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THESIS

FOR THE

Degree of Bachelor of Science

IN

MINE ENGINEERING.

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SUBJECT:

"Design of a Mill for the Concentration of an Arkansas Zinc Ore."

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R. A. CONRADS.

M. V. QUINN.

Design of a Mill for the Concentration of an Arkansas Zinc Ore.

The material to be treated is a zinc ore from Boone County, Arkansas, a district as yet but little developed but from present indications of the ore deposits found in the vicinity, it promises in time to become one of the most important zinc producing district of the United States.

An abundant water and timber supply makes the cost of erection and operation of the mill comparatively cheap.

One of the greatest drawbacks to the development of the district in the past has been the lack of railroad facilities but the White River branch of the Missouri Pacific Railroad, which is nearing completion, overcomes this difficulty, making the district easily accessible and putting it on a direct line to the market.

The water supply is of especial importance as it does away with the necessity of saving the water from the mill.

Analysis of Ore.

The ore, as carefully sampled in prospect working consists of an average of nine percent zinc blende in a gangue of gray limestone with a small amount of dolomite and a trace of iron pyrite.

Occurance of Ore.

The ore occurs in a fairly coarse state of crystallization, and as brought to the mill will average about twenty five percent fines (material passing a 24 m.m. ring)

Capacity of Mill.

The frame work of the mill will be of yellow pine. Sides and roof of corrugated iron.

Laboratory Tests on the Ore and Conclusions
drawn from them.

In the Missouri district the present practice allows from twenty to twenty five percent of the zinc in the ore to go to waste in the tailings. We propose to reduce this loss by a more careful and better treatment of the slimes which under the prevailing Missouri practice is almost totally neglected.

Experiments were carried on to ascertain the best methods of crushing and concentrating the ore. From these experiments the most economical size to which the ore should be crushed was determined to be twelve m.m. Finer crushing than this tended to make too large a percentage of slimes. Crushing to this size gives about ten percent of middlings but also gives a large enough concentrate for the first stage of crushing. The middlings were crushed through rolls set close and screened through two and one-half m.m. sieve and together with the same sized material from the first crushing were treated in a classifier. The spigot discharge from this classifier (consisting of 2 1/2 m.m. to 1 m.m. material) was treated in a fine jig.

The system of classifiers used in our experiments and which will be installed in the mill is the Sherman System. Although this system is new and has not been used in Missouri to our knowledge, it has been used in mills in the west and has proven its superiority in the following respects:

- (a) Simplicity and consequently few repairs, etc.
- (b) Easy regulation
- (c) Delivering the classified material to the tables, without an excess of water, thus effecting a higher saving from the fine material.

By the use of this system in connection with the Wilfley Tables, a greater percentage of the value in the fines and slimes will be saved and also a higher grade concentrate obtained with poorer tailings wasted

Flow of the Ore through the Mill

(subject to change in detail)

The ore is brought to the mill in cars and is dumped onto a grizzly with bars set twenty four m.m. apart. A powerful magnet is placed at the upper end of the grizzly to remove any pieces of iron, pieces of friek, drills, hammers, etc. which may be brought from the mine and would be injurious to the crusher and rolls.

The material passing over the grizzly goes into a bin and is fed through a chute to Two Blake Crushers set to twenty four m.m.

From the crusher it drops directly into a bin together with the material which passes through the grizzly. From the bin it is fed by a roll feeder to one set of Rolls set to ten m.m. From the rolls through a chute to an elevator delivering the ore to a trummel with twelve m.m. round holes. The oversize is returned to the bin and is recrushed, undersize goes to second trummel having six m.m. round holes. Oversize goes to two coarse Harz jigs, undersize to third trammel with two and one half m.m. square holes. Oversize to three Harz Jigs. Middlings from first five jigs together with second, third and fourth hutch product of same jig and hatches of jigs number six, seven and eight are recrushed ~~the~~ on middling rolls and pumped by centrifugal pump to third trammel. Undersize from this trammel to first classifier, Spigot discharging to three fine jigs, overflow to second classifier with spigot discharging to one Wilfley Table. Overflow from second classifier goes to third classifier with spigot discharging to One Wilfley table.

Overflow from third goes to fourth classifier with spigot discharge to one Wilfley Table. Overflow from fourth classifier to waste.

Specifications of Machinery Employed in the Mill.

- 1 Grizzley 6' X 10' bars 24 M/M. apart. Slope 45.
- 2 No.5 Blake Crushers, 15" X 9", feed set to 24 m.m.
- 1 Set Middling Rolls, set close
- 1 Set No.1 Rolls 14" X 36" set to 12 M/M.
- 1 Roll Feeder
- 1 Trommel 4' X 7 1/2' , 12 m.m. round holes. Incl. 5 degrees.
17 revolutions per minute
- 1 Trommel 2 1/2' X 5', 6 m.m. round holes, incl. 5 degrees,
17 revolutions per minute
- 1 Trommel 3 1/2' X 5', 2 1/2 m.m. square holes I incl. 5 deg.
17 revolutions per minute.
- 1 Elevator
- 2 4 Com. Harz Jigs 7 sq. ft. area wash screen
- 3 4Com. Harz Jigs, 3.5 sq.ft. area each screen
- 3 4 Harz Com. Jigs 3.5 sq. ft. area each screen.
- 3 Wilfley Tables.
- 1 Sherman Classifier 4'3" X 12'
- 1 Sherman Classifier 6'0" X 12'
- 1 Sherman Classifier 8'6" X 12'
- 1 Sherman Classifier 12'0" X 12'

Capacity and Horse Power Required by Machinery.

2	Blake Crushers	Capacity 80 tons/10 hours	20HP
1	Set Rolls	" 120 " "	10"
1	Set Rolls(middling)	" 25 " "	5"
1	Trommel	" 120 " "	1"
1	"	" 75 " "	1"
1	"	" 50 " "	1"
2	-4 Com. Harz Jigs	" 66 " "	6"
3	-4 " " "	" 25.2 " "	3"
3	-4 " " "	" 9 " "	1.5HP
1	Wilfley Table (coarse)	7 1/2" " "	1"
	(medium)	<u>6</u> " "	1 "
	(fine)	3 " "	1 "
1	Elevator		1.5"
	Centrifugal Pumps, One #2, One #6, One		_____
	Total		HP

This gives an actual needed HP of _____ but it would be well to allow 100 HP which would amply cover losses in friction, transmission, etc.

One one hundred horse power Corliss Engine, One one hundred horse power Heine Water Tube Boiler. Heine boilers are to be employed because of their efficiency, greater safety and longer life.

A feed pump and pump (#6 Centrifugal Pump) for mill supply. The diameter of shafting to be used was determined by formula given in Kent's Mechanical Engineers Pocket-Book.

D

D Diam of shaft in inches

H HP to be transmitted

R number of revolutions per minute.

The width of belting necessary was determined by formula from Kent's

W

W width of belt in inches

R revolutions per minute

L length of arc of contact in feet

d diam of pulley

a angle of arc of contact.

Corliss Engine 90 revolutions per minute

Diameter of fly wheel 10 feet

" of shaft 4 1/2"

To run main shaft at 120 revolutions per minute

120 : 90 120 : X 90" 7 1/2 feet diameter

pulley on shaft.

Shaft Making 120 revolutions per minute.

Machine	Speed Required	Pulley Mach.	Pulley on Shaft
Blake Crusher	250 rev. per m.	24" diam	50"
Rolls	120 " " "	78" "	78"
<i>Thommels, run by</i> Rolls on lower end, bevel gear <i>on lower end</i>	17 " " "	Ratio of bevels 3:20	
Jigs # 1 & 2	144 " " "	18"	21.6
" 3, 4 & 5	190 " " "	18"	28.5
" 6/7 & 8	200 2 " "	18"	30"
Tables by bevel gear from main shaft.	240 rev. per min	Ratio of bevel 2:1	
No. 2 Cent. Pump	850 " " "	6"	42.5"
No. 6 Cent. Pump	745 " " "	16"	99.3