gauged, and means for gauging the limiting position of said members to indicate the truncation of the thread being gauged in relationship to a basic dimension of the thread.

25. The combination called for in claim 24 in which the indicia is carried on the member which first engages the work piece in the gauging relationship.

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