

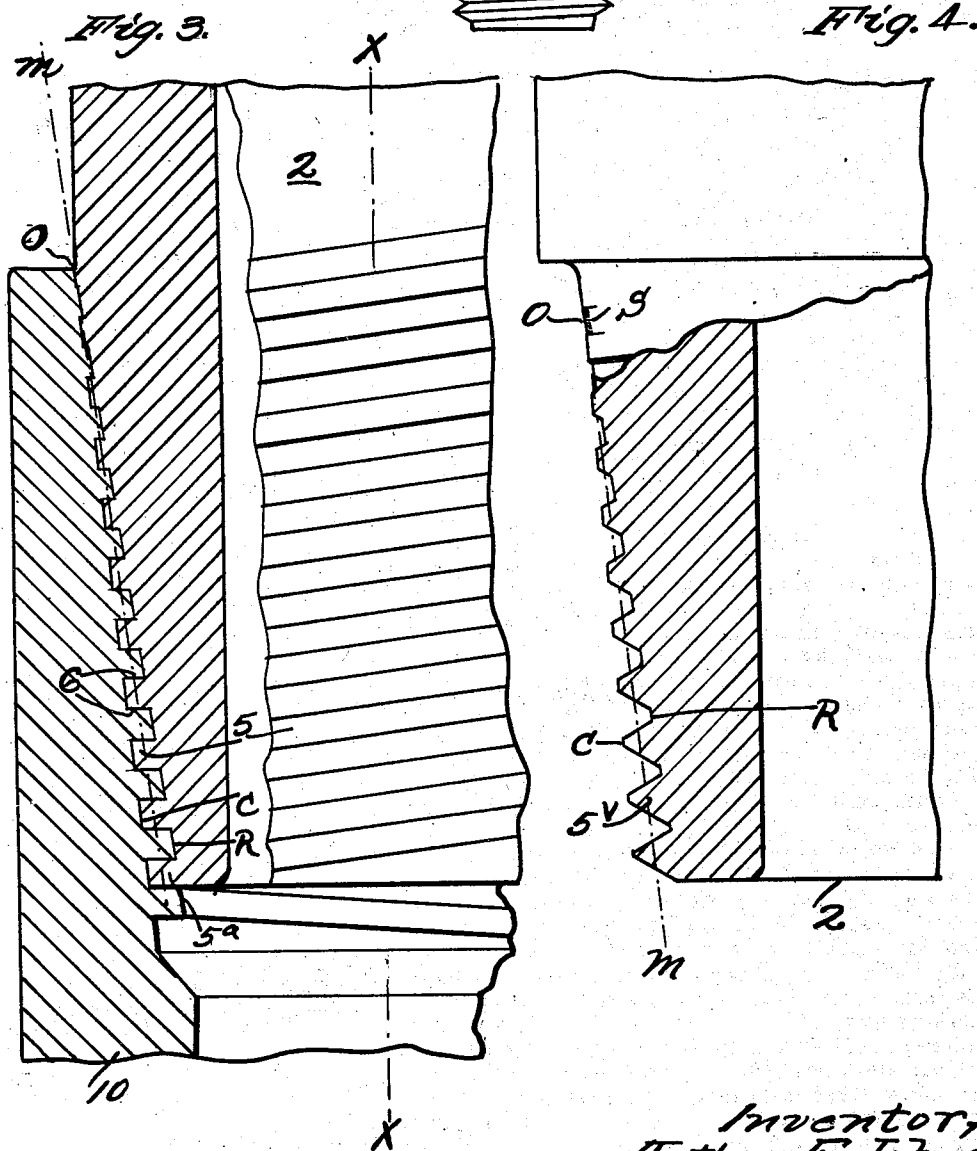
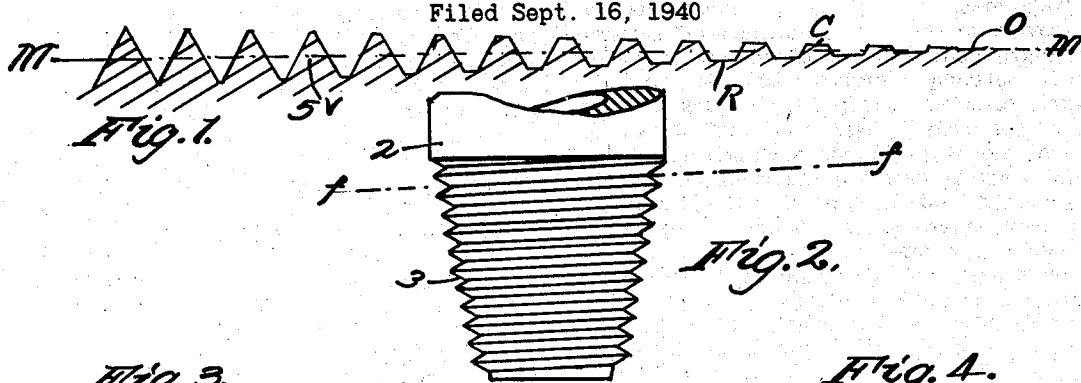
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SHEAR-REDUCING, DUAL VERGE THREAD FOR TOOL JOINTS, ETC.

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SHEAR-REDUCING, DUAL VERGE THREAD
FOR TOOL JOINTS, ETC.

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12 Claims. (Cl. 285—146)

This invention is a thread or tooth form for screws (male or female), dies and other mechanical apparatus.

The invention resides in a thread of this class and distinguishes from all other forms of tooth shapes for screws and dies, regardless of the style of thread cross-section, in that a thread of this invention is of constantly changing cross-section from the end of greatest depth of tooth to that of least depth of tooth, or to the "last scratch" of the tooth (be it threaded body or a cutting die). This constant change of the thread section is irrespective of the general cross-section; that is, whether it is of parallel wall sides or flanks or that such sides may be converged toward the thread crest, as in V-threads.

In a section longitudinally of a body and which section cuts a number of thread helices, and shows a row of teeth along the section, a line which passes as a mean between the roots and crests of the thread sections of a number of helices may be considered the pitch line of the series of the teeth and here will be called the mean line of the thread (sections) so as to avoid confusion as might arise when this new thread is cut on a part such as a tapered pin or pipe, and its complementary female element, box or collar. Taper pin tool joints are a highly important device in the deep well industry and it is desired to avoid confusion with the terms taper and pitch of the frusto-conoidal surfaces of such joints, as well as in pipe joints using threaded conical surfaces.

It is one of the objects of this invention to provide a new thread for use in such tool and pipe joints (and their dies) whereby at one and the same time substantially eliminate common shearing of the threads particularly at the maximum end of the conic surface; to reduce the hazard of transverse fracture of the pin at the base of its conic part, and to utilize latent capacity of stretch along the pin body at the root line of the threads.

This fracture almost invariably occurs in a cross-plane of the pin base at about the helical line of the first full root of the threads. Careful search and analysis shows that this fracture is caused by the fact that in conventional tool string joints the threads are of full depth throughout the length of the thread. It will therefore be seen at once that if the joint parts are well machined each and every thread presents a full depth side or flank area to its opposed thread on the companion element of a pair; whether tool joint or pipe joint. Now if

any bending moment is generated at the joint one side of the pin, or male pipe end, is compressed and the diametrically opposite side is conversely stretched. If the flank at the top side of a (vertical axis) pin thread is for its full length engaged by its box thread the total engagement area is so great that stretch due to bending moment is wholly negated as to the full threaded length of the pin and the stress of stretch becomes localized at the thread root nearest the base of the conical surface of the pin or pipe end since one full turn of the root at the pin base is on the cross-section of the pin that is not positively supported against oscillatory vibrations at the top of the box or pipe into which the male part threads, particularly so in shoulderless types of make-up. Thus in a good quality of material the fracture of a screw pin comes on a plane following the first root of one thread pitch (here the word pitch means the thread advance axially).

By the thread of this invention the base of the conical pin has no deep screw root or groove, and in fact the first root is preferably the "last scratch" and from this the groove is gradually increased to the axially far end of the thread. However the depth of the thread may be cut so as to taper from a full depth at one end to any suitable fraction of the full depth and not be run off to a fine last scratch.

This run off of the root is not to be confused with the conventional angular cut at the bottom of a last few turns of the screw thread at the butt of a threaded pin and where all of the remaining threads are of full thread depth from root line to crest line.

It can be stated at once that the thread of this invention is characterized in that in any selected body-type of thread and taking a mean line of thread depth, and which line is arbitrarily oblique to the axis of the screw threaded part, the root line of the thread turns preferably starts from a scratch point on the said part and verges away from the said mean of the thread section, and likewise the crest or ridge of the thread verges in the opposite direction, from the point of start of the thread, as to the said mean. Therefore, this new machine thread is a dual verge thread: its crest and its root each verge from a minimum depth or start at zero on the mean line, the scratch point, to a full depth section of thread at the very last turn of the thread body about the axis of the threaded part. The said mean line is to be understood as the angle of taper of the taper-threaded end of a pipe, or

line of the angle of taper of a die, or of a tool joint part, as it is the pitch taper of the thread mean as well as the mean pitch of thread coupled parts.

The result of such a dual-verge thread-body is that in any type of thread section the two flanks of the thread gradually increase in depth from the minimum or zero point to a substantially full given depth of the thread at the end of minimum diameter of the conical surface which is threaded.

It is interesting to note that in this new thread throughout its full length helically at no cross-section is the thread perfect to a conventional section for the reason that the thread begins at a given point, on an element, at or near the mean line of the thread and then verges each way from said line until the deepest thread body is produced at the remote end of the thread—and this remote end has its crest and root surfaces not parallel to the mean but each verged as to the mean. And another feature, every cross-section of the thread body has an absolutely uniform width at the mean of its depth.

It has been stated here that the mean line conforms to the angle line of a given taper of two tapered surfaces which are to be complementally threaded. That is one way of defining the structure of the thread but in any given case of taper it will be understood that the male part must have a rough machined conical taper of such an angle that its intended thread will have its full desired depth as a result of the fact that the crest of a pin thread verges out from the mean line of the thread.

A further feature of the invention is that, in any case, the radial depth of the thread body, its depth oblique to the mean line, is always on a line normal to the axis of the part threaded, and is not normal to the verge line or the crest nor of the root.

Conspicuous results are obtained here. First, the maximum depth of the thread is at maximum distance from the greatest diameter of the conical surface to be threaded, or is threaded, and the minimum depth of the thread is at the widest part of the conical surface. The root surface of the thread gradually verges in from the last scratch to the smallest diameter of the threaded part or element and therefore when the made-up joint flexes at one side under a moment of force lateral to the joint axis the incidental stretch at the convex side of the flex is distributed for a length of the element equal to the length axially of the element that is threaded. In fact the latent stretch zone is equal to the length of the mean extending from first to last screw helix. This mean length is many times the conventional helical-pitch distance between two or three threads of the butt of a pin or of a pipe joint. And this latent stretch is available for the threaded length of the element because when the joint is made up the single full depth thread helix at the small end of the conical part has the maximum side face interlock while all other turns of the thread to the large end of the conic surface decrease in depth with the result that the very shallow threads at the butt of the cone have capacity for some inherent stretch and in order that this stretch from helix to helix may be used it is a feature of the invention that the mean line thickness of the thread be slightly smaller in amount than the width of the slot or groove between thread coils. This will allow the threads of the pin to creep a

little in the opposite groove of the female joint-part. The interlock of the threads at the last scratch is practically nil, and there is no material objection to this nil effect for the very reason that in any case of conventional full depth screw thread from end to end of helix it is never known which of the threads in the length of the helix may be actually in holding effect and all of the rest without load. Workmanship and temperature are disturbing factors making unreliability of fit whereas in the present invention the locking load will inevitably come, by a little wear-off of the shallower flanks, onto the deepest thread turns.

This leads to consideration of a feature of the invention wherein it eliminates a high accuracy of thread finish, as in other threads of a type with full depth throughout the thread length in contrast to the thread of this invention because in this thread it is intended to definitely localize the thread interlock on a few full depth threads at the small end of the conic surface (male or female) enough to take the load of tensile strain of the coupled elements and enable the inherent elasticity of the threaded length of the flexed element to absorb the bending tension instead of throwing the whole bending moment onto just the first one or two thread turns at the butt of the pin where thread shear usually happens, and instead of placing the butt root of the first thread under such strain as to result in transverse fracture of the pin at the butt.

The invention consists in certain advancements in this art as set forth in the ensuing disclosure and having, with the above, additional objects and advantages as hereinafter developed, and whose constructions, combinations, and details of means, and the manner of operation will be made manifest in the description of the herewith illustrative embodiments; it being understood that modifications, variations and adaptations may be resorted to within the scope, spirit and principle of the invention as it is more particularly claimed presently.

Figure 1 is a diagram to show the dual verge of root and crest lines, of a V-type thread for a mechanical element, from the mean between crest and root of the thread; all lines emanating from a zero or last scratch point.

Figure 2 is an elevation of a conventional tool joint pin showing by a dotted line the usual cross-plane of fracture.

Figure 3 is an axial section of a fragment of a tool joint make-up showing a dual verge thread of parallel-flank type; the flanks being perpendicular to the axis of the pin.

Figure 4 is an axial section of a fragment of a pin with dual-verge V-type thread body, with the flanks symmetrical in angle to the pin axis.

A common pin 2 of a tool joint is shown in Fig. 2 as provided with a full cut V-thread 3. In a joint of a full cut thread, of any type where the thread is of the same height throughout, the transverse breaking strain of a bending moment, occurs at the plane whose circumference has the least reinforcement by the female surface at the joint and line $f-f$ shows where fracture develops in threaded joints of pipe, casing and tool strings in the well drilling and operating industry when for any reason joined sections flex out of line. The bending moment exerts its full effort at the cross-plane immediately above the first solid cinch between the mutually threaded elements; that is at the first cinched helix of the thread on the pin because the latent elasticity of the

threaded surface can only be utilized at that circumferential zone which is not cinched in contact to such a degree that the said zone can stretch (axially of the pin) at the tensioned side of the pin subjected to a moment of force transverse to the pin.

The present invention positively and effectively distributes the tension of bending strain for a very considerable distance along the tensioned side of the flexed pin, or pipe end. This is accomplished by the use of a helical thread body 5, Fig. 3, having at one end a substantially full depth, full size (arbitrary type) helix end 5a and the mean depth line M of which intersects at zero point O with the surface of a cylindric body, as the pin 2, and the root line R from the thread end 5a verges to the same point O. The crest line C of the thread extends to and intersects with the mean line M at the zero point.

The thread is distinguished in that its sides or flanks 6 are either normal in angle to the axis line X of the cylindric element 2 as in Fig. 3 showing parallel flanks normal to the axis X, or as in Fig. 4 showing a V-section thread body 5v whose sides or flanks are symmetrically inclined to the axis X. It is to be understood that the intent is to have the body depth of a thread normal to the axis X of the part 2 and not normal to the mean M.

In these several thread types it will be seen that the mean width of the body of the helical thread is constant at any cross-section of the thread. It will be seen that the thread gradually diminishes in depth from the deepest end 5a to minimum at the section lying next to the last scratch S, Fig. 4, ending the thread groove. It will be seen that because of the dual verge of the crest line C and the root line R as to the mean line M there is no conventionally "perfect" or full or uniform depth of thread in cross-section at any point of the whole length of the thread—because the depth constantly decreases to point O.

It will be understood that this thread may be cut on a terminal of a right-cylinder in which case the crest line C will be the periphery of the cylinder, or the thread may be cut on a male, conical element in which case the crest line C will be the periphery of the cone and the mean M will verge toward the point O, as, also, will the root line R.

It will be understood that instead of running the groove to the last scratch S, and making a very thin last thread helix, the cut can be stopped nearer the full end 5a and thus obtain any desired substantial thread depth at the base or butt end of the pin.

The capacity of axial stretch of the tensioned side of the pin or pipe is made available because the maximum degree of interlock of a threaded pin 2 to its box 10 is carried to the distal, small end of the pin as to the top edge of the box and when a bending moment is exerted the stress is not limited to a zone at the base or butt of the pin but is dissipated along and far down the convexed side of the bending pin radially distal from its axis thereby preventing the full moment from being exerted at one of two thread helices at the top of the pin in its box, or a pipe end threaded in a pipe bore, or in a casing joint.

The root and crest surfaces of this thread are made to fit snugly the companion element and are not disturbed by flexing action. Shearing effect is reduced around the base part of the

threaded pin because of the axial verge of the threads.

While the tapered-body thread is here shown as cut on a conic surface of a member, 2 or 10, a tool joint being shown, it is not intended to be limited as to the particular adaptation disclosed. In all cases longitudinal lines (as to the axis of the threaded member) of the crest, the root and the pitch circle all converge toward a circumferential surface zone where the thread body comes to least depth or the "scratch line." In other words, beginning with the pitch circle of the deepest thread helix the longitudinal line from its crest and its root both converge to meet at the zone of the pitch circle of the shallowest thread cross-section. In the claims the word "taper" is used with reference to the taper of thread depth from the deepest thread to the vanishing or least depth thread; unless otherwise defined. Crest line, pitch line and root line here mean elements extending longitudinally and passing through crest, or pitch, or root circles at any transverse plane. Crest means the outermost circle of a thread turn, and root means the circle at the valley bottom; the pitch circle is the depth mean.

What is claimed is:

1. A coupling joint including a body member with a screw thread characterized by a uniform cross-section width along the pitch circle of the thread turns and increasing depth from a minimum or "scratch" line end to its opposite, deepest end and the crest line and the root line of the thread converging from the thread section of greatest depth to the vanishing zone at the shallowest thread.
2. A coupling or joint member having an annular surface which is provided with a screw thread whose body cross-section at every transverse plane constantly decreases from a maximum at one end of the thread to its opposite end and whose root surface and crest surface are like elongate zones and the pitch width of the thread being the same for the length of the thread and the crest and the root lines of the thread equally diverging along the thread from the vanishing zone of the shallowest thread to the maximum depth thread.
3. A coupling or joint member having an annular surface provided with a screw thread whose body depth constantly decreases for its full length and whose pitch width is the same throughout, and the crest line and the root line of which both taper toward and converge with the pitch line of the shallowest helix part of the thread, and the crest and the root surfaces being, lengthwise of the thread, similarly shaped and sized.
4. A coupling or joint member having an annular surface provided with a screw thread whose sides or flanks each constantly change in depth throughout their length and whose crest and root zones are similar in shape; the pitch width being the same for the length of the thread and the root line and the crest line of the thread uniformly tapering toward the pitch line at the vanishing zone of the shallowest thread end.
5. A coupling or joint member having a conic surface and being provided with a uniform-pitch-width thread along said surface and which thread is of greatest depth at the smaller diameter of the tapered surface and whose depth diminishes as the diameter of said surface increases; the pitch line, the root line and the crest

line of the thread all inclining in one general direction away from the axis of the conical surfaces and severally converging at the vanishing point or shallow end of the thread.

6. A coupling or joint member having a threaded, annular surface, the thread having a body in which the flanks or sides diminish in depth uniformly from a deep end of the body to a minimum depth at the other end, and the crest and root surfaces of the thread being of like shape for their length along the thread and both inclined axially toward and converge with the pitch line of the said thread body from the thread convolution of maximum height to the thread convolution of minimum height.

7. The device of claim 6; in which the flanks are symmetrical to the axis of said member and which axis is oblique to the pitch line of the thread body.

8. A coupling or joint member having an annular surface provided with a thread body and which body has a crest zone and a root zone of similar size and shape, and the body width along the pitch line being the same for the length of the body, and said zones each converging toward the vanishing zone at one end of the thread.

9. A pair of joint making elements to be connected by a thread and which elements have a common axis and complementary male and female surfaces thereabout; a thread body on said surface of each element and the common pitch line of each thread body diverging from the said

axis and the crest line and the root line of the thread converging with the pitch line on the same longitudinal axial plane at the end of the thread where the height of the thread becomes zero; the width of the thread body along its pitch line being the same throughout the length of the body, the said divergence of the pitch line from the axis being in the direction from the deepest thread convolution toward the shallowest end of the thread.

10. The thread device of claim 9; the crest and the root of the thread being similar in shape and size.

11. The device of claim 9; the elements having conic, fitting faces and the deepest thread cross-section, on each, being at the smaller end of the conic faces; whereby to obtain greatest shear capacity of thread at the smaller end of one of said elements and to provide shallow threads at its large end to afford greater longitudinal flexibility thereat.

12. The device of claim 9; the elements having conic, fitting faces and the deepest thread cross-section, on each, being at the smaller end of the conic faces and the thread being generally of V-cross-section and the crest and the root of the thread being widest at the larger end of the said faces whereby to effect more directly radial reaction between the meeting roots and crests of the interengaged threads at the larger end of the conic faces of the said elements.

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