Gang Saw Gang

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Problem

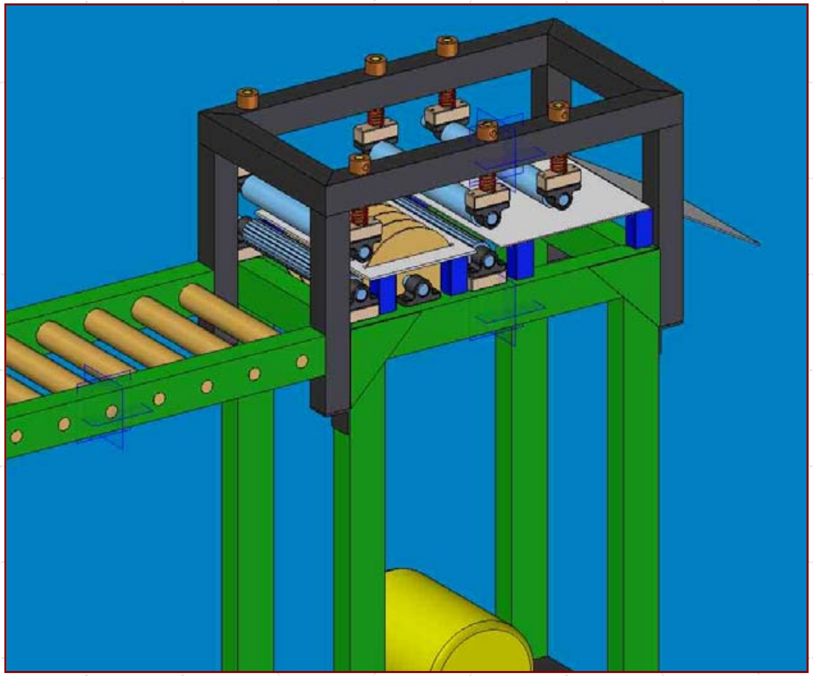
- To design a reliable machine to cut various sizes of scrap wood into survey stakes of specific dimension
- To reduce labor
- To maximize production

Constraints

- $1500 Budget
- 10 x 10 square ft. area
- Compatibility with Indexer Design
- Size of lumber

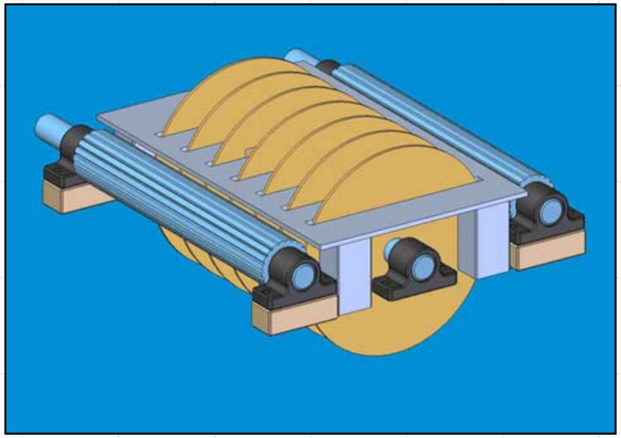
Gang Saw Layout

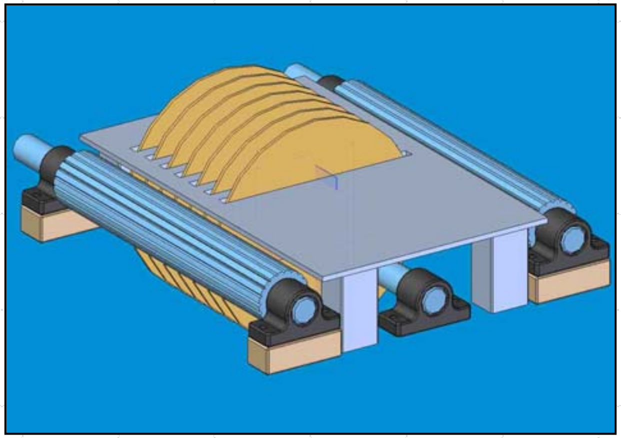
- Input conveyor with board alignment device
- Gang Saw Assembly
- Exit Slide



Saw Blade and Power Rollers

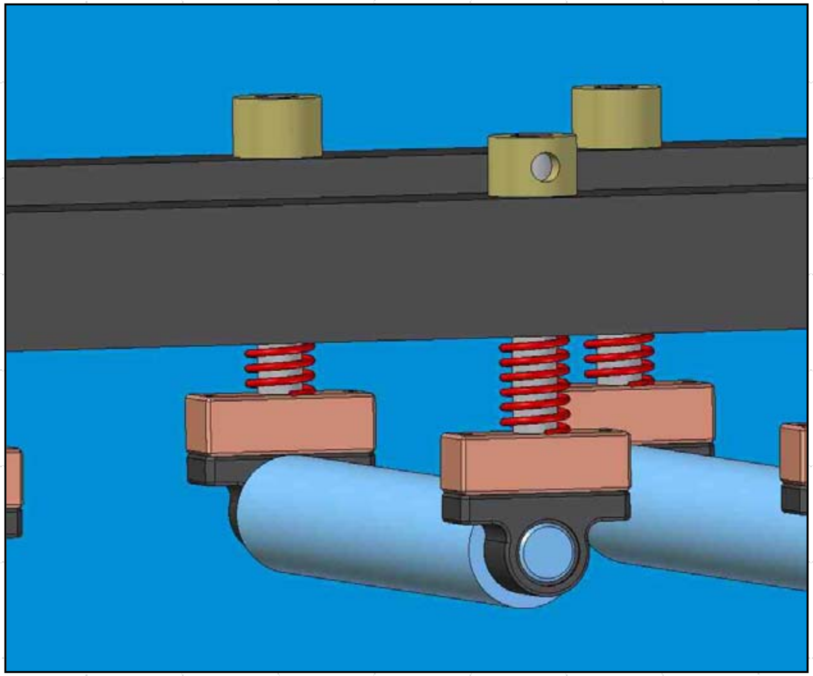
- Blades Adjustable for 1 ½'' or ¾'' Cut
- 1 ½'' Stakes for up to 12'' Board Width
- ¾'' Stakes for up to 6'' Board Width
- Minimum Board Length 12''





Feed Rollers

- Spring Loaded Free Spinning Top Rollers
- Powered Knurled Bottom Rollers
- Powered Exit Roller



Circular Saw vs. Band Saw

- Low cost of equipment
- Low cost of maintaining them
- Low cost of saws

- High initial cost
- High cost of saws
- More susceptible to damage from hard materials embedded in wood

Blade Constraints

- According to Rip Saw Applications,we needed to meet a rim speed of 9000.
- Kerf for carbide tips-.15
- Teeth must clear wood
- 8 inch blade for cutting 12 in. long pieces
- Larger the blade, the more maintenance

Standard Blades

- Cheap
- Will not last long
- Blade tips break easy

Diamond Tip Blades

- Mostly used for cutting steel.
- Diamond is very hard, but edge is not as sharp.
- Higher cost
- Extremely fragile
- There is a need for an increase of 15 to 30% in power consumption because of the increase in cutting pressure.

Not using the right power,you can run into problems like:

a. Premature edge wear

b. chipped or broken teeth

Carbide Tip Blades

- Powder-like material in its raw state.
- It is shaped by compressing it at high temperatures.
- Increasing the content of carbide, wear resistance increases but resistance to shock decreases.
- Harder and more resistant to corrosion.
- Much cheaper
- Lasts 20 times as long as the standard blade

Saw Calculations (8 in.)

R.P.M. = 3.8197 (Rim Speed) / Saw Diameter

= 3.8197 (9000 ft/m) / 8 inches

= 4297.16

Tooth Bite = Feed Rate (12) / RPM (Teeth)

= 16 ft/m(12) / 4297.16(8)

=.0055

Arbor RPM = 12 (Rim Speed) / Saw Diameter(3.14)

=12 (9000) / 8 in.(3.14)

=4299.36

Circumference =3.1416 (Diameter)

=3.1416 (8 in.)

=25.13

HP per saw =D of C(Kerf)(FPM)(Factor) / 144

= 1.5(.15)(16ft/m)(45) / 144

=1.125

Total HP= 1.125(7)

=7.875

Saw Calculations (10 in.)

R.P.M. = <u>3.8197 (Rim Speed)</u>
Saw Diameter

= <u>3.8197 (9000 ft/m)</u>
10 inches

= 3437.73

Tooth Bite = <u>Feed Rate (12)</u>
RPM (Teeth)

= <u>16 ft/m(12)</u>
3437.73(10)

=.0055

Arbor RPM = <u>12 (Rim Speed)</u>
Saw Diameter(3.14)

=<u>12 (9000)</u>
10 in.(3.14)

=3439.49

Circumference =3.1416 (Diameter)

=3.1416 (10 in.)

=31.416

HP per saw =<u>D of C(Kerf)(FPM)(Factor)</u>
144

= <u>1.5(.15)(16ft/m)(45)</u>
144

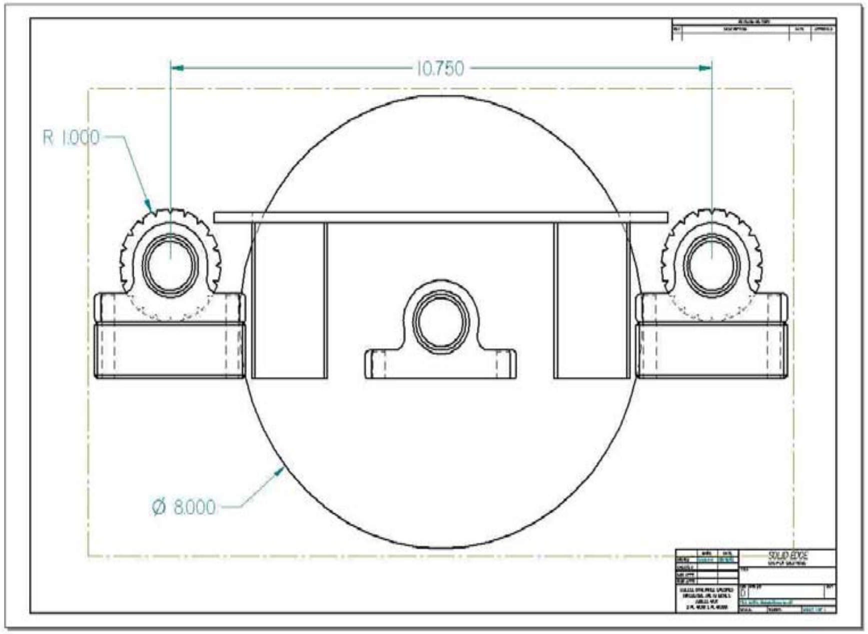
=1.125

Total HP= 1.125(7)

=7.875

8 inch Carbide Tip w/8 teeth

- Cost, most suitable for woodworking
- 12 inch boards would jam machine
- 8 teeth to carry load out of cut



Shaft Design

- Bending and Torsion
- 1045 Steel-industry recommended
- Torque on shaft from motor
- Calculated value of
  - 0.632 inch diameter shaft

Shaft Design Cont'd

- Industry experts recommend a diameter of 1 15/16 Inches
- Compare with calculated value
- ¾ inch shaft selected based on calculations and bearing availability

Shaft Selection
Keyed vs. Splined

- Keyed
  - Catalog item
  - 1045 Shafts Available
  - Supplier
  - Cheap if purchased
  - Easier to machine
  - Easy to replace
- Splined
  - Not catalog item
  - Expensive to purchase
  - Difficult to machine
  - Long wait if shaft fails

Shaft Prices

- Keyed
  - 3/4 inch diameter
  - 24 inch length
  - Keyway dim. of 3/16 IN.X 3/32 in.
  - $ 30.00
- Splined
  - Have to be custom made
  - Finding machinist
  - Custom job more expensive

Bearing Selection

- Self aligning for deflection
- Eccentric lock for one direction of rotation
- Load and rpm rating
- Supplier
- $30.00 per bearing
- Cost of two - $60.00

Major Motor Constraints

- Single Phase Motor
- Maximum 15 hp Motor

Advantages of the 15 hp motor

- 15 hp motor results in a feed rate of 30 ft/min
  - 2.1 hp = $\frac{(45)(.15in)X(1.5in)}{144}$

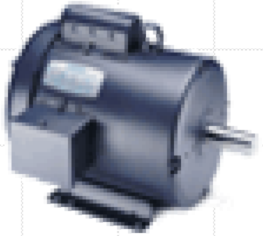
    = 30 ft/min
  - 7 blades x 2.1 hp = 15 hp

Disadvantages of the 15 hp motor

- TEFC motor unavailable
- The Cost of a 15 hp motor is $800
- Eliminates the fast feed rate of 30 ft/min
- This eliminates the possibility of a 15 hp

Advantages of 2 x 5 hp motors

- Efficient according to hp calculations
  - Hp per saw = $\frac{1.5(.15)(16)(45)}{144}$
    = 1.13 hp



  - 7 blades x 1.13 hp = 8 hp
- 2 x 5 hp motors are equal to 1 x 10 hp motor

Disadvantages of 2 x 5 hp motors

- The Cost of 2 x 5 hp motors is $974
- Hassle as far as one of the motors failing
- Motors have to be coupled together
- More space required for the two motors

Advantages of 1 x 10 hp motor

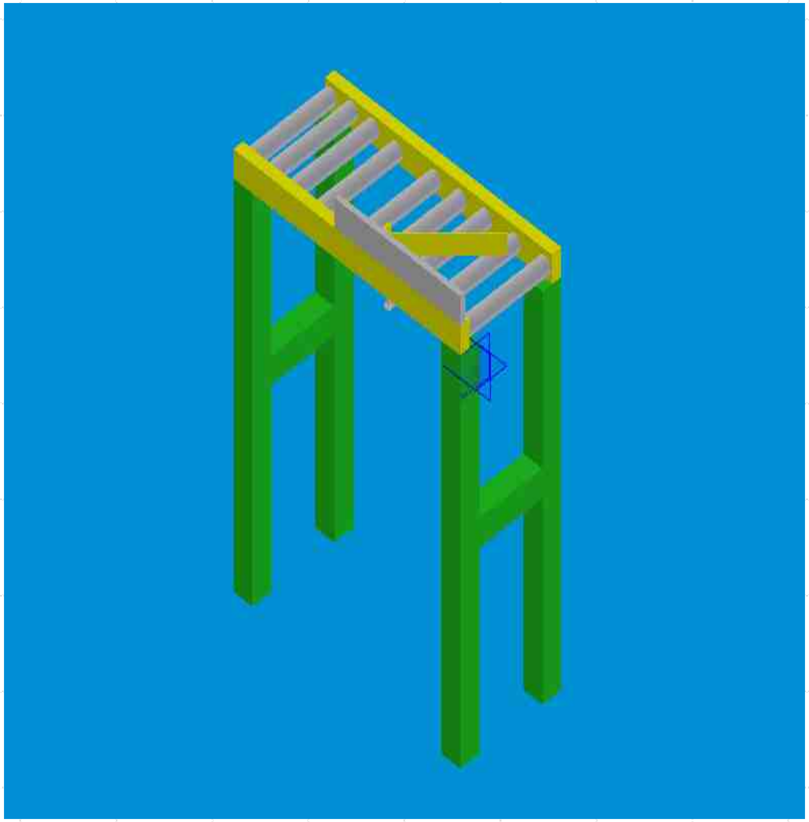
- The Cost is only $650
- The motor is the most efficient according to hp calculations
  - Hp per saw = $\frac{(1.5)(.15)(16)(45)}{144}$

    = 1.13 hp
  - 7 blades x 1.13 hp = 8 hp
- 1 motor is less hassle as coupling and failure are concerned
- A TEFC motor is available in a 10 hp electric motor.

Feeder System

- Gravity Conveyor
- Belt & Chain Conveyor
- Power Feeder
- Overhead Conveyor
- Machined Power Conveyor

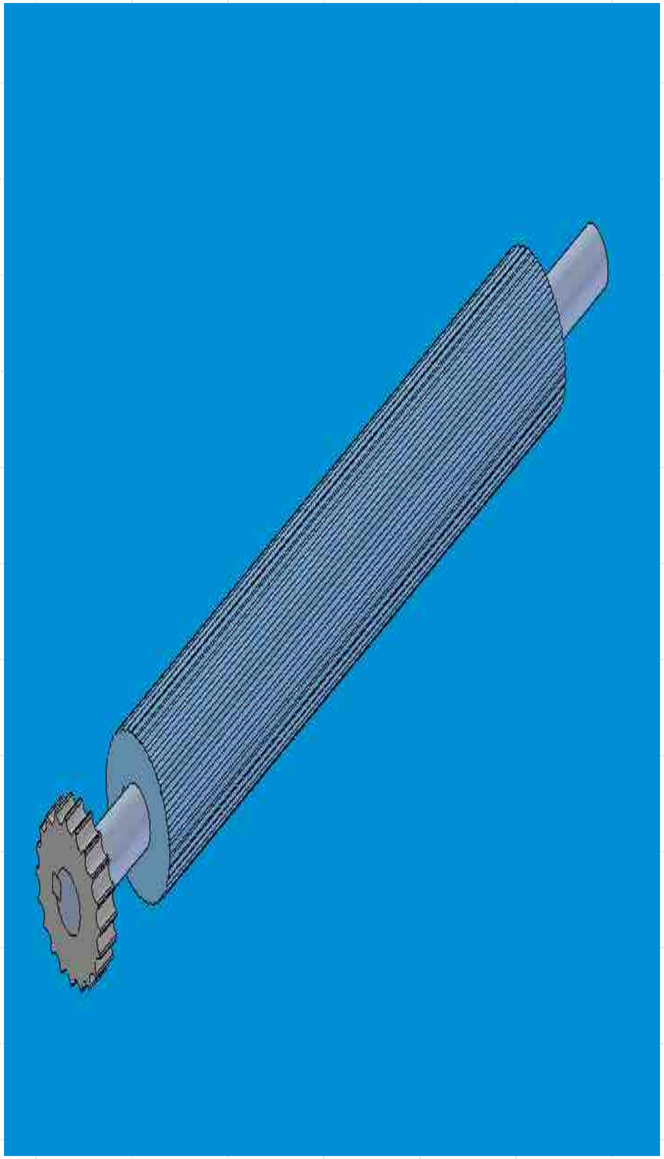
Feeder Considerations



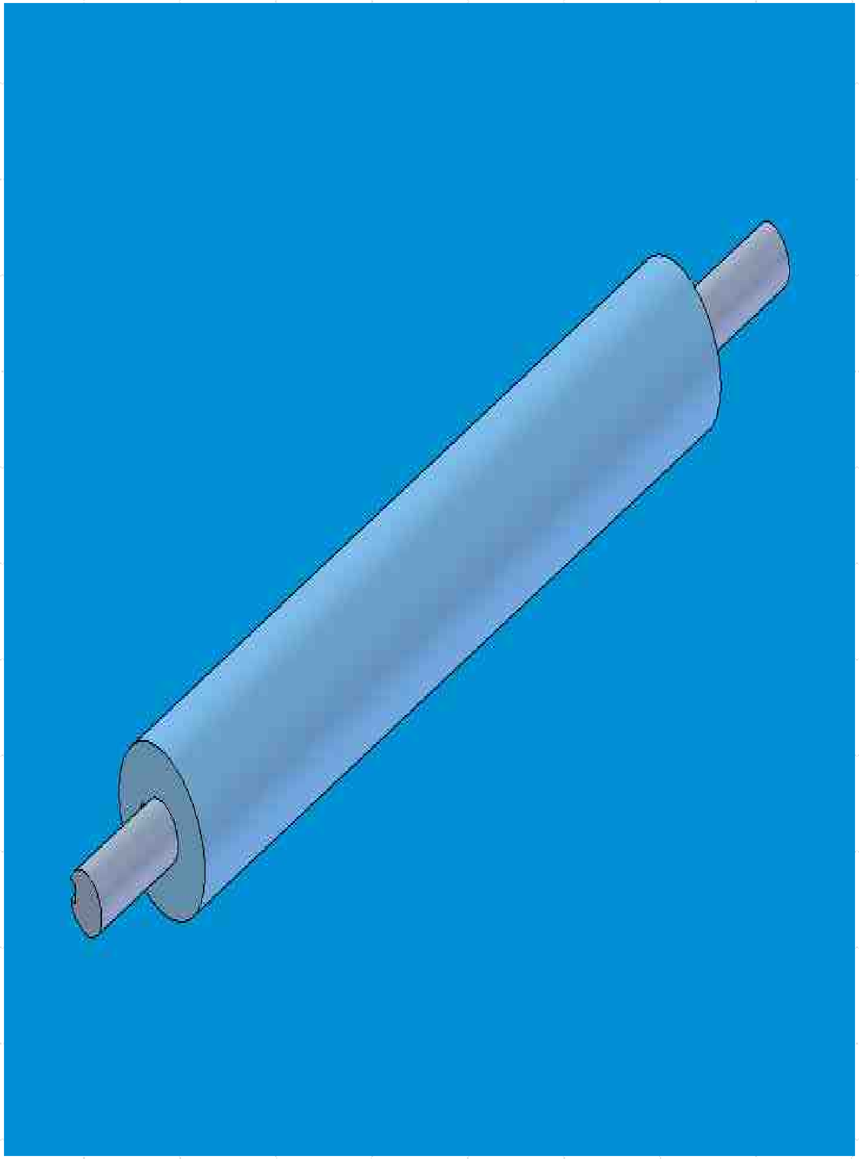
- Cost Analysis
- Final Decision
- Alignment Mechanism
- Outlet Ramp

Feed Rollers

- Rough knurled surface to grip the surface of the wood as it is being pushed through the saw blades
- Chrome coated to prevent wear
- Mounted just before and after saw blades
- Driven by sprocket connected to gearbox



- Smooth roller will be mounted directly above each of the rough rollers
- 2 inch diameter roller
- Does not need coating
- Spring loaded allowing it to be forced up by the board



Feed Roller Power Supply

- Torque = Force X Radius
- Torque = 140 lb X 0.0833 ft = 11.6 lb-ft
- Horsepower = (Torque X rpm)/5252
- hp = (11.6 lb-ft X 30 rpm)/5252= 0.066 hp
- 0.066 hp to force board through saw blades
- Power supplied from a gearbox connected to main motor
- Feed Rate = 16 ft/min or 30 rpm

Cost of Purchased Rollers

- Rough surface
  - $100-$150
- Smooth surface
  - $50-$100
- At least 4 rollers needed – 2 smooth, 2 rough
- Total - $300-$500

Cost of Chain Feed System

- 14 inch wide chain made from cast steel with race guide - $2500
- Must have a forced lubricating system which will cost extra
- Must have more horsepower to run

Cost to Fabricate Rollers

- 1 stick of cold roll steel

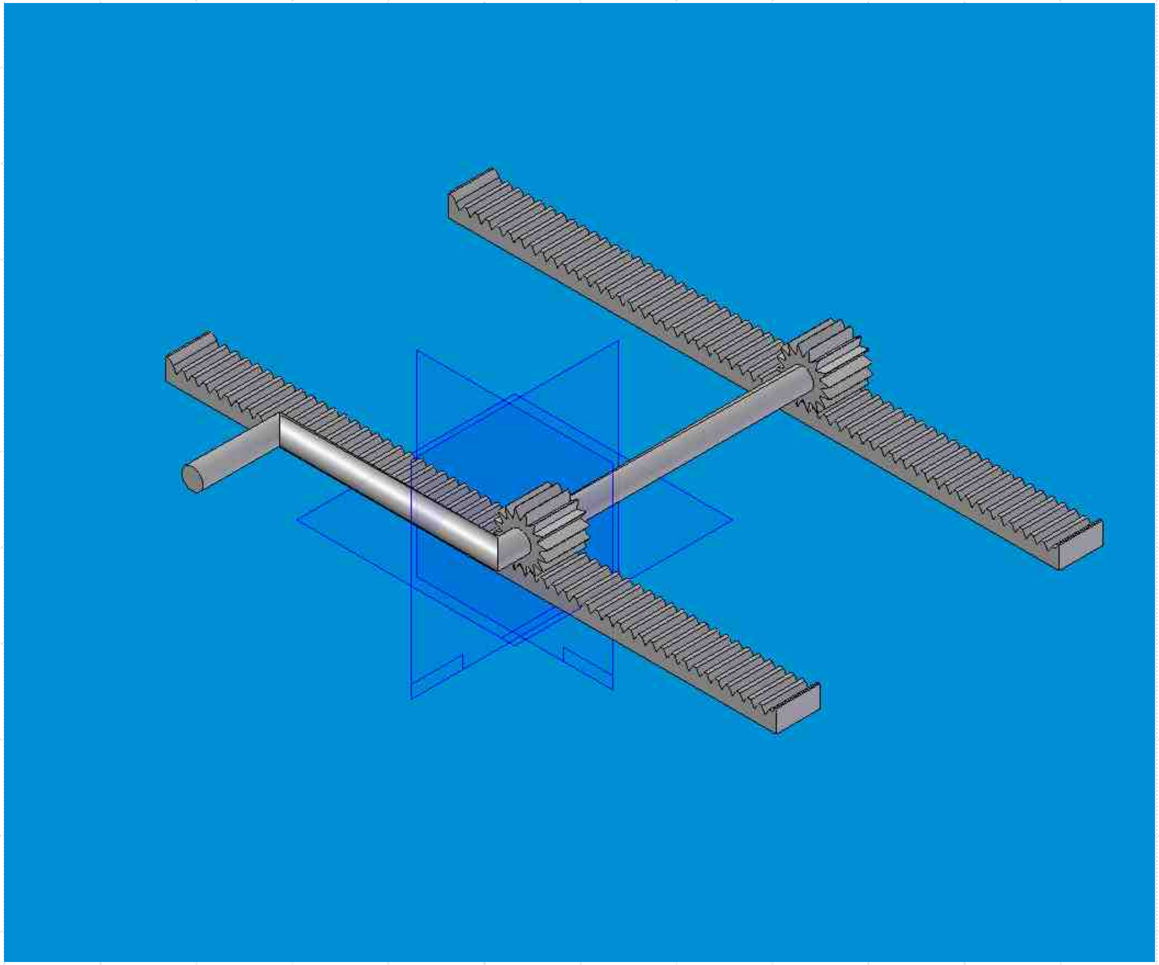
  20 feet long

  2 inches in diameter

  $100 or $5 per foot

  $75-$100 for chrome coating
- Time

Blade Spacing Mechanism



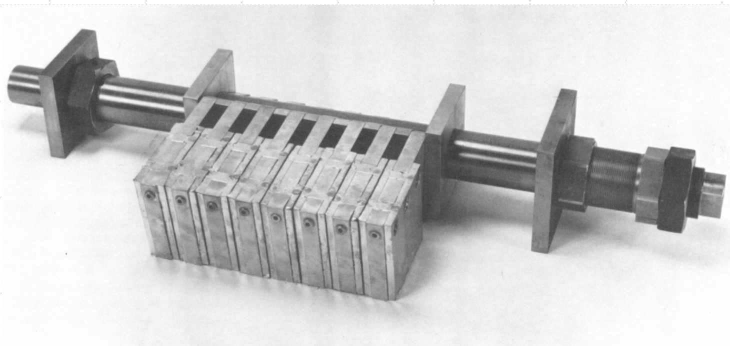
Requirements of Spacing Mechanism

- ♦Adjustment of blade spacing: 3/4” - 1.5”
- ♦Ease of operation
- ♦Short changeover time (< 5 min)
- ♦Reliability
- ♦Low maintenance
- ♦Low cost

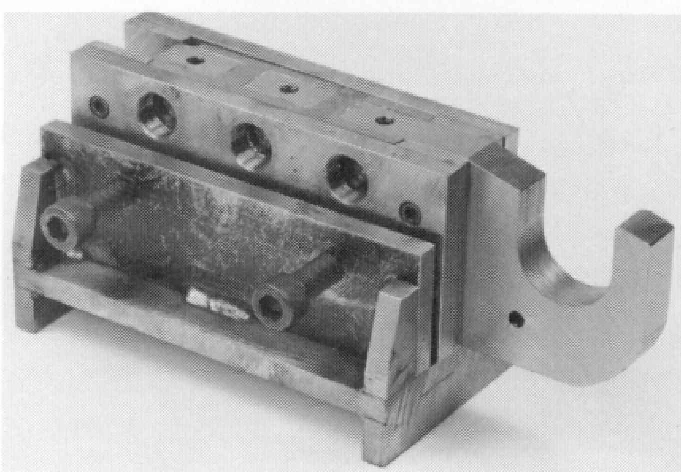
Alternatives

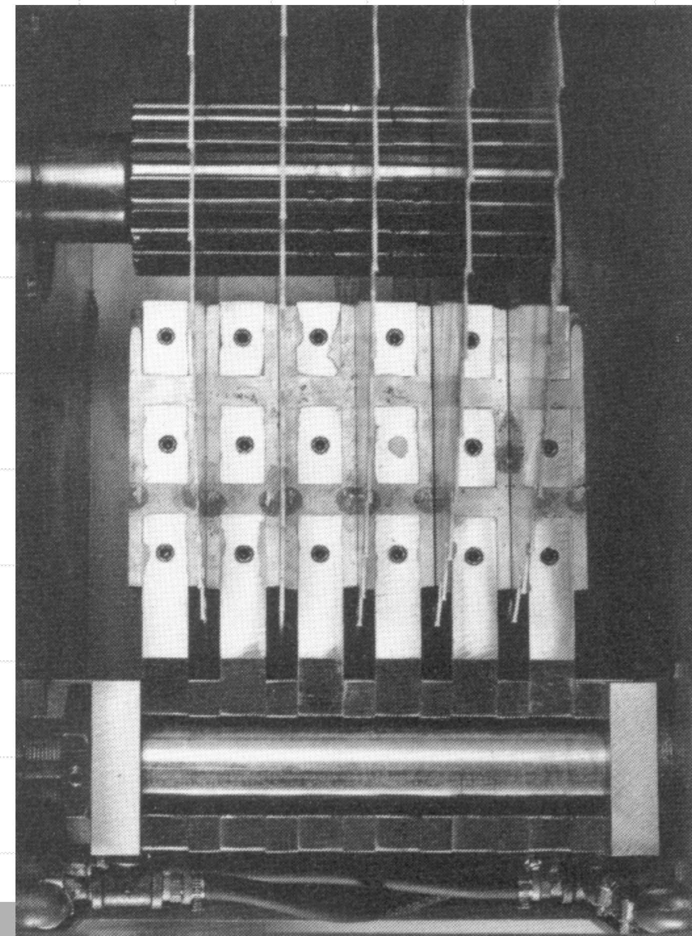
- Babbitt Guide System
- Set Collars
- Dual Arbors
- Compression Springs between blades
  - Pneumatic Actuation
  - Rack and Pinion (Human Powered)

Babbitt Guide System



BABBITT MOLD





Consideration of Babbitt Guide System

- Advantages
  - Proven Technology
  - Simple adjustment of Blade Spacing
- Disadvantages
  - Babbitt guides must be periodically re-poured.
  - Cost Exceeds Budget
  - Not available in 3/4” spacing

Consideration of Set Collars

- Advantages:
  - Simple
  - Inexpensive
  - Reliable
  - Low maintenance
- Disadvantages
  - Difficult and time consuming to adjust

Consideration of Dual Arbors

- Advantages:
  - No blade adjustment necessary.
  - Relatively simple to switch from 1.5” to 3/4” blade spacing(2nd arbor pneumatically actuated)
- Disadvantages
  - Horsepower doubled - 2 motors required
  - 15 Blades required
  - Additional shaft and bearings required
  - Pneumatic Cylinder and Control Valves required
  - Increase in cost = $1360

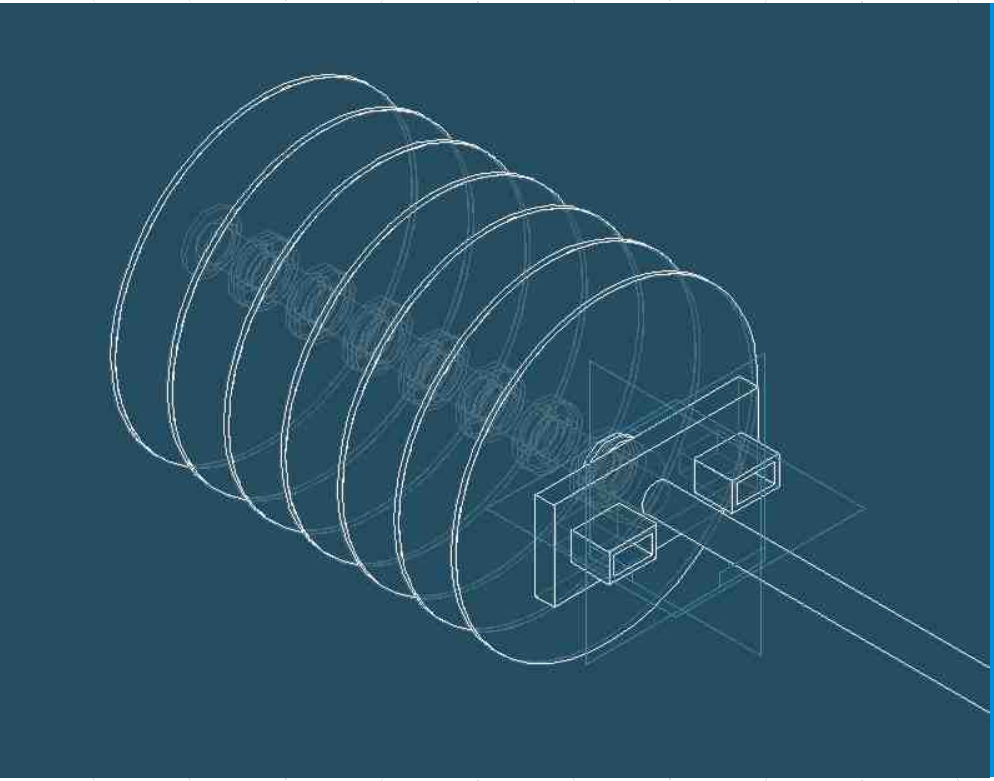
Compression Springs with Pneumatic Actuation

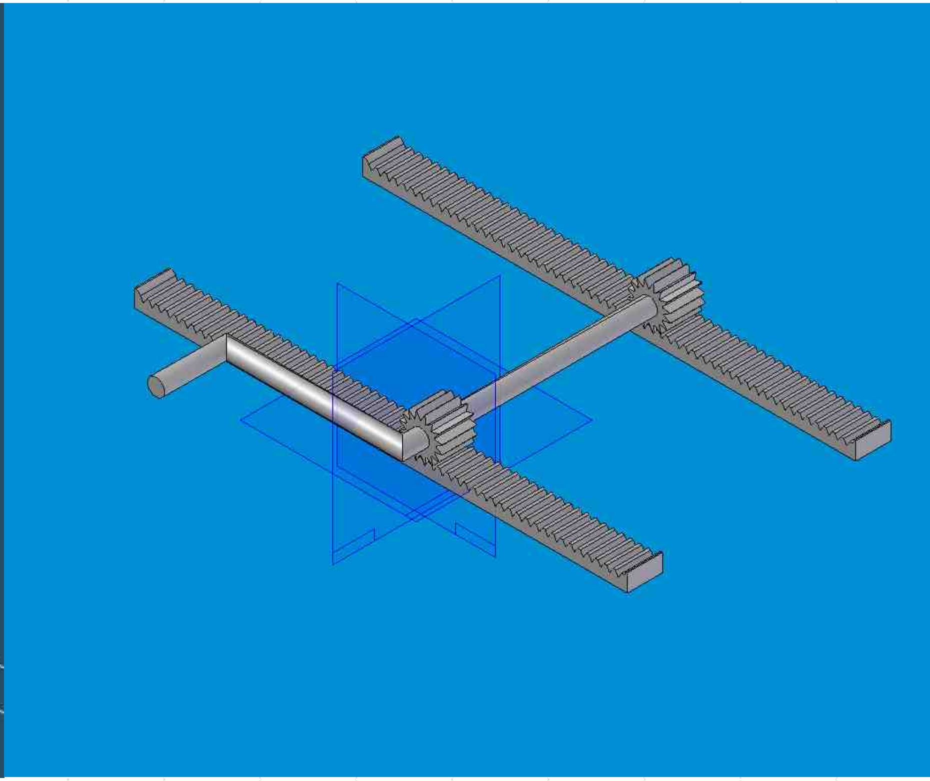
- <u>Advantages</u>:
  - Blade adjustment simple and quick.
- <u>Disadvantages</u>:
  - 2 pneumatic cylinders and control valve required ($150)
  - Latching mechanism still required

Compression Springs with Rack and Pinion

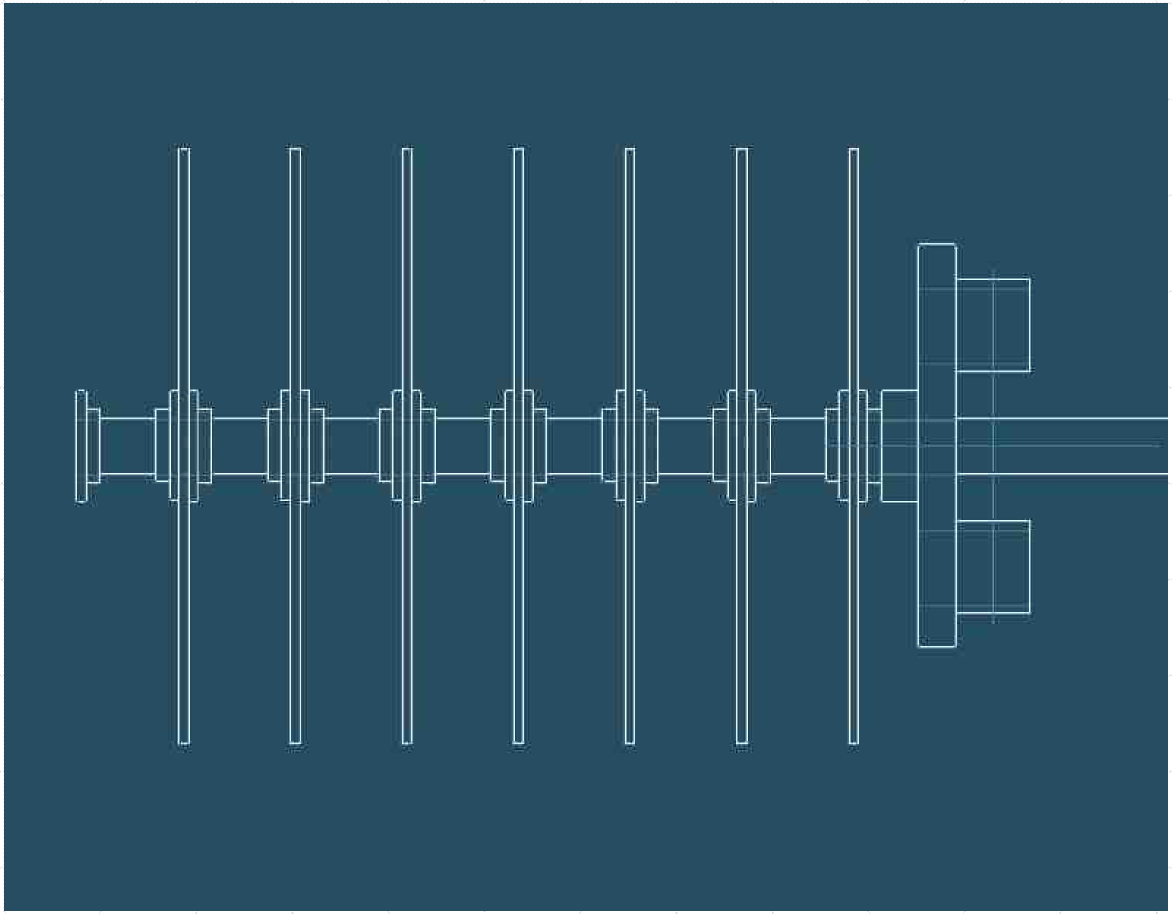
- Advantages:
  - Rack and Pinion-Proven technology
  - Simple to adjust blade spacing
  - Low maintenance
  - Inexpensive to machine.
- Disadvantages:
  - Expensive if purchased

Compression Springs with Rack and Pinion

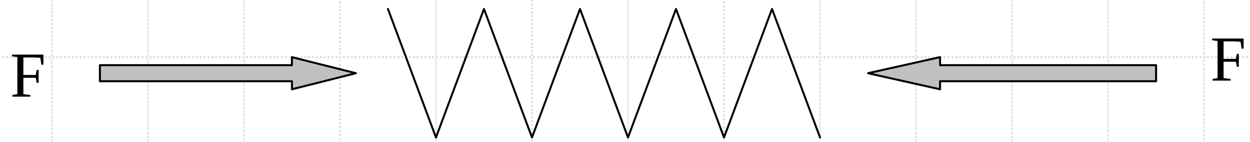




Compression Springs with Rack and Pinion



Spring Calculation

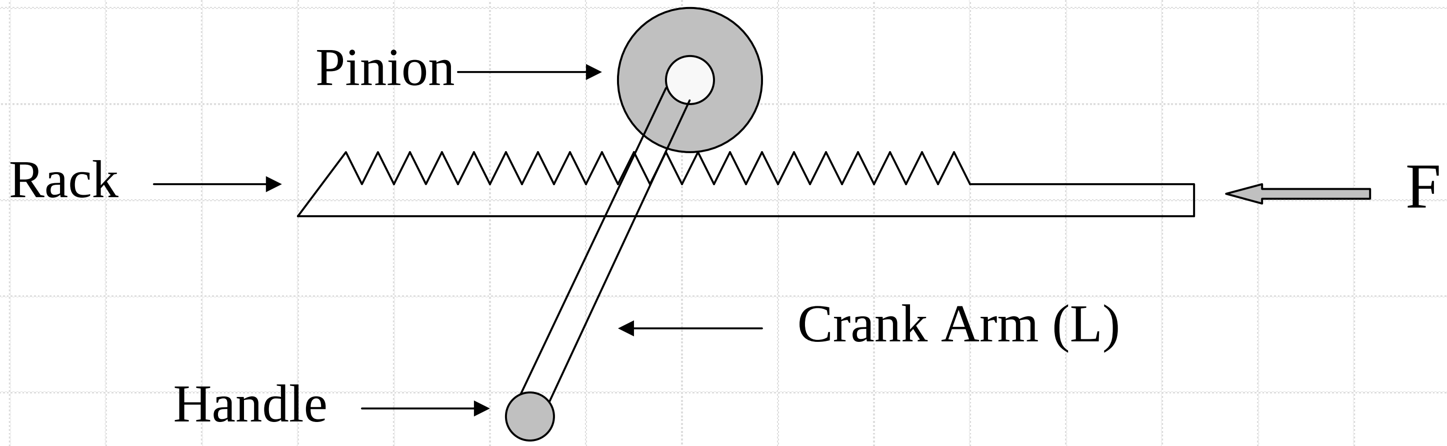


Spring Rate(k) = 111 lb/in

Free length = 2 in

Blade Spacing	Compressed Length	Delta L	Force(K*Delta)
1.5"	1.25"	.75"	83.25 lb
3/4"	.5"	1.5"	166.5 lb

Calculation of Crank Force



At Full Spring Compression F = 166.5 lb

Torque(pinion) = F*r

Crank Force = Torque/L= F*r/L

For r=1” and L = 8” :

Crank Force = 18.5 lb

Cost Analysis

Part	Purchased or Machined(P/M)	Cost Per Unit($)	Total Units	Cost($)
8" Blade	P	60	7	420
5/8" Shaft	P	50	1	50
pillow block bearings	P	18.61	10	186.1
Shaft Bearings	P	30	2	60
Rack	M	5	2	10
2" Pinion	P	9.64	2	19.28
Crank Arm	M	5	1	5
Compression Springs	P	2	6	12
10 hp Electric Motor	P	650	1	650
Drive Pulleys	P	9	7	63
Drive Belts	P	10	5	50
Feed Rollers	M	5	5	25
Frame Steel	M	75	1	75
			Total Cost	1625.38

OSHA Regulations

Guards

- All belts, pulleys, gears, shafts, and moving parts shall be guarded
- Feed Rolls and saws shall be covered with an exhaust hood or with a guard that shall be so arranged as to prevent accidental contact with the rolls or saws
- Shafting under bench machines shall be enclosed by a stationary casing or trough
- Belts where both runs of the belt are 42 inches or less from the floor shall be fully enclosed

Power

- The saw shall be provided with a disconnect switch that can be turned off, locked out, and tagged out in the off position while repairs or adjustments are being made
- A mechanical or electrical power control shall be provided on each machine to make it possible for the operator to cut off the power from each machine without leaving his position at the point of operation

Power

- Provision shall be made to prevent machines from automatically restarting upon restoration of power
- Power controls and operating controls should be located within easy reach of the operator while he is at his regular work location, making it unnecessary for him to reach over the cutter to make adjustments

Maintenance

- Dull or badly set saws shall be removed from service, before they begin to cause the material to stick, jam, or kick back when it is fed to the saw
- Saws to which gum has adhered on the sides shall be immediately cleaned
- Bearings shall be kept free from lost motion and well lubricated

Maintenance

- Arbors of all circular saws shall be free from play
- Pulleys with cracks, or pieces broken out of rims, shall not be used
- All power transmission equipment shall be inspected at intervals not exceeding 60 days and be kept in good working condition at all times

Questions?