

Oct. 16, 1962

W. E. BOUR
ROLL HEAD

3,058,196

Filed March 9, 1959

3 Sheets-Sheet 1

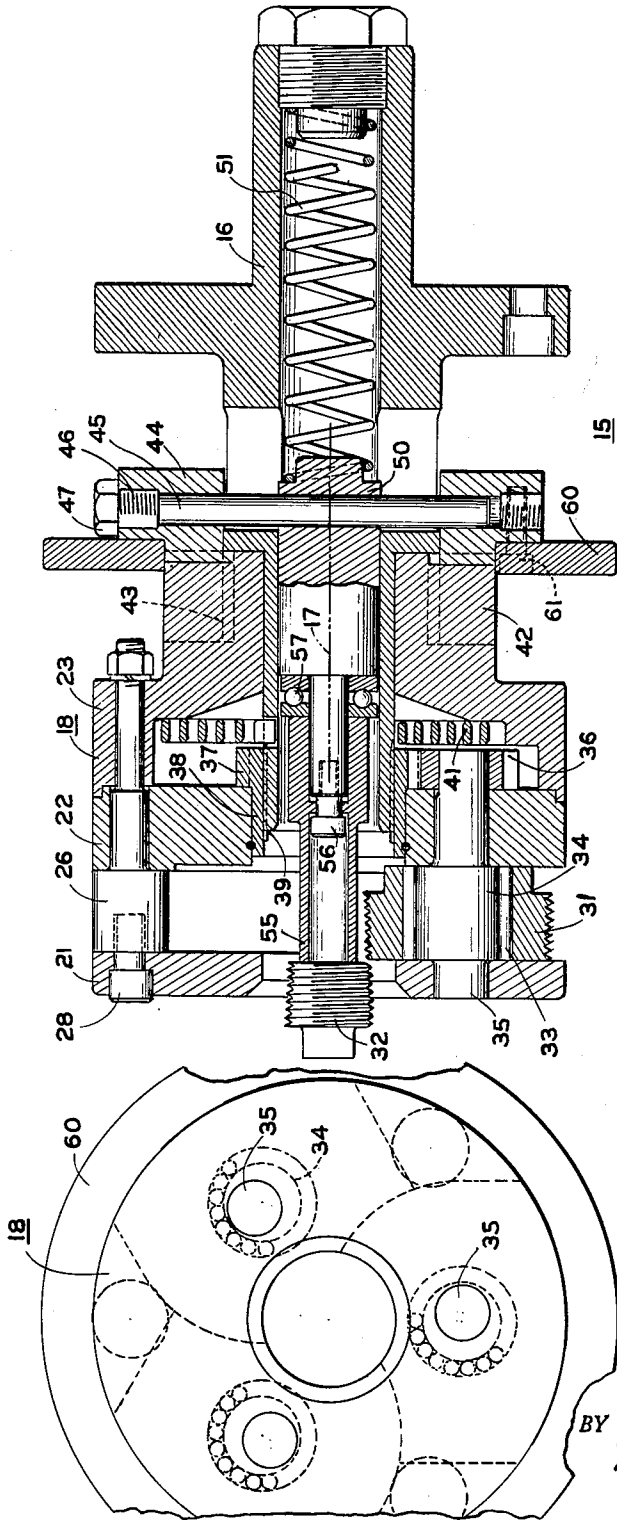


FIG. 1

FIG. 2

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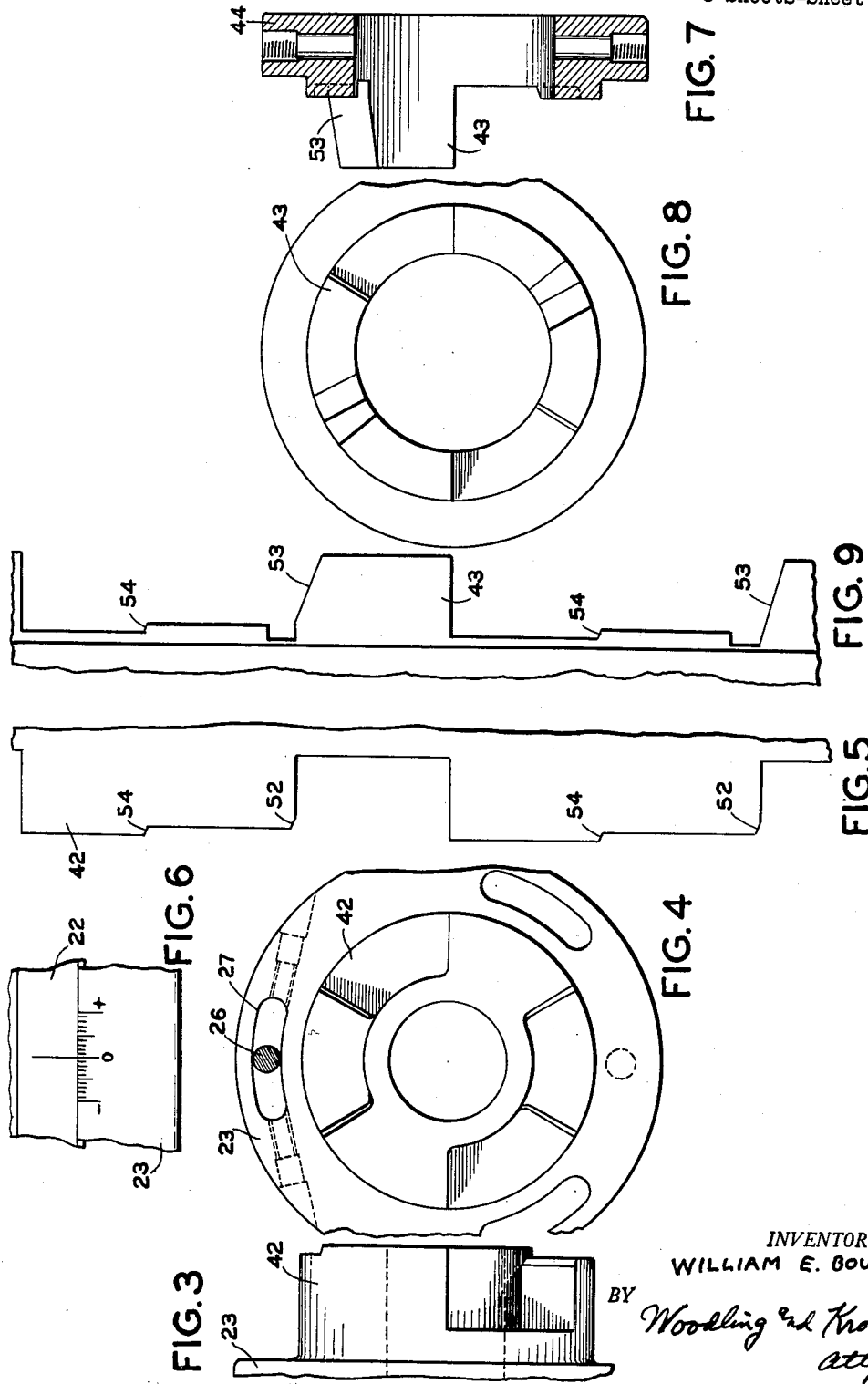
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3 Sheets-Sheet 2



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3 Sheets-Sheet 3

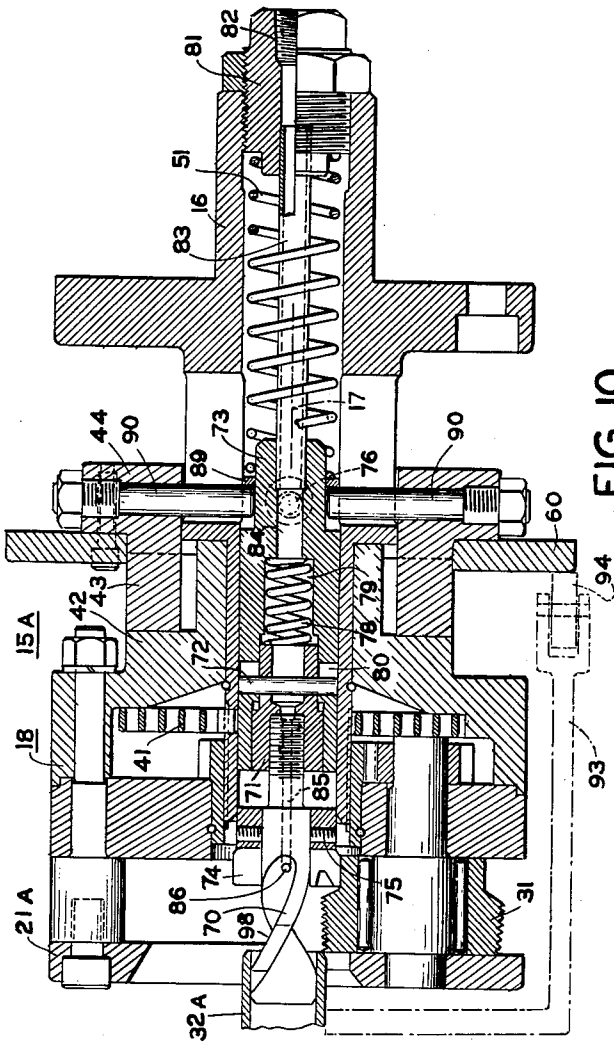


FIG. 10

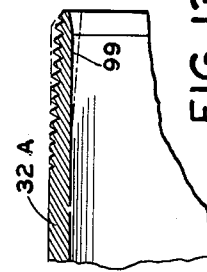


FIG. 13

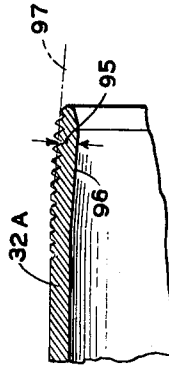


FIG. 12

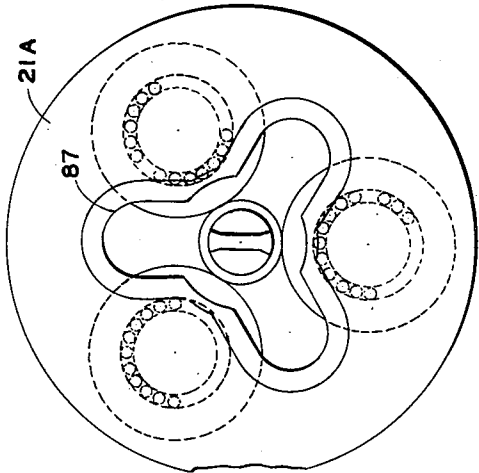


FIG. 11

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3,058,196

ROLL HEAD

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Filed Mar. 9, 1959, Ser. No. 798,225
16 Claims. (Cl. 29—35)

The invention relates in general to variable diameter roll heads and more particularly to a roll head capable of cold working a workpiece to form threads of different diameters on the workpiece.

Thread rolling heads have been used in the past for machine threads of constant diameter and have proved their superiority over cut threads in quality of finish and speed of production.

An object of the invention is to provide a thread rolling head which will produce variable diameter threads such as tapered pipe threads.

Another object of the invention is to provide a roll head with rolls for cold working a workpiece to deform the metal of the workpiece in a variable diameter as the working progresses axially.

Another object of the invention is to provide a roll head wherein the thread rolls are controlled in movement by a profile cam which can change the diameter of the workpiece as the threading progresses.

Another object of the invention is to provide a roll head wherein thread rolls move outwardly slowly to produce a tapered thread and then move out rapidly to provide a rapid opening action of the roll head.

Another object of the invention is to provide a roll head with a clutch to provide a tapering retractile movement of the thread forming means and also to provide a rapid retractile or collapsing movement of the thread forming means.

Another object of the invention is to provide a thread rolling head to roll tapered or changing diameter threads on either solid or hollow workpieces.

Another object of the invention is to provide a method of forming taper threads on a hollow workpiece.

Another object of the invention is to provide a method wherein a taper thread is rolled on a hollow workpiece during axial advancing movement and; subsequently, the hollow workpiece is drilled to a cylindrical internal surface during the retractile movement.

Another object of the invention is to provide a thread roll head with a drill which enters a hollow workpiece and then the head axially forms a taper thread on the external surface of the hollow workpiece and simultaneously crushes or deforms the workpiece to a tapered internal bore and then on the retracting movement the drill drills the hollow workpiece to a cylindrical bore.

Other objects and a fuller understanding of this invention may be had by referring to the following description and claims, taken in conjunction with the accompanying drawings, in which:

FIGURE 1 is a longitudinal sectional view of a roll head in accordance with the invention.

FIGURE 2 is a front view of the head of FIGURE 1.

FIGURE 3 is a side elevational view of the dog clutch on the roll head.

FIGURE 4 is a rear elevational view of the dog clutch of FIGURE 3.

FIGURE 5 is a developed view of the clutch surface of FIGURE 4.

FIGURE 6 is a fragmentary view of the dog clutch and frame showing the adjustment calibration.

FIGURE 7 is a longitudinal sectional view of the clutch collar.

FIGURE 8 is a front elevational view of the clutch collar.

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FIGURE 9 is a developed view of the clutch surface of FIGURE 8.

FIGURE 10 is a longitudinal sectional view of a modified roll head.

5 FIGURE 11 is a front elevational view of the roll head of FIGURE 10.

FIGURE 12 is a fragmentary view of the workpiece during the thread rolling operation and;

10 FIGURE 13 is a fragmentary view of the workpiece after completion of the thread forming operation.

FIGURES 1 and 2 show a roll head 15 shown as a taper roll head and which includes generally a shank 16 having an axis 17 and a frame 18 coaxial with the shank 16. The frame includes generally a front and rear plates 21 and 22 and a spring housing 23. A plurality of headed bolts 26 adjustably fasten together the rear plate 22 and the spring housing 23 with the bolts 26 passing through arcuate slots 27 in the spring housing for this adjustment purpose. Cap screws 28 fasten the front plate 21 into the heads of the bolts 26 so as to fasten together the various parts of the frame 18.

A plurality of rolls act on the workpiece such as two or three rolls, and FIGURES 1 and 2 show three thread rolls 31 cold working a workpiece 32 to form a thread thereon. The workpiece 32 has been shown as a solid pipe plug on which tapered threads have been formed by the roll head 15.

The thread rolls 31 are journaled on roller bearings 33 on eccentric portions 34 of shafts 35. These shafts are journaled in the front and rear plates 21 and 22 for arcuate movement. The shafts 35 are skewed at a slight angle so that the cold working surface on the thread rolls 31 is in the form of annular grooves rather than a true thread. Each shaft 35 carries a pinion 36 and all pinions mesh with a central spur gear 37 which has a hub 38 journaled on the second plate 22 and this gear in turn is splined to the shank 16 at 39. This gearing provides that when the center gear 37 rotates relative to the rear plate 22, the pinions 36 will rotate to rotate the shafts 35 and move the eccentrics 34 so that the thread rolls 31 are moved toward or away from the axis 17.

A torsion spring 41 interconnects the spring housing 23 and the shank 16 and urges the frame 18 in a first rotational direction relative to the shank which rotational direction is the same as the direction of rolling the particular thread onto a workpiece. For the right hand threads shown, this is a clockwise movement of the frame as viewed from the rear end of the roll head 15. A dog clutch includes a first clutch part 42 on the spring housing 23 and a second clutch part 43 on a collar 44. The collar 44 is coaxial on the shank 16 and is slideably mounted thereon but is prevented from relative rotation therewith by a transverse bar 45 having a threaded end 46 engaging the collar and locked by a lock nut 47. The transverse bar 45 passes through a central shaft 50 which is urged toward the front of the roll head 15 by an axial compression spring 51 so that the entire collar 44 is urged axially forwardly.

The first clutch part 42 on the spring housing 23 has first mating surfaces 52, see FIGURES 3 to 9, and the second clutch part 43 has second mating surfaces 53. These mating surfaces may mutually engage and the mating surfaces are long in an axial direction and the second mating surfaces 53 are axially tapering in the first rotational direction. As shown in FIGURE 1 the axial spring 51 axially urges together the clutch parts 42 and 43, and the torsion spring 41 rotationally urges together the mating surfaces 52 and 53. The first and second clutch parts are also provided with arcuate stop surfaces 54 which come into mutual engagement when the clutch parts have been separated axially sufficiently

so that the torsion spring 41 causes rotation between the clutch parts 42 and 43. This arcuate movement has been shown as being about 60 degrees and during this movement the thread rolls 31 rapidly move away from the axis 17 to effect an opening movement of the roll head 15. During the axial separation movement of the clutch parts 42 and 43, the mating surfaces 52 and 53 are urged into engagement by the torsion spring 41 and during this axial movement there is a slight relative rotational movement of the clutch parts because of the tapered mating surface 53. This slight rotational movement of the frame 18 relative to the shank 16 rotates the pinions 36 slightly to gradually move the thread rolls 31 outwardly. This forms a taper thread on the workpiece 32 as the workpiece and roll head are relatively axially advanced.

The axial separation of the clutch parts 42 and 43 in accordance with the relative axial advancing movement of the workpiece and roll head is effected by a work stop 55. This work stop 55 is loosely held on the shaft 50 by a bolt 56 and acts on this shaft through a thrust bearing 57. Thus as the workpiece 32 and the roll head 15 axially advance, the work stop 55 abuts the workpiece 32 and, hence, there is relative axial movement by the clutch parts 42 and 43 in accordance with this relative axial movement.

A disc 60 may be fastened to the collar 44 by the bolts 61 and this disc 60 may be engaged by a yoke, not shown, which is axially stationary relative to the workpiece 32. When this disc 60 is used the work stop 55 need not be provided since action of the yoke against disc 60 will provide for relative axial movement of the clutch parts 42 and 43 in accordance with the relative axial movement of the workpiece 32 and roll head 15.

Operation

The roll head 15 may be used in either stationary or rotating applications and in either application the roll head may be axially stationary or movable. The roll head 15 may thus be used in any one of four different modes of operation as long as there is relative axial movement between the roll head 15 and workpiece 32 as well as relative rotational movement. As the roll head 15 is used in an application wherein the head itself rotates and the blank workpiece 32 is fed axially into the roll head, then the workpiece moves into the space between the thread rolls 31 and contacts the work stop 55 approximately at the same time that the thread rolls 31 begin operation on the blank workpiece. The first one or two threads on the thread rolls 31 are chamfered so as to facilitate the beginning of the thread rolling operation. As the workpiece 32 feeds axially into the thread rolls 31 the work stop 55 moves the collar 44 backwardly against the urging of the coil spring 51. This means that the first and second clutch parts 42 and 43 begin to axially separate and because the mating surface 53 is tapered the spring housing 23 commences to rotate clockwise, as viewed from the rear, relative to the shank 16. In FIGURE 2, this means that the frame 18 is rotating counter-clockwise and; hence, the pinions 36 roll on the center gear 37 so that the shafts 35 turn counter-clockwise relative to the frame 18. This moves the centers of the eccentrics 34 gradually outwardly away from the axis 17 and; therefore, a taper thread is formed on the workpiece 32 during the axial movement wherein the mating surfaces 52 and 53 are in engagement. If the mating surface 53 is made other than a straight surface, as shown in the developed view thereof, the taper thread will be changed to a sloping or variable diameter surface directly in accordance therewith.

The length of the mating surface 53 is preferably made proportional to the length of the taper thread desired on the workpiece 32, and at the end of the thread rolling operation the dog clutch 42-43 has been axially separated sufficiently so that a rapid arcuate movement takes place under urging of the torsion spring 41. This rotates the

frame 18 relative to the shank 16 through an arc of about 60 degrees, as shown in FIGURES 3-9, until the arcuate stop surfaces 54 come into engagement. This is a rapid opening movement of the roll head so that the thread rolls 31 rapidly move away from the axis 17 so that the workpiece 32 and roll head 15 may be axially separated in a retracting movement without unthreading these two parts.

As the mating surfaces 52 and 53 are changed in surface contour, the amount of taper on the workpiece 32 will change accordingly and the mating surface 53 may be changed to slope even in the reverse rotational direction, if desired, to form a gradually decreasing diameter on the workpiece rather than gradually increasing diameter.

The roll head 15 may easily be reclosed ready for another thread rolling operation. This reclosing action is performed by relative rotational movement of the frame 18 and shank 16 in a second or reverse rotational direction. Viewing FIGURE 2, this is a clockwise rotational movement of the frame 18 relative to the shank 16, for right hand threads. When the head 15 is used in rotatively stationary applications, this closing may readily be accomplished by the operator grasping and rotating the frame 18, or a handle fastened thereto. For rotating head applications, the head may be closed by applying a braking force to some part of the frame 18, such as a pinch brake on the outer periphery thereof, because the second rotational direction is opposite to the first or thread rolling rotational direction. Inertia closing may also be used for rotating applications, and relies on the mass of the frame 18. In this method, the spindle chucking and driving the shank 16 is momentarily slowed and then re-accelerated, and during such acceleration the inertia of the frame 18 causes it to accelerate not as rapidly, hence the shank moves more quickly in the first rotational direction to close the clutch 42-43. In all these closing actions, once the clutch parts 42 and 43 have been rotated sufficiently in the second rotational direction so that the mating surfaces 52 and 53 are aligned, the axial urging of the spring 51 will effect axial closing of the clutch.

The mating surface 53 is shown as a tapered surface, but more broadly may be considered a profile cam controlling the movement of the thread rolls. If this mating surface is changed from a taper to one having two axially parallel portions with a step therebetween, then the thread rolls will roll a workpiece with a thread having a constant diameter until the step is reached, whereupon the workpiece diameter will be changed and a second part of the workpiece thread will be rolled at a different diameter, which may be either larger or smaller. Also, one part of the profile cam may be axially parallel and another part tapered or of any other desired shape, so that the threaded workpiece will have a shape as dictated by this profile cam 53.

FIGURES 10 and 11 show a modified form of the invention wherein the roll head 15A is adapted primarily for forming threads on the external surface of a workpiece 32A. In this modification the work stop 55 is removed and instead a central drill 70 is provided. This drill is threaded into a sleeve 71 which is fastened by a cross pin 72 to a central shaft 73. A chamfer tool 74 is fastened to the drill 70 by set screws 75. The central shaft 73 is fastened to the shank 16 by a set screw 76 threaded in the shank 16 and bearing against a flat on the shaft 73. Thus the drill 70 is rotatively stationary relative to the shank 16.

A compression spring 78 is mounted in a recess 79 in the shaft 73 and urges forwardly the sleeve 71 and drill 70 so that the cross pin 72 is at the forward end of an elongated slot 80 in the shaft 73. A stop 81 for the axial spring 51 is centrally apertured and tapped at 82 to be connected to a coolant supply. Coolant is furnished through a coolant conduit 83 to a central bore 84 in the shaft 73 and a central bore 85 is the drill 70. The cool-

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ant may emerge from an exit 86 to act upon the workpiece 32A. Because the drill 70 and chamfer tool 74 produce chips, the front plate 21A has been provided with an enlarged three lobed aperture 87 for easy egress of these chips.

The axial compression spring 51 acts against a thrust washer 89 against end of cross pins 90 fastened in the collar 44. By this means the clutch 42—43 is axially urged into engagement.

Operation

The roll head 15A is designed to be used with a hollow workpiece 32A such as metal pipe and to roll taper threads on such workpiece. The drill 70 extends forwardly of the front plate 21A so that it enters the internal bore of the hollow workpiece before the external surface of the workpiece engages the thread rolls 31. The drill 70 is chosen of a size that enters the workpiece without actually removing any metal therefrom during the advancing movement into the pipe workpiece 32A. As the thread rolls 31 engage the external surface of the workpiece 32A during relative axial advancing movement, the action of the rolls crushes or deforms the workpiece to a smaller internal bore. Again the first one or two threads of the thread rolls are preferably chamfered to aid in the commencement of the thread roll action. As the thread rolling commences the clutch parts 42 and 43 are relatively axially separated in any desired manner. This may be accomplished by a yoke 93 which is axially fixed relative to the workpiece 32A and which has rollers 94 bearing on the disc 60. By this means the collar 44 moves backwardly as the workpiece 32A enters the space between the thread rolls 31. The mating surfaces 52 and 53 of FIGURES 3-9 cause gradual relative rotational movement of the frame 18 and the shank 16 so that the thread rolls 31 are gradually moved away from the axis 17. This produces the taper thread on the external surface of the workpiece 32A. Initially the blank pipe workpiece 32A is as shown in FIGURE 10 with substantially cylindrical internal and external surfaces. After the thread rolling operation, when the end of the pipe is at the chamfer tool 74, the workpiece 32A appears as shown in FIGURE 12. Because of the thread rolling action, as opposed to a thread cutting action, the wall thickness 95 from the internal surface 96 to the pitch line 97 remains substantially the same as before the threading action on the workpiece. Also the internal surface 96 now has a tapered internal bore substantially parallel to the taper on the pitch line 97. This is due to the crushing or deforming action of the thread rolls 31 on the hollow workpiece. The drill 70 has likewise been advancing farther into the workpiece 32A so that it is forward of the tapered surface 96 and in a substantially nondeformed portion of the workpiece.

At the completion of the thread rolling action the chamfer tool 74 chamfers both inside and outside edges of the end of the workpiece 32A. Next the mating surfaces 52 and 53 become axially disengaged and the torsion spring 41 rotates the frame 18 in a forward rotational direction relative to the shank 16 until the arcuate stop surfaces 54 engage. This is the rapid opening action of the rolling head. Next the workpiece 32A and roll head 15A are relatively retracted. During this retracting movement the drill 70 cuts the internal surface of the workpiece 32A. For this purpose the drill 70 has a reverse cutting edge 98 which has a smaller diameter nearer the shank of the drill than at the forward end of the drill. This cutting action of the drill or reamer 70 cuts a new internal surface 99, as shown in FIGURE 13, which is the same diameter as the drill 70 and preferably is the same diameter as the original internal diameter of the pipe workpiece 32A. By this action the pipe is taper threaded, chamfered, and rebored to its original diameter, all with a single advancing and retracting cycle of operation. By

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this means much greater productive capacity is achieved for this roll head 15A because the taper threads may rapidly be rolled on the workpiece and then the drill 70 returns the internal bore to its original condition during the retracting movement.

Although this invention has been described in its preferred form with a certain degree of particularity, it is understood that the present disclosure of the preferred form has been made only by way of example and that numerous changes in the details of construction and the combination and arrangement of parts may be resorted to without departing from the spirit and the scope of the invention as hereinafter claimed.

What is claimed is:

1. A variable diameter roll head having an axis, comprising, in combination, a shank adapted for mounting in a support and disposed coaxially on said axis, working rolls carried on said head, a dog clutch including first and second clutch parts, first and second mating surfaces on said first and second clutch parts, respectively, a profile cam surface other than axially parallel on one of said mating surfaces, means connecting said clutch parts to said working rolls to effect movement of said rolls relative to said axis upon relative rotational movement of said clutch parts, spring means connected to axially urge together said clutch parts and to rotatively urge together said mating surfaces, and means to relatively axially separate said clutch parts as a workpiece and said head are relatively axially advanced to cold work said workpiece, whereby the profile cam surface and said spring means establish relative arcuate movement of said clutch parts to move said working rolls relative to the axis of said rolling head to form a variable diameter external surface on said workpiece.

2. A cold working head having an axis, comprising, in combination, a shank adapted for mounting in a support and disposed coaxially on said axis, a frame on said shank, eccentrics on said frame, working rolls journaled on said eccentrics, a collar on said shank, a dog clutch including a first clutch part on said frame and a second clutch part on said collar, first and second mating surfaces on said first and second clutch parts, respectively, holding said frame against rotation in a first rotational direction, a profile cam surface other than axially parallel on one of said mating surfaces, means connecting said clutch parts to said eccentrics to effect arcuate movement of said eccentrics relative to said frame upon relative rotational movement of said clutch parts, spring means connected to axially urge together said clutch parts and to rotatively urge together said mating surfaces, and means to relatively axially separate said clutch parts as a workpiece and said frame are relatively axially advanced to cold work said workpiece, whereby the profile cam surface and said spring means establish relative arcuate movement of said clutch parts to move said working rolls transversely relative to the axis of said head to form a variable diameter external surface on said workpiece.

3. A taper thread rolling head having an axis, comprising, in combination, a shank adapted for mounting in a support and disposed coaxially on said axis, a frame coaxial on said shank, shafts journaled on said frame, an eccentric on each shaft, thread rolls journaled on said eccentrics, a collar on said shank, a dog clutch including a first clutch part on said frame and a second clutch part on said collar, one of said clutch parts being axially movable, first and second mating surfaces on said first and second clutch parts, respectively, spring means connected to relatively axially and rotatively urge said mating surfaces together, an axially tapered surface on one of said mating surfaces tapering in a first rotational direction to establish relative rotation between said clutch parts upon relative axial movement thereof, means connecting said clutch parts to said eccentrics to effect rotation thereof upon relative rotational movement of said clutch parts,

means to relatively axially separate said clutch parts as a workpiece and said frame are relatively axially advanced to roll a thread on said workpiece, whereby said tapered surface and said spring means establish rotation of said eccentrics to move said thread rolls transversely away from the axis of said rolling head to form a tapered thread on said workpiece, and arcuate stop means on said first and second clutch parts to establish an arcuate stop for said first and second clutch parts after sufficient axial separation thereof has caused said first and second mating surfaces to become disengaged and said spring means has caused rapid relative arcuate movement of said clutch parts to effect a rapid opening of said thread rolls.

4. A taper thread rolling head having an axis, comprising, in combination, a shank adapted for mounting in a support and disposed coaxially on said axis, a frame coaxial on said shank, shafts journaled on said frame, an eccentric on each shaft, thread rolls journaled on said eccentrics, a pinion on each shaft, a spur gear meshing with said pinions, a collar on said shank, a dog clutch including a first clutch part on said frame and a second clutch part on said collar, one of said clutch parts being axially movable, first and second mating surfaces on said first and second clutch parts, respectively, spring means connected to relatively axially and rotatively urge said mating surfaces together, an axially tapered surface on one of said mating surfaces tapering in a first rotational direction to establish relative rotation between said clutch parts upon relative axial movement thereof, means connecting said clutch parts to said pinions and spur gear to effect rotation of said pinions relative to said spur gear upon relative rotational movement of said clutch parts, means to relatively axially separate said clutch parts as a workpiece and said frame are relatively axially advanced to roll a thread on said workpiece, whereby said tapered surface and said spring means establish rotation of said pinions relative to said frame to move said thread rolls transversely away from the axis of said rolling head to form a tapered thread on said workpiece, and arcuate stop means on said first and second clutch parts to establish an arcuate stop for said first and second clutch parts after sufficient axial separation thereof has caused said first and second mating surfaces to become disengaged and said spring means has caused rapid arcuate relative movement of said clutch parts to effect a rapid opening of said thread rolls.

5. A taper thread rolling head having an axis, comprising, in combination, a shank adapted for mounting in a support and disposed coaxially on said axis, a frame including first and second plates coaxial on said shank, shafts journaled on said frame between said plates, an eccentric on each shaft between said plates, thread rolls journaled on said eccentrics, a pinion on each shaft, a spur gear meshing with said pinions and splined to said shank, a hub on said spur gear journalling said frame on said shank, spring means connected between said shank and said frame to urge said frame in a first rotational direction relative to said shank, a collar non-rotatively attached on said shank, a dog clutch including a first clutch part on said frame and a second clutch part on said collar, one of said clutch parts being axially movable, first and second mating surfaces on said first and second clutch parts, respectively, holding said frame against rotation in said first rotational direction, said spring means acting to axially urge together said clutch parts, an axially tapered surface on said second mating surface tapering in said first rotational direction, means to relatively axially separate said clutch parts as a workpiece and said frame are relatively axially advanced to roll a thread on said workpiece, whereby the tapered surface and said spring means establish arcuate movement of said frame in said first rotational direction relative to said shank to move said thread rolls transversely away from the axis of said rolling head to form a tapered thread on said workpiece, and arcuate stop means on said first and second clutch parts to establish an arcuate stop for said first and second clutch parts after

sufficient axial separation thereof has caused said first and second mating surfaces to become disengaged and said spring means has caused rapid arcuate movement of said frame to effect a rapid opening of said thread rolls.

6. A taper thread rolling head having an axis, comprising, in combination, a hollow shank adapted for mounting in a support and disposed coaxially on said axis, a frame including first and second plates coaxial on said shank, skewed shafts on said frame between said plates, an eccentric on each shaft between said plates, thread rolls journaled on said eccentrics, a pinion on each shaft, a spur gear meshing with said pinions, a spring housing as part of said frame and arcuately adjustably fastened to said second plate, a collar on said shank, a dog clutch including a first clutch part on said frame and a second clutch part on said collar, one of said clutch parts being axially movable, first and second mating surfaces on said first and second clutch parts, respectively, a torsion spring connected to relatively urge said mating surfaces together, a coil spring in said shank acting to axially urge together said clutch parts, an axially tapered surface on said second mating surface tapering in a first rotational direction to establish relative rotation between said clutch parts upon relative axial movement thereof, means connecting said clutch parts to said pinions and spur gear to effect rotation of said pinions relative to said spur gear upon relative rotational movement of said clutch parts, means to relatively axially separate said clutch parts as a workpiece and said frame are relatively axially advanced to roll a thread on said workpiece, whereby said tapered surface and said torsion spring establish rotation of said pinions relative to said frame to move said thread rolls transversely away from the axis of said rolling head to form a tapered thread on said workpiece, and arcuate stop means on said first and second clutch parts to establish an arcuate stop for said first and second clutch parts after sufficient axial separation thereof has caused said first and second mating surfaces to become disengaged and said torsion spring has caused rapid arcuate relative movement of said clutch parts to effect a rapid opening of said thread rolls.

7. A taper thread rolling head having an axis, comprising, in combination, a hollow shank adapted for mounting in a support and disposed coaxially on said axis, a frame including first and second plates coaxial on said shank, skewed shafts journaled on said frame between said plates, an eccentric on each shaft between said plates, thread rolls journaled on said eccentrics, a pinion on each shaft, a spur gear meshing with said pinions and splined to said shank, a hub on said spur gear journalling said frame on said shank, a spring housing as part of said frame and arcuately adjustably fastened to said second plate, a torsion spring connected between said shank and said spring housing to urge said frame in a first rotational direction relative to said shank, a collar non-rotatively attached on said shank, a dog clutch including a first clutch part on said frame and a second clutch part on said collar, one of said clutch parts being axially movable, first and second mating surfaces on said first and second clutch parts, respectively, holding said frame against rotation in said first rotational direction, a coil spring in said shank acting to axially urge together said clutch parts, an axially tapered surface on said second mating surface tapering in said first rotational direction, means to relatively axially separate said clutch parts as a workpiece and said frame are relatively axially advanced to roll a thread on said workpiece, whereby the tapered surface and said torsion spring establish arcuate movement of said frame in said first rotational direction relative to said shank to move said thread rolls transversely away from the axis of said rolling head to form a tapered thread on said workpiece, and arcuate stop means on said first and second clutch parts to establish an arcuate stop for said first and second clutch parts after sufficient separation thereof has caused said first

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and second mating surfaces to become disengaged and said torsion spring has caused rapid arcuate movement of said frame to effect a rapid opening of said thread rolls.

8. A taper thread rolling head having an axis, comprising, in combination, a hollow shank adapted for mounting in a support and disposed coaxially on said axis, a frame including first and second plates coaxial on said shank, shafts journaled on said frame between said plates, an eccentric on each shaft between said plates, thread rolls journaled on said eccentrics, a pinion on each shaft, a spur gear meshing with said pinions and splined to said shank, a hub on said spur gear journaled on said shank, a torsion spring connected between said shank and said frame to urge said frame in a first rotational direction relative to said shank, a collar axially slidable on said shank, a work stop axially slidable relative to said shank and axially engageable with the end of a workpiece threadable between said thread rolls, means to cause axial movement of said collar with said work stop, a closed rear end in said shank, a coil compression spring in said shank between said closed end and said work stop urging said work stop to a position between said thread rolls, a dog clutch including a first clutch part on said frame and a second clutch part on said collar, first and second mating surfaces on said first and second clutch parts, respectively, holding said frame against rotation in said first rotational direction by the urging of said torsion spring, one of said first and second mating surfaces tapering in said first rotational direction, whereby as a workpiece is axially relatively advanced into the space between said thread rolls to roll a thread thereon said work stop is engaged by said workpiece and moved rearwardly to move said collar and to gradually separate said clutch parts whereupon the tapered surface and said torsion spring establish arcuate movement of said frame in said first rotational direction relative to said shank to move said thread rolls transversely away from the axis of said rolling head to form a tapered thread on said workpiece.

9. A taper thread rolling head having an axis, comprising, in combination, a hollow shank adapted for mounting in a support and disposed coaxially on said axis, a frame including first and second plates coaxial on said shank, skewed shafts journaled on said frame between said plates, an eccentric on each shaft between said plates, thread rolls journaled on said eccentrics, a pinion on each shaft, a spur gear meshing with said pinions and splined to said shank, a hub on said spur gear journaled on said shank, a spring housing as part of said frame and arcuately adjustably fastened to said second plate, a torsion spring connected between said shank and said spring housing to urge said frame in a first rotational direction relative to said shank, a collar axially slidable on said shank, an axially parallel slot diametrically through said shank, a work stop axially slidable within said shank and axially engageable with the end of a workpiece threadable between said thread rolls, a pin extending transversely through said slot and fixed in said work stop and in said collar to cause axial movement of said collar with said work stop, a closed rear end in said shank, a coil compression spring in said shank between said closed end and said work stop urging said work stop to a position between said thread rolls, a dog clutch including a first clutch part on said spring housing and a second clutch part on said collar, first and second mating surfaces on said first and second clutch parts, respectively, holding said frame against rotation in said first rotational direction by the urging of said torsion spring, an axially tapered surface on said second mating surface tapering in said first rotational direction, whereby as a workpiece is axially relatively advanced into the space between said thread rolls to roll a thread thereon said work stop is engaged by said workpiece and moved rearwardly to move said collar and to gradually

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separate said clutch parts whereupon the tapered surface and said torsion spring establish arcuate movement of said frame in said first rotational direction relative to said shank to move said thread rolls transversely away from the axis of said rolling head to form a tapered thread on said workpiece, and arcuate stop means on said first and second clutch parts to establish an arcuate stop for said first and second clutch parts after sufficient axial separation thereof has caused said first and second mating surfaces to become disengaged and said torsion spring has caused rapid arcuate movement of said frame to effect a rapid opening of said thread rolls.

10. A taper cold working head having an axis, comprising, in combination, a shank adapted for mounting in a support and disposed coaxially on said axis, working rolls carried on said head, a dog clutch including first and second clutch parts, first and second mating surfaces on said first and second clutch parts, respectively, an axially aligned drill mounted to enter a workpiece before said working rolls act on the external surface of said workpiece, means connecting said drill rotatively fixed relative to said shank, an axially tapered surface on one of said mating surfaces, means connecting said clutch parts to said working rolls to effect outward movement of said rolls relative to said axis upon relative rotational movement of said clutch parts, spring means connected to axially urge together said clutch parts and to rotatively urge together said mating surfaces, means to relatively axially separate said clutch parts as a workpiece and said head are relatively axially advanced to cold work said workpiece, whereby the tapered surface and said spring means establish relative arcuate movement of said clutch parts to move said working rolls outwardly away from the axis of said rolling head to form a tapered external surface on said workpiece, and said drill cutting the internal surface of said workpiece cylindrical to the diameter of the drill as said workpiece and said head are relatively axially retracted.

11. A taper cold working head having an axis, comprising, in combination, a shank adapted for mounting in a support and disposed coaxially on said axis, a frame on said shank, eccentrics on said frame, working rolls journaled on said eccentrics, a collar on said shank, a dog clutch including a first clutch part on said frame and a second clutch part on said collar, first and second mating surfaces on said first and second clutch parts, respectively, holding said frame against rotation in a first rotational direction relative to said second clutch part, an axially aligned drill mounted forward of said frame to enter a hollow workpiece before said working rolls act on the external surface of said workpiece, means connecting said drill rotatively fixed relative to said shank, an axially tapered surface on one of said mating surfaces tapering in said first rotational direction, means connecting said clutch parts to said eccentrics to effect arcuate movement of said eccentrics relative to said frame upon relative rotational movement of said clutch parts, spring means connected to axially urge together said clutch parts and to rotatively urge together said mating surfaces, means to relatively axially separate said clutch parts as a workpiece and said frame are relatively axially advanced to cold work said workpiece, whereby the tapered surface and said spring means establish relative arcuate movement of said clutch parts in said first rotational direction to move said working rolls transversely away from the axis of said rolling head to form a tapered external surface on said workpiece, and said drill cutting the internal surface of said workpiece cylindrical to the diameter of the drill as said workpiece and said frame are relatively axially retracted.

12. A taper thread rolling head having an axis, comprising, in combination, a shank adapted for mounting in a support and disposed coaxially on said axis, a frame coaxial on said shank, shaft journaled on said frame, an eccentric on each shaft, thread rolls journaled on said eccentrics, a pinion on each shaft, a spur gear meshing with

said pinions and fastened to said shank, spring means connected between said shank and said frame to urge said frame in a first rotational direction relative to said shank, a collar on said shank, a dog clutch including a first clutch part on said frame and a second clutch part on said collar, first and second mating surfaces on said first and second clutch parts, respectively, holding said frame against rotation in said first rotational direction, an axially aligned reverse cutting edge drill mounted to enter a hollow workpiece before said thread rolls act on the external surface of said workpiece, means connecting said drill rotatively fixed relative to said shank, said spring means acting to axially urge together said clutch parts, an axially tapered surface on one of said mating surfaces tapering in said first rotational direction, means to relatively axially separate said clutch parts as a workpiece and said frame are relatively axially advanced to roll a thread on said workpiece, whereby the tapered surface and said spring means establish arcuate movement of said frame in said first rotational direction relative to said shank to move said thread rolls transversely away from the axis of said rolling head to form a tapered thread on said workpiece, arcuate stop means on said first and second clutch parts to establish an arcuate stop for said first and second clutch parts after sufficient axial separation thereof has caused said first and second mating surfaces to become disengaged and said spring means has caused rapid arcuate movement of said frame to effect a rapid opening of said thread rolls, and said drill cutting the internal diameter of said workpiece cylindrical to the diameter of the drill as said workpiece and said frame are relatively axially retracted.

13. A taper thread rolling head having an axis, comprising, in combination, a hollow shank adapted for mounting in a support and disposed coaxially on said axis, a frame including first and second plates coaxial on said shank, shafts journaled on said frame between said plates, an eccentric on each shaft between said plates, thread rolls journaled on said eccentrics, a pinion on each shaft, a spur gear meshing with said pinions and splined to said shank, a torsion spring connected between said shank and said frame to urge said frame in a first rotational direction relative to said shank, a collar axially slidable on said shank, a dog clutch including a first clutch part on said frame and a second clutch part on said collar, first and second mating surfaces on said first and second clutch parts, respectively, holding said frame against rotation in said first rotational direction, an axially aligned reverse cutting edge drill mounted forward of said front plate to enter a hollow workpiece before said thread rolls act on the external surface of said workpiece, diametrically opposed slots in said shank, means including transverse pins extending through said slots and connecting said drill to said collar, a coil spring in said shank acting to axially urge together said clutch parts, an axially tapered surface on said second mating surface tapering in said first rotational direction, means to relatively axially separate said clutch parts as a workpiece and said frame are relatively axially advanced to roll a thread on said workpiece, whereby the tapered surface and said torsion spring establish arcuate movement of said frame in said first rotational direction relative to said shank to move said thread rolls transversely away from the axis of said rolling head to form a tapered thread on said workpiece, arcuate stop means on said first and second clutch parts to establish an arcuate stop for said first and second clutch parts after sufficient axial separation thereof has caused said first and second mating surfaces to become disengaged and said torsion spring has caused rapid arcuate movement of said frame to effect a rapid opening of said thread rolls, and said drill cutting the internal diameter of said workpiece cylindrical to the diameter of the drill as said workpiece and said frame are relatively axially retracted.

14. A taper thread rolling head having an axis, comprising, in combination, a hollow shank adapted for mounting in a support and disposed coaxially on said axis,

a frame including first and second plates coaxial on said shank, skewed shafts journaled on said frame between said plates, an eccentric on each shaft between said plates, thread rolls journaled on said eccentrics, a pinion on each shaft, a spur gear meshing with said pinions and splined to said shank, a hub on said spur gear journaled on said frame on said shank, a spring housing as part of said frame and arcuately adjustably fastened to said second plate, a torsion spring connected between said shank and said spring housing to urge said frame in a first rotational direction relative to said shank, a collar axially slidable on said shank, a dog clutch including a first clutch part on said spring housing and a second clutch part on said collar, first and second mating surfaces on said first and second clutch parts, respectively, holding said frame against rotation in said first rotational direction, an axially aligned reverse cutting edge drill mounted forward of said front plate to enter a hollow workpiece before said thread rolls act on the external surface of said workpiece, diametrically opposed slots in said shank, means including transverse pins extending through said slots and connecting said drill to said collar, a coil spring in said shank acting to axially urge together said clutch parts, an axially tapered surface on said second mating surface tapering in said first rotational direction, means to axially separate said second clutch part from said first clutch part as a workpiece and said frame are relatively axially advanced to roll a thread on said workpiece, whereby the tapered surface and said torsion spring establish arcuate movement of said frame in said first rotational direction relative to said shank to move said thread rolls transversely away from the axis of said rolling head to form a tapered thread on said workpiece, arcuate stop means on said first and second clutch parts to establish an arcuate stop for said first and second clutch parts after sufficient axial separation thereof has caused said first and second mating surfaces to become disengaged and said torsion spring has caused rapid arcuate movement of said frame to effect a rapid opening of said thread rolls, and said drill cutting the internal diameter of said workpiece cylindrical to the diameter of the drill as said workpiece and said frame are relatively axially retracted.

15. A work head having an axis, comprising, in combination, a frame adapted for mounting in a support and disposed coaxially on said axis, work dies carried on said head, a first mating part carried relative to said frame, a second mating part axially movable relative to said frame, first and second mating surfaces on said first and second mating parts, respectively, a profile cam surface other than axially parallel on one of said mating surfaces, means connecting said mating parts to said work dies to effect movement thereof relative to said axis upon relative movement of said mating parts, means connected to rotatively urge together said mating surfaces, and means to relatively axially move said mating parts as a workpiece and said frame are relatively axially advanced to work said workpiece, whereby the profile cam surface and said urging means establish relative arcuate movement of said mating parts to move said work dies relative to the axis of said head.

16. A work head having an axis, comprising, in combination, a shank adapted for mounting in a support and disposed coaxially on said axis, a frame on said shank, eccentrics on said frame, work dies carried for movement by said eccentrics, a first mating part carried relative to said frame, a second mating part axially movable relative to said frame, first and second mating surfaces on said first and second mating parts, respectively, holding said frame against rotation in a first rotational direction, a profile cam surface other than axially parallel on one of said mating surfaces, means connecting said mating parts to said eccentrics to effect arcuate movement of said eccentrics relative to said frame upon relative rotational movement of said mating parts, spring means connected to axially urge together said mating parts

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and to rotatively urge together said mating surfaces, and means to relatively axially move said mating parts as a workpiece and said frame are relatively axially advanced to work said workpiece, whereby the profile cam surface and said spring means establish relative arcuate movement of said mating parts to move said work dies transversely relative to the axis of said head to form a variable diameter external surface on said workpiece.

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