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[45] Patented **June 22, 1971**

[56] **References Cited**
UNITED STATES PATENTS
2,196,966 4/1940 Hammer..... 285/390 X
3,129,963 4/1964 Robbins 285/334
3,355,192 11/1967 Kloesel et al. 285/334 X
3,388,752 6/1968 Hanes et al. 285/334 X
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[54] **THREAD ARRANGEMENT FOR EARTH BORING MEMBERS**
14 Claims, 7 Drawing Figs.
[52] U.S. Cl..... **285/334,**
285/390
[51] Int. Cl..... **F16I 25/00**
[50] Field of Search..... **285/333,**
334, 355, 390; 287/117, 125; 85/46; 151/22

ABSTRACT: A thread arrangement for connecting solid, or essentially solid shafts, as well as shafts having a longitudinal bore extending therethrough for use in earth boring operations, which thread arrangement is defined in terms of the geometry, including the diameters, of the shafts upon which the thread is employed, rather than in specific, or absolute, unchangeable dimensions.

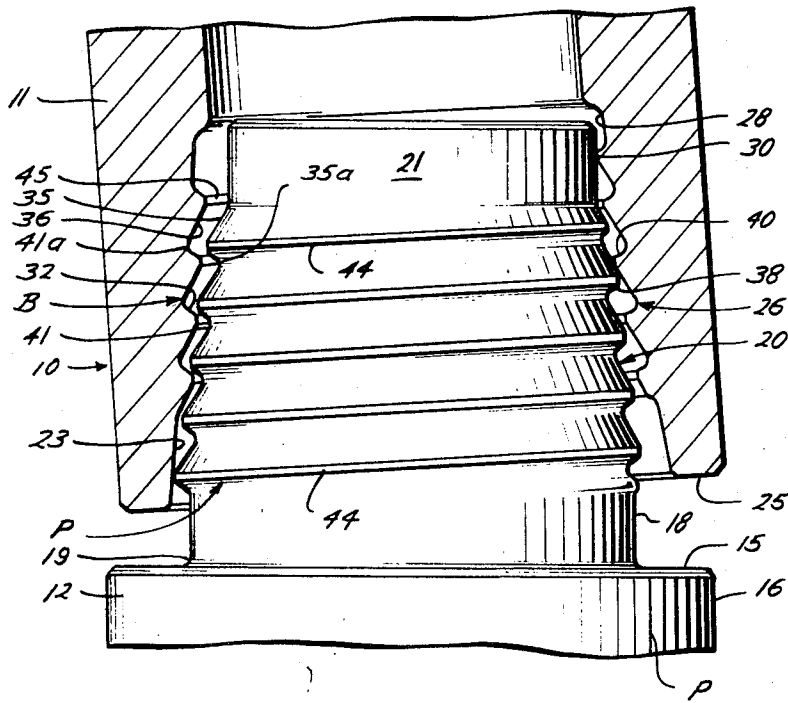


Fig. 1

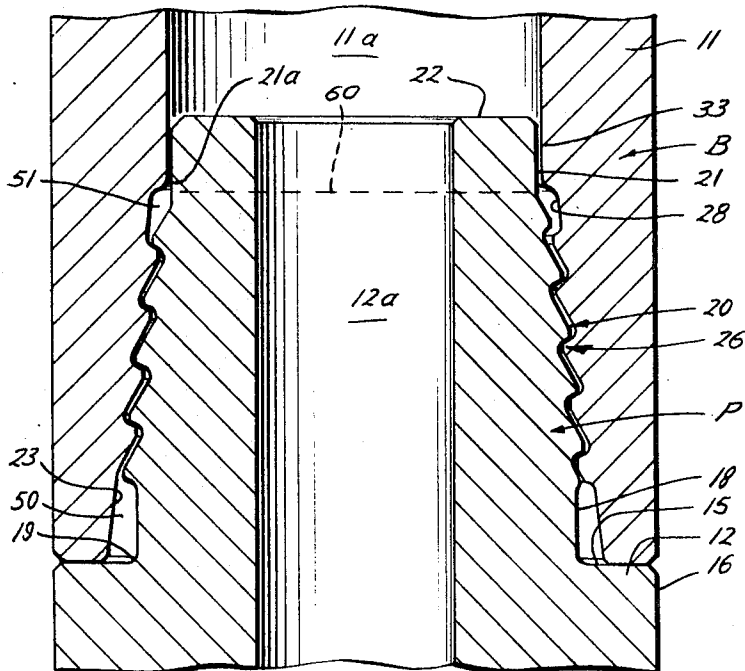
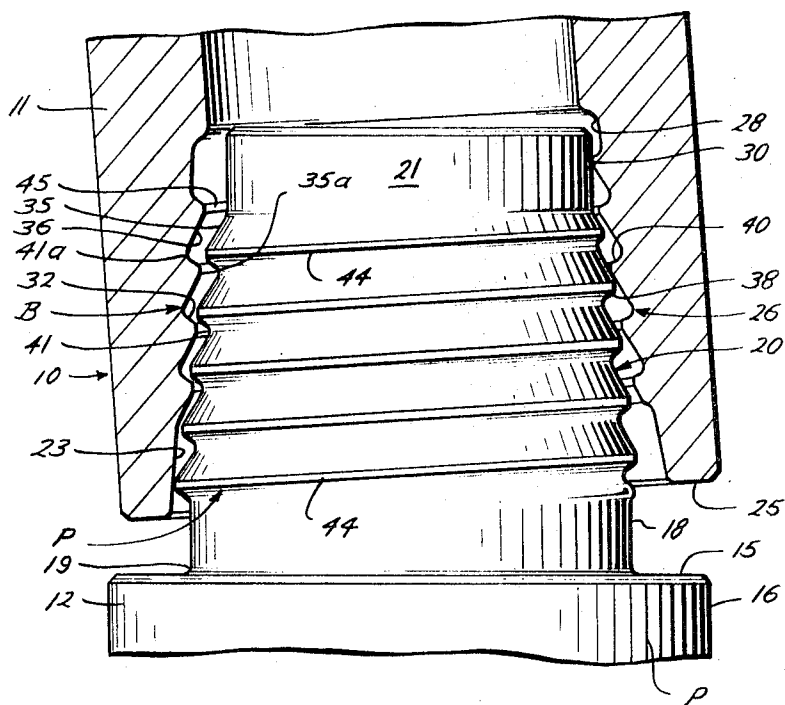


Fig. 2

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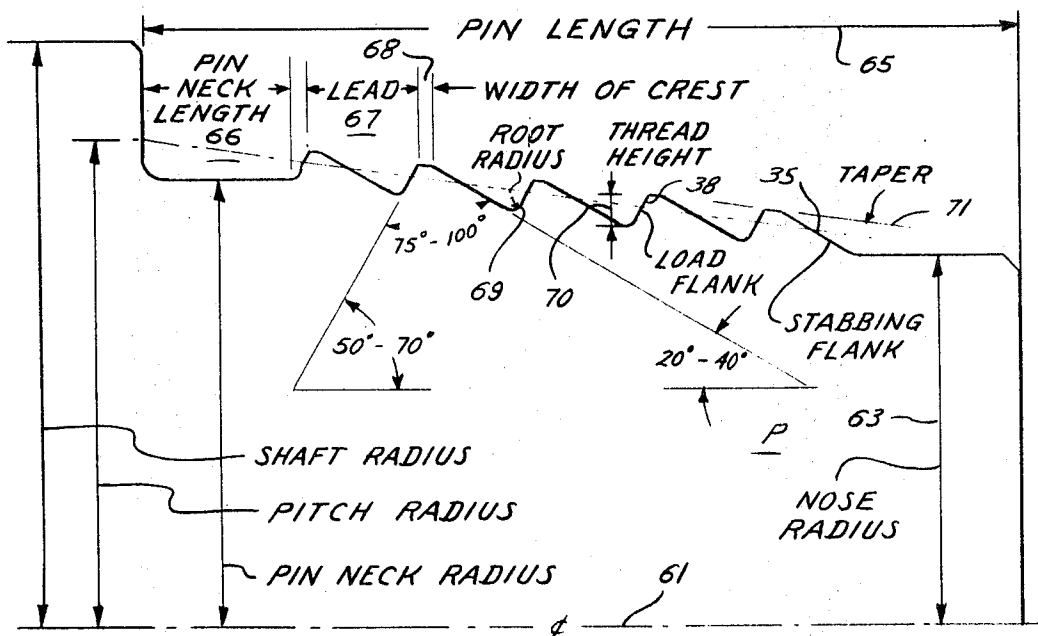
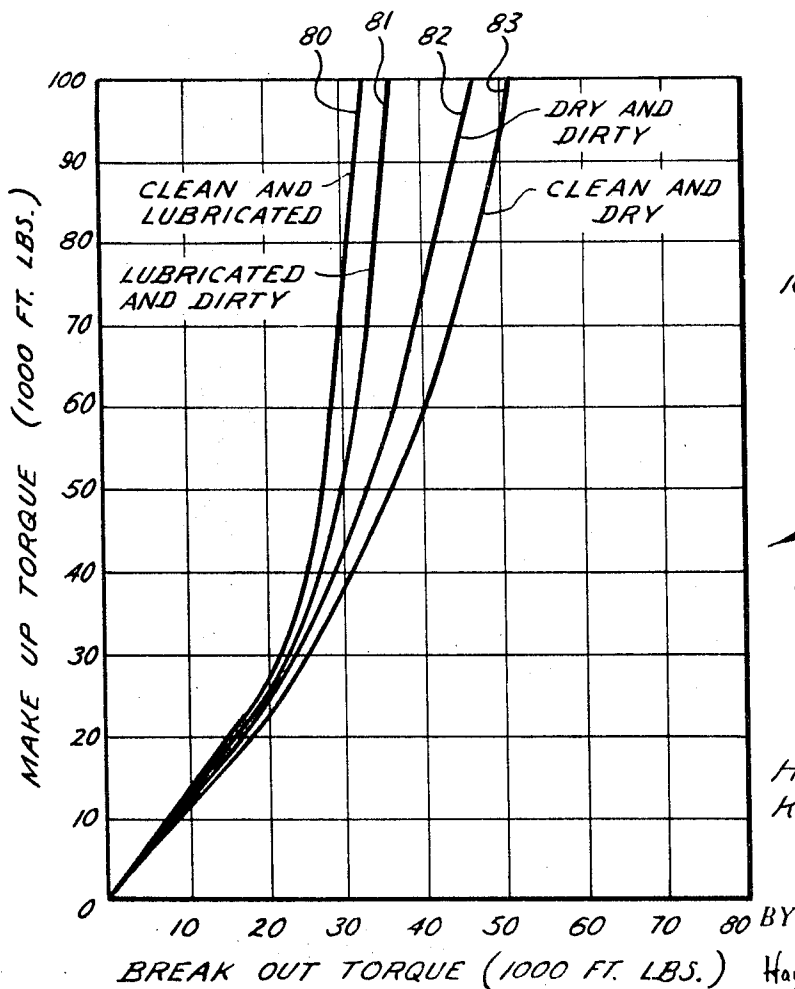


Fig. 3



TORQUE VALUES
TYPICAL FOR
10" O.D. JOINT

Fig. 4

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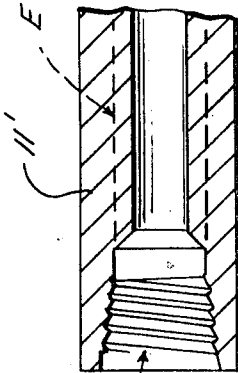
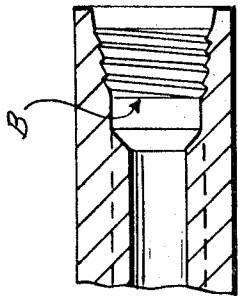


Fig. 6

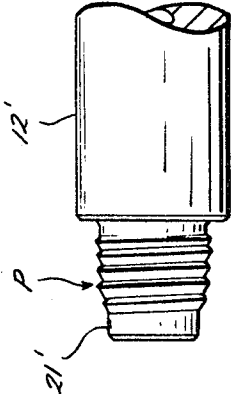
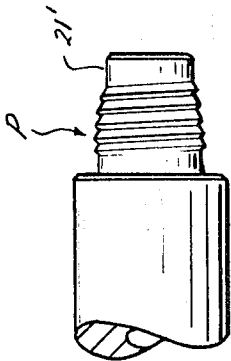


Fig. 5

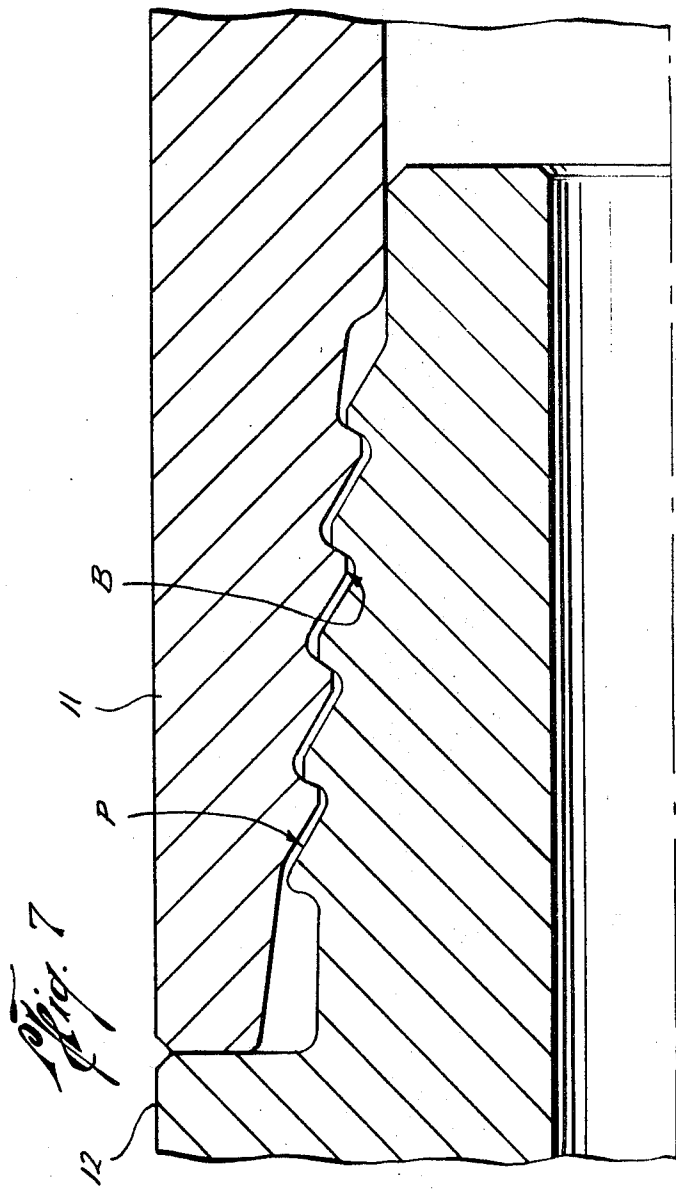


Fig. 7

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THREAD ARRANGEMENT FOR EARTH BORING MEMBERS

BACKGROUND OF the INVENTION

1. Field of the Invention

The present invention relates to a thread arrangement for connecting solid, or essentially solid shafts, as well as shafts having a longitudinal bore therethrough or use in earth boring operations wherein the thread arrangement is defined in terms of the geometry, including the diameter, or diameters, of the shafts upon which the thread is employed as opposed to absolute, unchangeable dimensions without regard to shaft geometry.

2. Description of the Prior Art

Applicants are aware of the patent to D.B. Robbins, U.S. Pat. No. 3,129,963 wherein a thread arrangement is shown for the pin and box of tubular members. In the Robbins patent the mating pin and box are described as having substantially complementary cooperating tapered surfaces on the flanks of the threads which are shown and understood to contact so that both flanks of each thread are loaded after make up. Also, the threaded complementary cooperating threaded surfaces on the male and female members are tapered approximately 7 to 9° from the longitudinal axis of the cylindrical members.

In the U.S. Pat. No. 3,355,192 to J.A. Kloesel, Jr. et al. it is contemplated that the threaded connections on the members are made up only hand tight and that applied torque during drilling makes up the threaded connections between the pin and box more fully.

Unfortunately, the thread contours of the prior art are such that they may cause excessive stress in the pins and boxes when they are connected together and possibly even splitting of the boxes and breaking off of the pins when high tensile loads as well as high rotational torques are applied thereto.

Also, in some instances, the pin and box of prior art threaded connections does not make-up to a predetermined make-up torque or to a predetermined level of torque so that the joint will not become loosened during use. On the other hand, some of the prior art teaches that it is preferable to make-up the connections only hand tight and let the joint tighten an unknown amount as it rotates. Also, in earth boring operations it is not always possible or economical to prevent dirt, sand, mud and particles of rock which are normally present during the earth boring operations and during the making of a connection or joining of sections of shaft together in earth boring operations from becoming caught or clogged between the pin and box as they are threadedly connected together. This foreign matter between the threaded portions on the pin and box sets up additional stresses within the pin and box during make-up and use of the shafts.

Additionally, with some prior art thread configurations it is impossible to predict the torque level necessary at which the shafts may be disconnected at the pins and boxes and thus it may, in some circumstances, be difficult if not impossible to determine the requirements of the tools necessary to disconnect the pin and box. Similarly in some situations where the amount of torque required or necessary to disconnect or break out the pin and box is unknown, it is also unknown as to whether the capability of the tools employed to break out the joints might be exceeded.

Another disadvantage with some of the threaded arrangements of the prior art is that the threaded a of the prior art is that the threaded arrangement on the pins and boxes of the shafts is not provided with cooperating unthreaded surfaces to aid in guiding the pin and box into initial thread contact as the pin and box are stabbed together, as well as aiding in transmitting high tensile and compressive loads, as well as large rotational forces and reverse bending moments after the pin and box are threadedly engaged.

Another disadvantage with some of the threaded arrangements with the prior art is that the thread configuration is empirically and unchangeably defined and predetermined

without regard to some of the characteristics of the shafts employed, such as the outer diameter of the shaft or tubular member in which they are to be employed, whether or not the shaft is solid or has a longitudinal bore extending therethrough.

SUMMARY OF THE INVENTION

The present invention provides a thread configuration for the pins and boxes of solid, or essentially solid shafts as well as shafts having a longitudinal bore extending therethrough for use in earth boring operations wherein the thread arrangement on the pin and box is related to various characteristics of the shaft such as the outer diameter of the shaft on which it is to be employed as well as to the inner diameter of any bore which may extend longitudinally therethrough, rather than being unchangeably fixed at some predetermined value.

Another object of the present invention is to provide a thread configuration for the pins and boxes of solid or essentially solid shafts as well as shafts having a longitudinal bore extending therethrough which is essentially unaffected by dirt, sand, mud and particles of rock which may be encountered during making the connection of joints in earth boring operations. Similarly, the thread configuration of the present invention renders the relationship of makeup torque to breakout torque virtually unaffected by variations in whether or not the pins and boxes are clean, or whether or not they are lubricated or nonlubricated.

Still another object of the present invention is to provide a thread arrangement for the pins and boxes of solid or essentially solid shafts, as well as shafts having a longitudinal bore extending therethrough for use in earth boring operations which thread arrangement is provided with a thread contour that tends to reduce the splitting of the boxes and the breaking off of pins caused by stress raising contours of other thread forms of the prior art.

Yet a further object of the present invention is to provide a thread configuration which reduces the tendency of boxes to split or the tendency of pins to break off caused by the pressure of foreign matter between the threads on pins and boxes thread during makeup and use, or the lack of adequate shoulder pre-load during makeup of the connection as a result of foreign matter between threads. In the present invention the thread arrangement for shafts is such that the shafts may be connected together in shoulder to shoulder abutment to prevent additional makeup during rotation of the shafts.

Additionally, the thread arrangement of the present invention is such that a consistent relationship between the amount of torque required to connect the thread arrangement on pins and boxes together and the amount of torque required to disengage pins and boxes is maintained, substantially regardless of foreign matter in the box or on the pin at the time that they are initially stabbed together and threadedly connected.

Yet a further object of the present invention is to provide a stabbing nose on the pin of a shaft in cooperation with a thread arrangement on pins and boxes of shafts to enable the pins and boxes to be more readily stabbed together and the threads initially contacted for subsequent threaded engagement to a predetermined amount of torque to inhibit subsequent relative rotation between the pins and boxes or additional makeup between the pin and box during use.

Still another object of the present invention is to provide a thread configuration on the pins and boxes of solid, or essentially solid shafts, as well as shafts having a longitudinal bore therethrough having certain parameters related to the outer diameter of the shaft, the inner diameter of any longitudinal bore extending through the shaft and other parameters as set forth in detail in the specification, so that the thread size will vary in relation to the outer diameter of the shaft, as well as the diameter of any bore therethrough.

Still another object of the present invention is to provide a thread arrangement for the pin and box of solid, or essentially solid shafts, as well as shafts having a longitudinal bore

therethrough wherein the thread crests on the pin and box have a desired length, and the roots of the threads on the pin and box are formed on a radius which is tangent to the thread flanks that the roots join together, with one thread flank being substantially longer and inclined more relative to the longitudinal axis of the shaft than the outer thread flank. The threaded arrangement is positioned on the pin and box between unthreaded portions thereon, with the unthreaded portions thereon, with the unthreaded portions on the pin being cylindrical, and one of which is to assist in stabbing two tubular members together and aid in maintaining rigidity when the members are threadedly engaged.

Still another object of the present invention is to provide a threaded arrangement for the pins and boxes of solid, or essentially solid shafts, as well as shafts having an internal bore therethrough for use in earth boring operations which is substantially unaffected by dirt, sand, mud or rock particles which are normally present during making the connection of joints in earth boring operations. The thread arrangement is contoured to reduce stresses that might occur in other thread arrangements and it will also transmit extremely high rotational torques in combination with extremely high compressive and tensile loads arising from imposed input power, shaft weight and alternating stresses resulting from high reverse bending moment.

The present invention is applicable in earth boring operations wherein the threaded connection between joints may be subjected to 2 million pounds, or even greater, if necessary, tensile loading and rotational forces, or torque to 300,000, or even greater, if necessary, foot pounds.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is a sectional view of a box formed in accordance with the present invention in a shaft having a bore therethrough, with the pin on an adjacent shaft being shown in elevation and stabbed in misalignment relative to the box;

FIG. 2 is a sectional view illustrating the pin and box of the present invention in final makeup position with the shoulder on the box in firm contact with a shoulder formed on the pin;

FIG. 3 is a diagrammatic representation of the threaded arrangement of the present invention on a pin of a shaft with nomenclature thereon related to the threaded configuration;

FIG. 4 is a graph illustrating the relationship of makeup torque to breakout torque with the threaded arrangement of the present invention when employed under various conditions;

FIG. 5 illustrates the thread configurations of the present invention on a tubular member having pin ends;

FIG. 6 illustrates the thread configuration of the present invention on a tubular member having box ends; and

FIG. 7 illustrates a partial sectional view of the thread configuration on a larger diameter member than that illustrated in FIG. 2.

DESCRIPTION OF THE PREFERRED EMBODIMENT

Attention is first directed to FIG. 1 of the drawings wherein the thread configuration of the present invention is referred to generally by the numeral 10. As described herein the shaft 11 and the shaft 12 shown in FIG. 2 are provided with internal bores 11a and 12a extending longitudinally thereof respectively; however, it is to be understood that the thread configuration of the present invention can be used on the pin and box of solid, or essentially solid shafts for connecting sections or lengths of shafts together, and that the illustration in FIGS. 1 and 2 employing the bores 11a and 12a longitudinally of the members 11 and 12 is for purposes of illustration only.

It can also be appreciated that the invention will be described in detail wherein a pin referred to generally by the letter P is provided on one end of a shaft 12 and a box designated generally by the letter B is provided on the other end of a shaft whereby adjacent joints or sections of shafts may be threadedly engaged by engaging the pin P on one shaft

with the box B on the next adjacent shaft as will be described in greater detail hereinafter. However, the invention can be as readily employed on shafts or tubular members having two pin ends, or two box ends as shown in FIGS. 5 and 6.

Referring to FIGS. 1, 2 and 3, the threaded arrangement on the pin P is defined by an annular shoulder 15 extends radially inwardly from the outer periphery 16 and terminates at the juncture with the cylindrical neck 18 which is on a smaller diameter than the outer diameter or outer periphery of the shaft. At the juncture of the cylindrical neck 18 and the shoulder 15 a curved surface 19 is formed and from the curved surface the cylindrical neck 18 extends longitudinally towards the threaded portion referred to generally by the numeral 20.

The threaded portion 20 on the pin P extends longitudinally from the cylindrical neck and the end threads thereon terminate in a manner well known in the art to define the beginning and termination of the threaded area or portion 20. Shown in FIG. 2 in solid line and extending longitudinally from the threaded portion 20 on the pin P is an unthreaded cylindrical nose 21 which extends to the end 22 of the shaft. The dotted line 60 represents the construction when the nose 21 is eliminated, as it may be in some situations.

The box B on each of these shafts is provided with an unthreaded portion 23 adjacent the outer end 25 of the box B which extends inwardly therefrom to the threaded portion referred to generally by the numeral 26. As with the pin P the threads on the box B are started and terminated in a manner well known in the art, and at the end of the threaded portion 26 on the box B, there is an unthreaded portion 28 which is recessed and extends longitudinally of the box B at the inner end thereof.

Generally speaking, in the type earth boring operations to which the present invention is directed, the box B will be stabbed downwardly over the pin P as illustrated in FIG. 1 of the drawings; however the present invention also may be used in situations where the pin is stabbed in the box. FIG. 1 illustrates the extreme or greatest misalignment that might occur during stabbing operations of a box B on a pin P and it can be noted that the unthreaded nose 21 abuts the last thread as represented at the numeral 30 and the threaded portion 20 on the pin P is engaged with one of the threads of the box B as represented at 32 in FIG. 1 so that upon relative rotation the box B and pin P are aligned and thereafter the threaded portions 20 and 26 on the pin P and box B engaged until the outer end or shoulder 25 of the box B abuts the shoulder 15 on the pin P and a predetermined amount of makeup torque applied thereto. When the shafts are made up to the predetermined amount of desired torque, the cylindrical neck will be telescopically received with the bore designated at 33 formed in the inner end of the box B.

Attention is now directed to the specific threaded configuration on a pin end P of a shaft or hollow tubular member and a conforming thread configuration on a box B of a shaft or hollow tubular member. It will be noted that each thread on the threaded portion 20 of the pin P is provided with one flank which may be designated as the stabbing flank and referred to by the numeral 35. Similarly a stabbing flank 36 is provided on each of the threads on the threaded portion 26 of the box B. Each of the threads is provided with two flanks and on the threaded portion 20 of pin P the other flank is referred to by the number 38 which is referred to as the load or pressure flank and the similar or mating thread flank on the threaded portion 26 of the box B is referred to by the numeral 40. It will be noted that the thread flanks 35 and 38 on each of the threads on the threaded portion 20 of the pin P are adjacent but opposed and are joined by the root 35a of each of the threads referred to by the numeral 41. Similarly the stabbing flank 36 and the load flank 40 on the threads of box B of the threaded portion 26 are adjacent but opposed and are joined by a root 41a. The roots of each of the threads on each of the threaded portions 20 and 26 are formed on a radius which is tangent to the thread flanks which the roots join together.

Each of the crests of each of the threads on the threaded portion 20 of the pin P is of a length referred to by the number 44 and each of the thread crests on the threaded portion 26 on the box B is of a length referred to by the number 45.

It will be noted that when the pin P and box B are threadedly engaged or made up the construction and arrangement of each of the threads on the threaded portion 20 and the construction and arrangement of each of the threads on the threaded portion 26 are such that the load flanks 38 and 40 will be engaged and the stabbing flanks 35 and 36 will be in spaced relation to its respective root when the pin and box are made up so that a continuous helical void is formed throughout the threaded portion 20 on the pin P and the threaded portion 26 on the box B.

The unthreaded portion 23, as more clearly seen in FIG. 2 of the drawings, is spaced relative to the cylindrical neck 18 formed on the pin P and extending longitudinally from the shoulder 15 to form annular void or space 50. Similarly the unthreaded portion 28 at the inner end of the box B is on a larger diameter than the portion 21a of the nose 21 adjacent thereto, as previously mentioned.

This arrangement enables any mud, dirt, scale, particles of rock or other contamination to be extruded through the voids formed between the threaded portions 20 and 26 and into the voids 50 and 51 at each end thereof as the joints are made up and thereby tends to reduce the tendency of the box B to split and the tendency of the pin P to break off caused by pressure of foreign matter between the threaded portion of the pin P and the threaded portion of the box B in other arrangements.

Similarly, attention is directed to the fact the stress raising contours of the threaded arrangement are substantially reduced in that there are no sharp corners or V-shaped edges formed on the threads which make up the threaded portion 20 on the pin P and the threaded portion 26 on the box B.

In addition, experience with the threaded arrangement with the present invention indicated that the relationship of breakout torque to make up torque remains substantially constant for the configuration embodied and described herein regardless of the presence or lack of foreign matter or the presence or lack of lubrication.

The configuration of the threaded connection of the present invention is related in part to the outside diameter of the shaft. In those instances where an internal bore extends longitudinally of the shaft, some dimensions are determined by considering the internal diameter of the bore as well. It can be appreciated that the present invention can be applied to shafts of any diameter and that the critical dimensions and arrangement of the threaded configuration are determined by the relationships as given hereinafter. Also, by way of example only there may be some slight variation—that is, the same thread may be used on a shaft of 7½ inches in diameter as on an 8½ inch diameter shaft. The preferred relationships are:

- thread lead = O.D. divided by about 10
- pin neck length = O.D. divided by about 7.25
- thread height = O.D. divided by about 40
- thread root radius = thread height divided by about 2
- thread crest length = thread height divided by about 2
- pin overall length = O.D. multiplied by about 0.8
- thread taper = (O.D. - I.D.), and this divided by about 2
- angle between adjacent but opposed thread flanks or surfaces = from about 75° to about 100°
- load flank angle relative to axis of shaft is from about 50° to about 70°
- stabbing flank angle relative to axis of shaft = from about 20° to about 40°
- pitch diameter = about 0.700 to about 0.800 of O.D. (.800 being preferred)
- nose diameter = about 0.625 to 0.700 of O.D. (0.675 being preferred)
- pin neck diameter = about 0.750 to about 0.800 of O.D. (0.750 being preferred)

Pitch diameter may be defined as the average diameter of the rests of the threads plus the average diameter of the roots of the threads divided by about 2.

It can be appreciated that where the thread taper is referred to that the "I.D." will be zero on a solid shaft, since there is no bore extending longitudinally therethrough (i.e. no I.D.). Similarly, where no nose 21 is used, the nose diameter will be zero. By way of example the threaded arrangement for a shaft having an outer diameter (O.D. in the foregoing relationships) of about 10" when using the above critical relationships would be as follows:

- thread lead is 10 inches divided by 10 = 1 inch
- pin root length is 10 inches divided by 7.25 = 1.38 inches
- thread height = 10 inches divided by 40 = 0.250 inch
- thread root radius = 0.250/2 = 0.125 inch
- thread crest length = 0.250/2 = 0.125 inch
- pin overall length = 10 inches multiplied by 0.8 = 8 inches
- thread taper is (10 inches - 4 inches divided by two times 10 inches 6 inches divided by 20 inches = 0.3 inch
- pitch diameter = 0.8 multiplied by 10 inches = 8 inches
- nose diameter = 0.675 multiplied by 10 inches = 6.75 inches
- pin neck diameter = 0.750 multiplied by 10 inches = 7.5 inches

Attention is directed to the fact that when the pin P and the box B are threadedly engaged as shown in FIG. 2 of the drawings, and the pin P and box B are made up to the desired torque the nose 21 will snugly fit within the bore 33 formed in the inner end of the box B to aid in maintaining rigidity and resist bending moments. It can be appreciated that where the shaft is not provided with a bore 11a as shown in FIG. 2 of the drawings then the bore 33 in which the pin 22 is telescopically received, would terminate adjacent the end 22 of the nose 21.

It will be noted that the pin neck 18 has a constant cross section throughout its length which is considerable relative to the threaded portion 20 on the pin P. The combined stresses on the pin neck 18 are distributed evenly over the length of the cylindrical neck 18 and the construction may withstand very large stresses, thus reducing the likelihood of failure compared with what it would be in the absence of the relatively long uniform cylindrical neck 18 as embodied in the present invention.

When the pin and box are made up, the nose 21 fits snugly within the bore 33 of the box B and aids in preventing wobbling of the connected shaft during operation. This close fit between the joints provides an arrangement which will transmit extremely high rotational torques in combination with extremely high compressive and tensile loads arising from imposed input power, weight of the shafts connected together in addition to forces arising from alternating stresses resulting from high reverse bending moments.

While the pin neck 18 is a critical section from the standpoint of possible failure due to the fact that combined stresses induced by torque-up, or joint makeup preload, working tensile load and applied bending moments are all additive, it can also be appreciated that the roots of all of the engaged threads on the threaded portions 20 and 26 respectively are subject to tensile loads and are hence subject to failure. However, the thread configuration of the present invention employs a thread root of a large radius which minimizes the likelihood of tensile or fatigue failures in this portion of each of the threaded portions on the box B and pin P by embodying a complete and maximum radius which is tangent to both thread flanks with which it is joined at each end.

It can be appreciated from viewing the threaded arrangement shown in FIGS. 1 and 2 of the drawings that the threaded portion 20 on the pin P reduces in diameter from the cylindrical neck 18 to the nose 21 to provide a taper in the threaded portion 20. Similarly the threads of the threaded portion 26 on the box B are on a larger diameter than the last thread adjacent the unthreaded portion 28 at the inner end of the box B so that the threaded portion 26 is also generally tapered.

By referring to FIG. 3 the diameter of the nose 21 is determined by the diameter as represented by the dotted line extending across FIG. 2 and referred to by the numeral 60. In FIG. 3 only one half of the pin is represented, the center line being indicated by the line 61 so that the distance represented by the line 63 is the nose radius.

It will be noted that the pin length is represented by the total length of the pin from the shoulder 15 to the end 22 of the pin and identified by the line 65. Similarly the length of the cylindrical pin neck 18 is represented at 66, the lead of the threads at 67; the width of the crest of each thread at 68; the thread root radius at 69; the thread height at 70 and the taper of the thread by the line 71 which is a line in a plane tangent to the crest of the threads on the pin and the box respectively and its angular relationship to the longitudinal axis of the shaft represented by the centerline 61. The angle between the load flanks and stabbing flanks is shown as being between 75 to 100°, with the stabbing flank angle relative to the axis of the shaft being 20° to 40° and with the load flank angle relative to the axis of the shaft being 50° to 70°.

It will be noted that the stabbing flank is inclined more relative to the longitudinal axis of the shaft than the load flank as more clearly illustrated in FIG. 3 of the drawings. Also, the stabbing flank of each thread is substantially longer than the load flank of each thread so that when the pin P and box B are initially stabbed together there is a substantial surface contact between the stabbing flanks on the pin P and box B.

FIG. 4 is a chart representing torque values typical for a 10 inches outer diameter shaft or joint with the vertical axis on the left representing the makeup torque in units of thousand foot pounds and the horizontal axis representing the breakout torque in thousand foot pounds. It will be noted that when the pin and box are clean and lubricated, for example, a predetermined makeup torque of approximately 72,000 foot pounds will require a breakout torque of 30,000 foot pounds. This is represented by the line 80. The line 81 represents the relationship of makeup torque to breakout torque when the pin and box are lubricated and dirty, and the curve 82 represents the same when the pin and box are dry and dirty, and the line 83 represents the same when the pin and box are dry and clean.

It will be noted that the curves or lines 80, 81, 82 and 83 present a family of curves so that the relationship of makeup torque to breakout torque is shown as being substantially constant regardless of the condition of the joint. In using the present invention it is preferred that the joint be made up to a predetermined torque initially to prevent additional makeup during use, as such condition is highly undesirable in earth boring operations. The predetermined makeup torque can be applied in any well-known manner as the pin and box are threadedly engaged.

Also, it can be appreciated that the misalignment represented in FIG. 1 of the drawings most often would occur when earth boring operations are conducted on other than in a vertical opening; however such misalignment may occur as well in a vertical bore.

By referring to the chart, FIG. 4, it can be appreciated that the threaded arrangement of the present invention gives a constant relationship between makeup torque and breakout torque generally regardless of the presence of foreign matter in the threads or the type and/or amount of lubrication or lack of lubrication in the pin and box when they are engaged. This is quite advantageous in that the threaded arrangement when employing the critical parameters as hereinbefore given achieves proper and predictable breakout torque to disengage the pin and box from each other.

Also, by applying a predetermined make up torque to connect the pin and box together it is possible to ascertain the compressive loads and stresses in the shoulder areas of the pin and box and the offsetting tensile loads and stresses in the pin and neck so as to operate or conduct the earth boring operations within the design limits of the threaded arrangement and shafts.

In FIG. 5, a shaft or tubular member 12' is shown wherein a pin P is provided on each end, and in FIG. 6 the shaft 11' is shown as having a box B on each end. It is contemplated that the thread configuration on shafts 11' and 12' will have parameters similar to that previously set forth herein.

When using the arrangement of FIGS. 5 and 6, it can be appreciated that the drill string will be composed of a shaft 11' and then a shaft 12', so that the pins and boxes can be

threadedly engaged. Also, while the shafts are shown as being hollow, they may be solid and the nose 21' may be eliminated as previously discussed with regard to FIG. 2. If desired, the shaft 11' may have a bore as shown, or the bore may be enlarged by removing the material along the dotted lines E, thus saving some material.

FIG. 7 is a sectional view of a part of a threaded connection and illustrates that the thread size of the present invention increases as the shaft outer diameter increases to provide a stronger thread for larger shafts. A shaft 12 is shown as having a pin P and a box B and shaft 11 is shown engaged therewith. It can be seen from FIG. 7 that as the outer diameter of the shafts increase, the thread size of the present invention also increases. This increases the area of the stabbing flank and load flank to initially accommodate the impact loading on the stabbing flanks as the shafts are stabbed together, and by increasing the area of the load flank in proportion to the shaft diameter, a greater load carrying area is provided. WHAT WE CLAIM IS:

1. A thread configuration for the pin and box of shafts for connecting the shafts together, said thread configurations having the following characteristics:

- a. thread lead = O.D. divided by about 10;
- b. pin neck length = O.D. divided by about 7.25;
- c. thread height = O.D. divided by about 40;
- d. thread root radius = thread height divided by about two;
- e. thread crest length = thread height divided by about two;
- f. pin overall length = O.D. multiplied by about 0.8;
- g. thread taper = (O.D. - I.D.) and this divided by about two times O.D.;
- h. angle between flanks = about 75° to about 100°;
- i. load flank angle relative to axis of shaft = about 50° to about 70°;
- j. stabbing flank angle relative to axis of shaft = about 20° to about 40°;
- k. pitch diameter = about 0.700 to about 0.800 of diameter;
- l. nose diameter = about 0.625 to about 0.700 of diameter;
- m. pin neck diameter = about 0.750 to about 0.800 of diameter;
- n. wherein O.D. is the outer diameter of the shafts;
- o. wherein thread lead is the number of threads per inch;
- p. wherein pin neck length is the length of the cylindrical surface on the pin from the end of the threads to the shoulder on the pin;
- q. wherein thread height is the vertical distance from the root to the crest of the thread;
- r. wherein pin overall length is the length of the pin from said shoulder to the end of the pin;
- s. wherein I.D. is the internal diameter of any bore extending through the shafts;
- t. wherein thread taper is represented by a line in a plane tangent to the crests of the threads on the pin and box and its angular relationship to the longitudinal axis of the shafts;
- u. wherein pitch diameter is average of diameter of crest of thread and average diameter of root of thread divided by 2;
- v. wherein the angle between the flanks is the angle between two adjacent, opposed surfaces of a thread;
- w. wherein the load flank is the surface of the thread on the pin which engages a similar thread surface on the box when the pin and box of the shafts are made up; and
- x. wherein the stabbing flank is the surface of the thread on the pin which is not engaged with a similar thread surface on the box when the pin and box of the shafts are made up.

2. A threaded connection for shafts comprising:

- a. a box of at least one end of one of the shafts; b. a pin on at least one end of another shaft, said pin and box having a conforming thread configuration whereby adjacent shaft ends may be connected together by threadedly engaging the pin of one of said shafts in the box of the other shaft;
- c. said pin including a shoulder projecting inwardly from the outer diameter of the shaft;

- d. a cylindrical neck extending longitudinally from said shoulder and on smaller diameter than the outer diameter of said shaft;
 - e. a threaded portion on said pin and extending longitudinally from said cylindrical neck an unthreaded cylindrical nose extending longitudinally from said threaded portion;
 - f. said box having an unthreaded portion adjacent its outer end which is in spaced relation to said cylindrical neck on said pin when said pin and box are made up to provide an annular space adjacent the outer end of said box between said pin and box when they are made up;
 - g. a threaded portion extending from said unthreaded portion into said box;
 - h. said box having an unthreaded portion adjacent and extending longitudinally from said threaded portion in said box and being in spaced relation to at least a portion of said cylindrical nose on said pin when said box and pin are threadedly made up to provide an annular space adjacent the inner end of said box between said pin and box when they are made up;
 - i. said threaded portion on said pin and box being tapered and each thread having two adjacent flanks, one of said flanks on said pin for contacting a similar flank on said box when said pin and box are stabbed together to be made up, and the other of said flanks on said pin engaging a similar flank on said box to transmit load in said connection when said pin and box are made up;
 - j. said flanks on said threads on said pin which engage said flanks on said threads on said box when said pin and box are stabbed together to be made up being in spaced relation when said pin and box are made up to form a helical void therebetween when said pin and box are connected together;
 - k. the crests of said threads in said pin and said box being flat and having a predetermined length;
 - l. the roots of said threads in said pin and box being formed on a radius which is tangent to the thread flanks which said roots join together whereby said flat crests of said threads are in spaced relation to said roots when said pin and box are made up to form a void which communicates with the void formed between said stabbing flanks when said pin and box are made up; and
 - m. said annular spaces adjacent the inner end and outer end of said box communicating with said voids whereby contamination on said pin and box may be extruded thereinto as said pin and box are made up.
3. The invention of claim 2 wherein said shafts are solid.
 4. The invention of claim 2 wherein said shafts are provided with an internal bore therethrough.
 5. The invention of claim 2 wherein said thread configuration on said pin and box has the following characteristics:
 - a. thread lead = O.D. divided by about 10;
 - b. pin neck length = O.D. divided by about 7.25;
 - c. thread height = O.D. divided by about 40;
 - d. thread root radius = thread height divided by about 2;
 - e. thread crest length = thread height divided by about two;
 - f. pin overall length = O.D. multiplied by 0.8;
 - g. thread taper = (O.D.-I.D.) divided by about two multiplied by O.D.;
 - h. angle between flanks = about 75° to about 100°;
 - i. load flank angle relative to axis of shaft = about 50° to about 70°;
 - j. stabbing flank angle relative to axis of shaft = about 20° to about 40°; and
 - k. wherein O.D. is the outer diameter of the shaft.
 6. The invention of claim 1 wherein said box has an unthreaded cylindrical portion extending from said unthreaded portion next to said threaded portion for receiving

said cylindrical nose of said pin when pin and box are threadedly made up.

7. A thread configuration for the pin of a shaft having the following characteristics:

- a. thread lead = O.D. divided by about 10;
- b. pin neck length = O.D. divided by about 7.25;
- c. thread height = O.D. divided by about 40;
- d. thread root radius = thread height divided by about two;
- e. thread crest length = thread height divided by about two;
- f. pin overall length = O.D. multiplied by about 0.8;
- g. thread taper = (O.D.-I.D.) and this divided by about two times O.D.;
- h. angle between flanks = about 75° to about 100°;
- i. load flank angle relative to axis of shaft = about 50° to about 70°;
- j. stabbing flank angle relative to axis of shaft = about 20° to about 40°;
- k. pitch diameter = about 0.700 to about 0.800 of diameter;
- l. pin neck diameter = about 0.750 to about 0.800 of diameter;
- m. wherein O.D. is the outer diameter of the shaft;
- n. wherein thread lead is the number of threads per inch;
- o. wherein pin neck length is the length of the cylindrical surface on the pin from the end of the threads to the shoulder on the pin;
- p. wherein thread height is the vertical distance from the root to the crest of the thread;
- q. wherein pin overall length is the length of the pin from said shoulder to the end of the pin;
- r. wherein I.D. is the internal diameter of any bore extending through the shaft; and
- s. wherein thread taper is represented by a line in a plane tangent to the crests of the threads on the pin and its angular relationship to the longitudinal axis of the shaft.

8. The invention of claim 8 wherein said shaft is solid.

9. The invention of claim 8 wherein said shaft is provided with an internal bore therethrough.

10. The invention of claim 8 wherein there is an unthreaded cylindrical nose extending from said threaded portion on said pin to the end of said shaft.

11. A thread configuration for the box of a shaft having the following characteristics:

- a. thread lead = O.D. divided by about 10;
- b. thread height = O.D. divided by about 40;
- c. thread root radius = thread height divided by about two;
- d. thread crest length = thread height divided by about two;
- e. thread taper = (O.D.-I.D.) and this divided by about two times O.D.;
- f. angle between flanks = about 75° to about 100°;
- g. load flank angle relative to axis of shaft = about 50° to about 70°;
- h. stabbing flank angle relative to axis of shaft = about 20° to about 40°;
- i. pitch diameter = about 0.700 to about 0.800 of diameter;
- j. wherein O.D. is the outer diameter of the shaft;
- k. wherein thread lead is the number of threads per inch;
- l. wherein thread height is the vertical distance from the root to the crest of the thread;
- m. wherein I.D. is the internal diameter of any bore extending through the shaft; and
- n. wherein thread taper is represented by a line in a plane tangent to the crests of the threads on the box and its angular relationship to the longitudinal axis of the shaft.

12. The invention of claim 12 wherein said shaft is solid.

13. The invention of claim 12 wherein said shaft is provided with an internal bore therethrough.

14. The invention of claim 12 wherein there is an unthreaded cylindrical nose extending from said threaded portion on said pin to the end of said shaft.

UNITED STATES PATENT OFFICE
CERTIFICATE OF CORRECTION

Patent No. 3,586,353 Dated June 22, 1971

Inventor(s) HOWARD I. LORENZ AND KEES M. VERHEUL

It is certified that error appears in the above-identified patent and that said Letters Patent are hereby corrected as shown below:

Column 1, lines 65 and 66, cancel "a of the prior art is that the threaded".

Column 2, lines 42, 43, 47, and 63; Column 3, lines 40 and 45, change "makeup" to --make-up--.

Column 4, line 6, after "15" insert --which--.

Column 4, line 54, change "threaded" to --thread--.

Column 5, line 37, change "indicated" to --indicates--.

Column 5, line 60, after "2" insert --times the O.D.--.

Column 5, line 74, change "rests" to --crests--.

Column 6, line 16, before "6" insert -- =--.

Column 5, line 5, change "p" to --P--.

Column 6, line 30, change "hose" to --nose--.

Column 7, lines 24, 28, 31, 37, 41, 43, and 53, change "makeup" to --make-up--.

Column 10, line 1, before "pin" insert --said--.

Column 10, line 67, change "n" to --an--.

Signed and sealed this 14th day of March 1972.

(SEAL)
Attest:

EDWARD M. FLETCHER, JR.
Attesting Officer

ROBERT GOTTFICHALK
Commissioner of Patents