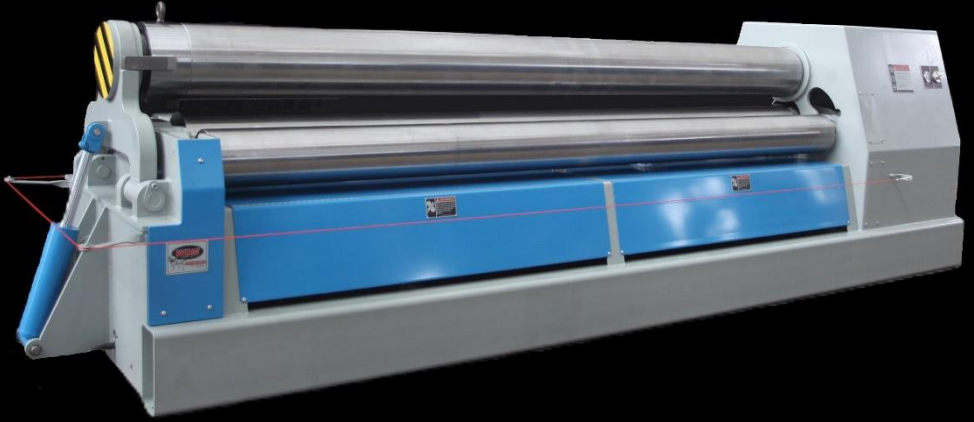


ROLL BENDING TIPS



Information For:

- 3 Roll Pyramid
- 3 Roll Initial Pinch
- 3 Roll Pinch Pyramid
- 4 Roll Double Initial Pinch

Includes:

- Procedures
- Trouble Shooting
- Rules of Thumb
- Nomenclature
- Features

Sheet & Plate Roll Bending Tips

For: Operators

Managers

Designers

Engineers

Compiled by:

Waldemar Design And Machine

Phone: 606-787-8474

Email: sales@wdmrolls.com

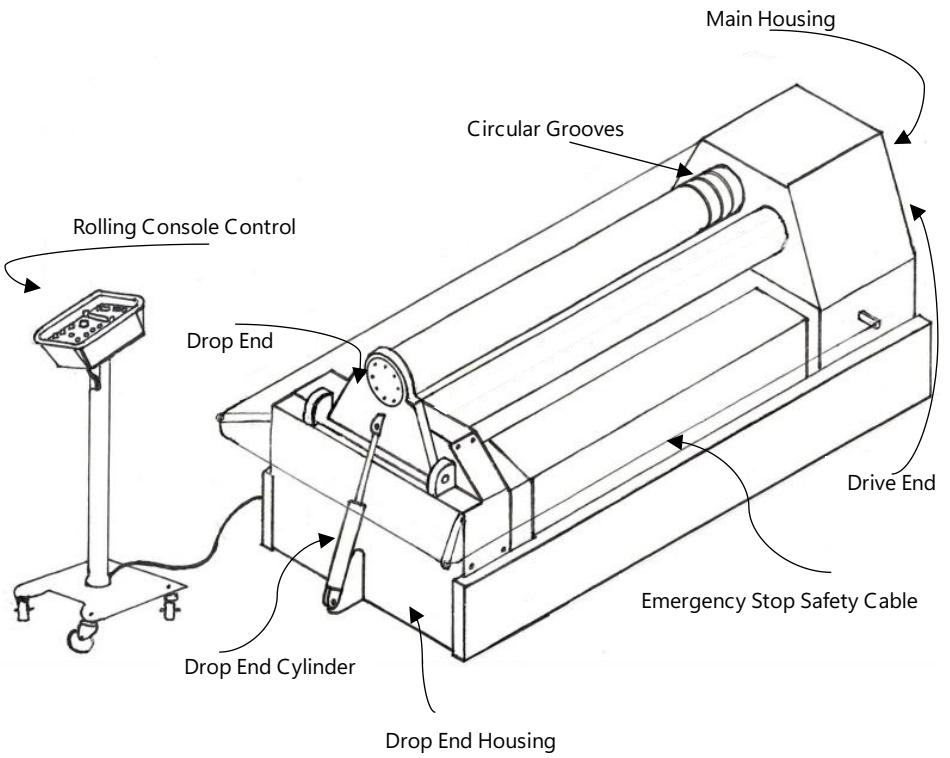
Website: www.wdmrolls.com

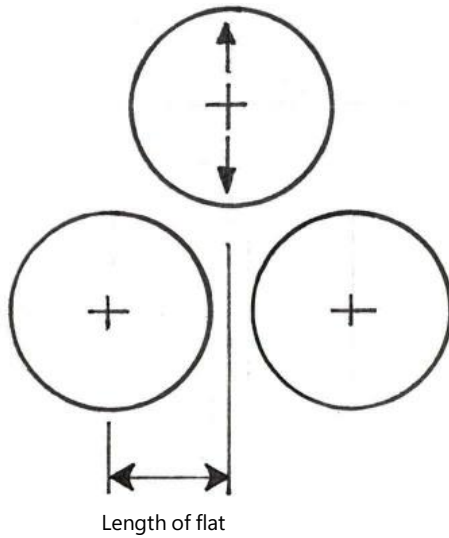
2748 State Road 55 – Moorefield – WV 26836

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- 1.1 Roll Nomenclature
- 2.1 Pyramid type
features, nomenclature, & forming cycle
- 3.1 Initial Pinch
features, nomenclature, & forming cycle
- 4.1 Pinch Pyramid
features, nomenclature, & forming cycle
- 5.1 Four Roll
features, nomenclature, & forming cycle
- 6.1 Work Piece Quality
- 7.1 Cone Rolling Procedure
- 8.1 Rules to Roll by
- 8.5 Machine Features to Consider

ROLL NOMENCLATURE





===Pyramid Type===

Advantages

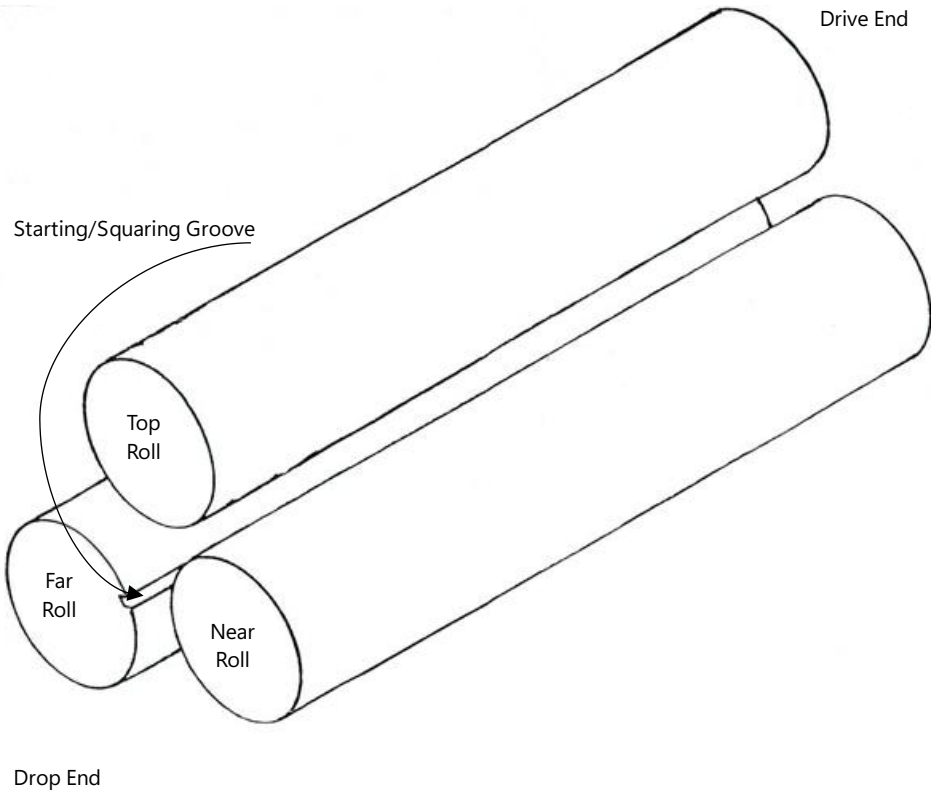
- Economical
- High capacity for given roll size
- Uniform rolling
- Ability to roll angle and flat bar with attachments

Disadvantages

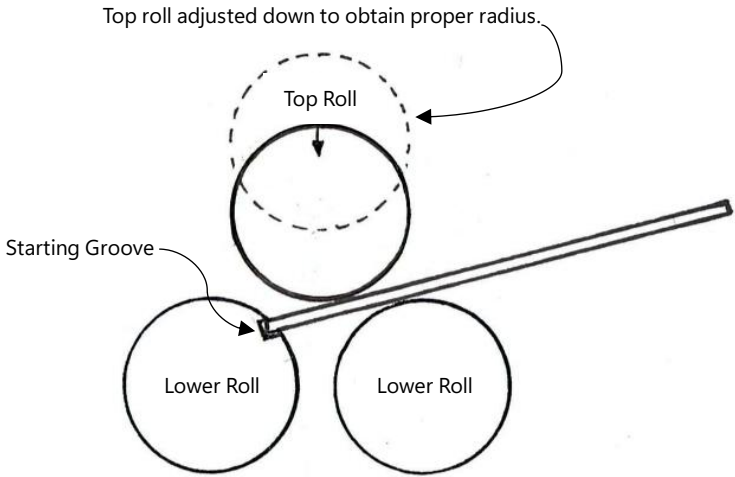
- Leaves a relatively long flat on leading and trailing edges.
- Moderate cone rolling capability and capacity

ROLL NOMENCLATURE

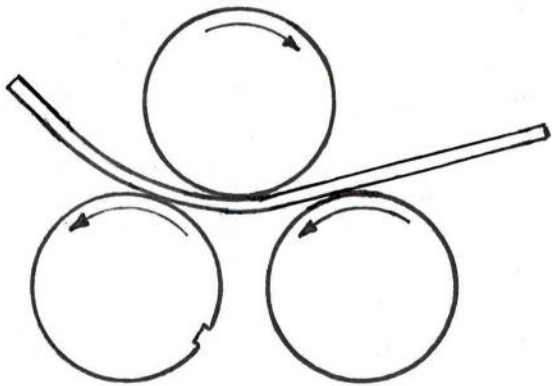
PYRAMID



ROLLING CYCLE
PYRAMID ROLL



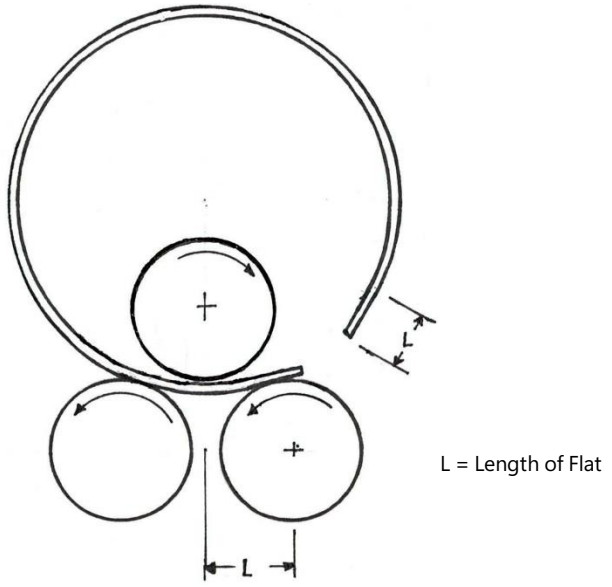
Work piece is entered into roll against starting groove.



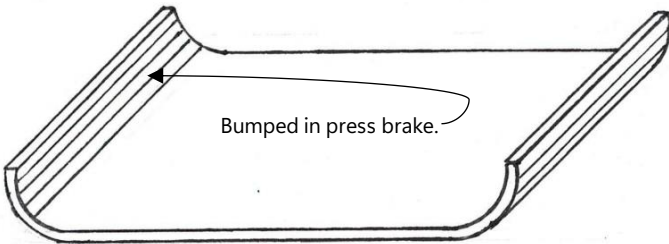
ROLLING CYCLE

PYRAMID ROLL

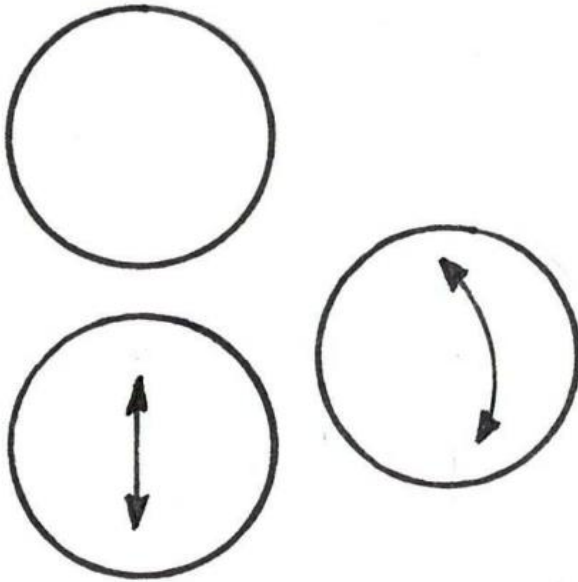
continued



Rolled to completion.



Secondary process required to eliminate flats, or flat may be cut off after rolling.



===Initial Pinch===

Advantages

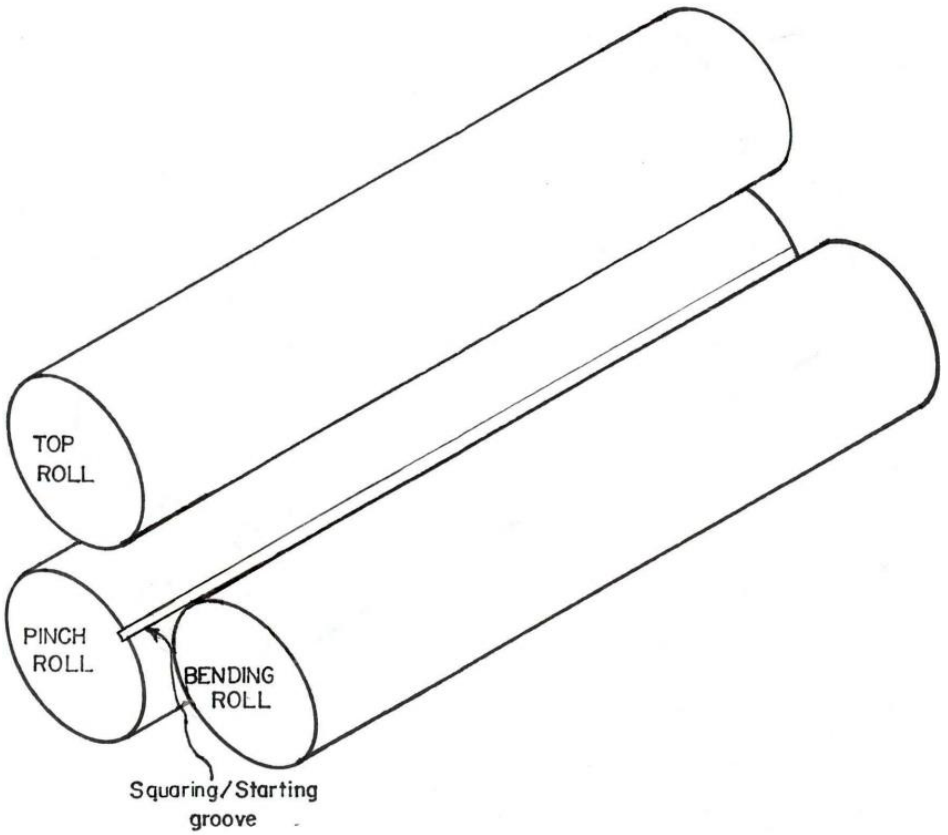
- Rolls minimal flats (approximately 1.5 to 2 x metal thickness) on leading and trailing edges
- Good cone rolling capabilities
- Good control of work piece

Disadvantages

- For proper formation, work piece must be pre-bent from the back side of the machine, then removed and re-entered into the front side.
- Small opening between pinch and top rolls

ROLL NOMENCLATURE

INITIAL PINCH

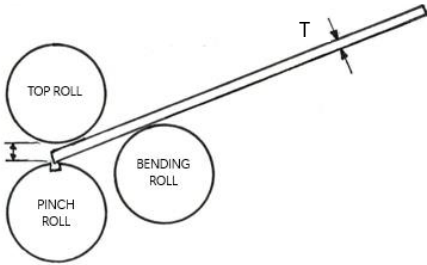


WDM K series
310 series

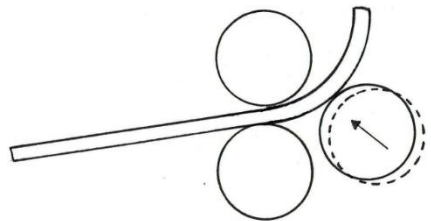
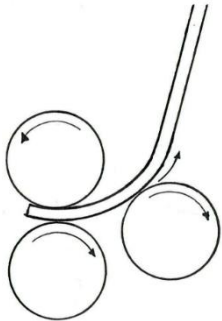
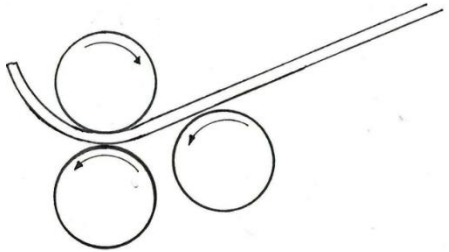
ROLLING CYCLE

INITIAL PINCH ROLL

1. Pinch roll is set to material thickness.
2. Work piece is entered from rear side of machine into starting groove in pinch roll.

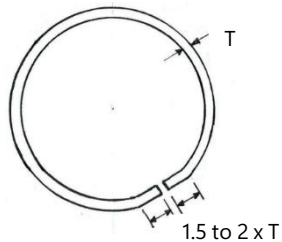
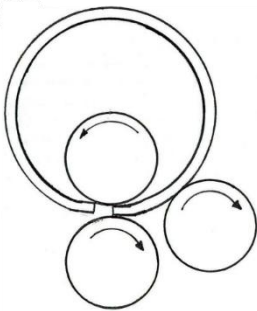


3. Bending roll is raised to position for pre-bend.
4. Rolls are rotated and work piece is rolled through 4 to 10 inches.



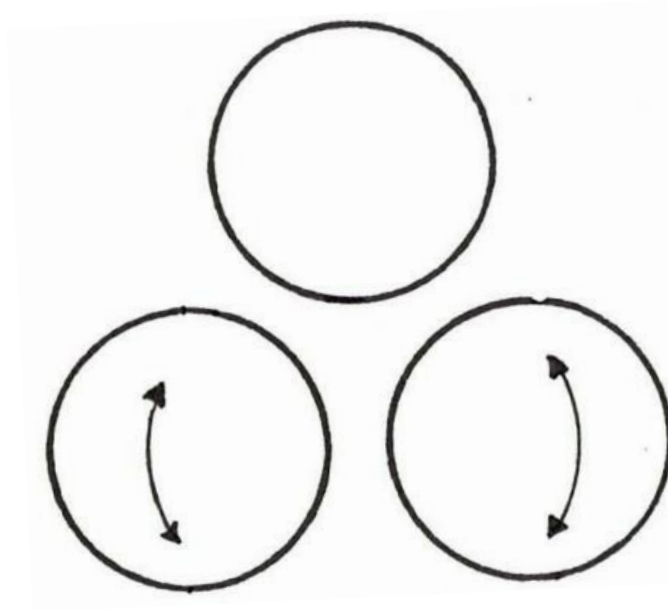
5. Rolls are reversed and pre-bent work piece is removed.

6. Work piece is re-entered from the front and bending roll is adjusted upward to final forming position.



7. Rolled to completion.

8. Completed cylinder.



===Pinch Pyramid===

Advantages

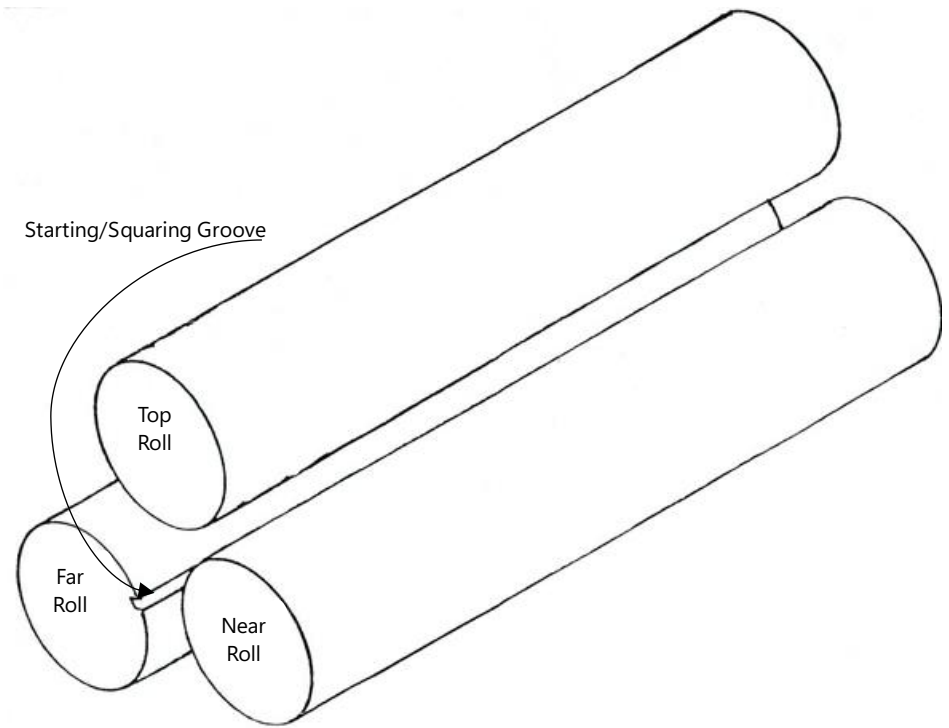
- Minimal flats on both ends with one entry
- Easy to operate
- Increased capacity when rolling large diameters
- Very versatile – symmetrical structural sections and welded/fabricated panels can be formed.

Disadvantages

- Moderate accuracy
- Moderate cone rolling capability and capacity
- Can have some flats on large diameters
- Can lose control of the work piece

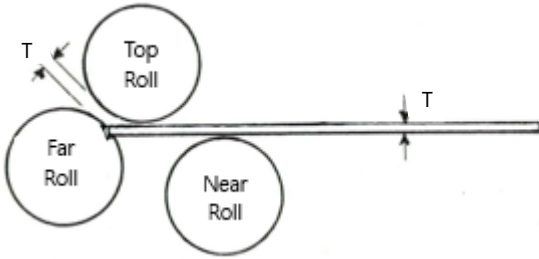
ROLL NOMENCLATURE

PINCH PYRAMID

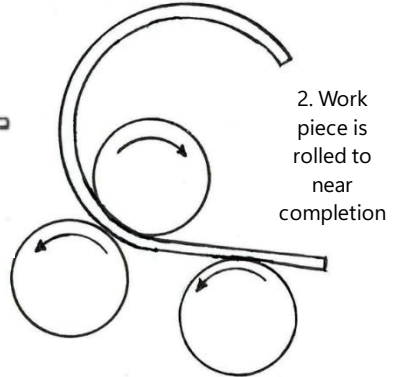


WDM 101 series

ROLLING CYCLE PINCH PYRAMID ROLL

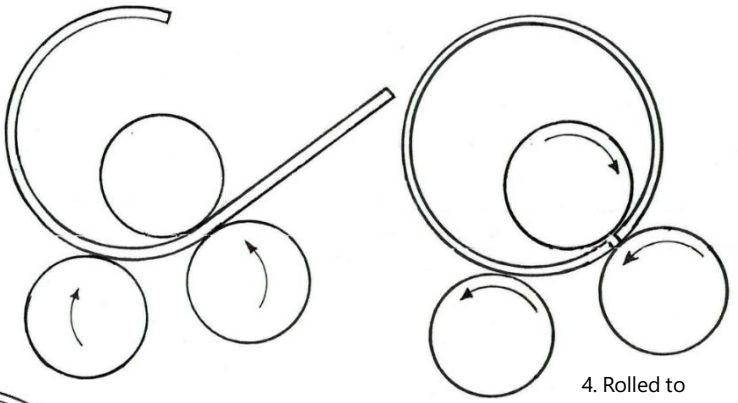


1. Work piece is entered into roll against starting groove.
Far roll is raised to pinch material.
Near roll is raised to obtain proper radius.

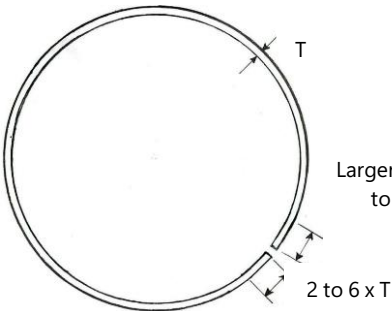


2. Work piece is rolled to near completion

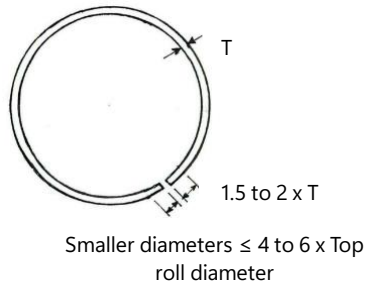
3. Far roll is lowered.
Near roll is raised to pinch material.
Far roll is positioned for proper radius.



4. Rolled to completion.

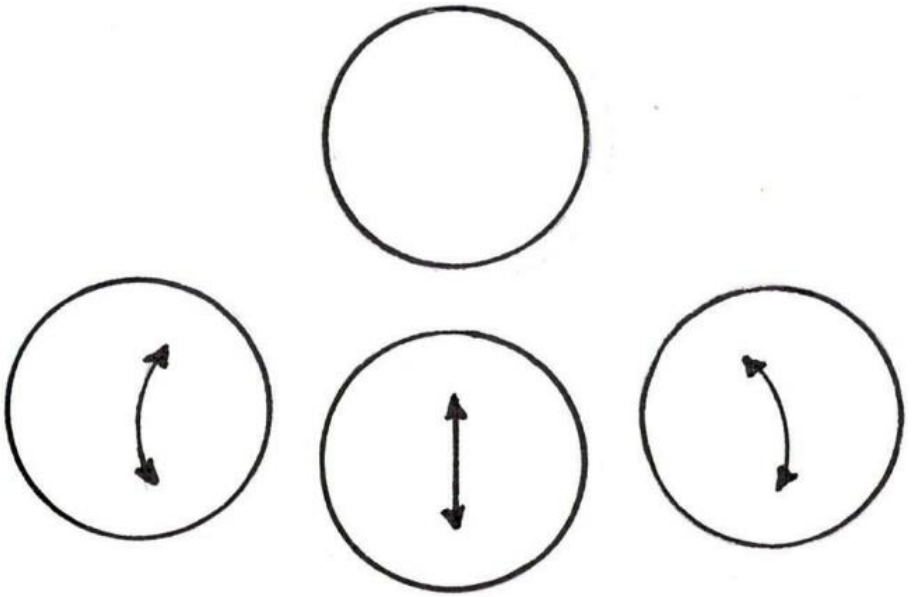


Larger diameters > 4
to 6 x Top roll



Smaller diameters \leq 4 to 6 x Top roll diameter

Caution! Be sure to maintain control of work piece when switching roll position.



===4 Roll===

Advantages

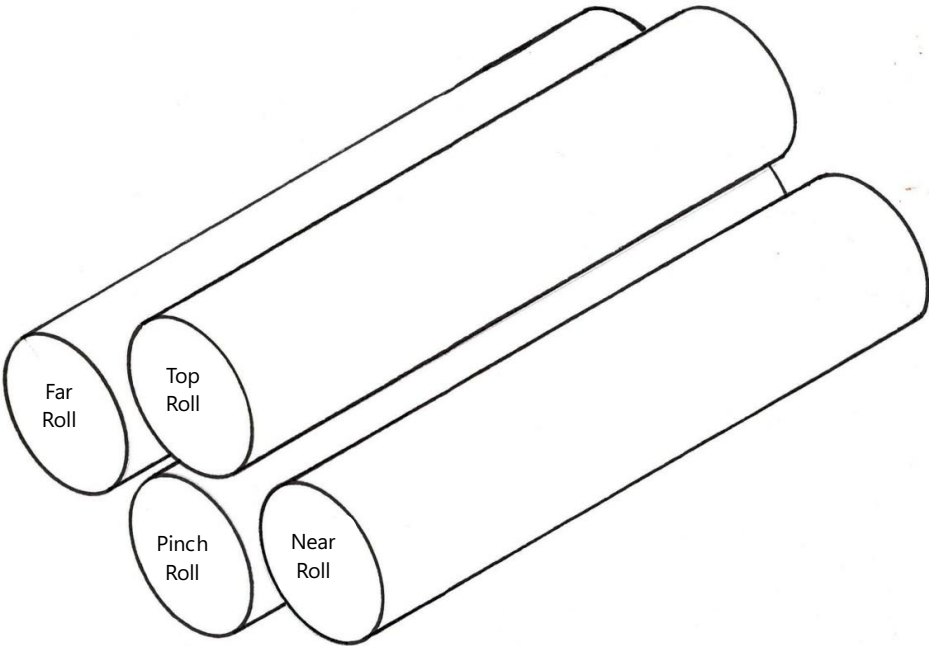
- Minimal flats (approximately 1.5 to 2 x metal thickness) on both ends with one entry
- Can be conveyor fed
- Excellent control of work piece
- Excellent cone rolling capacities
- Readily lends itself to automation

Disadvantages

- Small pinch opening
- Larger machine
- More costly
- Can be confusing for the periodic and unskilled operator

ROLLING NOMENCLATURE

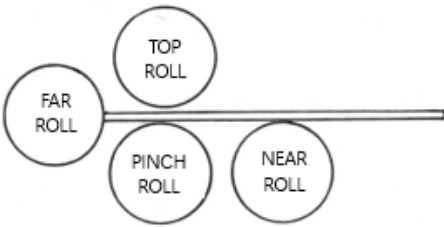
FOUR ROLL DOUBLE PINCH



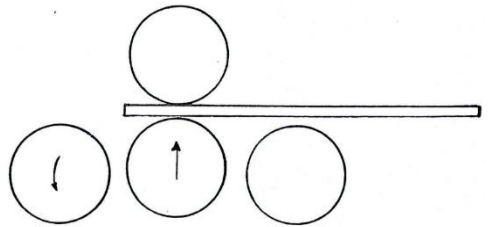
WDM 403 series

ROLLING CYCLE

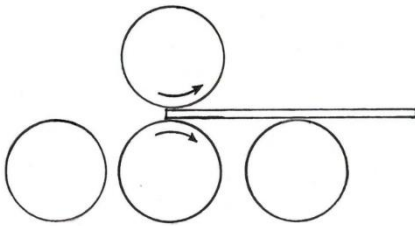
FOUR ROLL PLATE



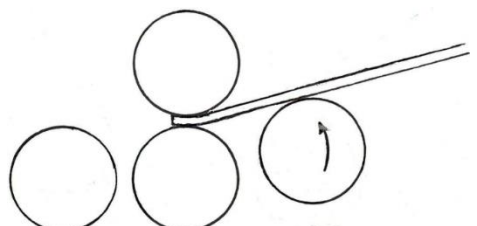
1. Work piece is entered and squared against far roll.



2. Pinch roll is raised to clamp work piece. Far roll is lowered.



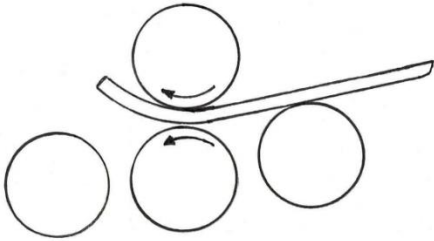
3. Rolls are reversed until leading edge is just short of the center line of the top and pinch rolls.



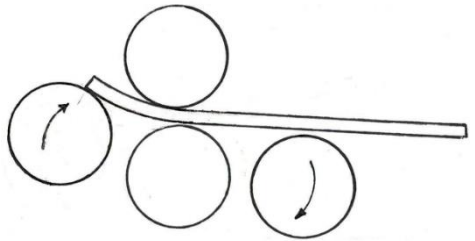
4. Near roll is raised to pre-bend position.

ROLLING CYCLE

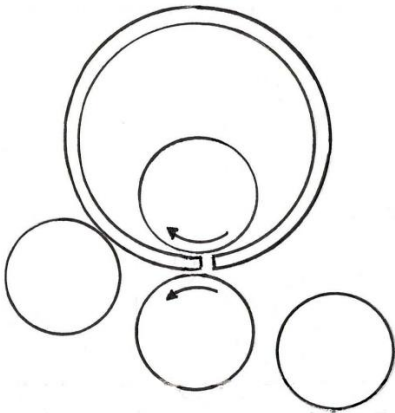
FOUR ROLL PLATE CONT.



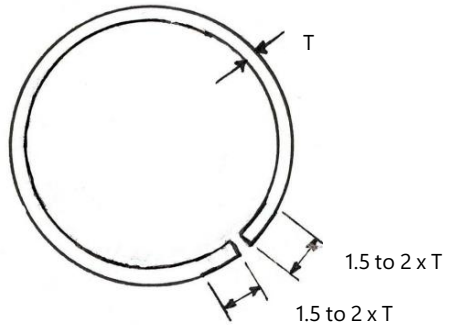
5. Rolls are rotated forward until prebend is complete. (4 to 10 inches.)



6. Near roll is lowered. Far roll is raised to finish bend position.



7. Rolled to completion.



8. Completed cylinder.

WORK PIECE QUALITY

WHAT AFFECTS IT

HOW TO CORRECT IT



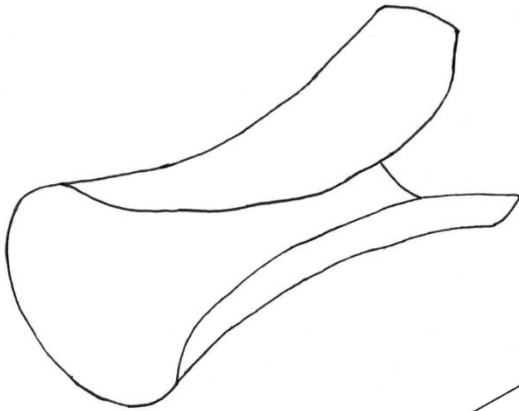
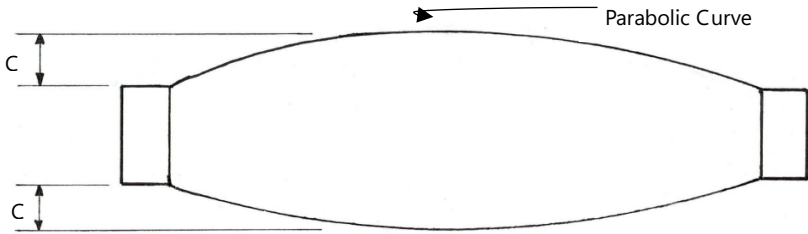
WORK PIECE QUALITY

Factors Contributing To Work Piece Quality

- Variations in metal thickness
- Variation in temper
- Variation in physical characteristics of different heat numbers
- Grain direction
- Uniform cross section of work piece

WORK PIECE QUALITY

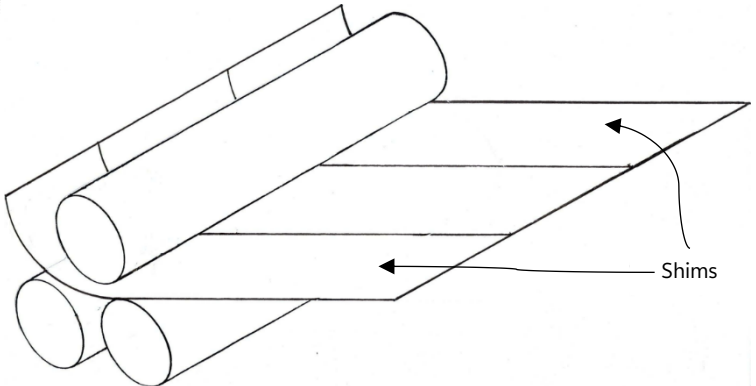
ROLL CROWN



Problem:
Hourglass shaped work piece.

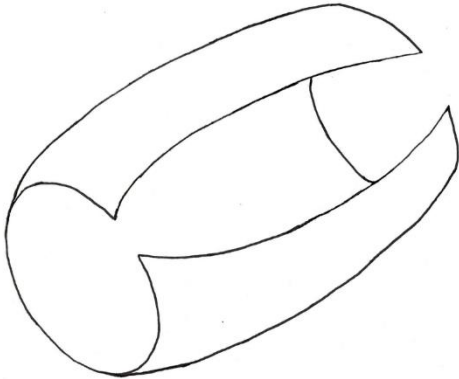
Reason:
"C" (roll crown) too much for this
size of work piece.

Remedy:
Roll cardboard
or sheet metal
shims along
with work piece
at the edges to
offset over-
crowning.



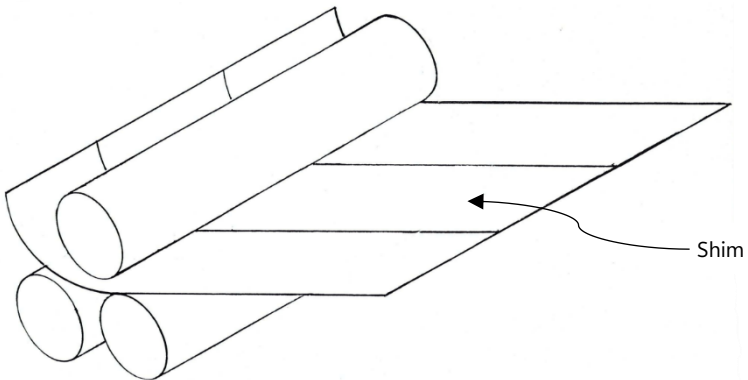
Tip: On 4 rolls and initial pinch, increase pinch pressure. If machine is equipped with variable crown option, lower the position.

WORK PIECE QUALITY



Problem:
Barrel shaped work piece.

Reason:
"C" (roll crown) too little for this
work piece.



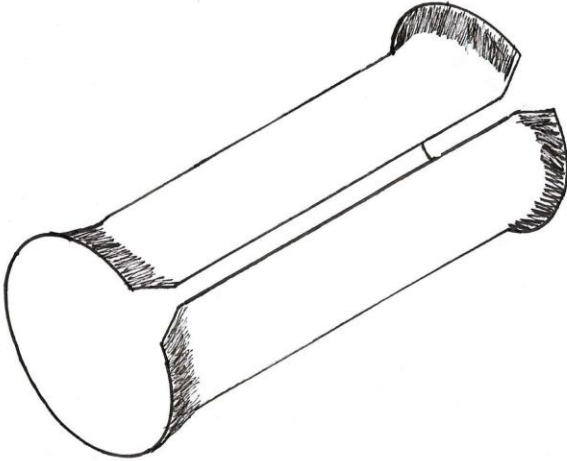
Remedy:
Roll cardboard or sheet metal shim along with work piece at the center to offset under-crowning.

Tip: On 4 rolls and initial pinch, decrease pinch pressure. If machine is equipped with variable crown option, increase the position.

!!WARNING!!

Do not exceed machine capacity

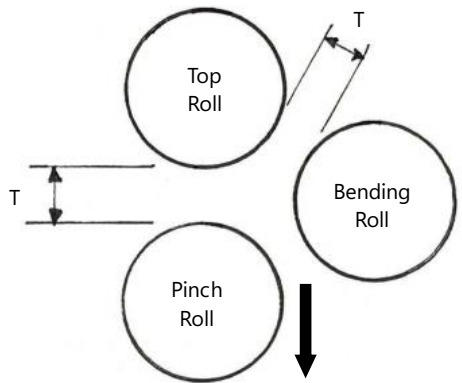
WORK PIECE QUALITY



Problem:
Bell mouth shaped work piece.

Reason:
Pinch or bending roll pressure
too tight. (cold working work
piece edges.

Remedy:
Lower pinch and bending rolls so that
opening at end of roll is equal to or greater
than "T" (work piece thickness).

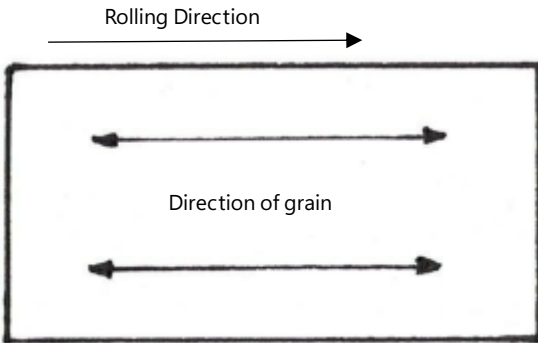
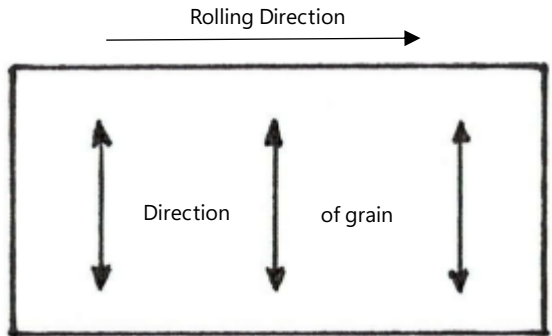


WORK PIECE QUALITY



Problem:
Flats on leading and trailing edges.

Reason:
Rolling transverse or perpendicular to grain. The grain is produced and runs in the direction the steel was rolled in the manufacturing process.

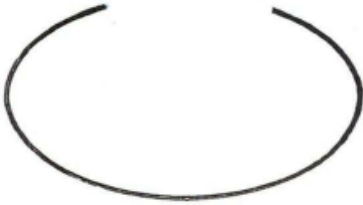


Remedy:
Roll in direction of grain.

Note: Attention needs to be given to this aspect when "nesting" the parts to be cut.

WORK PIECE QUALITY

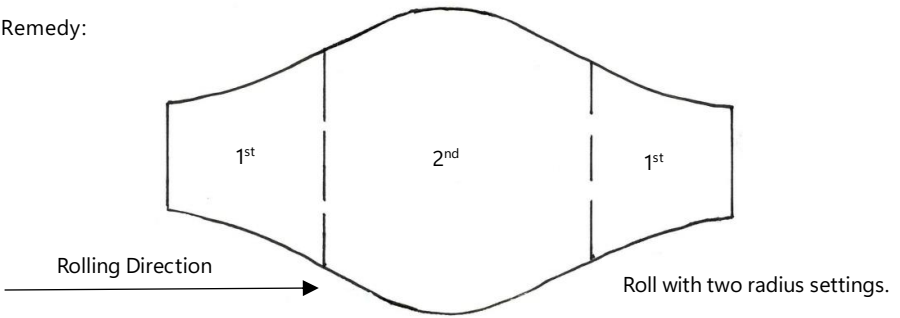
ELBOW GORES & SIMILAR PARTS



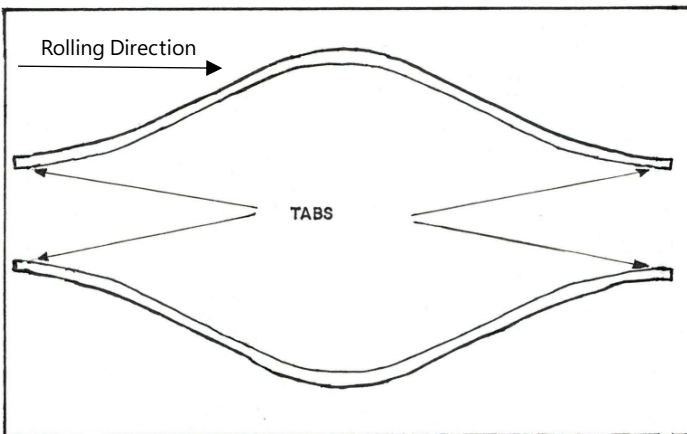
Problem:
Obround work piece.

Reason:
Unequal cross sections were
rolled with one radius setting.

Remedy:

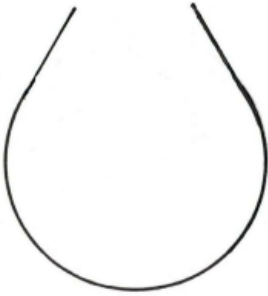


OR



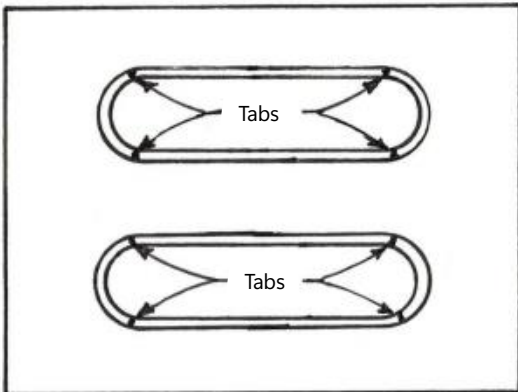
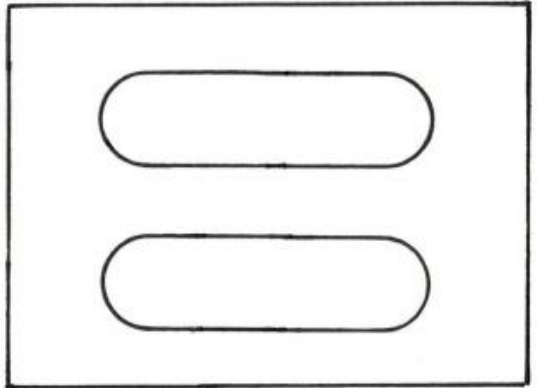
Create an equal cross section by connecting parts with tabs.

WORK PIECE QUALITY
WORK PIECES WITH CUT-OUTS



Problem:
Obround cylinder

Reason:
Unequal cross section.

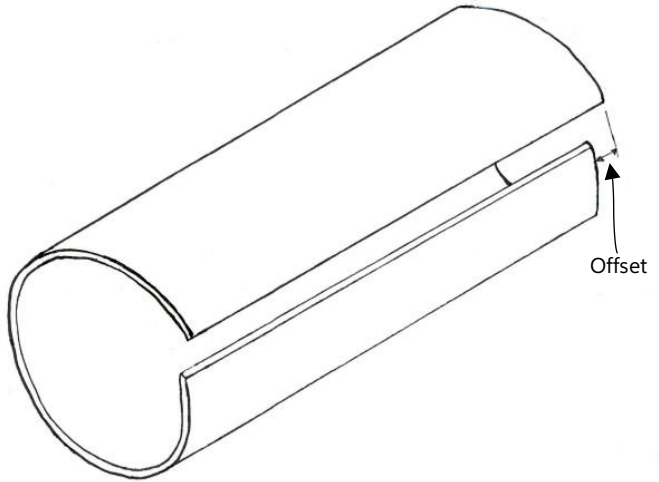


Remedy:
Create equal cross sections by
connecting drop to work piece
with tabs.

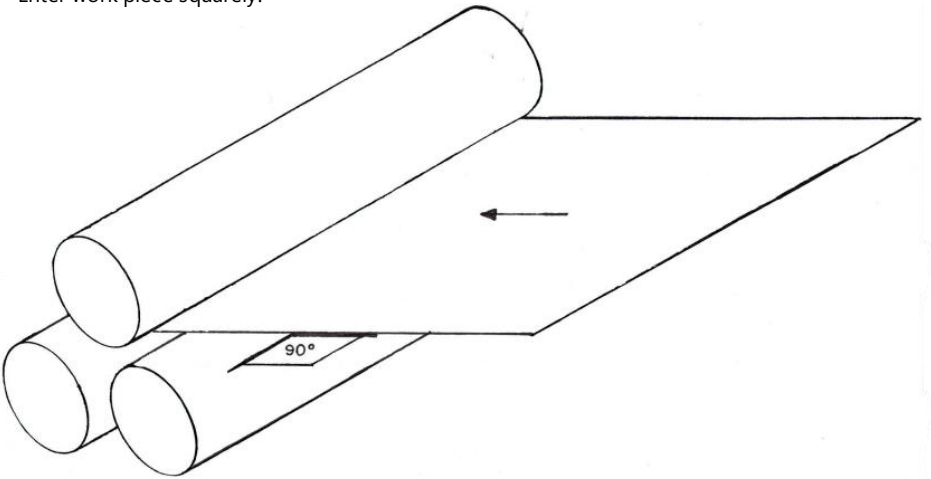
WORK PIECE QUALITY

Problem:
Skewed cylinder

Reason:
Work piece entered off square or blank cut off square.

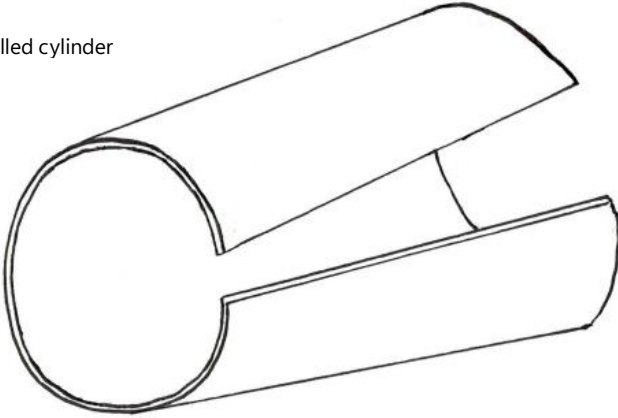


Remedy:
Enter work piece squarely.



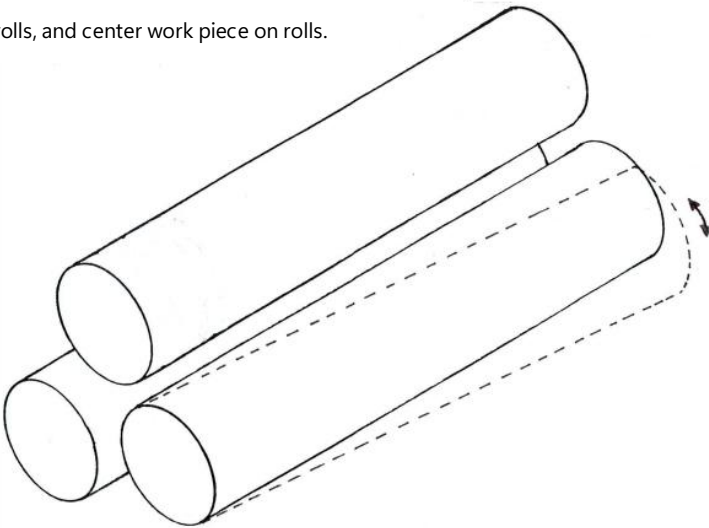
WORK PIECE QUALITY

Problem:
Unequally rolled cylinder



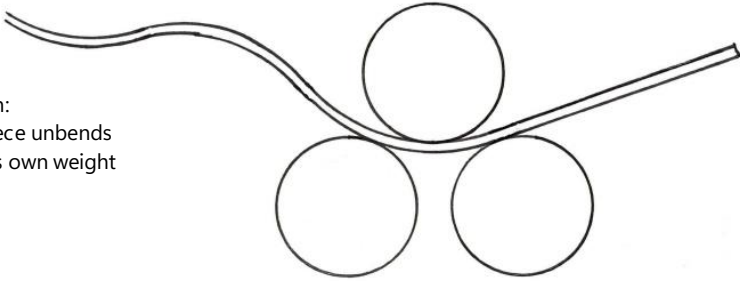
Reason:
The rolls are out of parallel or work piece rolled off center.

Remedy:
Level the rolls, and center work piece on rolls.



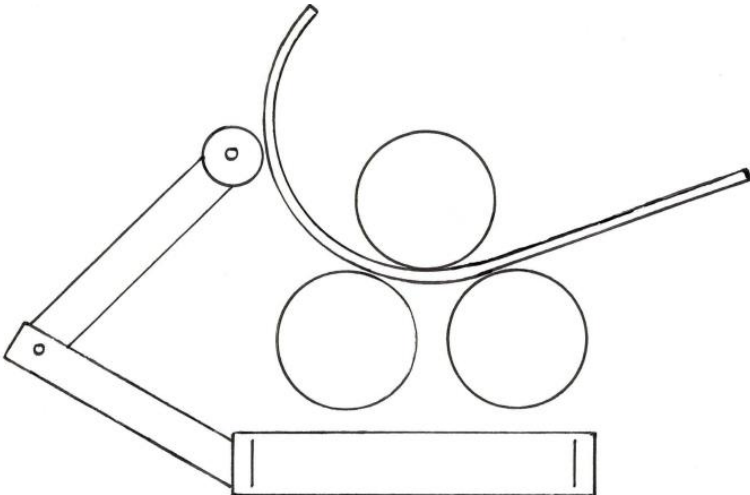
WORK PIECE QUALITY

Problem:
Work piece unbends
under its own weight



Reason:
Material strength insufficient to support its own weight.

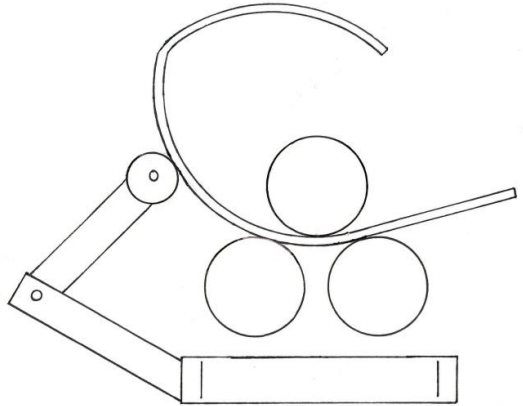
Remedy:
Provide support for work piece as it exits the forming roll.



Note: This usually becomes an issue when the ratio of rolled diameter to thickness is 300 - 1 or greater.

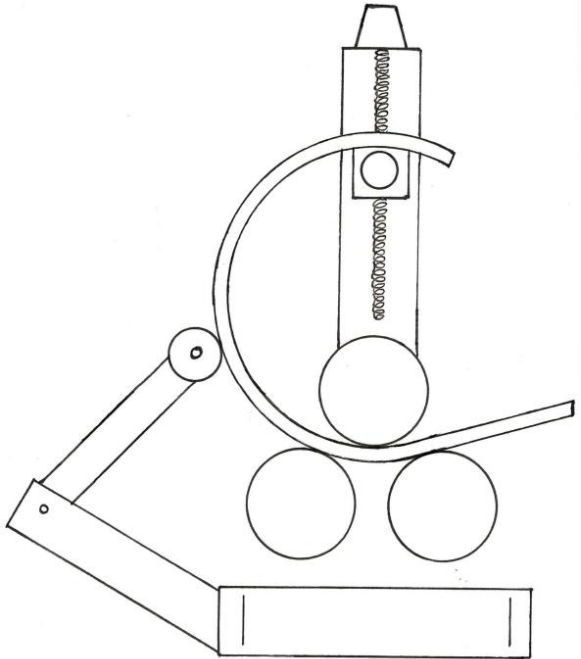
WORK PIECE QUALITY

Problem:
Work piece collapses
under its own weight.



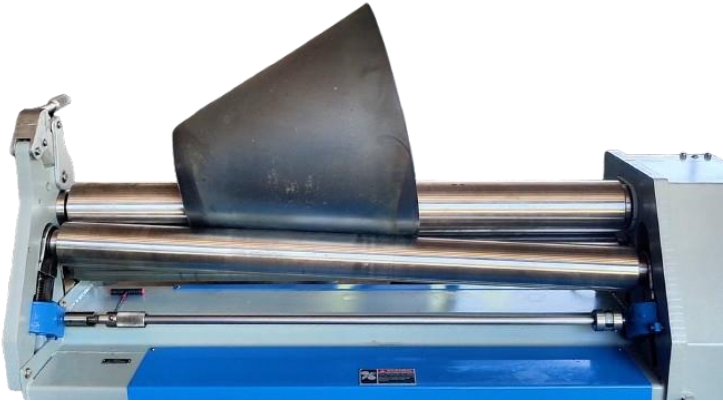
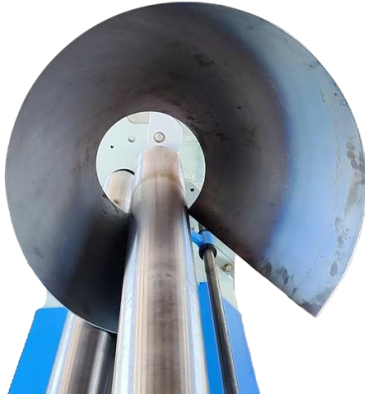
Reason:
Material strength
insufficient to support
its own weight.

Remedy:
Provide overhead support
for work piece as it comes
around overhead.



Note: This usually becomes an issue when the ratio of rolled diameter to thickness is 300 - 1 or greater.

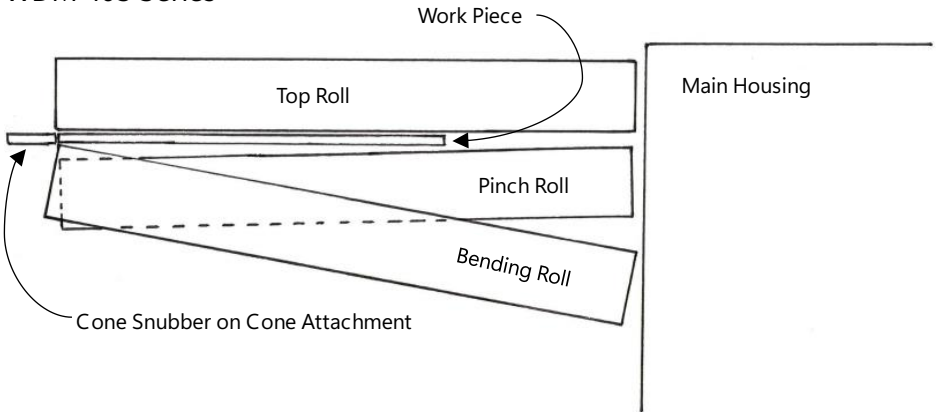
CONE ROLLING PROCEDURES



CONE ROLLING PROCEDURE

INITIAL PINCH & 4 ROLL MACHINES: WDM 403, K, 301 SERIES

WDM 403 Series



1. If the work piece is wider than half of the width of the machine, angle pinch roll to grip long end of workpiece. (If it is less than half, the crown in the roll will suffice.)
2. Angle bending roll to form small end of work piece to a tighter radius.
3. Enter work piece from back side with small end of cone blank against cone snubber. Align trailing edge with the pinch roll's centre line.
4. Raise far roll to set pre-bend radius.
5. Roll reverse for pre-bend (4-10 inches)
6. Lower far roll.
7. Reverse roll to leading edge.
8. Align leading edge with pinch roll's centreline.
9. Raise near roll to set pre-bend radius.
10. Roll forward for pre-bend (4-10 inches).
11. Lower near roll.
12. Raise far roll to position to roll to $\frac{1}{2}$ - $\frac{3}{4}$ of finish diameter.
13. Roll forward through.
14. Lower far roll.
15. Raise near roll to position to close the cone.
16. Roll reverse.

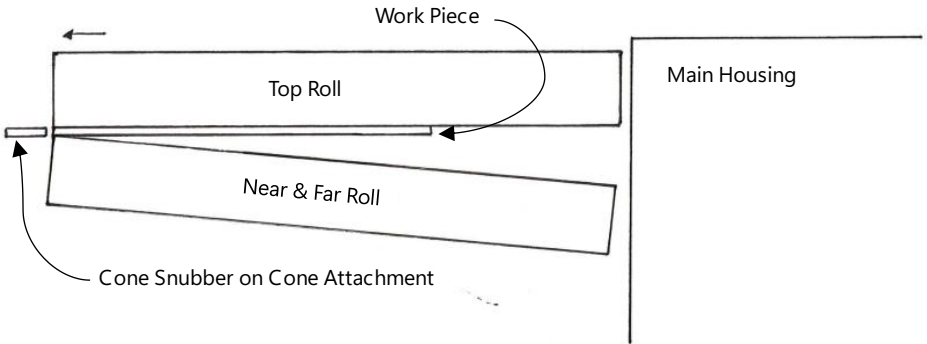
CONE ROLLING PROCEDURE CONT.

INITIAL PINCH

WDM K and 310 Series

1. Prebend the leading edge by rolling in from the back side same as you would for a cylinder. Remove work piece from machine.
2. If the workpiece is wider than half of the width of the machine, angle pinch roll to grip the long end of the workpiece. (If it is less than half, the crown in the rolls will suffice.)
3. Angle bending roll to form small end of the workpiece to a tighter radius.
4. Enter the workpiece with the small end of the cone blank against the cone snubber.
5. Raise the bending roll to position to roll to $\frac{1}{2}$ - $\frac{3}{4}$ of finish diameter.
6. Roll forward through.
7. Raise the bending roll for the final pass and reverse to complete the bend.

CONE ROLLING PROCEDURE PYRAMID & PINCH PYRAMID



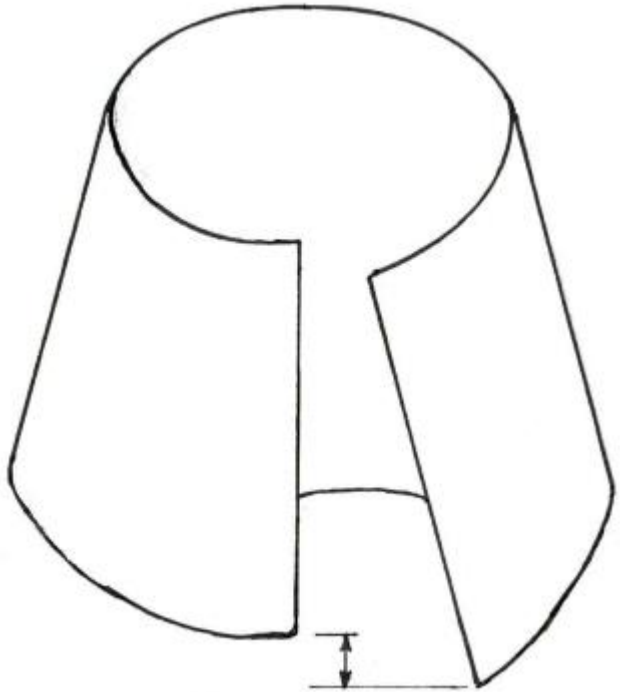
WDM 101 series

1. Angle both lower rolls (on Pinch Pyramid) or Top Roll (on Pyramid) to form small end of work piece.
2. Enter work piece with small end of cone against cone snubber.
3. Raise lower rolls (Pinch Pyramid) or lower top roll (Pyramid) to obtain about half of radius required.
4. Roll piece through.
5. Adjust rolls for final radius.
6. Roll reverse for completion.

CONE QUALITY

Problem:
Skewed ends.

Reason:
Work piece formed in
one rolling direction.



Remedy:
Roll partially in one direction
and complete rolling in
opposite direction.

RULES
TO
ROLL
BY



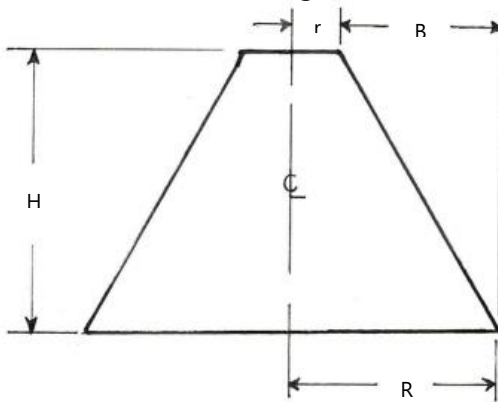
SOME RULES OF THUMB

MINIMUM ROLLING DIAMETERS

Wrought Iron / 1010 Mild Steel	1.1 x Top Roll Diameter
Mild Steel, i.e. M-1020	1.2 x Top Roll Diameter
Cold Rolled Sheet or Thin Galvanized Sheet, i.e. 20-28 ga.	1.5 x Top Roll Diameter
Soft Aluminum	1.1 x Top Roll Diameter
Tempered Aluminum, i.e. 6061T6	2 x Top Roll Diameter
Soft Copper	1.1 x Top Roll Diameter
Half Hard Copper	1.5 x Top Roll Diameter
Stainless Steel, Monel, Etc.	1.2 to 1.4 x Top Roll Diameter
A.R. Plate, T-1, Other Super Alloys	2 or more x Top Roll Diameter

BENDING CAPACITIES

- When bending steel of double thickness, approximately 4 times the forming pressure is required when the rolls are of the same diameter and spacing.
- With the same thickness and yield strength of material, bending pressure is reduced to 0.5 when roll spacing is doubled.
- When yield strength of same thickness material increases, forming pressure increases on a direct 1:1 ratio.
- When calculating cylinder blank length, multiply, 0.8 x metal thickness, add the inside diameter, multiply x pi.
- Use the following formula to calculate cone blanks.



Where

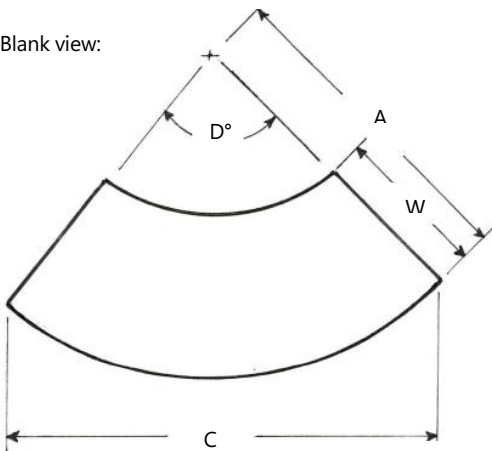
r = radius of small end

R = radius of big end

H = height of cone

$B = R - r$

Blank view:



Where

A = long arc

W = width of workpiece

D = degree of arc

C = chord of A

$W = \sqrt{(H^2 \times B^2)}$

$A = \frac{RW}{B}$

$D = \frac{R}{A} 360$

$C = 2 \text{SIN}(0.5D)A$

TIPS

- For best quality cylinders, whenever possible always push work piece against (do not pull across) the Bending Roll.
- For best quality cylinders, support work piece uniformly before, during, and after forming cycle.
- It is always easier to open up (increase diameter) of a finished work piece a bit than to close it (pull together). In fact in most cases the workpieces open up a bit by the normal handling between work stations. (stress relieves)
** Meaning: it is generally better to roll a bit tight (small) than too loose. (large)
- On four-roll machines use only 3 rolls at a time for best work piece quality.
- Orient work piece on raw material so the work piece is rolled with the grain. (not across the grain)
- When large cutouts are cut into work pieces prior to forming, tab leading and trailing edge. (not sides)

MACHINE FEATURES TO CONSIDER

- Controls with presets can be very advantageous for large volumes of identical parts.
- Hardened rolls should be seriously considered when Rolling:
 - Flame-Plasma or Laser Cut Parts
 - Stainless Steel
 - Abrasion Resistant Steels
 - High-Strength Steels
 - Super Alloys
- Hardened and polished rolls should be considered whenever rolling material with polished or fine finished surface, and when cone rolling any material.
- Side and overhead supports should be considered when large diameter, light gauge work pieces are formed. Specifically, when Diameter in inches \geq Thickness in inches x 300.
- In general a little automation in rolling machines increases productivity substantially. (Resist the inclination to over-automate.)
- Seriously evaluate your part families and have rolls crowned for your largest volume parts. (If this is not known, then the roll should probably be crowned for 2/3 capacity.)



Waldemar Design & Machine

sales@wdmrolls.com

www.wdmrolls.com

606.787.8474