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Introduction

Congratulations on your purchase of a C.J. Winter Cold Root Rolling Attachment. These attachments have been designed specifically for use in the manufacture of Rotary Shouldered Connections in the Petroleum Industry using a CNC lathe. With proper use, these attachment will cold root roll threads compliant with ANSI/API Specification 7.2:2008 and ISO 10424-2:2007, and in accordance with DS-1 Spec, Third Edition, Volume 3.33.6.

What is Cold Root Rolling?

Cold root rolling is the process of burnishing the root radius of a previously cut thread, in a Rotary Shouldered Connection. A hardened roll, similar in profile to the thread being manufactured, is placed in contact with the root radius of the tapered thread, and pressure is applied to force the roller to penetrate into the cut surface of the root radius, displacing and cold-forming the thread material. This deformation cold-works the material, imparting an improved surface finish, and compacts and displaces the grains of the root material. Industry experience with the cold root rolling process have suggested an increase in fatigue life of 3 to 5 times over similar, un-treated connections under the same working environment. Some studies have noted laboratory results of up to 27 times better life attributable directly to cold root rolling process\(^{(1)}\).

![Figure 1: Roll Entering Root Contact](image-url)
Figure 2: Roll Fully Engaged at .006” Penetration

Figure 3: Final Result After Elastic Springback
These studies have attributed the increase of fatigue life to one or more important effects of cold root rolling.

1. Cold root rolling imparts a thin zone of residual compressive stress in the root region. This residual compressive stress offsets the tensile stresses induced in service, and lowers the overall stress in the critical stress region of the thread root. Figure 4.0 is an illustration of the typical residual stress patterns that remain in the part after cold root rolling, as well as the condition and displacement of material throughout the root rolling process (Note: the magnitude and depth of the stress plot has been exaggerated for clarity).

![Figure 4: Residual Stress via Burnishing](image)

2. The burnishing effect of the smooth and hard roller, on the soft and torn root radius left by the threading insert, causes the small scratches and ridges left by the cutting operation to flatten into a more uniform surface. These scratches have very small tip radii, at the leading edge, or bottom of the scratch. These small tip radii are considerable stress concentration factors, in one of the most highly stressed regions of the drill string connection. As a result, these scratches are the crack propagation points for most fatigue failures. Any method that minimizes or eliminates them enhances fatigue life.

3. Scratches provide prime locations for chemical erosion. The microscopic surface of a scratch is very jagged and porous, exposing a large surface
area, and numerous molecular bonding sites, to the corrosive effects of liquids and gasses present in a drill string environment. The burnishing effect smoothes this surface, presenting a densely compressed and uniform surface. This burnishing eliminates outcroppings and inclusions, minimizes surface area, and inhibits chemical attack.

4. Root rolling the connection has a work-hardening effect on the surface of the material. On an atomic scale, the displacement of the crystalline lattice within the steel grain structure, causes the crystal structure to change from a repetitive and uniform atomic structure, to one with many dislocations in the pattern. These dislocations in the iron matrix cause the crystal structure to interlock, and become more resistant to further deformation. This added resistance to deformation at the surface of the material helps prevent cracks from starting, and helps arrest microscopic cracks from growing into structural flaws that threaten the integrity of the joint. In lab studies, cracks that have occurred in cold rolled joints have exhibited a significantly lower Crack Aspect Ratio (Crack Length/Crack Depth). A 30% to 50% lower CAR means that cracks in cold root rolled products are more likely to be deep and short (as illustrated by the crack at the top of the pipe shown in Figure 5), rather than long and shallow (as illustrated by the crack at the bottom). A shallow crack is more likely to lead to a sudden and complete structural failure of the joint. A deep crack that partially penetrates the section wall is detectable via pressure drop of circulating drilling fluids, and allows for an early recovery of damaged string prior to complete structural failure of the joint.\(^1\)

\(\text{Figure 5: Crack Aspect Ratio}\)
Why root roll Rotary Tapered Connections?

Cold Root Rolling is a requirement of DS-1 sec. 3.3.66, which requires all new and re-cut BHA and HWDP connections with API thread forms to be Cold Root Rolled.

Cold Root Rolling is also a money saving process. Cold Root Rolling can drastically increase the fatigue life of each rotary shouldered connection in a typical drillstring. It can also reduce the frequency of repairing connections in the field, and of having to fish for downhole failures. With the increasing popularity of extended reach drilling, multi-lateral wells, "hard rock" and horizontal well applications, the stress and bending moments being placed on rotary threaded connections, plus the sheer number of rotary threaded connections being placed into service, is growing each day \(^{(2)}\). With these increased stresses, and increased number of connections, also comes the increased chance of a downhole failure of the drillstring. T.H. Hill estimates that the cost of a single downhole failure can surpass 1 million dollars \(^{(3)}\). With that kind of risk, Cold Root Rolling is cheap insurance against drillstring failures that are otherwise bound to happen sooner or later.

Why Use CJ Winter's Cold Root Rolling Attachments?

C.J. Winter is the industry leader in supplying thread rolls to North American. Virtually everyone owns a consumer product that has a thread rolled part inside. From automobiles to power tools, and electronics to construction supplies, C.J. Winter supplies over half of the tools used to roll threads on this continent. That experience has been leveraged to design an attachment specifically for Rotary Shouldered Connections in the Petroleum Industry. We believe this is the ONLY self-contained, commercially available attachment that will cold root roll threads compliant with ANSI/API Specification 7.2:2008 and ISO 10424-2:2007, and in accordance with DS-1 Third Edition, Volume 3.33.6. When you need tooling fast, you've got our number. Your order for rolls will be processed in our world-class thread roll production facility, with the same level of attention to quality and service that has made us the industry leader in every other market segment.
But beyond C.J. Winter as a company, you have the unique advantages of our Cold Root Rolling attachments.

**This attachment does not require an external power device to pressurize the roller piston.** The only tool required to pressurize is an box-end wrench.

**This attachment does not require an external accumulator to roll the run-out thread.** It is a requirement of DS-1 to maintain full pressure on the roller until the last remnant of the run-out thread \(^{(4)}\). This requirement either forces perfect synchronization of the retraction of the cutting tool and roller, or an accumulator to allow the roller to retract into the holder body. Since perfect synchronization can be exceedingly difficult, the C.J. Winter holder comes standard with an integral accumulator to allow for the extra roller travel in this critical region.

**The rolls in this attachment cannot be loaded incorrectly.** Rotary Tapered Connections use threads that are tapered. The rolls and roll pins on a Cold Rolling attachment are tipped slightly to minimize side forces on the rolls and attachment components. Because the form on a standard API roll is not symmetric, assembly orientation is critical. When using OEM supplied rolls with the **EPL® system (Error Proof Loading® - Patents Pending)**, rolls CANNOT be loaded backwards. You do not need to rely on an imprecise and often overlooked, visual verification of the 5° skew on the thread form. The EPL system uses an asymmetric hub system where the hub on one side of the roll is larger than the other. The asymmetric hubs work in conjunction with a step in the roll holder to create Step/Hub interference if the user attempts to load the roll backwards. This eliminates this all too common mistake that can ruin a Rotary Shouldered Connection, and require a connection to be re-cut, or discarded.
This attachment requires no conversion between the values of hydraulic pressure, and roller force. To simplify life for the operator, and to reduce the chance for a damaging error, the numerical values of the pressure gage are the same for both PSI and Lbs force. Because we designed our working piston to be 1.128", which has an area of 1.00 in², no confusing lookup table is ever required to convert 1 PSI to 1 pound of force.

The supplied pressure gage is digital, and backlit, making pressure adjustments easier to read than analog scales with small divisions. It also comes equipped with max/min recording functions so values can be observed after the cycle is complete, rather than during cycle with moving parts and coolant spraying about the lathe. The stainless body is IP65 rated against coolant, and come pre-calibrated and certified.

Also available is an optional wireless digital pressure gage and data acquisition unit. This optional wireless solution will allow for easy monitoring of the attachment pressure, OUTSIDE the machine enclosure, and in real-time. It also allows you to record the pressure data digitally, for part quality and certification purposes.

The 11071-SA series of attachments will roll all API Rotary Shouldered PIN connections.

The 11070-SA series of attachments will roll API Rotary Shouldered BOX connections in the following ranges.

NC35 thru NC70
4-1/2 REG thru 8-5/8 REG
5-1/2 FH and 6-5/8 FH

We want this to be the easiest attachment you ever bought, ever used, ever ordered tooling for. When you think Cold Root Rolling, we want you to think C.J. Winter.
Package Contents

This attachment is shipped complete with everything you need to roll your thread roots except hydraulic oil. In addition, you have been provided with several spare parts, mostly hardware and seals, in the event one becomes damaged or lost. We don't want to shut down your line because someone dropped a set screw.

Included in the back of this manual is a complete assembly diagram, and part list. In the event you need a spare, each part, size permitting, is permanently identified with a laser-marked part # for easy identification, and replacement.

The attachment is supplied in a robust case designed specifically to protect your tool in shipping and at the job site, and to store your spares and manual safely when not in use.

Machine Mounting

Both the 11070-SA series for Boxes and the 11071-SA series for Pins, mount to the CNC Lathe tool holding turret via a 6-1/8" long shank, that is available in several shank diameters between 2" and 3". Larger shanks can be custom designed if required. Drill bushings can also be used to adapt to larger tool holders.

These attachments are intended to be mounted in non-rotating, end-working tool holders. The shank should be fully inserted into the tool holder, right up to the shoulder, and retained using setscrews hand-tightened against the factory-supplied flat on the shank. Due to the thin walls of the integral accumulator (located in the shank), and the high forces required to Cold-Roll threads, we DO NOT recommend any portion of the shank be extended unsupported from the holder.

In addition to the 6-1/8" long shank, the tool holder must be able to accommodate a 3/4" long hex that protrudes from the rear of the shank, and have ready access to this hex to pressurize the attachment. Most CNC lathes have more than adequate clearance behind the tool holder to accommodate this tool, but every new installation should check for possible interference with this attachment, particularly during index of a tool turret.

Modification of the attachment is not recommended. If you feel the need to modify your attachment, please contact the C.J. Winter first.
Configuring the Digital Gage

We suggest that you alter some of the default configuration settings for your digital gage. Your attachment comes with a manual specific to your gage model that will cover how to make the following changes.

Set the password - by default, there is no password, or if it has been changed during calibration, it should be noted in your manual. We suggest you set this password immediately, and note it in your manual. Setting this password will allow you to lock-out some features that could lead to an erroneous pressure reading.

Disable the ZERO button - Factory default for this option is 5% of full scale, which means the user can re-zero the gage between +/- 500 PSI. Set this to "dISAb" to prevent re-zeroing at any value other than factory calibration.

BACKLITE - Factory default is "NEVER", which means backlight will stay on until someone hits the backlite button again. We suggest setting this to 10 seconds to preserve battery.

AUTO OFF - Factory default is "NEVER", which means gage will stay on until someone hits the on/off button again. We suggest setting this to 30 minutes or less to preserve battery.

After configuring the gage, operation is fairly easy. Press On/Off for power. Press Min/Max to scroll between the current pressure, and recent high and low readings. Press Zero/Clear while displaying the Min or Max values to reset these results (which should be done prior to each rolling pass).
Filling the Attachment

You will need to fill the attachment with hydraulic oil, and bleed out any air, prior to first use. This attachment contains several Nitrile o-ring seals, and therefore can be filled with almost every commercially available petroleum-based hydraulic oil.

The use of a synthetic hydraulic oil, or additives known to have compatibility issues with Nitrile, is not recommended.

This may compromise the seals and lead to leakage and ineffective rolling. If in doubt, please check with your lubricant supplier to insure the compatibility of Parker compound N674-70 with your oil.

To fill the attachment:

1. Remove the storage plug, and install the pressure gage with a thread sealant into the indicated hole.

   Never operate attachment with any plug or gauge that was not provided by CJ Winter. This attachment is under extreme pressure when rolling, and most commercially available fittings will leak or fail under these loads.

2. Completely remove the course adjustment screw and accumulator assembly from the rear of the tool.

3. Place the attachment in a shallow oil drip-pan. Tip the attachment upright, and fill the rear reservoir with oil within roughly 3.50" from the top. Replace the accumulator assembly. It may not be possible to thread the assembly in yet, but the o-ring should seal the oil.
4. Flip the attachment so the roller end is towards the top, and rock it back and forth several times, leaning towards the gage, and then away, to allow all air bubbles to rise to the top.

5. Place the Allen® driver and socket wrench into the course adjustment screw, and allow the tool to lay in the drip pan.

6. Remove the air purge plug, while covered with a rag to prevent a sudden spray or jet from escaping air and oil. Make sure the o-ring on the plug nose is still in place.

7. Gently push down on the attachment, fully inserting the course adjust screw in the rear of the attachment. Rotate the attachment, threading in the course adjusting screw that is prevented from spinning by the socket wrench, until oil starts to exit the air purge hole.

8. Continue turning the course adjust screw in until the pressure rises.

   The threads on the coarse adjust screw should be between .125 to .375 standout from the back of the shaft. It may be necessary to add or remove oil thru the air purge port to achieve this standout.

9. Replace the air purge plug, making sure the o-ring is seated on the plug nose.

10. Check to ensure all fittings are pressure tight. This is best done with the attachment mounted in a tool holder due to the significant torque that must be applied to the screw. Wipe the attachment down to remove any oil, and turn the coarse adjust screw in until the pressure gage reads the maximum pressure required for your application. Failure to reach this pressure indicates inadequate oil in the reservoir, entrapped air, or a leak. Absent of leaks, a slow but steady decrease of the pressure for the first 10 minutes is normal, as the spring pack and o-rings take a set.

   **DO NOT check for fluid leaks with your hand.**

   Look for pooling of oil near fittings, and use a rolled up piece of paper, or some similar object if you suspect you may have a leak.
Safety

When the attachment is pre-charged, and especially during use, the hydraulic fluid in this attachment is under tremendous pressure.

**DO NOT replace any components with non OEM components.**

All the OEM supplied components have been designed and rated to operate safely at up to at least 8,000 lbs, which is more than twice the maximum required roller force for any API Rotary Threaded Connection. Hydraulic fluid under pressure can be very dangerous. A pinhole leak can puncture the skin, injecting toxic fluids into body tissue, or in extreme cases, even slicing soft tissue.

**DO NOT check for fluid leaks with your hand.**

Use a rolled up piece of paper as a wand, or some similar object if you suspect you may have a pinhole leak. Also, the pressure can propel components such as plugs and gages should they come loose from their mounting threads. C.J. Winter recommends every precaution be taken whenever the attachment is under pressure, that would normally be used around hydraulic machinery.

**WEAR SAFETY GLASSES.**

Whenever practical, use this attachment in a CNC lathe with an enclosure, and keep the door closed. When servicing the attachment, relieve the pressure using the coarse adjust screw BEFORE removing any other component. Do not remove the any plugs, the retaining ring, or the gage until the pressure reads near ZERO. If you are injured at any time when using or servicing this attachment, follow your company procedure for reporting injuries and seek medical attention immediately.
Periodic Maintenance

C.J. Winter recommends an annual teardown and inspection of this attachment.

We recommend the periodic replacement of the 4 O-rings in the attachment, as well as a replacement of the Bellville washer stack. The frequency of this replacement depends greatly on the severity of service the attachment sees, the type of connection being rolled, and the adherence to proper setting and operation procedures. This frequency should be determined by your own in-shop experience, and be scheduled in a preventative manner. At a minimum, we recommend replacement of these components during the annual inspection.

The supplied pressure gage is calibrated and certified by the gage manufacturer prior to sale. DS-1 requires the gage be recalibrated every 6 months.

ONLY replace this gage with an OEM supplied replacement.

This gage, as well as all the plugs, retaining rings, and other components supplied with this attachment, have been rated for the anticipated pressure spikes of the Cold Root Rolling process. Replacement with unapproved aftermarket gages or hardware could compromise the function and safety of the attachment.

The remaining components are not generally considered "service" parts, and should be replaced only in the event of damage or excessive wear.

For safety reasons, C.J. Winter does not recommend modification of any part of this attachment.
Quality Control

Per API Spec 7-2 section 7.5, Cold Root Rolling is performed after a connection has been inspected and certified to conform with the proper thread specs.

Cold Root Rolling displaces material on the root of the thread, which will cause an increase in thread depth, and often will slightly distort the thread flanks.

As a result, attempts to use thread gages used after Cold Root Rolling may show a change in the gage standoff. This change is anticipated and permissible by API Spec 7-2 section 7.5, and will not affect the interchangeability of connections (5).

Prior to Cold Root Rolling, DS-1 Third Edition requires the thread root be cleaned and inspected for scratches that visually are estimated to exceed .002". Scratches exceeding .002" may leave remnant defects after Cold Root Rolling, and are not allowed (4).

After Cold Root Rolling, a visual inspection under 10x magnification shall be performed to ensure the root has been burnished, and has a smooth and shiny appearance. Quantitative inspection should be performed using an appropriate micrometer and anvil tip to measure tooth depth, as described and illustrated in API 7-2 Section H.4.3. The DS-1 recommends (but does NOT require) a minimum of .004" increase in tooth depth after cold rolling (4).
## Setting the Roller Pressure

Mount the tool in your turret, and adjust the pressure with the tool in free space, to 95% of the value below. Particularly during the first use, there may be a gradual pressure drop as the o-rings and internal springs take a set. Before and after rolling, monitor the tool pressure to ensure the displacement of the roller raises the pressure the remaining 5% to the MINIMUM chart value. If there is an insufficient rise pressure, there may be too little contact between the roller and part. A tool offset should be made to increase the roller contact, which will raise the pressure to meet the DS-1 force requirements listed below\(^{(4)}\). NOTE: The work cylinder is Ø1.128, which has an area of 1.00 in\(^2\). The conversion of PSI to pounds of force is 1:1.

### Connection

<table>
<thead>
<tr>
<th>Connection</th>
<th>Thread Form</th>
<th>Req. Roller Force (lbs) (1PSI = 1 Lb force)</th>
<th>Recommended CJW Roller</th>
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<tbody>
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<td></td>
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<td>Pin</td>
<td>Box</td>
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<td>V-0.050</td>
<td>1350</td>
<td>1800</td>
</tr>
</tbody>
</table>
Preparing the Attachment
First, install the appropriate roller in the roll holder. We recommend using C.J. Winter’s EPL series of cold rolls in this attachment. The EPL series is designed with the Error Proof Loading system, to ensure the asymmetric rolls used in Cold Root Rolling are loaded in the proper orientation. When inserting the roll, make sure the bore and pin are clean, and lubricated with oil or a EP grease.

Most modern CNC's will have tool probing capable of pre-setting the X and Z location of both the centerline of the thread insert, and the centerline of the roll. To establish an accurate centerline, first probe the X location by touching off the tip. Then, touch off each flank of the tool, making sure that both sides of the tool are probed using the same ΔX offset. The average of the two location values will be the centerline of the tool.

The Cold Rolling Procedure
API 7-2 does not dictate a procedure for the cold rolling process. Speeds, pressures, even roller geometry are left to the discretion of the user.

DS-1 does however outline many of these parameters, and may be specified by your customer or end user as a requirement for their connections. The full recommendations of DS-1 can be found on pages 83 thru 85 of volume 3, third edition\(^4\). In the event your customer requires strict adherence to this spec, and our procedure differs in any way, we suggest you consider the DS-1 guidelines to supersede ours.
We suggest cleaning and gauging the thread just prior to Cold Root Rolling to avoid possible thread contamination. Flood coolant should be activated during the Cold Root Rolling Operation.

To set the penetration amount of the roller into the root, we suggest using tool wear or tool geometry offsets rather than changing the part diameter in the CNC threading canned cycle.

![Warning]

**On most machines, changing the part diameter, RPM, or Z start point of the cut, can affect the angular start point relationship of the cut vs. rolled thread, and cause a mismatch between the tool paths that would be detrimental to part quality and roll life.**

For the purposes of cold root rolling, the roller should be introduced at the same, or similar, depth of cut for each of 3 passes required by the DS-1 spec.

DS-1 recommends, but does not require, a minimum increase in tooth height after cold rolling of .004" (4). To achieve this result, a wear offset of double the per-side penetration, or at least .008", would need to be used. In practice, a larger wear offset will likely be required to accommodate both the elastic spring-back of the thread material, as well as any deflection in the tool and machine, which can be .020" or more.

**CNC Programming**

The roller must be synchronized to the cut thread on the connection. To accomplish this, we recommend using a similar canned threading cycle for both thread cutting and Cold Root Rolling. On most CNC controllers, this is best accomplished with two back to back G76 canned cycles, using the same OD, Lead, Taper Angle, start and stop points, and speeds.

There are 3 distinct CNC programming methods that can be used to cold-roll threads. G76, G32, and G92. Each will get the job done, but some will be easier to setup, synchronize, and ensure proper operation. Your shop may be familiar with a programming style that has worked well for thread cutting with a single insert in the past, but that programming style may not lend itself well to the synchronizing of multiple tools required in Cold Rolling. We will go into a detailed description of all three threading cycles, and their strengths and weaknesses, but we recommend the G76 method over all others.
• **G32 Threading Command**

G32 is the most basic of the threading commands. G32 is similar to a G01 linear feed move, except that feed is defined as per revolution, and feed rate is valid only in one axis. For tapered threads, even though the move is in both X and Z axis, feed is controlled and defined by the Z-axis movement.

G32 is also a simple, 1-motion command. It controls the thread generation motion ONLY (from point #2 to point #3). It does not retract the tool from the cut (3 to 4), it does not back the tool out to the start plane (4 to 1), and it does not feed the tool to the proper depth for the next cut (1 to 2). These motions must be independently programmed as separate lines. As a result, the multiple passes that are required to cut a thread to full depth, require at least 4 lines of code for every depth of cut. For a deep thread with 15 passes required for the various depths of cut, this can be a block of code exceeding 75 lines. Attempting to change variables like the start and end points, the amount of taper, or the depth of cuts can be very challenging and time consuming on the machine.

G32 threading typically uses a radial-style infeed, where the thread insert cut each progressive deeper pass straight down the center of the tooth form. This style of infeed is generally not optimal. It places a long insert edge in contact with the work piece at any given time, and creates a V-profile chip that is harder to break, and places greater stress on the insert, and tooling. Plunge infeed can lead to premature tool failure, chatter, lead errors. The remedy is usually to decrease the depths of cut for any given pass, which will lead to an excessive number of passes, and a longer cycle time.

G32 does have a one notable advantage over the other threading commands. Two G32 lines can be written on consecutive program lines, that have non-collinear geometry. In other words, two G32 commands can be written on back to back
lines, the first for a straight thread, the second for a tapered thread, and the pitch between the threads will be maintained throughout the transition. This can come in helpful if, for example, you want the burnish roll to only burnish some of the thread, but not all of them. Some customers prefer to have the burnishing roll "drop into" the thread 1 pitch past the start of the thread, so the roll is always supported on both sides by the cut thread. This practice is generally not recommended, and may violate DS-1 requirements, but is nonetheless made possible by the G32 command.

• **G92 Thread Cycle**

G92 is the next evolution of threading commands. Like a G32 command, a G92 cycle defines feed as per revolution, and feed rate is valid only in one axis.

Unlike a G32 command, a G92 cycle is a complex, multi-motion cycle. A single line of G92 programming will not only control the feed motion of the tool during the threading cut (2 to 3), but will also control the retract of the tool from the cut (3 to 4), will pull the tool back to the starting plane (4 to 1). However, moving to each successive depth of cut (1 to 2) must be programmed as individual lines. For a thread with 15 passes required for the various depths of cut, this can be a block of code of approximately 15 lines. G92 does offer the ability to control the depth of cut for each pass individually, and gives the user total control over the number of passes from 1 to infinity.

Unlike G32, a G92 thread profile must be linear (either straight or tapered). As a result, you cannot use G92 to burnish only some of the threads by dropping into the first or second pitch as described in the G32 section. G92 is MODAL, so each additional depth of cut can be called out as a new line by calling out a simple X value. The infeed using G92 will be a radial plunge infeed, with the same drawbacks described in the G32 cycle. More sophisticated infeed approaches, like compound or zigzag infeed are possible with G92 code, however it requires the user to manually calculate the proper Z-axis offset for each depth of cut to feed the tool in anything but a straight-down direction. Editing depths of cut at the machine, particularly with these Z-axis offsets, can be very challenging.
**G76 Threading Canned Cycle**

G76 is the latest evolution of threading commands. G76 is a canned cycle, that will cut the entire thread, with multiple infeed passes and pullouts, controlling all of the parameters needed to generate that thread, in a single command. G76 can be written as a 1 or 2 line command, depending on the vintage of your controller, and possibly a machine parameter setting. The principle advantages are: a compact code that is easy to edit, advanced infeed techniques for better thread quality and insert life.

The principle limitations of the G72 threading canned cycle are:

- Unlike G32, a G76 thread profile must be linear (either straight or tapered). As a result, you cannot use G76 to burnish only some of the threads by dropping into the first or second pitch as described in the G32 section.
- You must take at least 1 rough pass, and 1 finish pass. To cold-roll while conforming to the DS-1 spec, you are required to perform a minimum of 3 rolling passes anyway, but a G76 cycle does not allow the option of a 1-pass rolling cycle.

The 2-line G76 syntax:

```
G0X__Z__     (approach Point)
G76P_ Q_ R_   (first G76 line)
G76X_Z_R_P_Q_F_  (second G76 line)
```

Actual code appears like this:

```
G0 X4.1158 Z.2543
G76 P021060 Q.001 R.001
G76 X3.147 Z-3.75 P1218 Q200 R-.3292 F.25
```
First G76 line meaning:

G76 P021060 Q.001 R.001 (# of finish Passes - radial infeed)
G76 P021060 Q.001 R.001 (End chamfer length - expressed in 0.1 Leads)
G76 P021060 Q.001 R.001 (Tool Tip Infeed - defined as Included Angle of thread)
G76 P021060 Q.001 R.001 (Minimum roughing pass radial Depth Of Cut )
G76 P021060 Q.001 R.001 (Finishing pass radial Depth of Cut)

Second G76 line meaning:

G76 X Z R P Q F (minor Dia Of Male)(major Dia Of Female)
G76 X Z R P Q F (end Point Z)
G76 X Z R P Q F (radial X Diff. Of Tapered Thread)
G76 X Z R P Q F (Thread height - Value expressed in .0001" : P1218=0.1218")
G76 X Z R P Q F (1st Depth of Cut - Value expressed in .0001" : Q200=0.0200")
G76 X Z R P Q F (feedrate / Pitch)

Here is the syntax for the far less common, 1-line format.


X : specifies the final thread diameter.
Z : is the position of the thread end.
I : specifies the amount of taper, radially.
K : is the single thread depth.
D : is the depth of the first pass.
A : is the thread included angle.
F : is the thread lead.
P : is the infeed method

P1: One-side cutting with constant cutting amount (constant chip area)
P2: Zigzag cutting with constant cutting amount (constant chip area)
P3: One-side cutting with constant cutting depth
P4: Zigzag cutting with constant cutting depth
Using this G76 method, the roller will start roughly a 1/4" before the face of the part, and ride up the chamfer at the start of the thread, falling directly into the root radius created by the thread cutting insert. It will retract at the same depth, and at the same rate as the thread insert, applying a constant pressure all the way through the last scratch.

An example of the G76 machine code required for cutting and rolling the threads of a NC38 connection on a generic lathe is shown below. This code will need to be modified for your specific lathe and part geometry.
**Code for Pins**

(OD Threading)
T0101
G97 S240 M03
M08
G0 X4.1158 Z.2543
G76 P021060 Q.002 R.001
G76 X3.147 Z-3.75 P1218 Q200 R-.3292 F.25
M09
M01 (clean and gage thread)

(OD Cold Rolling)
T0202
G97 S240 M03
M08
G0 X4.1158 Z.2543
G76 P011060 Q.0001 R0.
G76 X3.147 Z-3.75 P1218 Q1218 R.3292 F.25
M09

**Code for Boxes**

(ID Threading)
T0101
G97 S240 M03
M08
G0 X3.047 Z.2541
G76 P021060 Q.002 R.001
G76 X4.0157 Z-3.75 P1218 Q200 R.3292 F.25
M09
M01 (clean and gage thread)

(ID Cold Rolling)
T0202
G97 S240 M03
M08
G0 X3.047 Z.2541
G76 P011060 Q.0001 R0.
G76 X4.0157 Z-3.75 P1218 Q1218 R.3292 F.25
M09
Please note, the G76 method detailed above will ensure that the roller remains in contact with the thread root until the very end of the last thread scratch, applying the proper pressure the entire way. This is a requirement of DS-1, and has been shown by several studies to be a key factor in maximizing the anti-fatigue properties of Cold Root Rolling in this most critical region\(^1\).

- **Synchronizing tools**

If you choose to use a programming method other than the G76 cycles described, particularly if you change RPM from threading to rolling, take care to ensure the full roller pressure is being applied to the final scratch, and the roller is not being retracted too early.

Conversely, retracting the roller too late can be detrimental to seal life. While the attachment has been designed to allow the roller to float upward in the last-scratch region by up to a full tooth height, this will increase the internal pressure of the hydraulic fluid as it is forced into the accumulator. Any momentary increase up to 10,000 PSI is tolerable, but will shorten the life of the o-ring seals. These pressure spikes should be avoided whenever possible.

To ensure synchronization, we suggest the following set-up procedure. Turn the tapered blank, unthreaded, leaving .020" extra material on the taper, and then altering TOOL GEOMETRY or using WEAR COMP to back both the thread insert and cold-roll wheel out by 2 tooth heights plus .010". On a 4 TPI thread, that would be 2 x 0.168"+.010" or 0.346". Then run both the thread insert and cold-roll wheel. Inspect the marks left in the tapered blank. The cut groove and the burnished groove should have fallen right on top of each other, and have terminated at the same angular position along the blank. If the grooves are not synchronized, a change to the Z-axis start position of the cold-roll wheel tool path will be required. If the grooves do not end at the same angular position, a change to the Z-axis end position is required.

If these values are changed, we suggest re-qualifying the taper leaving .010" of material, and re-running both the thread insert and cold-roll wheel, but altering TOOL GEOMETRY by only double the tooth height (@4TPI = .336").
Once the two tools are synchronized, remove the extra comp, and re-run the tools to create your thread.

> On most machines, changing the part diameter, RPM, or Z start point of the cut, can affect the angular start point relationship of the cut vs. rolled thread, and cause a mismatch between the tool paths that would be detrimental to part quality and roll life.

If for any reason, diameter, RPM or Z start point needs to be adjusted, this set-up procedure will need to be repeated.

- **Non-CNC operation**

Your CJ Winter attachment can also be used on manual lathes, or similar oil-field rotary equipment, that have sufficient size and rigidity to support the tools and loads required. However, when manually operating the attachment, consistently maintaining synchronization and full roller pressure in the final scratch region may be exceedingly difficult. Reliance on the accumulator may be necessary, along with the decreased life expectancy of the o-ring seals.
Ordering Parts

Our sales staff will be happy to assist you in ordering rolls or replacement parts for your attachments. We can be contacted in a variety of ways.

By phone at: 1-800-288-ROLL
              1-800-288-7655
By fax at: 585-235-6568
Or on the web at: www.cjwinter.com

Standard rolls that conform to API specs can be ordered by the part number found on page # 16. Rolls can also be manufactured to alternate geometry to meet your requirements. Please consult a sales representative for your options.

Legal Disclosure

The devices described within this manual use technologies which are Patent Pending, and are protected under U.S. and international patent law. The manual and all content contained herein is copyrighted, and is protected under U.S. Copyright Laws.

Acknowledgements

This manual includes numerous references to, and excerpts from, previously published technical and functional material, and these references and excerpts have been included in accordance to copyright laws of the United States. These references are included for the purpose of providing the user with a single document with pertinent information required to use this attachment. This manual is not intended as a replacement for the cited works, but rather as a supplement.

The information conveyed in this manual should not be the sole source for determining adherence to any official specification or standard.

CJ Winter encourages the users to acquire and familiarize themselves with the cited works as a whole, and to insure that newly released editions of these documents have not substantively changed the information provided since the printing of this manual.


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<thead>
<tr>
<th>ITEM NO.</th>
<th>PART NUMBER</th>
<th>DESCRIPTION</th>
<th>QTY.</th>
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</thead>
<tbody>
<tr>
<td>1</td>
<td>11070-1</td>
<td>Roll Holder - Internal</td>
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<td>2</td>
<td>11070-2250</td>
<td>Shank: Cold Roll Attachment - 2.25&quot; Shank</td>
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<td>11070-3</td>
<td>Roll Pin - Internal (Carbide)</td>
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<td>4</td>
<td>11070-7</td>
<td>Lock Screw, 1/4-28</td>
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<td>5</td>
<td>11070-8</td>
<td>Rings: Retaining, 1.206 x 0.999 x 0.050</td>
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<td>6</td>
<td>11070-9</td>
<td>Cylinder End Cap</td>
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<td>11070-10</td>
<td>Bevel Washer</td>
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<td>8</td>
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<td>Accumulator Piston: 11070 Attachment</td>
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<td>9</td>
<td>11070-12</td>
<td>Bearing: Thrust Needle Bearing</td>
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<td>11070-13</td>
<td>Race for Needle Thrust Bearing</td>
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<td>11070-14</td>
<td>Course Adj. Screw: 11070 Attachment</td>
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<td>11070-16</td>
<td>Screw: S&amp;SS .250 dia. x .625 Shoulder Screw</td>
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<td>11070-17</td>
<td>Fine Adjust Piston: 11070 Attachment</td>
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<td>11070-20</td>
<td>O-Rings: 1.064 OD x 1.076 ID x .039 W</td>
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<td>O-Rings: 1.117 OD x 0.911 ID x .039 W</td>
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<td>11070-25</td>
<td>Digital High Pressure Hydraulic Gauge</td>
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<td>18</td>
<td>11070-26</td>
<td>1/4-NPT Hex Plug</td>
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<td>21</td>
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<td>Air Purge Screw</td>
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<td>22</td>
<td>125043</td>
<td>Screw: SS, #8-32 x .186 Cup Pt.</td>
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</tbody>
</table>

**Diagram Note:**

Attachment MUST be inserted into a rigid holder right up to the shoulder. No portion of shank may be exposed.
<table>
<thead>
<tr>
<th>ITEM NO.</th>
<th>PART NUMBER</th>
<th>DESCRIPTION</th>
<th>QTY.</th>
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<tr>
<td>1</td>
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<td>Roll Holder - External</td>
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<td>Shank + Cold Roll Attachment - 2.50&quot; Shank</td>
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<td>3</td>
<td>11071-3</td>
<td>Roll Pin (Carbide)</td>
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<td>4</td>
<td>11070-9</td>
<td>Lock Screw [1/4-28]</td>
<td>1</td>
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<td>11070-8</td>
<td>Ring Retaining, DIA 1.255 x 0.995 x 0.60</td>
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<td>6</td>
<td>11070-8</td>
<td>Cylinder Endcap</td>
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<td>7</td>
<td>11070-10</td>
<td>Bearing Washer</td>
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</tr>
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<td>11070-11</td>
<td>Accumulator Piston (11070 Attachment)</td>
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<tr>
<td>9</td>
<td>11070-12</td>
<td>Bearing + Thrust Needle Bearing</td>
<td>1</td>
</tr>
<tr>
<td>10</td>
<td>11070-13</td>
<td>Race for Needle Thrust Bearing</td>
<td>2</td>
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<td>11</td>
<td>11070-14</td>
<td>Course Adj. Screw, 11070 Attachment</td>
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<tr>
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<td>11070-16</td>
<td>Screw SHSS, 1/4&quot; DIA x .25 Serrated Shank Screw</td>
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<tr>
<td>13</td>
<td>11070-17</td>
<td>Fine Adjust Piston (11070 Attachment)</td>
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<tr>
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<td>11070-20</td>
<td>O-Ring: 1.264 O.D. x 1.278 I.D. x .037</td>
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<td>11070-21</td>
<td>O-Ring: 1.111 O.D. x .091 I.D. x .103</td>
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<td>16</td>
<td>11070-23</td>
<td>O-Ring: 1.111 O.D. x .091 I.D. x .103</td>
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<td>17</td>
<td>11070-25</td>
<td>3/4&quot; NPT High Pressure Hydraulic Gage</td>
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<tr>
<td>18</td>
<td>11070-26</td>
<td>3/4&quot; NPT Plug</td>
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<td>20</td>
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<td>Air Furge Screw</td>
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<td>21</td>
<td>128043</td>
<td>Screw SS, 3/8-16 x 1.60 Cup Plt</td>
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</tbody>
</table>

SPECIFICATIONS:

- **SECTION A-A**
  - SCALE: 1:2

- **Attachment MUST be inserted into a rigid holder right up to the shoulder.**
  - No portion of the shank may be exposed.

- **EPL Roller as required.**

- **Dimensions are approximate.**

- **Drawing Date:** 12/24/2001

- **Material:**
  - **Steel:** See chart
  - **Heat Trace:**

- **C.J. WINTER MACHINE TECHNOLOGIES, INC.**

- **Drawing No.:** 11071-200-SA