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Design of a mill for a cyanide plant

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THESIS

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IN

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SUBJECT: "Design of a Mill for a Cyanide Plant."

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THE DESIGN OF A MILL FOR A CYANIDE PLANT,

in which the ore, direct from the mine, is to be crushed or ground to the required fineness.

OBJECT.

Designing a mill, which according to my ideas, would be the best in practice.

The machinery used in practice at the present time, is mostly old style. In this work of mine I have substituted a great deal of lately invented machinery which would give much better and quicker results than the machinery now used. Many ideas have come to me while working on this subject which I think would assist me in any further work on the subject.

Ore.

The mill is designed especially for the ore which Messrs. Fraizer and Jamison (class of 1900) took to do their thesis work on.

Contents of the Ore.

1st Quantitatively.

Sodium	1.68	per	cent.
Silica	58.15	"	"
Potassium	9.89	"	"
Iron	3.274	"	"
Alumina	22.9453	"	"
Sulphur	4.2011	"	"
Manganese	.3396	"	"
Gold and Silver	.0164	"	"
Calcium	Trace		
Strontium	"		
Magnesium	"		

2nd Mineralogically.

It is a phonolite.

Hardness of the Ore.

Hardness was found to be.

Capacity.

Capacity is two hundred tons ore per day.

Principle of the Mill.

The ore as it comes from the mine is allowed to fall over an inclined grizzley(distance between bars, two inches) two-thirds of which goes through and one-third does not. The latter,after rolling to the bottom of the grizzley,falls into a Gates Crusher, whose jaws are set at one inch. The former goes,with that portion from the Gates Crusher to Dryers(the ore being assumed to be damp when taken from the mine).

After the ore is dryed ,it goes into some separator,thus it is classified larger and smaller than two-thirds(2/3) inches. That larger than two-thirds inches goes to a Dodge Crusher(whose jaws are set at one inch).

That smaller than two-thirds inches from the first set of separators is rejoined and with that which comes from the Dodge Crusher,passes over a second set of separators and thus it is again sized as larger and smaller than one-twelvth.

That larger than one-twelvth inch goes to a set of rolls which crushes it to one-fourth of an inch. That smaller than one-twelvth inch goes to a fourth set of separators.

The ore coming from the rolls,goes to a third set of separators which sizes it as larger and smaller than one-twelvth (1/12) inch. That smaller than one-twelvth goes to a fourth set of separators. That larger than one-twelvth, goes to the second set of rolls and from here to the fourth set of separators.

The fourth set of separators classify the ore as that larger and smaller than one-thirty-sixth (1/36) inches. That smaller than one-thirty-sixth inches goes to the roaster. That larger than one-thirty-sixth inches goes to the third set of rolls.

The third set of rolls crush the ore to one-thirty-sixth (1/36) inches. The ore as it comes from these rolls goes to the roaster.

The ore after it comes from roaster is ready for leaching by means of cyanide.

Machinery Used.

1	No. 4	Grizzley
1	No. 4	Gates Crusher
1	No. 2	Dodge Crusher
2	Largest size Howell White Dryers.	
4	Largest size Howell White Roasters.	
8	No. 2 Screens or Separators	
3	Sets High Speed Crushing Rolls.	

Grizzley.

This grizzley not only first separates the ore that comes from the mine, thus saving the fine from passing through the crusher, but it also serves to recover gads, drills, and hammers that may have come from the mine in the ore before they reach the rock breaker and thus preventing serious accidents to the crusher. The grizzley is placed at the highest point in the mill where the ore cars can be dumped on it and the coarse material screened from the fine.

The grizzley is placed at an angle of forty-five degrees. The size of the grizzley is 4 X 10 feet and size of bars 3/4 X 3 inches. The weight is 1.380 pounds

Gates Crushers.

The crusher is of style "D" and is a breaker of the gyratory form. The crushing is done between a cone placed on a gyratory shaft vertical through the center of a cylinderical shell. As it gyrates, the crushing cone impinges against the sides of the shell in relation to which it isconstantly approaching and receeding. The top of the shaft carrying the crushing cone is held riding while the bottom is gyrayed by means of a simple gearing. Ore opening is 8 X 27 inches. Weight is 21000 pounds.

Dodge Crusher.

This crusher is used to crush the ore to a more uniform size for the rolls. The crushing is done by means of a moveable jaw, hinged at the bottom and giving a large amount of movement at the top, thus reducing the material by gradually breaking the pieces until they drop through the opening between the jaws at the bottom, where the movementis less. Weight is 10000 pounds. Size of jaw opening is 7 X 9 inches.

Howell White Dryers.

These dryers are used to expell the moisture from the one to be treated. This is done in order that there will be no wet ore to clog the screens and rolls and thus reduce their capacity. These dryers are too familiar and their method will not be discussed

Howell White Roasters.

Used to expell the Co_2(if any) and the sulphur. This roaster occupies but little space and also secured the workmen's safety from the injurious gases (SO_2 ,etc.) arising from the hot ore.

Screens.

These produce a uniform product. When the screens are in operation,the material is fed in at the hopper,from which it is taken by a spiral conveyor which distributes it in a continuous thin stream over the entire surface of the screen. The screen frame fibrates rapidly as the material flows down its surface,the finer passing through,the coarser tailing over.

Rolls.

High speed crushing rolls are used. These rolls have narrow faces and they wear truly across the faces.

Building.

The brace work,of the sides ,is wooden posts covered with corrugated iron. The roof and all posts within building is made of medium steel. The roof covering is corrugated iron. The building is sixty feet wide.

Design of Roof.

The roof is divided into three sections . The uppermost section(50 feet in length),and lowest section(60 feet in length) are inclined at an angle of thirty degrees and the middle section (forty feet in length) at an angle of forty-five degrees.

Truss for Roof.

Truss # 1 is for highest section of roof and is fifty feet in length.

Truss # 2 is for middle section of roof and is forty feet in length.

Truss #3 is for lowest section of roof and is sixty feet in length.

There are two of each trusses used which are placed so spacing them will be twenty feet.

Design of Roof Trusses.

Weight on Each Truss

Using formula, $$W' = \frac{W}{\dfrac{6\,r}{y\left(\left(\frac{e}{2}\right)^2 + r^2\right)} - 1}$$

Where W' = the dead weight of the truss.

W = total external load due to wind, snow, roof covering.

6 = the allowable stress per square inch.

r = the rise in feet of the truss.

l = length of span in feet.

Y =

Truss I

e = 50 feet

W = (50 x 20 x 30 #) = 30,000#

6 = 10,000#

$Y = \frac{10}{3}$

r = 7.2 feet.

$$W' = \frac{30000}{\dfrac{10000 \times 7.2}{\frac{10}{3}\left(\left(\frac{50}{2}\right)^2 + (7.2)^2\right)} - 1} = 1935\#, \text{ make } = 2000\#$$

Weight on each apex $= \frac{2000}{10} = 200\#$

30 pounds per square foot for snow load and three pounds per square foot for iron covering.

Total weight on each apex $20 \times 5 \times (30+3) + 200 = 3500\#$

Truss II

$W = 40 \times 20 \times 30\# = 24000\#$

$l = 40$ feet

$r = 5.7$ feet

$Y = 10/3$

$\sigma = 10000$ pounds.

$$W' = \frac{\frac{24000}{10000 \times 5.7}}{\frac{10}{3}\left(\frac{(40)^2}{2} (5.7)^2\right)} = 1230\# \text{ make } = 1240\#$$

Now weight at each apex $= \frac{1240}{8} = 155\#$

Then total weight at each apex $= (20 \times 5 \times 33\#) + 155\# = 3455\#$

Truss III

$W = (60 \times 20 \times 30\#) = 36000\#$

$l = 60$ feet

$r = 8.6$ feet

$y = 10/3$

$\sigma = 10000$

$$W' = \frac{\frac{36000}{10000 \times 3.6}}{\frac{10}{3}\left(\frac{(60)^2}{2} (8.6)^2\right)} = 2834\#, \text{make} = 3000\#$$

Weight at each apex $= \frac{3000}{12} = 250\#$

Total weight at each apex $= (20 \times 5 \times 33\#) + 250\# = 3550\#$

Worked out the load on each panel, then laid this load vertically to scale, then worked up a "Dead Load" diagram for each truss. These diagrams will be found on the sheet which accompany this thesis. After the "Dead Load" diagram was drawn carefully, the stresses were measured carefully and the stresses laid out in pounds. From these figures, the design of each piece was figured as will be shown later. The different members are lettered on the drawing.

Compression Members (I Beam)

Took formula as follows: for all dead load strains:

$$P = (20,000 - 90 \frac{l}{r})$$

when P = the allowed strain in compression per square inch of cross section, in pounds.

l = the length of compression member, in inches.

r = the least radius of gyration of the section, in inches.

P and l being known, substituted values for r (found in carriage) and multiplied right hand member by the area of the section, in square inches corresponds to the r found, until the right hand member of the equation was equal to or greater than the left hand member of the same equation.

Design of Compression Member in Truss I.

As the stresses in members Aa, Bb, Cc, Df, Eh, Fk, Gm, Ho, Iq, and Jr even so nearly alike, took the greatest stress of any one member, which in this truss was Jr(55600#) and then making all the above named members of the same style and weight.

This was done to have a uniform and even surface for the roof (having height same), in order that no snow or sleet would accumulate in any crevice formed by such, causing any one member to have more weight than any one of the remainder members.

Substituted this value (55600#) for P in equation

$l = 5$ feet $= 60$ inches.

$55600\# = (20{,}000 - 90\ \frac{60}{2.05}) = 17366$ pounds.

Area of section in square inched, in this case is 3.

$55600\# = 17366\# \times 3 = 54498\#$

These values correspond to shape 309 A(steel) in Carnagie.

Depth of beam is 5 inches.

Truss II

Worked as Truss I. Members A,a, B,b, C,d,D,f,E,i,F,k,G,n,H,o,

Largest stress is in H,o, (39500#)

$$39500 = \left(20000 \quad \frac{90 \times 60}{1.63}\right) \approx 2.2 = 36?11.4$$

This r (1.63) corresponds to shape (310a) in Carnegie.

Depth of Beam is four inches. Section area = 2.2 square inches.

Truss III

Took the largest of any stress occurring the members

$A_{''}a_{''}B_{''}b_{''}, C_{''}d_{''}, D_{''}f_{''}E_{''}h_{''}\ F_{''}j_{''}G_{''}m_{''}H_{''}o_{''}$

This was found to be $B_{''}b_{''}$ (53800#)

$$53800\# = \left(20{,}000 - \frac{90 \times 60}{2.47}\right) \quad 4.7 = 83725.8\#$$

$r = 2.47$ Section area $= 4.7$ square inches. Shape = 308 a.

Then took largest of any of the stresses occurring in the members $I_{''}q_{''}\ J_{''}s_{''}\ K_{''}n_{''}\ M_{''}v_{''}$.

This was found to be $M_{''}v_{''}$(53800#)

This $$53800\# = \left(20{,}000 - \frac{90 \times 60}{2.48}\right) \qquad 3.8 = 67727.4\#$$

$r = 3.8$ Section area = 3.8 square inches. Shape = 308 b.

The above 308 a and 308 b have the same depth(six inches).

Compression Members, continued.

Truss I

For members (a b) (c d) (e f)) (g h) (K l) (m n) (p o) (q r)

largest stress was found to be in (gh) and (kl) 7500#

$$7500 = \left(20,000 - \frac{5.7 \times 12}{1.63}\right) 2.2.$$

r = 1.63

l = 5.7 ft = 5.7 x 1268.4 inches.

shape = 310 a . Depth of beam = 4 inches weight per foot = 7.5#.

For members Ij, stress = 15000#.

$$15000 \quad \left(20,000 - 90\ \frac{7.2 \times 12}{2.03}\right) 3.8$$

r = 2.03

l = 7.2 ft = 7.2 x 12 = 86.4 inches.

Shape = 309 b. depth beam = 5 inches, weight per foot = 13 lbs.

Truss II

For members (a,b,) (c,d,) (e,f,) (i,j,) (k,m?) (n,O,)

Largest stress is in (i,j,) and (e,f,) 4900#

$$4900 = \left(20,000 - 90\ \frac{4.3 \times 12}{1.63}\right) 2.2$$

r = 1.63 l = 4.3 ft = 4.3 x 12 = 51.6 inches.

shape = 310 a. Depth beam = 4 inches. Weight per foot = 7.5 pounds.

For member (g,h,) stress = 9800#

$$9800 = \left(\left(20,000 - 90\ \frac{5.7 \times 12}{1.63}\right) 2.2\right)$$

r = 1.63 l = 5.7 feet = 5.7 x 12 = 68.4 inches.

Shape = 310 a Depth beam = 4 inches.

Truss III

For members $(a_{\prime\prime} b_{\prime\prime})$ $(c_{\prime\prime} d_{\prime\prime})$ $(e_{\prime\prime} f_{\prime\prime})$ $(g_{\prime\prime} h_{\prime\prime})$ $(i_{\prime\prime} j_{\prime\prime})$ $(m_{\prime\prime} n_{\prime\prime})$ $(o_{\prime\prime} p_{\prime\prime})$ $(q_{\prime\prime} r_{\prime\prime})$ $(s_{\prime\prime} t_{\prime\prime})$ $(u_{\prime\prime} v_{\prime\prime})$

Largest stress is found to be in $(i_{\prime\prime} j_{\prime\prime})$ and $(m_{\prime\prime} n_{\prime\prime})$=96000 pounds.

$$96000 = \left(20{,}000 - 90 \; \frac{7.2 \times 12}{1.63}\right) 2.2$$

l=7.2 feet r =1.63 Shape = 310 a

For members $(k_{\prime\prime} l_{\prime\prime})$ 18900 pounds.

$$18900 = \left(20{,}000 - 90 \; \frac{8.6 \times 12}{4.87}\right) 9.4$$

l = 8.6 feet r=4.87 Shape = 303 a Depth = 12 inches.

weight per foot = 32 pounds.

Tension Members.

For the tension members(bottom chords and diagonals) took 20,000 pounds per square inch for medium steel. then $a = \frac{d^2 \pi}{4}$

solving for d, $d = \sqrt{\frac{4a}{3.14}}$

Truss I

Members (b c)(d e)(n o)(q p)

Largest stress was in (de)or (on) and equal to 6000 pounds.

Area $= \frac{6000}{20000} =$ .3 square inches diameter $= \sqrt{\frac{.3 \times 4}{3.1416}} =$. 3 inches

Members (f g)(h i) (k j)(m l)

largest stress wasin (j k) an d equal to 8200 pounds.

Area $= \frac{8200}{20000} =$. 4 inches . Diameter $\sqrt{\frac{4 \times 4}{3.1416}} =$ 5 inches

Truss II

Members $(b_, c_,)(d_, e_,)$ $(f_, g_,)(n_, m_,)(k_, j_,)(i_, h_,)$

largest stress found to be in $(i_, h_,)$ and equal to 5700 pounds.

Area of cross section $= \frac{5700}{20000} =$ .3 square inches.

Diameter $= \sqrt{\frac{.3 \times 4}{3.1416}} = .3$ inches.

Truss III

Members (b'', c'') (d'', e'') (f'', g'') (q'', p'') (s'', r'') (u'', t'')

largest stress in (q'', p'') or (f'', g'') and equal to 7200 pounds.

Area $= \frac{7200}{20,000} = .4$ square inches. Diameter $= \sqrt{\frac{.4 \times 4}{3.1416}} = .5$ inches.

Members (h'', i'') (j'', k'') (l'', m'') (n'', o'')

largest stress in (j'', k'') and equal to 10300 pounds.

Area of cross section $= \frac{10300}{20,000} = .5$ square inches.

Diameter $= \sqrt{\frac{.5 \times 4}{3.1416}} = .6$ inches.

Note- Took all diameters which were smaller than one inch as one inch.

Tension Members, continued.

Truss I.

Members (a l)(c L) (e L) (r L) (p L) (n L)

largest stress in (r L) and equal to 49600 pounds.

Area $= \frac{49600}{20000} = 2.5$ square inches.

Diameter $= \sqrt{\frac{4. \times 2.5}{3.1416}} = 1.8$ inches.

Members (g L) (i L)(lL)(j L)

Largest stress in (lL) and equal to 33000 pounds.

Area $= \frac{33000}{20,000} = 1.7$ square inches.

Diameter $= \sqrt{\frac{4 \times 1.7}{3.1416.}} = 1.5$ inches.

Truss II

For members (a,L,)(c,L,)(o,L,)(m,L,)

largest stress in (a,L,), equal to 32200#

$$\text{Area} = \frac{32200}{20000} = 1.6 \text{ square inches.}$$

$$\text{Diameter} = \sqrt{\frac{4 \times 1.6}{3.1416}} = 1.5 \text{ inches.}$$

For members (e,L,)(g,L,)(j,L,)(h,L,)
Largest stress in (j,L,)
equal to 22900 pounds.

$$\text{Area} = \frac{22900}{20000} = 1.1 \text{ square inches}$$

$$\text{Diameter} = \sqrt{\frac{4 \times 1.1}{3.1416}} = 1.2 \text{ inches.}$$

Truss III

For members (a,,L,,) (c,,L,,)(e,,L,,) (v,,L,,) (t,,L,,) (v,,L,,).

Largest stress in (a,,L,,) equal to 64700 pounds.

$$\text{Area} = \frac{64700}{20000} = 3.2 \text{ square inches.}$$

$$\text{Diameter} = \sqrt{\frac{4 \times 3.2}{3.14}} = 2 \text{ inches.}$$

For members (g,,L,,)(i,,L,,) (k,,L,,) (p,,L,,) (n,,L,,)(l,,L,,)

Largest stress in (g,,L,,), equal to 47200 pounds.

$$\text{Area} = \frac{47200}{20,000} = 2.4 \text{ square inches.}$$

$$\text{Diameter} = \sqrt{\frac{4 \times 2.4}{3.416}} = 1.8 \text{ inches.}$$

Design of the Post.

Taking formula same as in compression members.

Post at End of Truss III

Length = 12.5 feet. P = 3550 x 6 = 21300 pounds.

$$21300 = \left(20000 - 90 \frac{12.5 \times 12}{1.57}\right)(1.4 \times 2) = 31920 \text{ pounds.}$$

Use two channel bars No. 364. Depth of channel = 4 inches. Weight of single channel bar = 5 pounds per foot.

Post Between Trusses Number 2 and 3.

Took crusher as weighing 2000 pounds. Area of flooring = 60 X 20.5 = 1230 square feet X 100 = 12300 pounds.

Took flooring as weighing 100 pounds per square foot.

$$\frac{123000 + \text{weight of machinery}}{2} = \frac{123000 + 2000}{2} = 62500 \text{ pounds.}$$

$$P = (3550 \times 6) + (3455 \times 4) + 62500 = 97620 \text{ pounds.}$$

$$97620 = \left(20000 - 90\,\frac{12.4 \times 12}{2.09}\right)(2 \times 3.6) = 999200$$

Use two channel bars No. 362. Depth of channel = 6 inches. Weight = 12 pounds per single foot.

Post Between Trusses No. 1 and 2.

Length=31.7 feet but made it 16 feet and enforced it near its middle point.

$$P = (3455 \times 4) + (3500 \times 5) = 31320 \text{ pounds.}$$

$$31320 = \left(20,000 - 90\,\frac{16 \times 12}{1.41}\right)(2.4 \times 2) = 38400$$

Used two channel bars No. 364. Depth of Channel = 4 inches. Weight of single channel = 8.25 pounds.

Post at end of Truss No. I.

Length = 23.8 feet. $P = 3500 \times 5 = 17500$ pounds.

$$17500 = \left(20,000 - 90\,\frac{23.8 \times 12}{1.94}\right)(1.7 \times 2) = 23800$$

Used two channel bars No. 363

Depth of Channel = 5 inches.

Weight per single channel bar = 6 pounds.

Lattice Bars for Post.

For channel Bars at end of Truss No. III From DuBois, Page 407.

Having the depth of channel as 4 inches, take x as equal to 5 inches and from table get y equal to 6 inches. Length of bar is equal to 7.5 inches.

For channel Bars Between Trusses Nos. II and III.

Here depth of channel is equal to 6 inches. then x is equal to 8 inches and y equal to 7 inches. Length of bar is equal to 10 5/8 inches.

For Channel Bar Between Trusses No. 1 and 2.

Take the dimensions the same as in channel bar at end of truss No. III.

For Channel Bar at End of Truss No. 1.

Depth of channel is equal to 5 inches, x taken as 7 inches and y equal to 6.5 inches. Length of bar is equal to 9 9/16 inches.

As depth of channel bars on the different trusses are 4, 6, 4 and 5 inches respectively, took all bars as equal to 6 inches. This is done because they are all equal to or below 6 inches. From table on page 406 (DuBois) get dimensions for lattice bars as 1 3/4 x 5/16 inches. Weight of bars is equal to 1.82 pounds per foot.

Dimensions of Stay Plates.

Stay plates, for all channel bars are all of thickness 1/4 inch as depth of channels are less than 8 inches.

The length of plate is obtained by formula

$$l = d + \frac{2d}{b} + 2$$

The stay plates are single riveted lacing. For channel bar at end of truss No. III, the length of stay plate is equal to 8.5 inches.

For channel bars between trusses Nos. 2 and 3 the length of stay plate is equal to 10 2/3 inches. Stay plate in Channel bars between trusses Nos. 1 and 2, length is equal to 8 inches. For stay plate at end of truss No. 1, the length of plate is equal to 9 4/5 inches.

Dimensions of Rivets on Lattice Bars.

Worked out by formula, diameter of all rivets $d = 1\ 1/4t + 3/16$
$= (1\ 1/4 \times 5/16) + 3/16 = 37/64$ inches.

Thickness of Eyebars at Pins.

Use one inch pins. The largest stress is a little over three tonsand taking linear bearing for each pin as .16 inches for each ton.

$.16 \times 3 = .48$ Make this equal to .5 inches for thickness.

Calculation for Floor Beams.

$$R = \frac{3\ m\ y\ l^2}{2T} = \frac{3 \times 150 \times 20 \times 756.25}{2 \times 16000} = 211$$

m = total load in pounds per square foot.

y = diameter between beams.

l = span of beam in feet

T = Allowable fibre stress in pounds per square inch.

R = the section modulus in inch units.

T found in Carnegie (for steel) as 16000 pounds per square inch. Flooring was taken as 150 pounds per square foot, including machinery. Now looking up R which corresponds to 211.7, find a m301C is necessary. Depth of eye beam is 20 inches. Weight of beam is 80 inches per foot.

For lower Beam.

$$R = \frac{3 \times 150 \times 20 \times 44p}{2 \times 1600} = 123.9 \text{ pounds.}$$

This R corresponds to the R for a No. 301 A beam in Carnegie. Depth of Beam is equal to 20 inches. Weight equal to 64 pounds per foot.

Flooring.

Put wooden beams on top of the steel eye bars,and on top of this laid 2 inches planks. Assumed wooden stringers of 6 x 12 and solving formula used above for spacing $\frac{tb\ h^3}{18\ mb^2 v}$ $\frac{1000 \times 6 \times 1728}{18 \times 100 \times 400 \times 6} =$ 2.4 feet. Made spacing equal to 2.5 feet. M was taken as 100 pounds per square foot as the weight of the steel beams was taken off.

Dimension of Other Wooden Beams.

Wooden frame work for Grizzley taken as 6 vy 8 inches.

The size of stringers for track taken as 4 x 6 inches.

Cross ties for track taken as 6 x 8 inches.

Width of track taken as 20 inches.

Dimension of Pulleys.

Pulleys for rolls run 160 revolutions per minute. Belts for rolls are 6 inches in diameter . Fly wheel on roll 5 feet in diameter by 6 inches face. Now take pulley on shaft as 4 feet in diameter,then the number of revolutions that they would have to make is found as follows:

160 : n = 4:5 or n = 200 revolutions per minute.

Driving pulley for Gates Crusher is 32 inches in diameter and face is 12 inches. Makes 400 revolutions per minute .

Diameter of pulley is 5 1/3 feet. Found as follows.

n : 32 400 : 200 or n = 64 inches in 5 1/3 feet.

Driving pulley doe Dodge Crusher is 36 inches in diameter by 10 inch face. Runs at 250 revolutions per minute. Size of pulley found thus:

3: n : 200 : 250 or n = 3 3/4 feet.

Driving pulley for all spiral conveyors make 50 revolutions per minute and have a diameter of 40 inches. Size of pulley is

n: 40 = 50 : 200 or n = 10 inches.

Driving pulley for separator makes 200 revolutions per minute, diameter of pulley same as driving pulley on separator or equal to two feet. Cylinder on drivers make one revolution per minute. Driving wheel on cylinder is two feet in diameter and cylinder is 4 feet in diameter.

Then driving wheel revolves thus:

1: n = 2: 4 or n = 2 revolutions per minute.

But intermediate where on driver is 4.5 feet in diamter. Then this revolves two revolutions as it is on the same shaft.

This wheel turns on axis by means of a small cog wheel 8 inches in diameter. This cog wheel revolves n revolutions per minute.

2 : n = 8 : (4.5 x 12) or n = 131/4 revolutions.

Transmission of this pulley on the next cog wheel is as one to three or about 13.5 x 3 40.5 revolutions per minute. At the other end of this shaft is a wheel 6 feet in diameter, this makes the same number of revolutions, that is 40.5

40.5 : 200 = n 6 or n = 1.2 feet.

When w = width of belt.

HP = horse power = 5

v = velocity = πdn = 3.14 x 1.2 x 200 = 753.6

n = number of revolutions and d = diameter.

Taking HP for each as 2.5 there being two driers then HP = 2.5 x 2 = 5

$$\text{width} = \frac{1000 \times 5}{753.6} = 6 \text{ inches.}$$

Cylinders on roasters make 20 revolutions per hour or 1/3 revolutions per minute. Shaft makes 200 revolutions per minute.

Driving wheel two feet in diameter and cylinder is four feet in diameter.

Driving wheel revolves thus:

1/3 : n = 2:4 or n = 2/3 revolutions per minute.

But intermittant wheel on roasters is 4.5 feet in diameter, these revolve 2/3 times per minute as they are on the same shaft.

This wheel turns on a axis by means of a small cog wheel, four inches in diameter.

This cog wheal revolves n revolutions per minute

2/3 : n = 4: (4.5 x 12) or n = 9 revolutions.per minute.

Transmission of this pulley on the nest cog wheel is as 1 to 3 or bout 9 to 5 = 45 revolutions per minute. At the other end of the shaft is a wheel, 6 feet in diameter, this makes the same number of movements as it is on the same axis, that is 45 revolutions.

45: 200 = n : 6 or n = 1.35 feet.

Width of belt will be

HP = 8

$v = \pi d\, n$ = 3.14 x 1.35 x 200 = 848

$$\text{width} = \frac{1000 \times 8}{848} = 9.5 \text{ inches.}$$

Horse power Necessary.

Gates Crusher	30 Horse power.
2 Driers = 3 x 2	= 6 " "
Dodge =	10 " "
6 Separators = 2 x 6	12
3 Rolls = 25 x 3	75
4 Roasters = 2 x 4	8
22 Spiral Conveyors = 22 x 1	22
Total Horse Power =	163 Horse Power.

Calculation of Shaft.

Upper shaft has 30 Horse Power.

Then Taking formula, $d = \sqrt[4]{\frac{4 \text{ Horse Power}}{n}}$

where d = diameter.

n = number of revolutions.

HP equals horse power.

$$d = 4\sqrt[4]{\frac{30}{200}} = 4.\sqrt[4]{.15} = 4 \times .6 = 2.4 \text{ inches.}$$

Middle shaft has 80 Horse Power.

$$d = 4\sqrt[4]{\frac{80}{200}} = 4\sqrt{.4} = 4 \times .79 = 3.16 \text{ inches.}$$

Lowest Shaft has 58 HP.

$$d = 4\sqrt[4]{\frac{58}{200}} = 4\sqrt[4]{.29} = 4 \times .7 = 2.8 \text{ inches.}$$