Feb. 16, 1954 H. J. FINCH 2,669,139

APPARATUS FOR ROLLING THREADS INTO METAL PIPE

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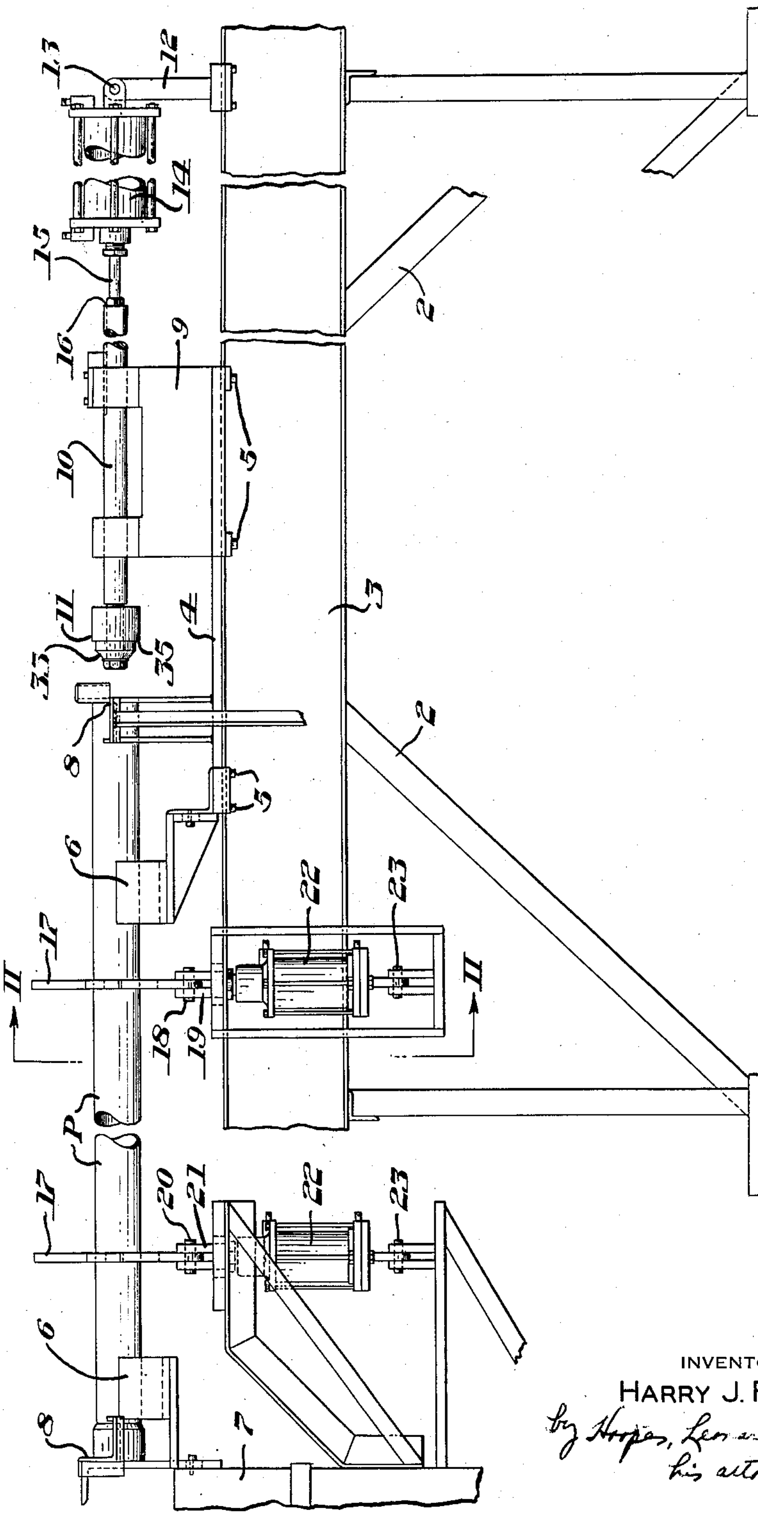

Fig. 1.

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APPARATUS FOR ROLLING THREADS INTO METAL PIPE

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Fig. 6.

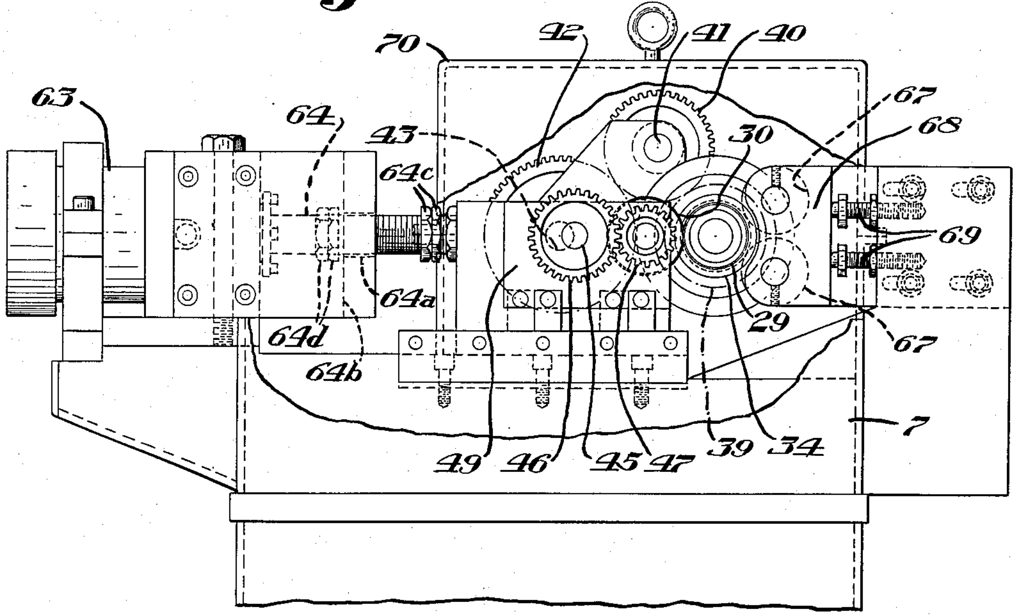
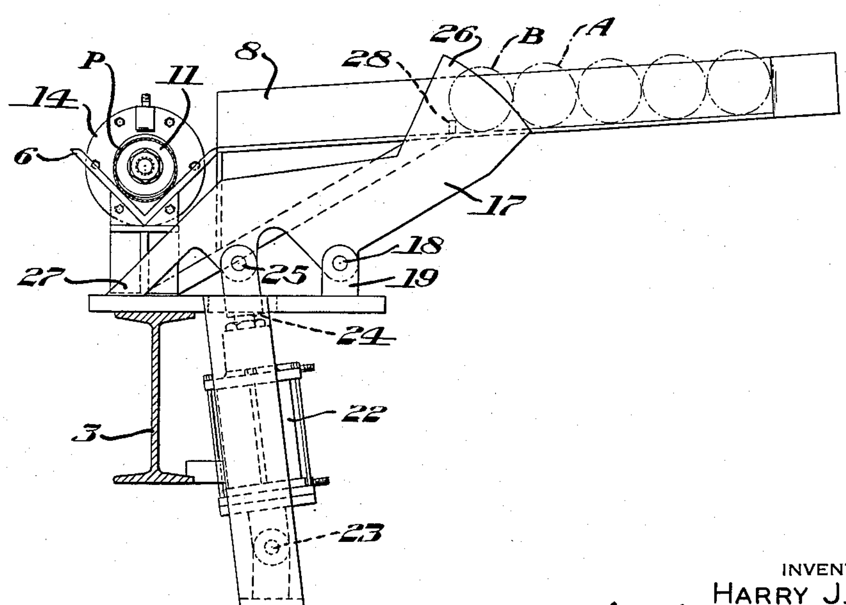



Fig. 2.

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APPARATUS FOR ROLLING THREADS INTO METAL PIPE

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Fig. 3.

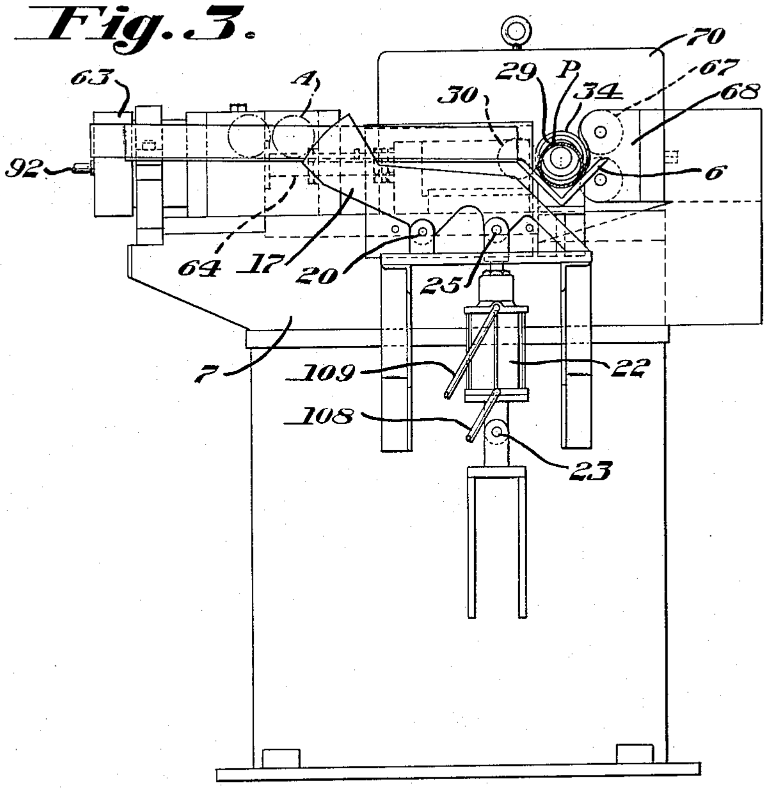
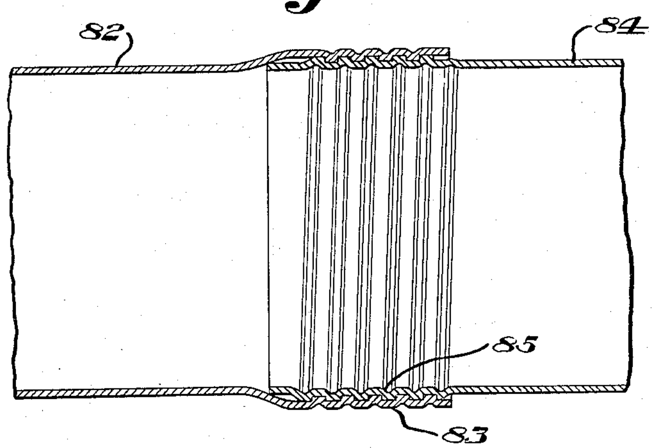



Fig. 10.

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APPARATUS FOR ROLLING THREADS INTO METAL PIPE

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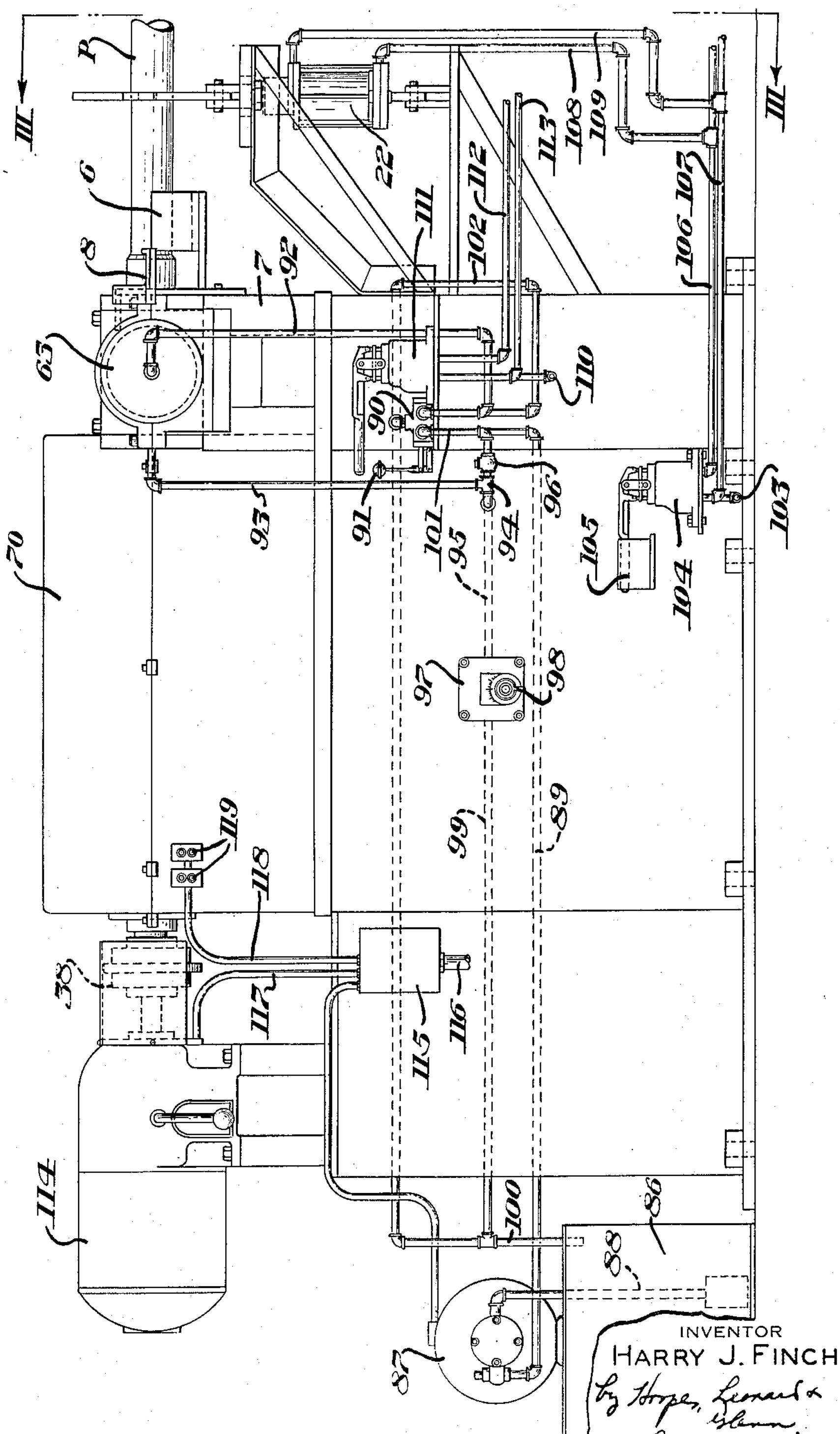
Fig. 4.

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APPARATUS FOR ROLLING THREADS INTO METAL PIPE

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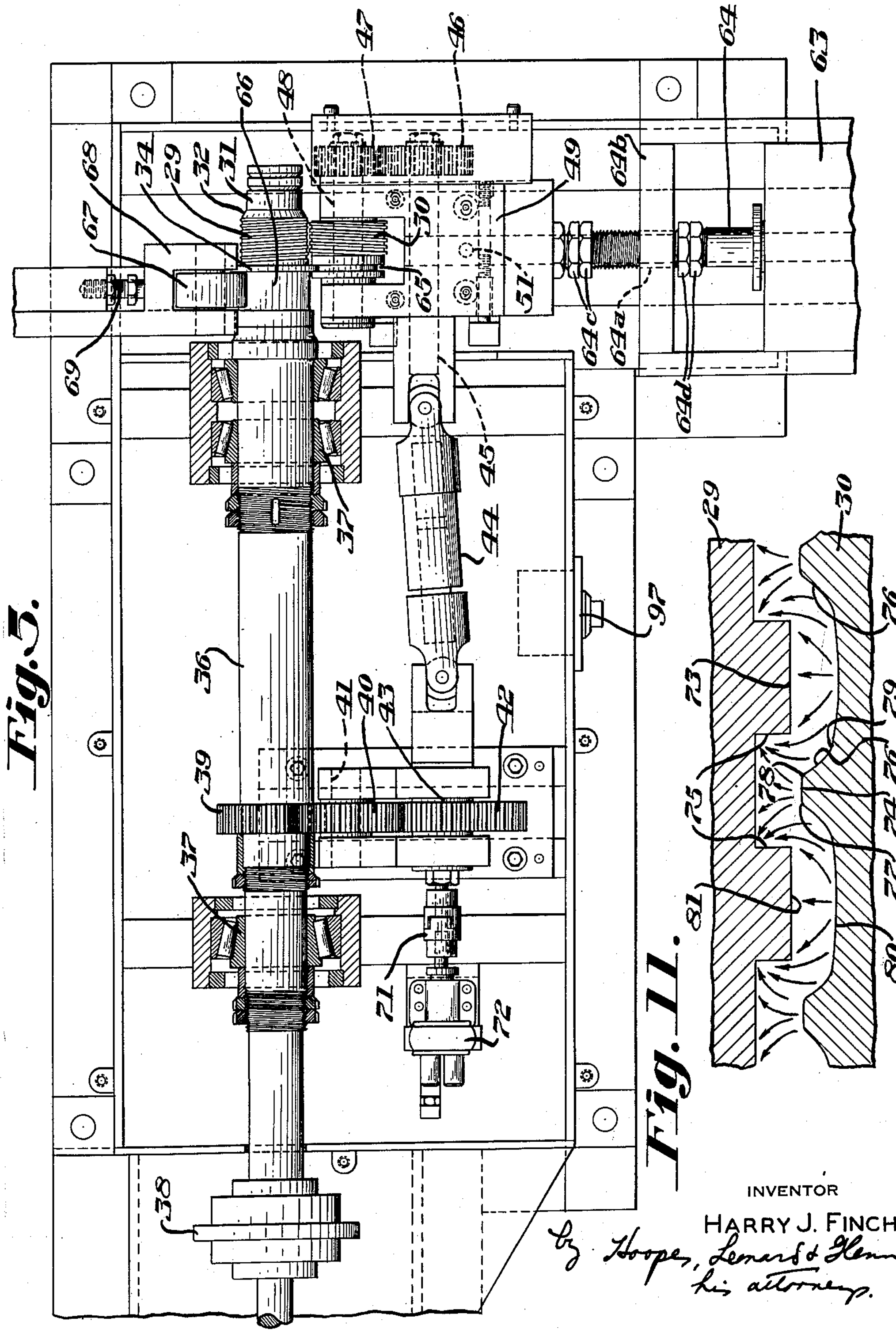

Fig. 5.

Fig. 11.

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APPARATUS FOR ROLLING THREADS INTO METAL PIPE

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Fig. 7.

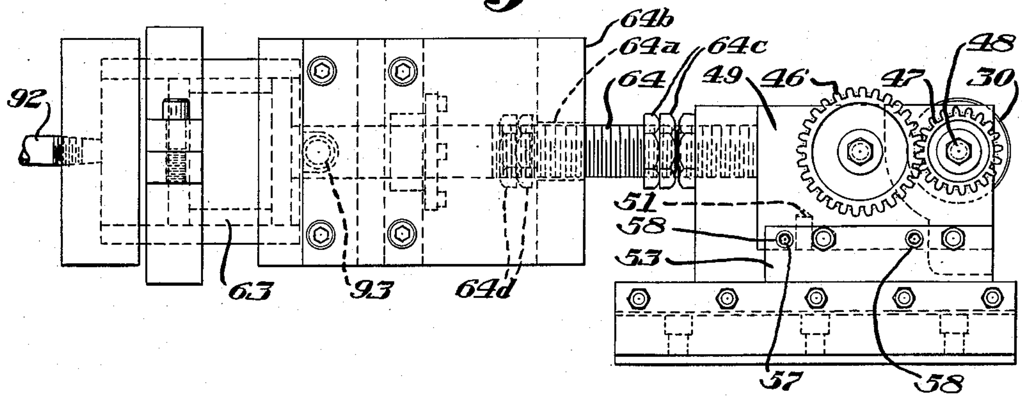



Fig. 8.

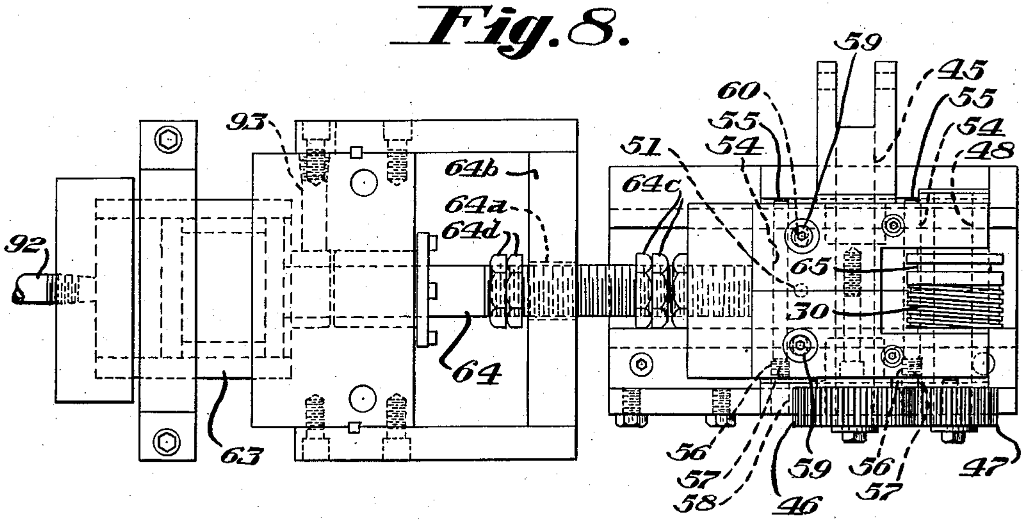
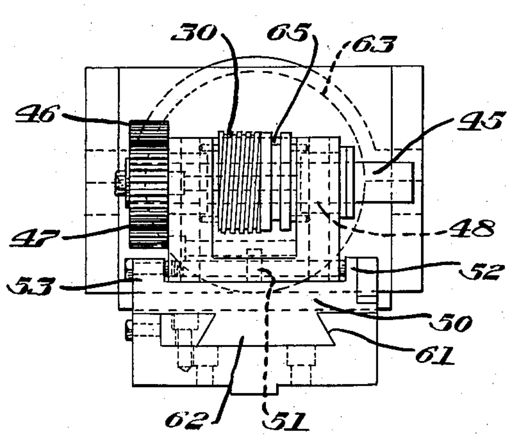



Fig. 9.

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Patented Feb. 16, 1954 2,669,139

# UNITED STATES PATENT OFFICE

2,669,139

## APPARATUS FOR ROLLING THREADS INTO METAL PIPE

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Application April 28, 1949, Serial No. 90,071

5 Claims. (Cl. 80—6)

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This invention relates to rolling threads into metal pipe. It comprehends improvements in machines for rolling threads into metal pipe, improved methods of rolling threads into metal pipe and new and improved metal pipe having threads rolled thereinto whereby important advantages both in the rolling of the threads into the pipe and in the structure and use of the threaded pipe are obtained.

Metal pipe of certain characteristics may be threaded by rolling. Relatively thin-walled pipe or tubing and heavier-walled pipe of sufficient ductility may be thus threaded. For purposes of explanation and illustration I shall discuss the threading of thin-walled steel tubing although my invention is not limited in all of its aspects to the threading of such tubing but may be otherwise embodied and practiced.

Lengths of thin-walled steel tubing are fastened together end to end to make long tubes for various purposes, as, for example, so-called shot hole casing. Desirably each length or section is somewhat expanded at one end so that it will telescope with the unexpanded opposite end of a similar section and threads are rolled into the telescoping ends so that they may be screwed together. The thread rolling operation is rapid and economical and for relatively thin-walled pipe and pipe of sufficient ductility is far less costly than cutting threads by the conventional method; moreover, a stronger and otherwise superior product is produced.

It has heretofore been proposed to roll threads into thin-walled tubular articles but the threads which have been produced have been inferior and no practicable way of threading relatively long sections of pipe has been developed. I have devised a machine for rolling threads into metal pipe which accomplishes the result in a highly accurate, effective and efficient manner. I have also devised a method of rolling threads into metal pipe whereby important advantages are obtained. I have also devised a new thread form of importantly increased strength and efficiency relatively to rolled threads heretofore developed.

In rolling threads into thin-walled steel tubing it has heretofore been considered necessary to effect a partial shearing of the metal to sharply displace metal substantially radially to form the threads. The result has been a lack of uniformity in the threads, the thread form differing especially in articles of steel of different characteristics, and being in any event subject to early failure or pulling out under load. I have discovered that the conception that the rolled

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threads should be formed by a shearing action is fallacious and that it is not necessary to so form them. On the contrary, I form a vastly superior and more uniform thread through causing a flow of the metal while avoiding any substantial shearing action. I rotate the pipe generally about its axis and during such rotation simultaneously engage the pipe internally and externally at radially opposed portions thereof and squeeze the metal so as to cause it to flow without any substantial shearing to form threads projecting from one surface of the pipe while deforming the opposite surface so that metal throughout the entire thickness of the pipe is flowed and reshaped during thread formation. I preferably form in the pipe by simultaneous internal and external rolling at radially opposed portions thereof internal and external alternately arranged grooves and projections in generally helical form and during the forming of such grooves and projections somewhat foreshorten the pipe and thereafter flow the metal at the grooves and projections without any substantial shearing of the metal to form a thread at one surface of the pipe. I desirably form in that way a thread whose side walls ore substantially parallel to each other.

In rolling into metal pipe threads whose side walls are substantially parallel to each other I desirably rotate the pipe generally about its axis and during such rotation press the metal from the surface of the pipe opposite the surface to be threaded toward the surface to be threaded, limiting the metal flow at the crests of the incipient threads and forcing the metal laterally generally parallel to the crests to form generally square corners on the threads. I may form in the pipe a generally helical corrugation.

I further provide a method of rolling threads into metal pipe comprising engaging the pipe internally and externally by rotating dies which squeeze the metal of the pipe therebetween and cause rotation of the pipe during the threading operation and by one of the dies flowing the metal without any substantial shearing of the metal into a thread forming cavity in the other die.

I roll into metal pipe threads of new and improved shape which are vastly stronger than the previous rolled threads both with respect to pulling out and with respect to failure under load. I provide metal pipe having a rolled thread at one surface thereof, the opposite surface of the pipe having a helical depression whose dimension axially of the pipe at its bottom is not over about half the dimension of the thread axially of the pipe at its crest, the depression being disposed radially opposite the center of the thread crest, and a helical projection radially opposite the thread throat and merging into the depression. The dimension axially of the pipe of the helical projection opposite the thread throat is preferably at least one-third greater than the dimension axially of the pipe of the thread throat.

I further provide metal pipe having at one surface thereof a rolled thread whose side walls are substantially parallel to each other, the opposite surface of the pipe having a helical depression whose dimension axially of the pipe at its bottom is not over about half the dimension of the thread axially of the pipe, the depression being disposed radially opposite the center of the thread crest, and a helical projection opposite the thread throat whose dimension axially of the pipe is at least one-third greater than the dimension axially of the pipe of the thread throat and merging into the depression. The side walls of the helical depression are preferably inclined toward each other and the side walls of the helical projection are preferably inclined toward each other and the depression and the projection preferably merge into each other. Desirably the thinnest section at the thread is at least about eighty per cent of the thickness of the pipe wall at a point removed from the thread.

So far as apparatus is concerned one of the fallacies of thread rolling apparatus as heretofore developed has been that the dies are mechanically forced together, virtually eliminating the possibility of adequate metal flow to form a thread as above described. The machine design has been consistent with the fallacious theory that the metal should be sheared during thread formation. Not only have I discovered that the metal should not be sheared during thread formation but I have also devised improved apparatus for rolling threads into metal pipe which insures proper metal flow. I employ hydraulic means for forcing together the dies which roll the threads into the pipe. By use of such means I can attain a relatively smooth flow of the metal which is not possible, or at least not regularly obtainable, with mechanically operated dies.

In use of my apparatus as the dies are pressed together hydraulically the metal is first bent or corrugated during which time the tube is somewhat foreshortened. After a time, perhaps twenty or more revolutions of the dies, the metal begins to flow from the surface of the pipe opposite the surface to be threaded toward the surface to be threaded, but as the extent of flow of such metal is limited at the thread crests by the thread forming die the metal then spreads or flows laterally generally parallel to the crests. Thus I am enabled to form with ease and accuracy threads whose side walls are substantially parallel to each other, e. g., threads of generally square contour. Moreover, I do so without greatly reducing the wall thickness at the threads, the thinnest section at the threads normally being at least about eighty per cent of the thickness of the pipe wall at a point removed from the thread.

My thread rolling machine has other important features and advantages. One of the most important advantages is that I can with ease and accuracy roll threads into the ends of relatively long sections of pipe which has not been possible with thread rolling machines heretofore available. To accomplish that advantage I desirably employ a guideway for approximately aligning a pipe for presentation of an end thereof to the die means and also employ means engaging the opposite end



of the pipe moving the pipe along the guideway to present the first mentioned end of the pipe to the die means, there being means inclined to the horizontal raising the pipe ends upon presentation of the first mentioned end to the die means whereby to free the pipe from the guideway while the threads are being rolled thereinto. Desirably the die means and the pipe engaging means have pipe engaging portions unseating the pipe from the guideway and freely supporting it upon presentation of the first mentioned end to the die means. The pipe engaging portions are preferably rotatable with the pipe during rolling of the threads thereinto.

More specifically I provide, in a machine for rolling threads into metal pipe, rotary dies adapted respectively to be positioned inside and outside a pipe end when the pipe end is presented thereto and to co-operatively roll threads into the pipe end, one of the dies having a pipe engaging portion adapted to enter the pipe and to position the pipe end for action thereon by the dies, a guideway for approximately aligning a pipe with said portion and means engaging the opposite end of the pipe moving the pipe along the guideway onto said portion, said last mentioned means having a generally conical portion adapted to enter the pipe and to unseat the pipe from the guideway as the pipe is moved into position to be acted upon by the dies.

I further provide, in a machine for rolling threads into metal pipe, rotary dies adapted respectively to be positioned inside and outside a pipe end when the pipe end is presented thereto and to co-operatively roll threads into the pipe end, one of the dies having a portion adapted to enter the pipe to guide the pipe into proper relationship with the dies to be acted on thereby, a guideway for approximately aligning a pipe with said portion and means for feeding pipes one by one to the guideway. I may employ pipe delivery means for delivering pipes laterally into the guideway and means for delivering pipes one by one from the delivery means laterally into the guideway.

I also provide, in a machine for rolling threads into metal pipe, complementary rotary dies adapted respectively to be positioned inside and outside a pipe end when the pipe end is presented thereto and to co-operatively roll threads into the pipe end and means for rotating the dies at the same angular velocity in opposite directions to roll threads into the pipe end, said means rotating the inside die in a direction such that when the threads are formed in the pipe the threaded pipe will be fed back off of the inside die upon slowing of the rotation of the pipe relatively to that of the inside die, the diameter of the outside die being greater than that of the inside die so that during rolling of the threads in the pipe end the outside die frictionally engages the pipe end and thereby exerts force on the pipe tending to prevent the pipe from backing off during formation of the threads.

I desirably provide means for maintaining the dies in relatively fixed axial position during formation of the threads in the pipe. Such means may be in the form of portions of the dies which move into interengagement when the dies are relatively moved toward each other. One of the dies may have a radial flange and the other may have a radial groove receiving the radial flange of the first mentioned die.

The dies preferably have co-operating portions positioned for abutment with eachother upon predetermined movement of the dies toward each other whereby to limit the extent of action of the dies on the pipe. The radial dimensions of the flange and groove above referred to may be proportioned so that the flange bottoms in the groove upon predetermined movement of the dies toward each other whereby to limit the extent of action of the dies on the pipe.

The radial flange may be on the inside die and may be positioned to be engaged by the pipe end to act as a stop to limit the extent to which the pipe end passes over the inside die.

I have referred above to the fact that I prefer to employ hydraulic means for relatively moving the dies toward and away from each other or transversely of the axes thereof. One of the dies, preferably the inside die, may be mounted for rotation about a fixed axis and the other die may be mounted on a support movable transversely of the axes of the dies to provide for pressing the second die against the outside of the pipe end so that the second die rolls threads into the pipe end co-operatively with the first mentioned die. Either die may be the thread forming die in any particular case, the other die being the co-operating die which causes the metal to flow as above described into the thread forming cavity of the thread forming die. In threading a pin end the thread forming die is the outside die while in threading a box end the thread forming die is the inside die.

The support for the outside die is preferably pivotally mounted on a base, the base being movable generally toward and away from the inside die and means being provided for maintaining the support in desired angular position about its pivotal mounting on the base. Means are preferably also provided for adjustably positioning the base in the direction of its movement relatively to the means for moving it generally toward and away from the inside die.

I provide for controlled relatively slow movement of the dies toward each other during a thread forming operation and relatively rapid movement of the dies away from each other. I desirably employ hydraulic means for relatively moving the dies toward each other and throttle means operable to limit the flow of fluid in the hydraulic means whereby to determine the speed of movement of the dies toward each other. I may employ a hydraulically operable piston for relatively moving the dies toward each other and the throttle means may limit the flow of fluid from in front of the piston. The hydraulic system is preferably such that the throttle means function only while the dies are being moved toward each other and not while they are being moved away from each other. Thus by adjustment of the throttle means the movement of the dies toward each other may be controlled as desired without affecting the rapidity of the movement of the dies away from each other.

I preferably provide roller means rotatively supporting the inner die against the pressure exerted thereon through the pipe by the outer die. The inner die may have a radially outwardly open groove adjacent but axially removed from the thread forming portion thereof and supporting means comprising a plurality of rollers may engage the die within the groove to support it against the pressure exerted thereon through the pipe by the second die. Means are preferably provided for adjustably positioning the roller means toward and away from the second die.

The thread forming dies have complementary metal forming faces, one of the faces having thereon a helical metal forming projection whose side walls may be substantially parallel to each other and the other of said faces having thereon a helical metal forming projection whose side walls are inclined to each other, which inclined side walls extend substantially to the crest of the second mentioned projection, the projections being in axially staggered relation. The inclined side walls preferably have rounded corners at the top and bottom extremities thereof facilitating the desired metal flow. The face of the non-thread forming die preferably has thereon a helical metal forming projection whose dimension axially of the pipe at its crest is not over about half the dimension of the metal forming projection of the thread forming die axially of the pipe.

By the improvements above referred to I provide greatly improved threaded pipe at high speed and low cost and of greater uniformity than pipe with rolled threads heretofore produced. Certain of my improved features may be used without others but I prefer to include all of my improved apparatus features in a single machine. Such a machine is shown in the accompanying drawings. Other details, objects and advantages of the invention will become apparent as the following description of the machine shown in the drawings, constituting a present preferred embodiment of my apparatus invention, and of my improved method and product, of which latter a present preferred embodiment is also shown in the drawings, proceeds.

In the drawings

Figure 1 is a fragmentary elevational view of the portion of the apparatus for feeding pipes to the thread rolling dies;

Figure 2 is a vertical cross-sectional view taken on the line II—II of Figure 1;

Figure 3 is a vertical cross-sectional view somewhat similar to Figure 2 but to smaller scale and looking in the opposite direction so as to show a portion of the thread rolling means, the figure being taken on the line III—III of Figure 4;

Figure 4 is a somewhat diagrammatic fragmentary elevational view of the portion of the machine for rolling threads into pipes, the portion of the apparatus shown in Figure 4 being positioned to the left of the portion of the apparatus shown in Figure 1, part of the apparatus, however, being shown in both of Figures 1 and 4;

Figure 5 is an enlarged fragmentary detail view partly in elevation and partly in vertical cross section showing the thread rolling dies and the mechanism for operating them;

Figure 6 is a fragmentary elevational view of the apparatus shown in Figure 5 as viewed from the right-hand end of Figure 5;

Figure 7 is a fragmentary elevational view to enlarged scale showing a portion of the structure shown in Figure 6;

Figure 8 is a fragmentary plan view of the structure shown in Figure 7;

Figure 9 is an elevational view showing the structure of Figure 8 as viewed from the right-hand end of that figure;

Figure 10 is a cross-sectional view showing a pipe joint made of pipes threaded by the use of my invention; and

Figure 11 is a greatly enlarged diagram showing the shape of the dies and the thread formed thereby.

Referring now more particularly to the drawings and especially to Figures 1 and 4, the apparatus shown comprises pipe feeding apparatus which is shown in Figure 1 and apparatus for rolling threads into pipe ends which is shown in Figure 4. The feeding apparatus comprises a supporting structure 2 comprising an I-beam 3 upon which is carried a member 4 adapted to be bolted to the I-beam 3 at desired adjusted locations along the I-beam by bolts 5. The member 4 carries at its left hand end viewing Figure 1 one of a pair of co-operating V-shaped guides 6, the two guides 6 being in horizontal alignment and together forming an upwardly open V-shaped guideway for positioning pipes for presentation to the threading dies. The other of the guides 6, shown at the left-hand end of Figure 1 and at the right-hand end of Figure 4, is carried by the main frame 7 of the machine.

There are also provided two generally angle-shaped support members 8, one carried by the member 4 and the other by the main frame 7, which together constitute an inclined chute or trough for delivering pipes to the guideway 6, 6. The members 8 are adapted to be spaced apart a distance determined by the length of the pipes being threaded so that the respective pipe ends are supported by the respective members 8. The member 4 is moved along the I-beam 3 to position the member 8 carried thereby appropriately relatively to the other member 8 which is mounted in fixed position on the main frame so that pipes delivered to the upper end of the chute or trough 8, 8 will be supported thereby at their ends and will roll down by gravity toward the guideway 6, 6.

Also carried by the member 4 is a guide bracket 9 for guiding a rod 10 carrying at its left-hand extremity, viewing Figure 1, a member 11 freely rotatable on the rod. The bracket 9 is constructed and arranged so that the member 11 is approximately aligned with the guideway 6, 6 as will presently be described.

Also carried by the I-beam 3 is a bracket 12 to which is pivoted at 13 a fluid pressure cylinder 14 within which operates a piston having a piston rod 15 connected at 16 with the end of the rod 10. The bracket 12 may be adjusted along the I-beam 3 as required.

There are provided two similar pipe actuating members 17, one pivoted at 18 to a bracket 19 carried by the I-beam 3 and the other pivoted at 20 to a bracket 21 carried by the frame 7. Each of the actuating members 17 is operated by a piston in a fluid pressure cylinder 22, means being provided as will presently be described for operating the pistons in the two cylinders 22 simultaneously. The respective cylinders 22 are pivotally mounted on their brackets by pivots 23 and their respective piston rods 24 are pivoted to the respective actuating members 17 at 25 (Figure 2).

Each of the actuating members 17 has a generally upwardly extending portion 26 and a generally downwardly extending portion 27. Upon pivotal movement thereof about the axis of its pivot pin in the clockwise direction viewing Figure 2 through action of the piston in the corresponding cylinder 22 the portion 26 swings downwardly and the portion 27 swings upwardly from the position shown in the drawings. Movement of the actuating members 17 in the counterclockwise direction viewing Figure 2 is limited by contact of the foot of the portion 27 with the upper surface of its supporting bracket.

The two dies for rolling threads into the ends of the pipes are designated respectively by reference numerals 29 and 30 (Figure 5). The die 29 is adapted to be disposed inside the pipe end when the pipe end is presented to the dies and the die 30 is adapted to be disposed outside the pipe end. The die 29 has a projection 31 adapted to enter the pipe and an inclined annular shoulder 32 between the projection 31 and the die proper. The member 11 also has an inclined annular shoulder 33. The die 29 is mounted for rotation about a fixed axis and that die and the member 11 are coaxially mounted. The die 29 has a radial flange 34 which serves a number of purposes, one of those purposes being to stop and position the pipe when introduced over the die 29.

Before proceeding with a detailed description of the dies and their operating mechanism it may be desirable to describe the operation of the mechanism for feeding the pipes one by one to the dies. The pipes are fed onto the inclined chute 8, 8 by any suitable means, as, for example, from a hopper or by hand. In any event, a supply of pipes is continuously provided on the chute 8, 8, the pipes rolling down the chute by gravity and contacting one another as shown in Figure 2. When the actuating members 17 are in the position shown in Figure 2 they restrain the pipes from rolling down the chute with the foremost pipe on the chute in position A. When the cylinders in the pistons 22 are moved upwardly by the means for synchronously operating such pistons, which will be described below, the members 17 are turned in the clockwise direction about the axes of the pivots 18 and 20 until the portions 26 thereof pass below the level of the chute whereupon the foremost pipe on the chute moves by gravity from position A to position B in Figure 2, the remaining pipes following down the chute by gravity. The foremost pipe is arrested by the stop or stops 28 when it reaches position B. When the pistons in the cylinders 22 are moved downwardly the members 17 turn counterclockwise and the portions 26 thereof lift the foremost pipe over the stops 28 so that it rolls down the chute, at the same time preventing the pipes behind from rolling down. The foremost pipe rolls down the chute and drops into the guideway 6, 6.

When a pipe is lying in the guideway 6, 6 its axis is slightly lower than the common axis of the die 29 and the member 11 as shown in Figure 2, wherein the pipe is designated P. With a pipe resting in the guideway 6, 6 the piston in the cylinder 14 is moved toward the left viewing Figure 1 causing the member 11 to engage the end of the pipe remote from the dies and exert pressure thereagainst toward the left or toward the dies. It should be mentioned that in the embodiment shown the box ends of the pipes are being internally threaded. The member 11 pushes the pipe along the guideway so that the box end of the pipe moves over the projection 31 of the die 29. The inclined shoulders 33 and 32 engage the pipe ends and lift the pipe slightly so that as it is presented to the dies both ends are raised from the guideway and the pipe is supported entirely by the dies and the member 11. When the pipe is in position to be operated upon by the dies its forward or box end is against the flange 34 and its rearward or pin end is against the shoulder 35 of the member 11. While the pipe is being operated on by the dies it is being urged to the left viewing Figures 1 and 5 by fluid behind the piston in the cylinder 14. It is to be remembered that the member 11 is freely rotatable on the rod 10 so that when the pipe is being acted on by the dies 29 and 30 it rotates and the member 11 rotates with it.

After the pipe has been threaded the member 11 is retracted and the pipe is returned to approximately its original position in the guideway 6, 6 as shown in Figure 1. Thereupon the members 17 are turned in the clockwise direction, their portions 27 lifting the threaded pipe up out of the guideway 6, 6 and discharging it to the left viewing Figure 2. At the same time another pipe rolls down the chute against the stop or stops 28 as above described ready for repetition of the cycle.

Referring now more particularly to the mechanism for supporting and operating the dies 29 and 30, the die 29 is disposed on the end of a shaft 36 rotatably mounted in bearings 37 in the machine frame (Figure 5). The shaft 36 is adapted to be rotated by a suitable source of power through a coupling 38. The die 29 may be formed as an integral part of the shaft 36 or may be removably attached to the shaft so that different sized dies may be selectively used with the same shaft.

Fixed to the shaft 36 is a gear 39. The gear 39 meshes with a gear 40 mounted on a stub shaft 41. The gear 40 in turn meshes with a gear 42 fixed to a shaft 43 which is connected through a flexible coupling 44 with a shaft 45 to which is fixed a gear 46. The gear 46 meshes with a gear 47 fixed to a shaft 48 which carries the die 30. The shafts 45 and 48 are journaled in a support 49 which as shown in Figure 5 has a yoke-shaped forward end in which the die 30 is disposed. The support 49 is mounted atop a base 50. A pivot pin 51 is connected with the base 50 and projects upwardly therefrom. The pivot pin 51 enters a bore in the support 49 whereby to position the support 49 upon the base 50 for limited turning movement about the axis of the pin 51 (Figure 9). Thus I provide for precise angular adjustment of the die 30 for cooperation with the die 29 whose position is fixed.

The base 50 has opposed upwardly projecting portions 52 and 53. The support 49 has two cross bores 54 in each of which is positioned a pin 55. One end of each of the pins 55 is adapted to bear against the portion 52. Each of the bores 54 has at its end which is adjacent the portion 53 an enlarged and internally threaded portion 56. A screw 57 is threaded into each of the portions 56 so that its inner end engages the adjacent end of the corresponding pin 55. The portion 53 has openings 58 therethrough to provide for access to the screws 57. The screws 57 may have wrench receiving sockets in their outer ends and a wrench such as an Allen wrench may be inserted through each opening 58 to engage and turn the corresponding screw 57. The angular position of the support 49 on the base 50 is adjusted by turning the screws 57 to exert pressure against or relieve pressure upon the respective pins 55, the pressure of the pins 55 against the portion 52 causing turning of the support 49 about the axis of the pin 51 until it assumes its desired adjusted position. At that time nuts are tightened on bolts 59 connected with and extending upwardly from the base 50 through elongated slots 60 in the support 49 to maintain the support 49 in desired adjusted angular position upon the base 50.

The frame has a guideway 61 receiving a dovetailed guiding portion 62 on the bottom of the base 50 so that the base 50 and everything carried by it may be moved toward and away from the die 29. A piston in a cylinder 63 has a piston rod 64 connected with the base 50 so that upon movement of the piston in the cylinder the base 50 is moved along the guideway 61 toward or away from the die 29 depending upon the direction of movement of the piston in the cylinder. The piston is operated by hydraulic means presently to be described. Hydraulic actuation of the die 30 relatively to the die 29 has very important advantages over mechanical operation of the dies as mentioned above and as will be further developed below.

The piston rod 64 passes freely through a bore 64*a* in a bracket 64*b* which is stationarily mounted on the frame. The piston rod 64 is threaded for a portion of its length and has two pairs of co-operating locknuts 64*c* and 64*d*, one pair on each side of the bracket 64*b*. The locknuts 64*c* limit the movement of the piston in the cylinder 63 when the die 30 is retracted away from the die 29. The locknuts 64*c* may be adjusted to different positions when pipe of different diameters is being operated upon so as to desirably limit the stroke of the piston and eliminate unnecessary lost motion. The locknuts 64*d* have no function in normal operation of the apparatus but may be used to limit the forward movement of the piston during setting up; also they serve as a safety device to stop the piston in the event of die breakage or other emergency. In Figures 5, 6, 7 and 8 clearance is shown between the locknuts 64*d* and the bracket 64*b* as the forward movement of the piston is limited by bottoming of the flange 34 in the annular recess 65 presently to be described.

I have mentioned above the flange 34 on the die 29 which serves as a stop for the end of the pipe disposed over the die 29. The flange 34 also has other functions. It enters an annular recess 65 in the die 30 (Figure 5). The flange and recess co-operate to maintain the dies 29 and 30 in relatively fixed axial position. Also, the radial dimensions of the flange 34 and the recess 65 are proportioned so that when the flange bottoms in the recess it limits the movement of the dies toward each other and hence limits the extent of the operation upon the pipe. Thus I insure uniform and accurate thread formation.

Immediately behind the flange 34 the die 29 has a radial recess 66 against which two rollers 67 bear to counteract the thrust against the die 29 of the die 30 when the latter is moved toward the former. The thrust bearings 67 are mounted in a head 68 mounted on the machine frame and adjustable toward and away from the dies by adjusting screws 69.

During operation of the dies on the pipe the shaft 36 turns in the clockwise direction when viewed from the right-hand end thereof in Figure 5. Thus the tendency of the die 29, as will be observed by a consideration of Figure 5, is to turn out of the end of the pipe or conversely to back the pipe off of the die 29 during thread formation. To counteract that tendency the die 30 is made of somewhat greater diameter than the die 29; but the gearing is of necessity arranged so that both dies turn at the same angular velocity but in opposite directions. Thus during thread formation the die 30 not only co-operates with the die 29 to form threads in the pipe but also exerts a frictional force on the outside of the pipe tending to turn the pipe onto the die 29 and thence prevent it from backing off. Since the end of the pipe is disposed against the flange 34 during rolling of the threads it is maintained in fixed axial position relatively to the dies during the thread forming operation.

The gearing is enclosed within a casing 70. Disposed within the casing and connected with the shaft 43 by a coupling 71 is an oil pump 72 (Figure 5) which picks up the lubricating oil from the bottom of the oil pan and delivers it through pipe (not shown) to the gears and bearings.

The shape of the dies is of great importance in the formation of my improved threads. One of the dies is a thread forming die while the other die is a non-thread forming die which co-operates with the thread forming die to cause the metal of the pipe to flow into the thread forming die. The dies have complementary metal forming faces, the thread forming die preferably having thereon a helical metal forming projection whose side walls are substantially parallel to each other and the non-thread forming die having thereon a helical metal forming projection whose side walls are inclined to each other, which inclined side walls extend substantially to the crest of the second mentioned projection, the projections being in axially staggered relation. The projections are shown to greatly enlarged scale in Figure 11. In that figure the thread forming die is the die 29 since it forms the threads on the inside of the box end of the pipe. The dies for operating on the pin end of the pipe are reversed, the thread forming die being the outside die. In Figure 11 the outside die 30 is a non-thread forming die. The helical metal forming projection of the thread forming die 29 is shown at 73 and the helical metal forming projection of the non-thread forming die 30 is shown at 74. The side walls 75 of the projection 73 are substantially parallel to each other while the side walls 76 of the projection 74 are inclined to each other and extend substantially to the crest 77 of the projection 74. The projections 73 and 74 are in axially staggered relation. The inclined side walls 76 of the helical projection 74 on the die 30 preferably have rounded corners 78 and 79 at their top and bottom extremities respectively. The dimension of the projection 74 axially of the pipe at its crest is not over about half of the axial dimension of the projection 73. In between the convolutions of the projection 74 the face of the die 30 has a helical groove 80 of somewhat dished shape merging through the rounded corners 79 into the inclined walls 76 of the projection 74. Since the axial dimension of the projection 74 at its crest is not over about half the axial dimension of the thread forming projection 73 of the die 29 the groove 80 is of substantially greater axial dimension than the projection 73.

The end face 81 of the helical thread forming projection 73 is shown as being substantially at right angles to the side walls 75 so that the thread forming projection 73 is substantially square as shown in Figure 11. The dies co-operate so that in the threaded pipe the thinnest section at the thread is at least about eighty per cent of the thickness of the pipe wall at a point removed from the thread.

The improved results obtained by my improved dies are realized to the fullest extent through the hydraulic actuation of the dies toward each other. Hydraulic actuation plus the shape of the dies results in formation of a thread greatly superior to rolled threads heretofore produced.

As the outer die 30 moves toward the inner die 29 and engages the outer surface of the pipe it first deforms or corrugates the pipe so that in its initial stages the pipe is wavy internally and externally like corrugated iron culvert pipe. This corrugation of the pipe results in its being foreshortened, i. e., in its length being somewhat decreased. As the pipe is foreshortened the piston in the cylinder 14 moves forward due to the constant hydraulic pressure which is applied to it so that during the foreshortening process the box end of the pipe is at all times maintained firmly against the flange 34. The foreshortening and corrugating process may continue for a number of revolutions, say twenty, until the inner faces of the corrugations engage the bottom of the groove between the convolutions of the thread forming projection 73. At that time the hydraulic pressure on the die allows for commencement of flow of the metal of the pipe without shearing of the metal. The non-thread forming projection 74 with its inclined faces and rounded corners causes the metal of the pipe to flow somewhat axially along the groove between the convolutions of the thread forming projection 73 to fill the corners of the groove and thus produce a square cornered thread. Continued hydraulic pressure consolidates and solidifies the metal so that a strong compact metallic structure results.

During the thread formation the metal is squeezed so that it is caused to flow without any substantial shearing to form threads projecting from one surface of the pipe while the opposite surface is deformed; thus the metal throughout the entire thickness of the pipe is flowed and reshaped during thread formation. The metal flow is limited at the crests of the incipient threads and the metal is forced laterally generally parallel to the crests to form the generally square thread corners.

Figure 10 shows a joint between two sections of pipe having threads rolled thereinto in accordance with my invention. The section 82 has an internally threaded box end 83 and the section 84 has an externally threaded pin end 85. The internal threads in the box end and the external threads in the pin end are of substantially the same form except that the internal threads face inwardly and the external threads face outwardly. Since the threads are substantially square they interfit very accurately and provide the maximum resistance to pulling out. Also, due to the form and proportions of the threaded pipe ends as above explained, the joint is exceptionally strong in tension tests to failure.

The thread proportions and dimensions are determined by the dies and are, of course, the same as the proportions and dimensions of the dies. The surface of the pipe opposite the thread has a helical depression whose dimension axially of the pipe at its bottom is not over about half the dimension of the thread axially of the pipe and the depression is disposed radially opposite the center of the thread crest. A helical projection is disposed radially opposite the thread throat. The projection and depression merge into each other through rounded corners. The helical projection opposite the thread throat has a dimension axially of the pipe at least one-third greater than the dimension axially of the pipe of the thread throat. The side walls of the helical depression opposite the thread crest are inclined toward each other and extend substantially to the bottom of the depression. The thinnest section at the thread is at least about eighty per cent of the thickness of the pipe wall at a point removed from the thread.

The operating and controlling mechanism is shown in Figure 4. The oil tank for the hydraulic actuating mechanism is shown at 86. The pump for placing the oil for the hydraulic cylinders under pressure is shown at 87. Oil is drawn out of the tank 86 through a pipe 88 and is delivered from the pump 87 through a pressure line 89 to a 4-way valve 90 having a valve operating lever 91. The valve may be of conventional form. When the die 30 is to be moved toward the die 29 the valve 90 is operated so that the fluid from the pressure line 89 passes through a pipe 92 to the outer end of the cylinder 63 to push the piston in that cylinder in the upward direction viewing Figure 5. The fluid in front of the piston passes out of the cylinder 63 through a pipe 93 to a T 94 in a pipe 95. A one-way valve 96 permits flow of fluid only from right to left and not from left to right in the pipe 95 viewing Figure 4. Therefore, the fluid passing downwardly through the pipe 93 is constrained to move to the left in the pipe 95.

The pipe 95 delivers the fluid to a flow-controlling throttle valve 97 having an adjustment device 98 for controlling the opening therein so that a desired amount of throttling of the fluid passing to the valve 97 through the pipe 95 may be obtained. Fluid leaving the valve 97 passes through a pipe 100 and back into the tank 86. Thus the throttle valve 97 is effective to throttle or slow down the flow of fluid from in front of the piston in the cylinder 63 when the die 30 is being moved toward the die 29. By a proper setting of the valve 97 the desired speed of movement of the die 30 toward the die 29 may be obtained so as to bring about the proper metal flow. However, the hydraulic system is such that when the die 30 is withdrawn away from the die 29 the throttle valve 97 does not function so that the speed of withdrawal may be rapid and independent of the speed of advance. When the die 30 is to be withdrawn away from the die 29 the valve 90 is moved to the position in which the fluid under pressure from the pipe 89 passes out of the valve through the pipe 101 and thence through the one-way valve 96 into the T 94. Due to the throttling effect of the valve 97 the fluid passes upwardly through the pipe 93 and into the cylinder 63 at the side of the piston nearest the die 30. The fluid from the side of the piston remote from the die 30 passes out of the cylinder through the pipe 92 through the 4-way valve 90 and back to the pipe 100 through a pipe 102.

There is provided a source of compressed air which passes through a pipe 103 to a valve 104 controlled by a treadle 105. Depending upon the position of the treadle the valve 104 may direct the air under pressure through either of two pipes 106 and 107. Those pipes lead through pipes 108 and 109 respectively to the lower and upper ends of the cylinders 22 so that by operation of the treadle 105 the actuating members 17 are operated. Only one of the cylinders 22 is shown in Figure 4 but the pipes 106 and 107 are connected with both of such cylinders in like manner.

The source of compressed air is connected through a pipe 110 with a hand operated valve 111 so that the compressed air may be delivered through either of two pipes 112 and 113. Those pipes lead to the respective ends of the cylinder



14 so that depending upon the position of the valve 111 compressed air may move the piston in the cylinder 14 in either direction. The function accomplished by that movement has already been explained.

The shaft 36 may be driven through the coupling 38 by an electric motor 114 through a suitable gear reducer. The pump 87 may be operated by an electric motor either on the same shaft or geared to the pump shaft. Electrical energy may be delivered to a switch box 115 through wires (not shown) passing through an inlet conduit 116 and to the respective motors through conduits 117 and through a conduit 118 to control switches 119. The electrical control system may be conventional.

When a pipe end is to be threaded the die 30 is moved away from the die 29, a pipe end is introduced over the die 29 as above explained, the dies and pipe are rotated and during such rotation the die 30 is moved against the outside of the pipe end opposite the die 29 as above explained to roll threads into the pipe end. When the threading has been completed the die 30 may be retracted and the pipe slowed up relatively to the die 29 manually or otherwise whereupon the threaded pipe automatically backs off of the die 29. This is a rapid way of removing a threaded pipe from the die. If desired, the rotation of the dies may be stopped and the pipe may be turned off of the die 29. The dies may be rotating or stationary when the pipe end is presented thereto prior to threading.

My metal pipe having a rolled thread is claimed in my divisional application Serial No. 189,828, filed October 12, 1950.

While I have shown and described present preferred embodiments of my invention and a present preferred method of practicing the same it is to be distinctly understood that the invention is not limited thereto but may be otherwise variously embodied and practiced within the scope of the following claims.

I claim:

1. In a machine for rolling threads into metal pipe, a rotary die adapted to be positioned inside a pipe end, the die being mounted for rotation about a fixed axis, a second rotary die adapted to be positioned outside the pipe end, a support in which the second die is mounted, a base on which the support is pivotally mounted, the base being movable generally toward and away from the first mentioned die, and means for maintaining the support in desired angular position about its pivotal mounting on the base.

2. In a machine for rolling threads into metal pipe, a rotary die adapted to be positioned inside a pipe end, the die being mounted for rotation about a fixed axis, a second rotary die adapted to be positioned outside the pipe end, a support in which the second die is mounted, a base on which the support is pivotally mounted, hydraulic means for moving the base toward and away from the first mentioned die, means for maintaining the support in desired angular position about its pivotal mounting on the base and means for adjustably positioning the base relatively to the hydraulic means in the direction of movement of the base.

3. In a machine for rolling threads into metal pipe, opposed rotary dies having complementary metal forming peripheries, one of said peripheries having thereon a helical metal forming projection comprising a plurality of convolutions having in axial cross-section a substantially flat crest

extending generally parallel to the axis of the die and substantially flat side walls substantially perpendicular to said substantially flat crest forming a depression between adjacent convolutions of the projection, the bottom of said depression being substantially flat in axial cross-section and extending generally parallel to the axis of the die and joining the side walls of adjacent convolutions of the projection, and the other of said peripheries having thereon a helical metal forming projection comprising a plurality of convolutions directly opposed to the helical depression of the first mentioned periphery, the helical metal forming projection of the second mentioned periphery having in axial cross-section an elongated substantially flat crest extending generally parallel to the axis of the die whose dimension axially of the die is not over about half the dimension of the depression of the first mentioned periphery axially of the die and outwardly inclined side walls with rounded corners at the top and bottom extremities of the side walls, said elongated crest being of sufficient length to force the metal of the pipe into said first mentioned depression and against the bottom thereof and the side walls being so related as to create axial flow of said metal to fill the corners of said first mentioned depression.

4. In a machine for rolling threads into metal pipe, rotary complementarily threaded dies adapted respectively to be positioned inside and outside a pipe end when the pipe end is presented thereto and to cooperatively roll threads into the pipe end, means for supporting said dies so that the outer end of the inside die is unsupported to permit the pipe end to be introduced endwise thereover, the inside die having a radial flange located inwardly of the threads thereof at a predetermined distance and spaced from the unsupported outer end thereof acting as a stop to limit the extent to which the pipe end passes over the inside die and thereby determine the location of the threads in the pipe, and the outside die having a radial groove receiving the radial flange of the inside die to maintain the dies in relatively fixed axial position during formation of the threads in the pipe.

5. In a machine for rolling threads into metal pipe, rotary complementarily threaded dies adapted respectively to be positioned inside and outside a pipe end when the pipe end is presented thereto and to cooperatively roll threads into the pipe end, means for supporting said dies so that the outer end of the inside die is unsupported to permit the pipe end to be introduced endwise thereover, means acting on the outside die to move that die transversely of its axis toward the inside die, the inside die having a radial flange located inwardly of the threads thereof at a predetermined distance and spaced from the unsupported outer end thereof acting as a stop to limit the extent to which the pipe end passes over the inside die and thereby determine the location of the threads in the pipe, and the outside die having a radial groove receiving the radial flange of the inside die to maintain the dies in relatively fixed axial position during formation of the threads in the pipe, the radial dimensions of the flange and groove being proportioned so that the flange bottoms in the grooves upon predetermined movement of the outside die toward the inside die whereby to limit the extent of action of the dies on the pipe, and roller means acting against the portion of the inside die at the side of the flange thereof remote from the outer end of the inside die and remote from the outside die supporting the inside die against bending caused by the action of the means for moving the outside die toward the inside die and thereby minimizing deflection of the inside die during rolling of threads in the pipe end to effectuate the limiting effect of said flange and groove.

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