Treatment
of
Nashua Copper Ore.

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Treatment of Nevada Copper Ore Woodcock.

The ore -

The kinds of mineral composition that make up the ore - Chemical analysis of the elements found in the ore.

The Kiln. discription - its merits. Methods of working the kiln. the roasting. the arangment of fuel, draft. time. and suggestions for future work.

The Furnace. Plan. after being rebuilt and bosh's put in.
Plan of the bottom. with overflow arrangment. Substitution of one tuyere. subsequent working of same.

Details of runs. I, II, III.

Charges. feed and tap record.

remarks on the working of the furnace during the run.

Anal. of matl. slags and ores in wt.

Chemical analysis of the products of the run.

Roasting of Matl. in Kiln and in the reverberatory furnace. Comparison of work done by the two furnaces.

Summary -

Chemical methods used -

Color determination of copper. Tables

Table of Fuel. showing how much used

Index

Index.

The ore - to be treated, was given to me already sorted and reduced to a uniform size - and was quite free from dust. The average size of the ore - was from the size of an egg - down to pieces of the size of a marble -

It was remarkably free from gangue - it being cobbed for us - of extra richness -

What gangue were to be found, consisted mainly of mica schist - a small amount of quartz and mica.

The ore as treated at the Mines - has only six per cent of Cu - but that sent here was cobbed of extra richness - The percentage being double that used at the Mines - that is twelve per-cent -

The mineral composition of the veinstone. is mainly of coarse crystalline Chalcopyrite, Pyrrhotite - with small quantities of Blende and fine quartz scattered all through.

The relative proportions of the principal constituent parts are approximately as follows

Chalcopyrite---- 34. per cent-
Pyrhotite------ 58. " "
Quartz-------- 5. " "
Blenda------- 2. " "

The ore was sampled and treated by chemical processes, wh showed its Composition to be as follows-
These analyses are those of Mr. Southworth and Mr Bartol-

Mr Southworth-		Mr Bartol-	
S-------	33.46. per cent.	S.----	33.97 per cent
Si-insol---	6.40 " "	Si-insol---	5.45 " "
Si-sol------	.15 " "	Si-sol-----	.20 " "
Cu-------	11.25 " "	Cu----	11.29 " "
Fe-------	46.49 " "	Fe-----	46.76 " "
Zn + Co-----	1.66 " "	Zn------	1.27 " "

in each case slight traces of

Alumina
Magnesia
Alkalies
Calcium
Nickel + Cobolt-

As shown by the table of percentages. the amount of S - is quite large - it now is necessary to roast off about a half or less thirds of the Sulphur - before smelting for matter.

Until lately - it has been the custom to crush and roast in the reverbatory furnace -

Last year a kiln was built by Mr Southworth. for roasting - and carried on successfully by him -

It's only advantages are - less amount of fuel needed, and less amount of work - while on the other hand - it is quite uncertain - it being impossible to roast "dead" with it - and needs skill and experience to run it well -

On a large scale, however, I think it is much more economical than the more certain yet more expensive reverbatory furnace -

I shall endeavor to show by comparisons with work in Kiln and the same ant. of work done in Reverbatory furnace - the ant. of

labor and fuel were used, to produce the same results.

The Kiln is made of fire brick - rectangular in form, with an arched top.

The following figures gives the interior dimensions - on floor - 23" x 18" wide height 43.5"

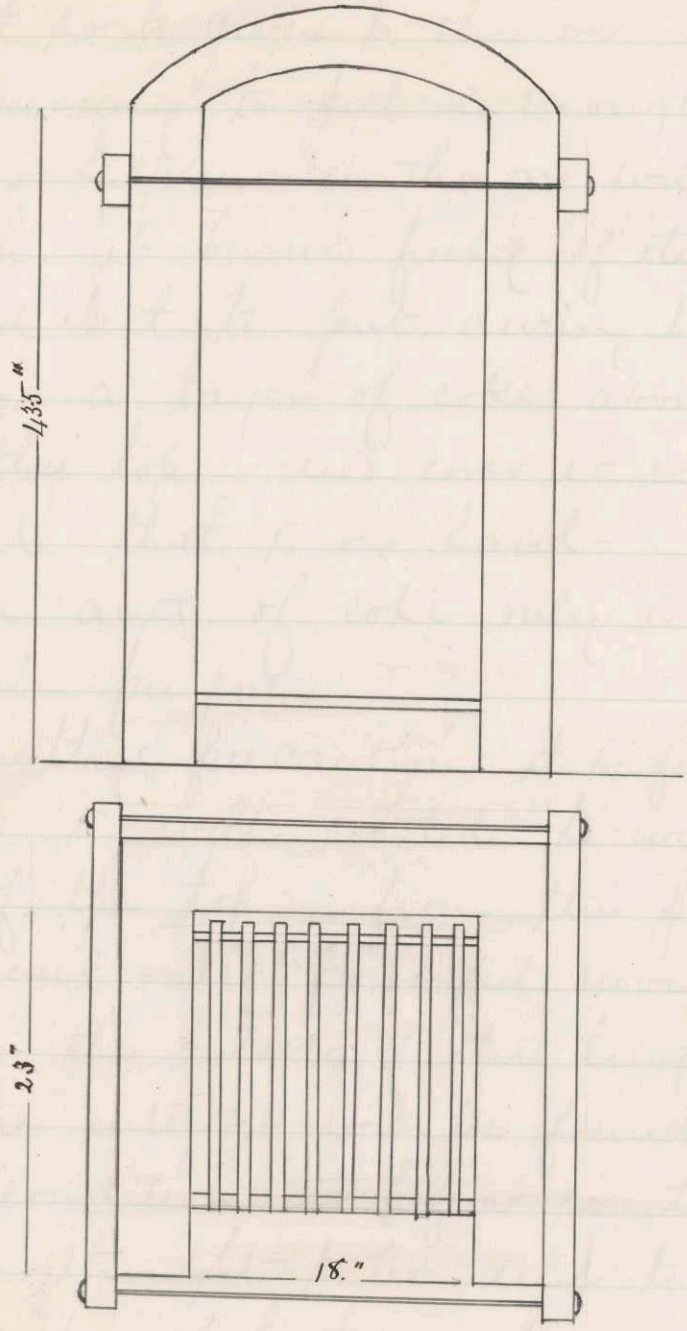
It has a grate about 5" from floor, with movable grate bars -

To start a roast - it was my custom to have a good supply of shavings to start the kindling wood and preclude the possibility of the going out.

Then on the shavings - an amount of charcoal - that varied from 4 - 6 lbs

This charcoal I found necessary to get the coke pile under way -

On the charcoal - was put about half a load of coke - then the ore was put on and it depended on the ore whether any more coke was put in or not.



Plan of Kiln.

The first roasts given to the ore it was only necessary to put in enough fuel to get the Sulphur in the ore well on fire - after wh. it burned freely of itself.
It is found best to put during these first roastings a layer of coke about a foot from the top and cover it with small material that is on hand -
A small amt. of coke only is needed for this purpose -
Without this precaution it is found that the ore is well roasted to within a foot of the top. - from this point the fire seems only powerful enough to oxidize the outside of the lumps of ore and the interior will be found in the same condition as before roasting -
This is thought to be due to the too free escape of heat - wh. not having a large body of ore to confine it. easily passes off - only touching the outside of the lumps of ore

This remedy was tried and it was found that the space was lessened - that is - from 4"-6" from the top it was not much roasted - It was however an improvement on the former roasts -

After the ore had all been roasted twice it became necessary to increase the amt. of coke, as the amt. of Sulphur in the ore was less -

This was done by putting in layers of coke - {It could hardly be called a layer - but rather a judicious sprinkling of coke over the surface of the ore, } and then filling up - about 10" - of ore - then repeat -

The average time taken for a roast was about 30 hours - that is - a roast that was put in at 10. A.M. of one day was taken out at 4 P.M. of the following day -

It was found best not to hurry the operation but to let the fuel burn slowly - with little air let in at bottom - the whole front being plastered.

The following table show the amt of ore. coke. charcoal - shavings - that were used for each roast.

I

570.4 lbs. Cu ore.
coke. 24 lbs — top not good
char - 4 " middle - good
wood. shavings. 6" bottom - caked

At one time the fire must have been too hot. as the lower front was caked, solid, showing that there was too much fuel at that point - and not enough fuel at the top.

II

590.5 lbs Cu. ore. — top not roasted at all
coke 20.5 lbs centre. good
char. 6.5 " bottom. caked.
wood shavings. 6"

The conditions of this roast must have been like the first. as the result was much alike

III

659. lbs Cu. Ore.
Coke - 14 lbs — did not roast at all.
Char - 3.5 " made second roast.
Wood shavings. 5"

ore same.
Coke. 25.25 lbs. very good result.
Char. 5.25 " very little cake at
Wood shavings. 8" the bottom

The first attempt was a failure owing to the very small amount of fuel used. The only result of the roast was a complete burning out of the fuel. which only gave out enough heat to oxidize the outer coating of the lumps of ore.
The second roast of the same ore with a different arrangement of fuel was a success. the ore was but little caked. A layer of coke was put near the top which aided the roasting of the top very much.

IIII

621.25. lbs Cu. ore — very good roast, a
Coke 24 lbs. small amt. of ore
char. 4.75 " not roasted. found near
fuel 7". the front, near the cracks.
very little bottom
distribution of coke pans last in last
roast.

The ore was then taken, and sampled.
and a chemical determination made for
the amount of S it contained.
The result of this analysis showed
that the ore this contained. 18.51 %
of S. which was judged to be too
much. as it would give us a
matte of but little more richness
in Cu. than the ore itself.
Accordingly the whole amount was
run through the kiln a second time
with beneficial results. as the amount
of S was reduced to about 10 per cent.

I.

char. 5 lbs
coke. 35 " — very good roast.
fuel. 8".

II

char. 5.5 lbs.
coke. 32 " — fair roast.
wood. 7".

III

char. 5.5 lbs
coke. 40 " — good roast.
wood. 6".

IV

char. 5.5. lbs
coke 33. " — good
wood. 5".

This was all picked over and the green that were not roast enough, put back for another roast.

V

char 6. lbs
coke. 28 " not very satisfactory.
wood 6.

The ore was now sampled and an analysis made for the determination made of the S that remained from the two roastings -
The analyses gave - 6.21% and 6.52
These results were wholly unexpected and for this cause, were discredited and in the calculation for slag - the determination was ignored - and the calculations were made from a basis of 10%.
Subsequent results showed that we had figured too low, even at that percent.
The cause of such a low estimate being made will be explained in the chapter on the method used for the chemical determinations.
The Kiln - taken altogether did its work well - and by carefully arranging the fuel - very good roasts can be had.
The damper that was put on, I did not use often for the purpose intended, but rather as a "peep hole"

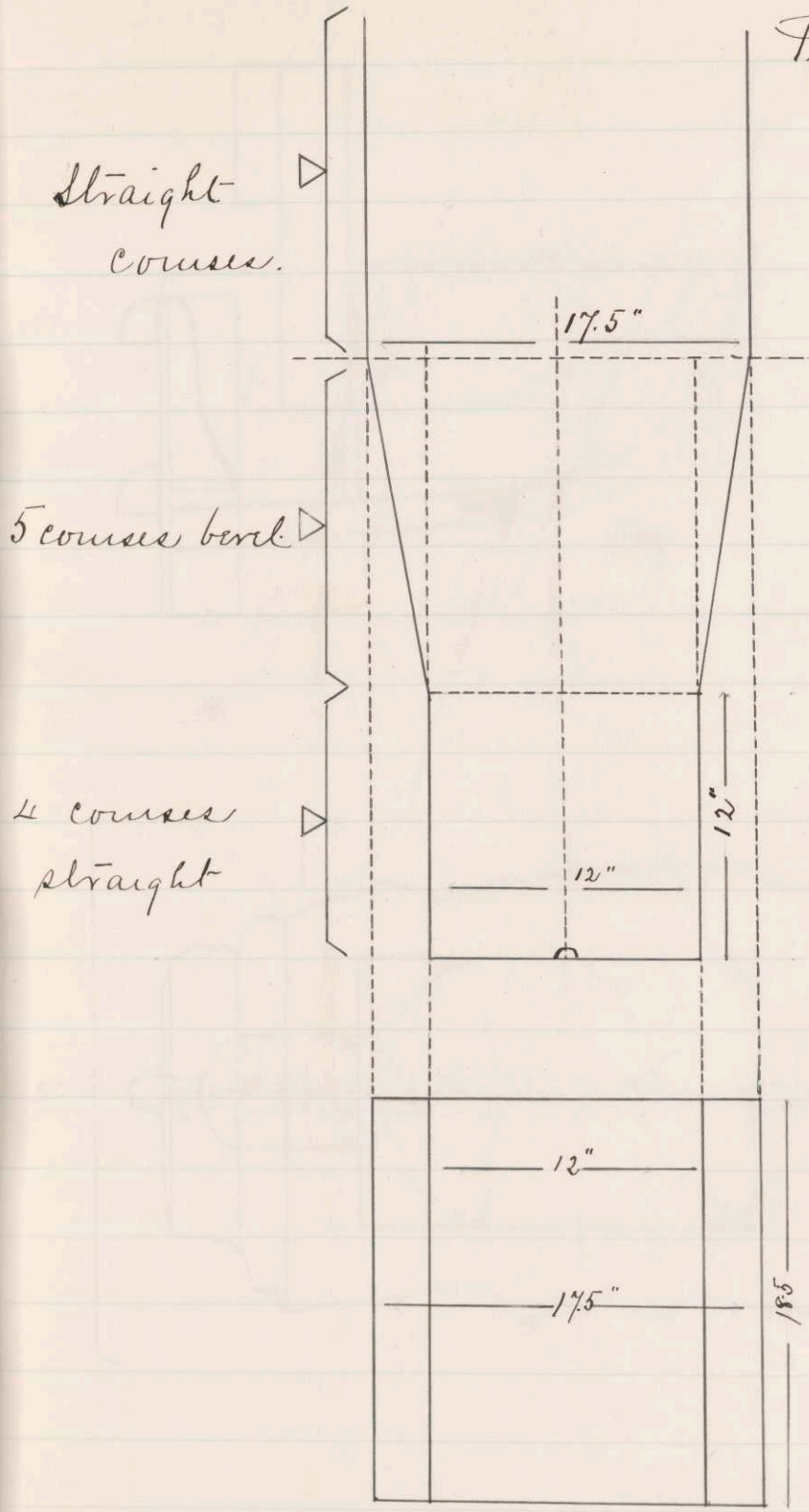
The ore weighed before roasting. 2421.75 lbs.
" " " after " 2340.5 "
this loss is not due entirely to S' - but also to the loss of fine dust. which the best of care cannot prevent.
This loss is not great as it would seem. but the ash. of the coke. charcoal and the shavings. make it appear less.
Preparation were now made for a fast smelt for matte. containing about 25% of metalic Cu.
Before the run was made however the furnace was torn down and "boshes" put in - also one tuyere was substituted for the three that were formerly used -
As this took some time I made some Cu. assays -
The first assay - gave me only a button of matte - and as I thought that the roasting was complete - I put the blame on the Soda used -

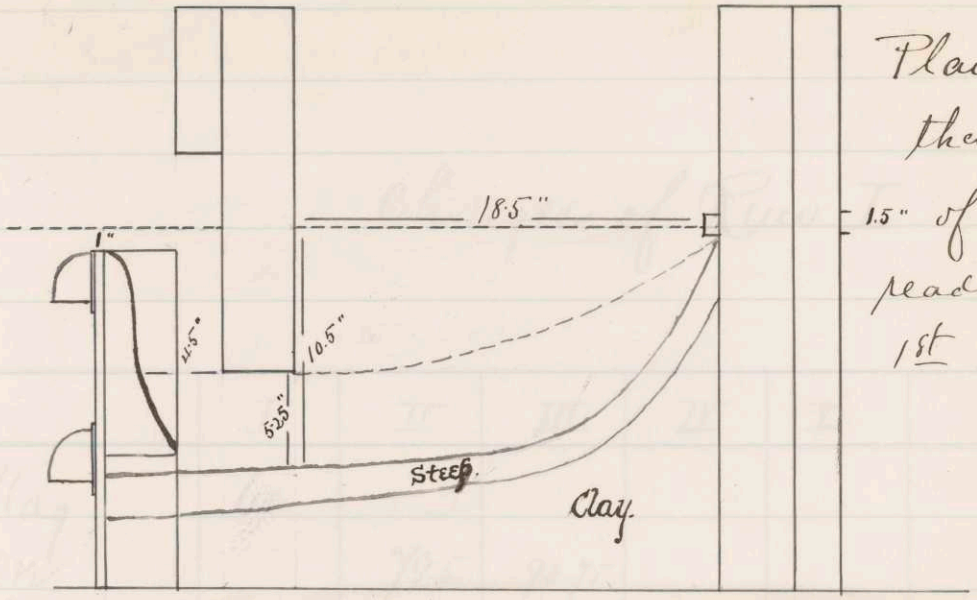
I therefore tested the Soda for S, and found a larger amount - wh. showed clearly when the trouble lay -
The second time, chemically pure Soda was used and a Cu button was obtained wh. gave only 7.%.
Again I tried it - carrying along two assays. using the same Soda, and the results were quite good -
In one case the button was free from nails and looked clean, did not break under the hammer until quite flattened - the percentage obtained was 10.9. wh. comes near the determination by the wet method - 11.25.
The second crucible did not get enough heat - the Cu. being scattered through in small buttons - not result obtained -
By practicing constantly this method could be made to give very fair results but the time being limited - the method of determination was dropped -

The bottom of the furnace was arranged so as to give an overflow of the slag - at the top - and at the lower tap - the matte was run out. being tapped and plugged - The figure explains itself -
At the slag outlet charcoal was put. which. by burning. kept the slag from getting cold -
One tuyere was substituted - instead of three that had been used in the Pb. run - of 1.5" diameter.

A new Roots Blower was substituted for the old Sturtevant Blower - and it has been found to work much better than the old form. not only a higher pressure being obtained. but more air was put into the furnace -
A gate was put into the air pipe. so that the pressure could be regulated at will -

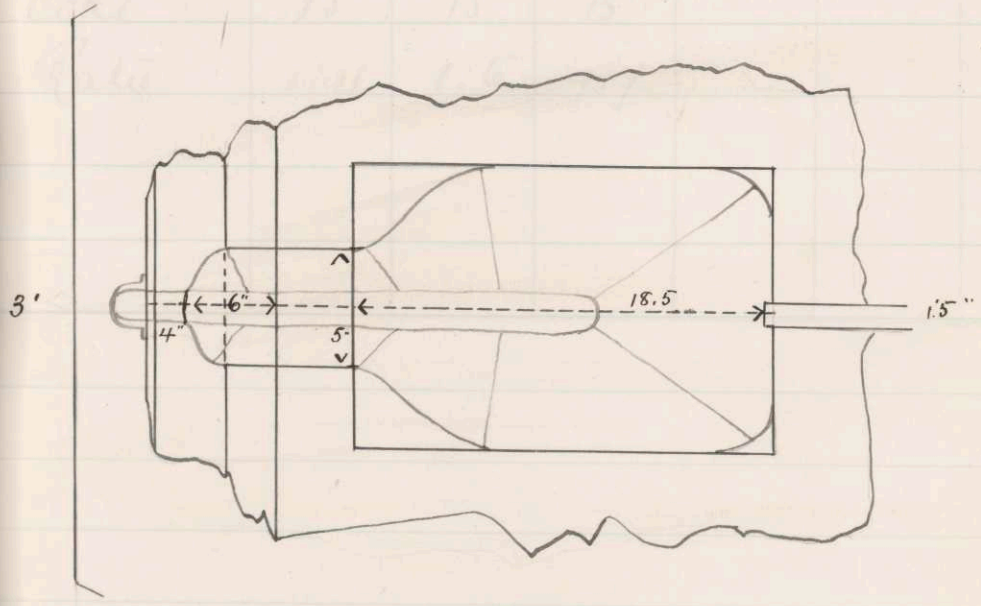
Plan of the Furnace after being rebuilt and "bodies" put in.





Plan of the bottom of Furnace ready for 1st run.

1.5" of



Charges of Run I

	I	II	III	IV	V	
Slag	60					
Ore		79.5	90.75			
Sand		11	12.5			
Total		90.5	103.25			
Coke	15	15	15			
Ratio	1:4	1:6	1:7			

Feed Record I

Time	Interval	charge	depth		Notes.
5. PM	1 load	charcoal.		4 load	coke. to start.
8.10	3/4 "	"		5 "	" . Blast on.
8.45		I			
8.50	5	I	—		
8.52	2	I	2.5		
8.55	2	I	3.		
9	5	I	3.		
9.10	10	II	3.		
9.16	6	II	3.2		
9.22	6	II	3.5		
9.30	8	II	3.5		
9.38	8.	II	—		
9.46	8	II	—		
9.54	8	II	—		
10.2	8	II	—		
10.12	10	II	5.		
10.25	13	II	5.		
10.35	10	II	5.		
10.40	5	II	5.		
10.45	5	II	5.		
10.55	10	II	5.		

Feed Record. I.

Time	Int	Charge	depth.		Notes.
11.05	10	II	5.		
11.15	10	II	5.1		
11.25	10	II	5.1		
11.40	15	III	5.		Changed to Charge III
11.50	10	III	5		
12.6	16	III	5.+		
12.21	15	III	5.		
12.37	16	III	5		
—					
—					
—					
1.50	13	III	4.5		
2	10	III	4.5		
2.10	10	III	5.		
2.20	10	III	4.8		
2.40	20	V	4.5		Last of the ore 3 hods coke on top furnace hot in the back
3.15	35		3.		slag - stopped.
3.30	15				

-Tap Record- I.

Time	Int.	Matte	Slag.		Notes
9.10					Slag appeared.
9.16			I		
			II		
9.23			III		
			IV		
			V		
9.30			VI		
9.45		I			
10.1		II			
10.30		III			Lost tap hole.
12.45					When the furnace was
12.45		IIII			tapped a break
12.45					occured - lost the
					upper row. took off
					the blast. and sealed
					the leak with slag
					wh. hardened -
1.38					Blast on again
1.45					going well.
—		...			
3.35					End -

In the early part of the run. the lower tap hole was lost. so that the slag and matte had to overflow together over the top run. Toward the end of the run a break occurred between the iron plate and the brick work letting the contents of the furnace out onto the floor. The blast was taken off immediately and by means of iron slice and with the aid of the slag itself / the slag hardening in cooling / the leak was stopped and the run proceeded.

After the lower tap hole was lost no acc. was kept of the number of the buggies or of their amount. it was on account of the fouluess of the run that this was done.

The entire slag was filled with matte. so that the matte with slag as soon as cool. were dumped into a heap to be sorted and picked over.

The first few buggies that we got from the lower tap hole. were very rich

- Matte -

Copper -	21.40 " 21.32. %	97.467 %
Iron -	52.37 " %	
Sulphur -	22.70 %. (14.7 : 16.64)	
Silica -	.997. %	

- Slag -

Copper.	.876 " .895 %	103.33. %.
Iron -	Fe = 52. FeO . 66.8 %	
Silica	35.65. %	

- Foul slag -

Copper 4.83 % " 4.77 %

- Ends -

Copper 4.48 % " 4.43 %.

Analysis of the products of
1st run.

The results obtained from the matte are very satisfactory - but those from the new slag are very poor -
The trouble was in the solution used for the titration of iron. too much HNO_3 being used to change the iron into the ferric oxide -
This free HNO_3 in the sol - caused the poor results. I think this may be the cause. but am not certain And as the time was getting short. I did not try the analysis over again.
The determination of Copper in the Foul slag - and in the ends. show what a waste took place by the poor working of the overflow arrangement.
It put the whole operation back. this having so much foul slag - and matte in the Ends.
For it became necessary to roast the matte. to get rid of the Sulphur.
but we see that in the two other products the foul slag and the Ends

then was enough Sulphur in combination with Copper. to hinder the operation of enrichment -
for if the matte was roasted to any low per cent - the resulting matte of the next fusion or smelt would be but very little richer -
This turned out to be the case.
it being only a gain of 7%

The matte was run through the crusher. and was roasted in the Kiln
The same arrangements were made as in the first place - the ant of S. being quite larger, only enough fuel was put in at first. to light the S. when it would burn of itself
Towards the last of the operation more fuel was put in - and a much higher heat obtained.

Roasting of Matte.

I
- coke - 20. lbs — good roast. top not much
- char. 5. " — touched - a little
- shaving &c. 5". — melted and ran through.

II
- coke. 18. lbs — fair - top not much
- char. 4 " — roasted.
- wood &c. 5". — did not melt any -

I a.
- coke. 28 lbs — good roast - but not
- char. 6 " — enough fuel.
- wood &c. 6". — more needed.

II a.
- coke 30 lbs — bottom not roasted.
- char. 6 " — centre and top - good -
- wood &c. 7". — more fuel needed

I b
- coke. 40 lbs
- char. 5 " — very good roast.
- wood 6".

II b.	coke	45 lbs	at bottom not much
	char	45 "	roasted. but at
	wood	6"	centre and top - very good

Through the entire operation of this roast. I find that the bottom of the kiln - just above the grate bars about a foot - that the ore did not roast at all -

The fuel seemed to burn out with out any effect on the charge at that point -

But from about a foot above the grates. very good results were obtained, the ore being roasting into a porous condition -

I tried an increase of fuel - but the result were not marked with any degree of success.

The reason of such action. has not been satisfactorily explained

An analysis of the matte was now made for the S. it contained.

The analysis showed that it also contained

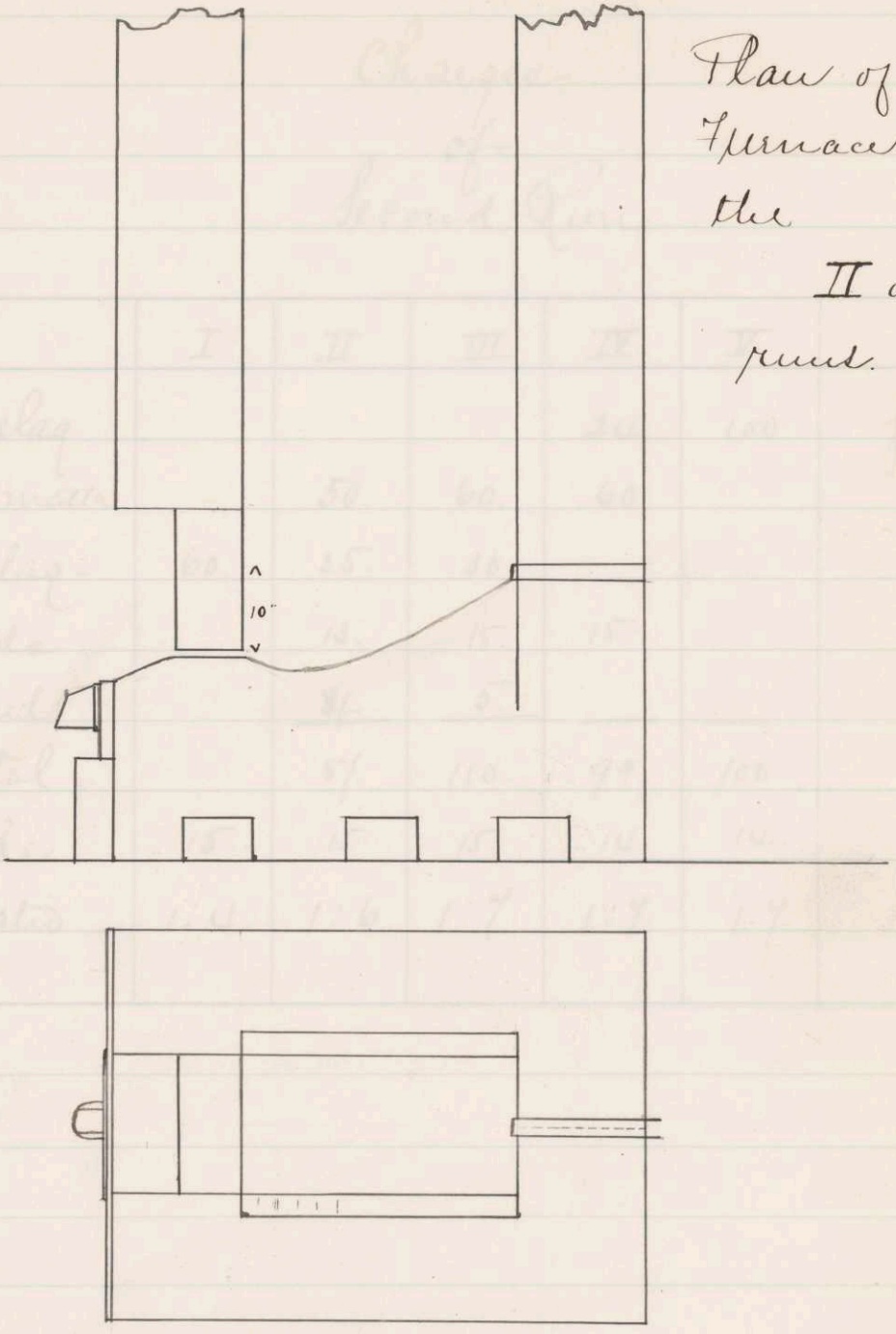
13.17 %

which was quite a reduction from the percentage obtained before past wh. was

22.7 %

showing that it had ~~lost~~ nearly one half of its S.

As the amount of foul slag and ends was so large. it was thought best to run with this percentage of S. only for a richer ~~matte~~. The amount of S in the slag and ends, being so large as to preclude the hopes of saving Black Cu.



Plan of the Furnace. for the II and III pund.

Charges of Second Run.

	I	II	III	IV	V	
Fr. slag				24.	100	pounds
roast matte		50.	60.	60		"
F. slag -	60.	25.	30			"
Ends		13.	15.	15.		"
Sand		8/.	5.			"
Total		87.	110.	99.	100	
Coke	15.	15.	15.	14.	14.	"
Ratio	1:4.	1:6.	1:7.	1:7.	1:7.	

Tap Record II

time	int.	buggy amt.			Notes
Apr. 26. 4 PM. 4					hods coke. 15 hour char.
Apr 27 A.M. 2					. .
9.40					blast on.
10.15					slag coming.
10.40					p.
10.45					t.
10.47		1.25			p.
10.57					t.
10.58		2			p.
11.10					t.
11.12		2.25			p.
11.23					t.
11.24		2			p.
11.35					t.
11.37		2.5			p.
11.48					t.
11.49		2.5			p.
12					t.
12.2		2.75			p.
12.13					t.
12.14		2.5			p.

Tap record II.

time	mt.	buggy ant.			Notes.
12.23					t.
12.24		2.5			p.
12.33					t.
12.34		2			p.
12.46					t.
12-48		2			p.
12 59					t.
1.1		3			p.
1.13					t.
1.15		2.75			p.
1.26					t.
1.28		1.5			p.
1.38					t.
1.39		1.25			p.
1.48					t.
1.49		2.25			p.
1.58					t.
1.59		1.75			p.
2.8					t.
2.9		1.75			p.

Tap record II

time	ent.	Berggy cent			
2.19					t.
2.20		1.75			p.
2.30					t.
2.31		2			p.
2.41					t.
2.42		1.5			p.
2.51					t.
2.52		1.75			p.
3.					t.
3.1		1.75			p.
3.11					t.
3.13		2			p.
3.21					t.
3.22		2.25			p.
3.30					t.
3.31		1.75			p.
3.39					t.
3.40		1.75			p.
3.48					t.
3.49		1.5			p.

Tap record II.

time	int	buggy amt.			
3.57					t
3.59		-			p
4.7					t
4.9		1.5			p
4.14					t
4.18		1.5			p
4.26					t slow slag coming
4.31		1.5			p
4.39					t
4.44		2			p
4.50					t
4.57		1			p
5.3					t
					Furnace torn down at the end of run.

Fred mond. II

time	int	charge	depth		Notes.
9.40			ft.		blast on.
10.8	7	I	2.5		
10.15	7	I	2.8		
10.20	5	I	3.1		
10.25	5	I	3.5		
10.30	5	I	~~3.5~~		
10.33	3	I	4.2		
10.49	16	II	4.5		
10.59	10	II	4.8		
11.9	10	III	5		flame gone
11.22	13	IV	4.75		
11.35	13	IV	5		
11.46	11.	IV	5.1		
12.2	16	IV	5		during high depth
12.14	12.	IV	5.		pressure went up
12.24	10	IV	5		to 2.25 inches
1-3	39	IV	4.4		flame after charging
1.16	13	IV	4.1		no " " "
1.36	20	IV	4.1		
1.51	15	IV	4.2		
2.14	23	IV	4.		

Feed Record II

time	cwt	charge	depth		Notes.
2.26	12	IV	4.		
2.47	21	IV	4.		
2.58	11	IV	4.1		
3.21	23	IV	3.6		
3.23	2	IV	4.2		
3.39	16	IV	4		
4.3	24	V	3.7		
4.12	9		4.1		2 hods coke
4.20	8		3.5		
4.28	8		3.2		
4.44	16		2.8		
4.54	16		2.2		Almost all iron slag.
5.5	11.		7.		
5.10	5.		1.8		
					The furnace now only held coke. the slag being about all out! The front wall torn out. Large "sow" found mostly Fe.

This second run was done very successfully very little foul slag being made.
The plan of having a small tap hole wh. was plugged with a piece of charcoal so cut as to fit the hole quite snugly worked very nicely-
The tapping was done with a small bar - the hole being made in the charcoal. the result was, a nice clean hole. through wh. the material came in a quiet stream. not any spattering to speak of -

The matt was picked over and broken quite small. The slag of two kinds - viz. I & II.
I slag was that obtained from the buggies containing matts. and supped to be a little foul-
II slag. from the overflows of I and was almost all slag - in some buggies a very small cake of matts being found in the bottom. — was thrown away -

The determinations from this run II - in the various products are given as follows.

Matt.

$Cu.$ =	in per cents.	30.58
$Fe.$ =	" "	30.46
$S.$ =	" "	23.05 and 22.7
$SiO_2.$ =	" "	1.80

Slag

$Cu.$ =	in per cents.	1.2
$Fe.$		28.8
SiO_2		34.11

The amount of Cu. in the Ende was not calculated.
Duplicates not made, except in case of 8'. reason - shortness of time.

The products of run II being picked over and sorted, the weights of each were found to be as follows

Matt.	— in pounds	687.7
Beads	"	225.5
Slag I	"	648.3
Slag II	"	685.25
"Sows"		34.
Total amt of product.		2280.75

The time being so short. it was thought best to roast this matt in the Reverberatory furnace — accordingly the matt was crushed and passed through the rolls, and reduced so that it would pass the 1/IV th sieve — and was then ready to roast.

The fire was started the night before on the furnace —

The following calculation was gone through to ascertain the amt. per charge.

662. 7 lbs matt. to be roasted.

Furnace I 4' x 5' = 20 sq ft. of surface

" II 3.5 x 3.5 = 12.25 " " "

2 charges. 200 lbs I = 10 lbs per sq ft.

" " 131 " II = 13 " " " "

3 charges 140 lbs I = 7 lbs per sq ft.

" " 81 " II 7 " " "

4 charges in large furnace

165.5 lbs per charge or 8 lbs per sq ft.

This last was decided upon and the following arrangement made for shifts Thursday May 2.

7 - 10 Ans. Fires made

10 - 4 " I charge. -- Adams.

4 - 10 " II " -- Richards

10 - 4 III " -- Fred.

4 - 10 IIII " { 4-7 Fred {{ 7-9 Richards {{ 9-10 || Adams

This programme was carried out just as calculated. with the exception that two of the charges were four pounds heavier - Some of the matte had been over looked and was added in the second and third charges -

The amount of coal used for the roasting was.

Starting - 104.25 lbs.
Roasting - 301.75 "
Total amt - 406.00

This was sampled and an analysis made for the amount of S. that it contained -
It was not so low as we hoped but still. time was wanting to roast again

The determination for S in the roasted matt gaves

$$S = 7.283\ \%$$

From these percentages were Calculated the charges for the third run.
This run was expected to give us black cu.
The charges are as folows for

Run III

	I	II	III	IV	V	VI
roast matt		30	60	60	60	13. pounds
sand		7.25	14.5	14.5		"
ends		10	20	20	15.5	"
slag	60	10	20	20		80 " foul.
coke	15	14	28	26	28	28 "
soda	left out-		too much soda			"
roast slag					40	"

Tap Record III

time	T+P	amt.			Notes
10·15					slag coming
10·25	p				first plug-
10.30	t				
10·38	p	1·25			coming hot
10 44	t				cut 5 minutes to
10 49	t	1·5			start slag-
10.51	p				
10.56	t				hot and clean. Lays bar.
11	p	1			
11·8	t				running hot
11·10	p	1.25			
11 19	t				
11·21	p	1.25			hot
11 29	t				
11·31	p	1			some metallic "
11.39	t				
11.41	p	1·25			" " "
11 49	t				
11.51	p	1·25			
11.59	t				
12.2	p	1.			

Tap Record III

Time	T and P	amt.			Notes
12.10	t				
12.11	p	1			
12.19	t				
12.21	p	1.25			
12 30	t				
12.32	p	1			
12.44	t				
12.46	p	1			
12.57	t				
1.	p	1.25			
1.10	t				
1.11	p	1.5			
1.20	t				
1.25	p	1.5			
1.30	t				
1.32	p	1			
1.38	t				
1.39	p	1			
1.44	t				
1.45	p	1			

Tap Record III

time	T & P	amt.			Notes.
1.51	t				
1.53	p	1.			
1.58	t				
1.59	p	1.			
2.8	t				
2.9	p	1.			
2.14	t				
2.15	p	.75			
2.20	t				
2.21	p	.75			
2.26	t				
2.27	p	.75			
2.35	t				
2.36	p	1.			
2.44	t				
2.45	p	1.			
2.52	t				
2.53	p	1.			
3.1	t				
3.2	p	1			

Tap Record III

time	T and P	amt.			Notes.
3.8	t				
3.9	p	1.			
3.18	t				
3.19	p	1.			
3.27	t				
3.28	p	1.			
3.37	t				
3.39	p	1			
3.47	t				
3.48	p	1.			
3.58	t				
3.59	p	1.			
4.8	t				
4.9	p	1			
4.16	t				
4.18	p	.75			
4.26	t				
4.27	p	1.			
4.34	t				
4.35	p	1.			

Tap Record III

Time	Tap or P	Quant.			Notes.
4.43	t				
4.44	p	1.			
4.53	t				
4.54	p	1.			
5.3	t				
5.4	p	1.			
5.16	t				
5.17	p	1.25			
5.27	t				
5.28	p	1			
5.36	t				
5.37	p	1			
5.45	t				
5.46	p	1.25			
5.54	t				
5.55	p	15			
6.3	t				Last tap at 6.55
6.4	p				Furnace torn down
6.12	t				
6.39	t				
6.40	p	1.			

Feed record III.

time	int	charge	depth	pressure 8th of in.	Noted.
9		4 hods	coke	depth	1.5
9.40	40		1.5		blast on
9.55	15	1 hod coke	1.7		
10.5	10	I	19	4	flame strong.
10.12	7	I	2.4	4	
10.40	28	I	2.	4	
10.59	19	I	2.6	4.5	flame not free
11.20	21	II	2.4	4	
11.44	23	II	2.1		
11.54	10	II	2.1		flame after charge
12.1	7	II	2.1		" " "
12.14	13	II	2.5	12	no " " "
12.22	8			4	flame in slight
1.	38	III	2.3		little flame
1.40	40	III	2.2	4	height kept and
2.14	34	III	2.4		regulated throughout
2.58	44	III	2.	flame	this run do as to just
3.40	42	III	2.2		check the flame
4.2	22	III	2.2		one shovel of or put
4.35	33	IV	2.3		on at time
5.44	39	III	2.3		

Feed Record III

Time	cut	charge	depth	pres. 8 lbs to ½ in.	Notes
5.35	21			8	blast changed .4 – 8
5.41	20	V	2.7		to saw times
5.46	5			11	full blast
6.3	17	VI	2.7	1	all in –
6.9	6		2.9		2 loads coke about
6.21	15		2.4		30 lbs
6.44	23		1.0		
					Furnace slow down

The same method of tapping and plugging was used, as in the second run. and gave great satisfaction.
Very little foul slag was obtained at the end - as, all that had accumulated during the run. was put in toward the close of the run.
Several times in drawing out the tapping bar. it was found to be covered with metalic Cu. showing that some might be expected in the buggies.

The products were poled over and three product were obtained viz - slag - Matt and black Cu
The amounts of each are given below

Matt - in pounds -		305.25
Slag -	" "	1202.75.
Black Cu -	" "	30.25
Total amt -		1538.25

owing to the shortness of the time. the amount of Cu. and the various constituents of the matt and slag could not be determined.
But from the appearance of the matt. it must be very much richer than before. and acc. to the report of the Professor in charge - probably between 65 and 75 per cent of Cu. was present in the matt.
The slag was very free from matt but few buggies being found that were foul.

A very low pressure was kept up during the whole of this run. it being regulated by a gate made for the purpose

- Summary -

The roasting in the kiln, has been explained in the first part of this paper, and it need not be mentioned again.

The first result for matt. was not at all satisfactory. The form of the furnace did not give good results - after the lower tap hole had been lost. the slag and matt. overflowed together into the buggies.

This gave us a large amount of foul slag - which interfered with the next shift. the amount of Cu. in shape of sulphides in this slag - which could not be very well roasted, was so great. that even if the matt were roasted nearly dead, this sulphur, would hinder very much the formation of blast Cu.

So the matt was poured and the whole run down for a fresh

matt. great pains beng taken to prevent the accumulation of cinder and fore slag =

Accordingly in the second pun. a new form of furnace. that of tap and plug - using charcoal for plug - and by working carefully very little fore slag was made.

This form of tapping, with charcoal gave such general satisfaction that it is to be recommended for future use - its great recommendation is, the "clean" tap hole it makes - the bar being driven into the charcoal and rob. drawn out. leaves a nice clean opening for the melted material - Very little wear of the steep is noticed when using this form of plug - that is, the steep of the pun is not torn and cracked, leaving the pun in a bad condition for the flow of the matt and slag -

Accordingly in the third run, the same form of furnace was used. The ore in this case, had been run thro rolls preparatory to the roasting in the percolating furnace, and was in a finely divided state, with considerable dust.

This run was very successful indeed the furnace worked well.

A low pressure was kept up, not over half an inch, all the time until the end when it was put on in full force, to clean out the furnace.

The effect was - there was no loss up chimney of dust, and the reduction of copper took place with less danger of the reduction of Fe, wh. would enter into the black cu. and spoil the metal. The little black Cu obtained - showed the effect of this care and precaution.

All through the three runs. no Ca. was used as a flux.
It had customary in past years to use Ca. but from observations made it was concluded best "not" to use any more.
The effect of Ca. in the flux is to throw out the Fe. who reduces and finds it way into and with the Cu.
As has been mentioned. the black Cu obtained, showed clean with "little" evidences of Ca.
Fe. is present but not in such great quantities as in the runs of previous years.
I regret exceedingly that I was not able to make an analysis of the black Cu. obtained.

Methods used for the determination of of the constituent parts of the products of the blow pipe. and of the ore.

Cu - by means of battery. HNO_3. sol
Fe - " titration with bichromate
S - heat with fuming HNO_3. evaporate to dryness " to get rid of free HNO_3- precipitate the Fe and other things by means of Na_2CO_3 - make acid and precipitate with $BaCl_2$ - Care must be taken to get rid of the free HNO_3 as it interfers with the precipitation of the Barium sulphate - let stand over night -
Si. treat with acids to decompose as much as possible. fuse with Na_2CO_3. evaporate the " whole ". { acid. sol. and the Carbonate sol - } after being made acid - heat to make Si insol - add acid to dissolve out the other constituents " and weigh as SiO_2.

boiling roasting the ore, the first time as there was plenty of space time the color method of determination for Cu - the small amount was tried This method is only applicable to slags or such materials as do not contain more than 2 per cent of Cu.

It depends on the blue color produced when ammonia is added in excess to an acid sol. of copper. The intensity of the blue color depending on the amount of Cu present.

Two ways that are easy of manipulation are given - descriptions of wh. follow.

Take a gram of pure Cu and dissolve in HNO_3 - { a gram not necessary but I took an even lot. as the calculation would be much simpler. } add an excess of Ammonia - a deep blue color results — now make up to 1000 c.c.

First method -

In this solution of Cu - wh. has been made up to 1000 c.c. - 10 cc is equivalent to .1 of a per cent., 20.cc - " "
" .2 " " " " 30. cc - " "
" .3 " " " " 40 c.c. and so up.

I took a number of large test tubes and commencing with 40 c.c or .4 %. arranged a series of tubes containing 40. 50. 60. 70. 80. 90. 100. 120. 130. 140. 150. 160. c.c's

I now filled them with distilled water, all up to the same height. and corked them up tight.

I now had a series of bottles containing a solution of Cu - colored blue, of different intensities.

These were the standard solutions

I now took a slag containing a small cent. of Cu. .8 of a per cent. treated with acid - and then with Ammonia made up to the same height with water. as the standards and then compared with the standards

At first. I could not do much at it. but in a short time - it was quite an easy matter to locate the test tube containing the sol. at the standard bottle. I now tried some unknowns and succeeded very well.

The whole operation was an experiment, and though I tried to get perfectly cylindrical test tubes. probably they were a little out.

But even with that trouble the experiment was a grand success.

It would haves been better to have had larger test tube or something that would hold much more solution as - the whole bulk of the solution that I had did not probabely exceed 200 cc and the colors were too intense - it being hard to destinguish them.

The second method was that of using burette. the per cent being determined by the amount of water that ha to be added to make the unknown solution of the same color as the standard.
The standard solution may be taken from that already made. Take .50 cc. then make up in suitable vessel to 200 cc by adding 150 cc distilled water -
The unknown solution is put into a like vessel - and Ammonia added - then add water till the colors of the two bottles are alike.
Did not obtain good results - it being very hard to tell any difference of color even if two cubic centimeters of water over and above the amt. desired was added.
Did not try any unknowns - for the above reason.
The first method much the best and is capable of being put to good use -
Practice would make this method very valuable.

Analysis of Ore.

Element.	Southworth.	Boulöl.
Sulphur	33.46%	33.97%
Silica - insol.	6.40 "	5.45 "
" sol.	1.50 "	2. "
Copper.	11.25 "	11.29 "
Iron.	46.47 "	46.76 "
Zinc & Cobalt.	1.66 "	1.27
	Trace	
Alumina	"	
Magnesia	"	
Alkalies	"	
Calcium	"	
Nickel & Cobalt	"	

Analyses of Roasted Ore and Mealts for Sulphur.

1st roast in Kiln	18.51 %
2nd " " "	6.21 % " 6.52 % ?
1st " of matt.	13.17 %
2nd " " "	7.28 % in R.F.

Run, I.

Matt

Copper.	21.40% 21.32%
Iron	53.37%
Sulphur	22.70%
Silica	.997%

Slag.

Copper.	.876% .895%
Iron „ Fe	52.%
Silica	35.65%

Foul-slag.

Copper.	4.83% 4.77%

Ends

Copper	4.48% 4.43%

Run II.

Matt.

Copper	30.58 %
Iron	30.46 "
Sulphur	23.05 . 22.7 "
Silica	1.80 "

Slag

Copper	1.20 %
Iron	28.80 "
Silica	34.11 "

Fuel used

	Coke.	Char.
Two roastings in Kilns, used	450.75	78.75
"Coke used in the 1st smelt"	645.	16
"Coke used in the 2nd smelt."	587.	10.
"Coke used in the 3rd smelt"	563.	10.
Total lbs =	2245.75 "	114.75

"Coal used in the R. F.	
" for starting "	104.25
" " roasting "	301.75
Total pounds =	406.00