THE USE OF CAST IRON AND STEEL BRIQUETTED BORINGS IN CENTRIFUSE BRAKE DRUM IRON

Thesis for the Degree of M. E.
MICHIGAN STATE COLLEGE

John L. Lowe

1938

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Economical reclamation of cast iron and steel borings is one of the continually recurring problems in machine shops and foundries. The difference in the price of borings and other scrap, governs the intensity of attention paid to their recovery by utilizing them as part of the cupola charge. The charging of loose borings directly into the cupola has been attempted again and again. But up to recent times this did not prove practicable, as the borings jammed up the cupola with partially oxidized, partially melted material, interfering with blast penetration and introducing all kinds of irregularities in the melted metal.

One well known way of utilizing borings is to fill short stove pipe lengths with them, closing each end of the pipe with a sheet metal disc.* These canisters are charged directly into the cupola. (Powdered sodium carbonate (Na_2CO_3) for desulphurizing purposes, may be mixed in with the borings before filling the stove pipe lengths.) This canister method is simple and does not necessitate much outlay of capital for equipment. The big drawback is that one cannot depend on regular and uniform results. Due to the way the container arrives at a point in the cupola where it begins to melt, the borings come out partly loose and partly fused, making complete distribution very uncertain.

* Moldenke, THE PRINCIPLES OF IRON FOUNDING p. 278 ff

On account of these irregularities, attention has been directed to the possibility of forming borings into briquets. Briquetting methods can be divided into two classes:*

(1) Formation of briquets by using chemical binders, with or without moderate pressures.

(2) Formation of briquets by high pressure, with or without the use of chemical binders.

At the beginning, the first classification of briquetting methods appealed to the foundryman on account of involving little initial investment in equipment. Tar, pitch, oils, sodium silicate, calcium chloride, sal-ammoniac, portland cement, limewater, clay wash, and core gums have all been used with more or less success as binders. Tar, pitch and portland cement were found to be dangerous on account of the possibility of a high sulphur content. Core gums and some of the other binders usually prove too expensive for general commercial purposes.

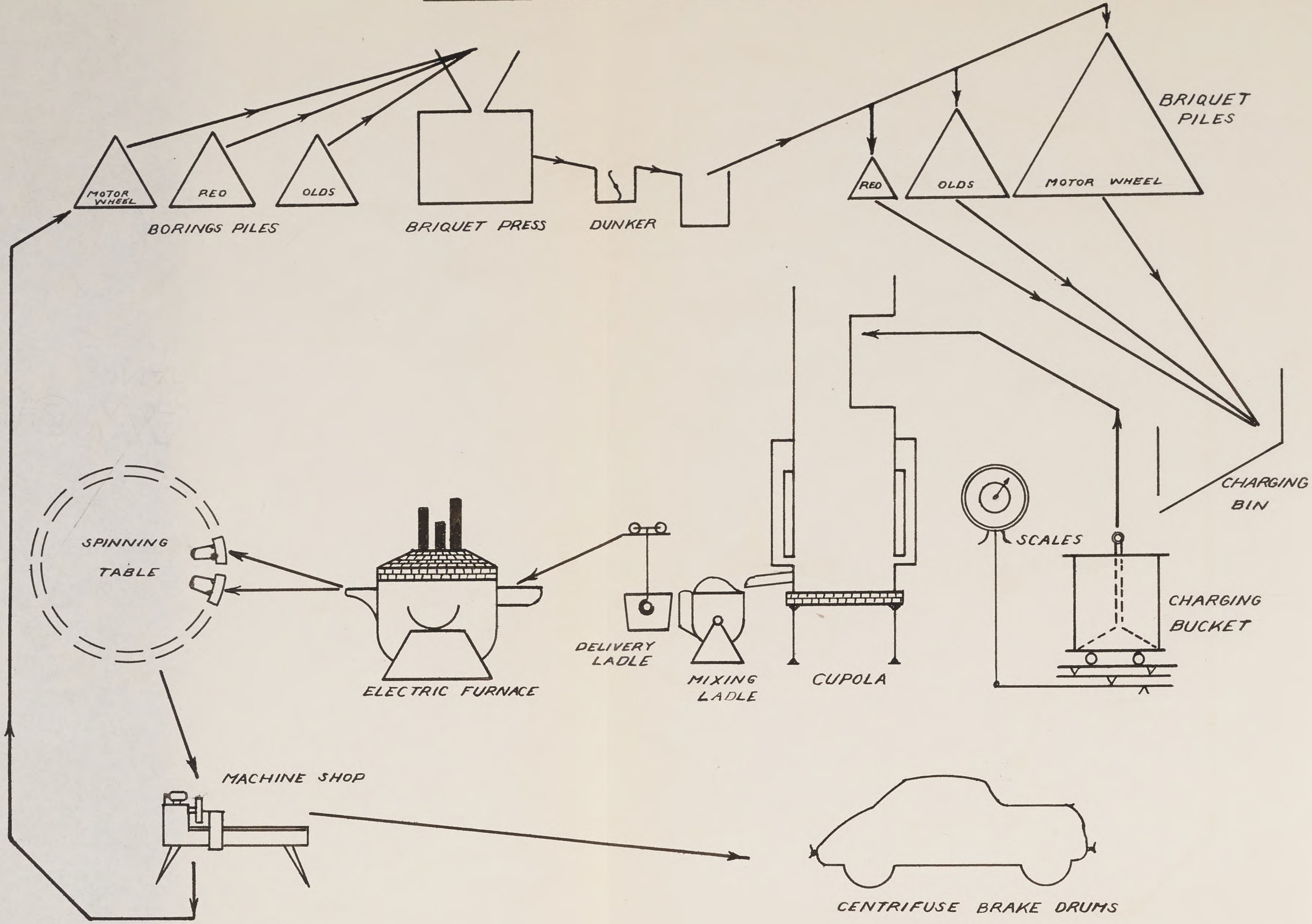
The best methods so far brought out are those briquetting under high pressures without the use of chemical binders. The main advantage of high pressure briquetting are twofold:

(1) The borings are consolidated to a point which reduces the relation of surface to weight enormously, and hence offers less chance for oxidation effects.

(2) Briquets can be handled and charged in the same manner as pig iron and scrap iron.

*Hurst, J.E.; MELTING IRON IN THE CUPOLA p. 201 ff.

GENERAL CYCLE OF BORINGS



Using either of the above mentioned processes approximately similar cycles would be followed. The sketch on the opposite page illustrates this general cycle and also shows the particular or individual setup in the Centrifugal Fusing Company, where the investigations embodied in this thesis have been made under actual production conditions.

Borings are piled as they come from various sources: that is, Motor Wheel borings from the Centrifugal drums are kept in one pile; borings from the Olds cylinder blocks, and cylinder heads are in another; and similar material from the Reo in a third. The reason for this is to keep each source of material separate so that each can be accurately analyzed for carbon, silicon, manganese, sulphur and chromium.

Fom the storage pile (where excess oil and cutting compounds drain off) the borings are picked up by a magnet and dropped into a large hopper, whence they pass through an oscillating sieve (which side tracks larger pieces of material) into a small hopper just above the briquetting press. Into the same hopper is fed a measured amount of powdered sodium carbonate which mixes with the borings before briquetting for desulphurizing purposes.

(It is interesting to note that Motor Wheel borings, which come from brake drum surfaces spun by centrifugal force, are definitely higher in sulphur content than the molten iron from which they are spun. This is due to the centrifugal force of the spinning process which forces sulphur toward the center, and also to the mild desulphurizing action of the sodium carbonate used as a flux on the inside surface of the stamped steel drums. Analysis of the finished drum surface shows a 0.08-0.12% sulphur content; iron in the electric furnace has 0.12-0.16% or less, if possible, sulphur; and analysis of the borings from these same drums shows them to have 0.16-0.20% sulphur content.)

But to return to the cycle, from the small hopper, the mixed borings and sodium carbonate drop into the briquetting press proper. This mechanism applies first a preliminary pressure sidewise (90 pounds per square inch) by means of compressed air, and then a final hydraulic compression lengthwise (1500 pounds per square inch operating pressure of fluid; 350 tons total pressure exerted on briquet). The briquet, as it is thrown from the machine is cylindrical in form (3-4 inches long and 4 inches in diameter) and weighs from eight to ten pounds.

This cylindrical briquet rolls down an incline, a simple hook device which dips it into a bath of cement (Petosky High Early Quicksetting low sulphur cement)(a coloring compound is used for identification purposes, red for Olds and buff for Reo). Thence the briquets are dropped into a pit by gravity and are picked up by a magnet and dropped into storage piles until needed for charging.

From the storage piles the magnet picks up the briquets and drops them into the charging bins, convenient for shovelling into the cone type charging bucket in any desired quantity. From this they are charged into the cupola; the iron is tapped from the cupola into a mixing and desulphurizing ladle and from the mixing ladle it is taken to the electric furnace in a delivery ladle. Chemical tests are taken every hour from a chill test sample out of the electric furnace and chill tests are made after each tap is put into the electric furnace.

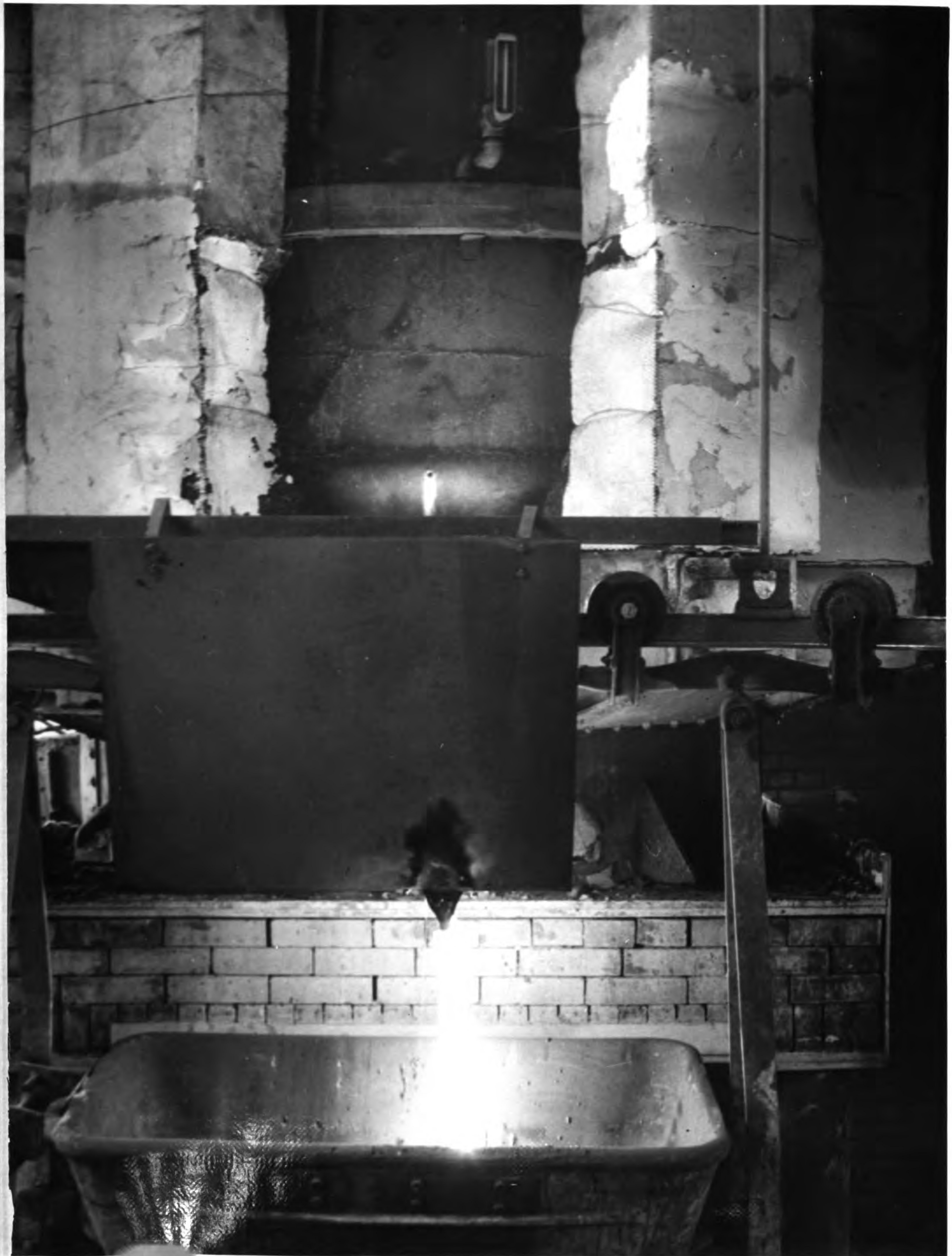
Rectification (guided by the hourly analysis and the chill tests) is made at the electric furnace. Test chills are also taken from the mixing ladle after each tap to give the furnace operator advanced information regarding iron conditions. This enables him to make analysis correction either in the delivery ladle or in the electric furnace. Then the iron goes to the spinning tables; then on the cooling chain; then through the shot-blast and then to the machine shop. Finally, the borings from these drums come back to the storage pile to begin a new cycle.

Magnet picking up borings from the pile.

Briquette Press

Magnet picking up briquetted borings
from the pile.

Charging bins and coke hopper, showing cone type charging bucket in place on scale, ready to be filled.



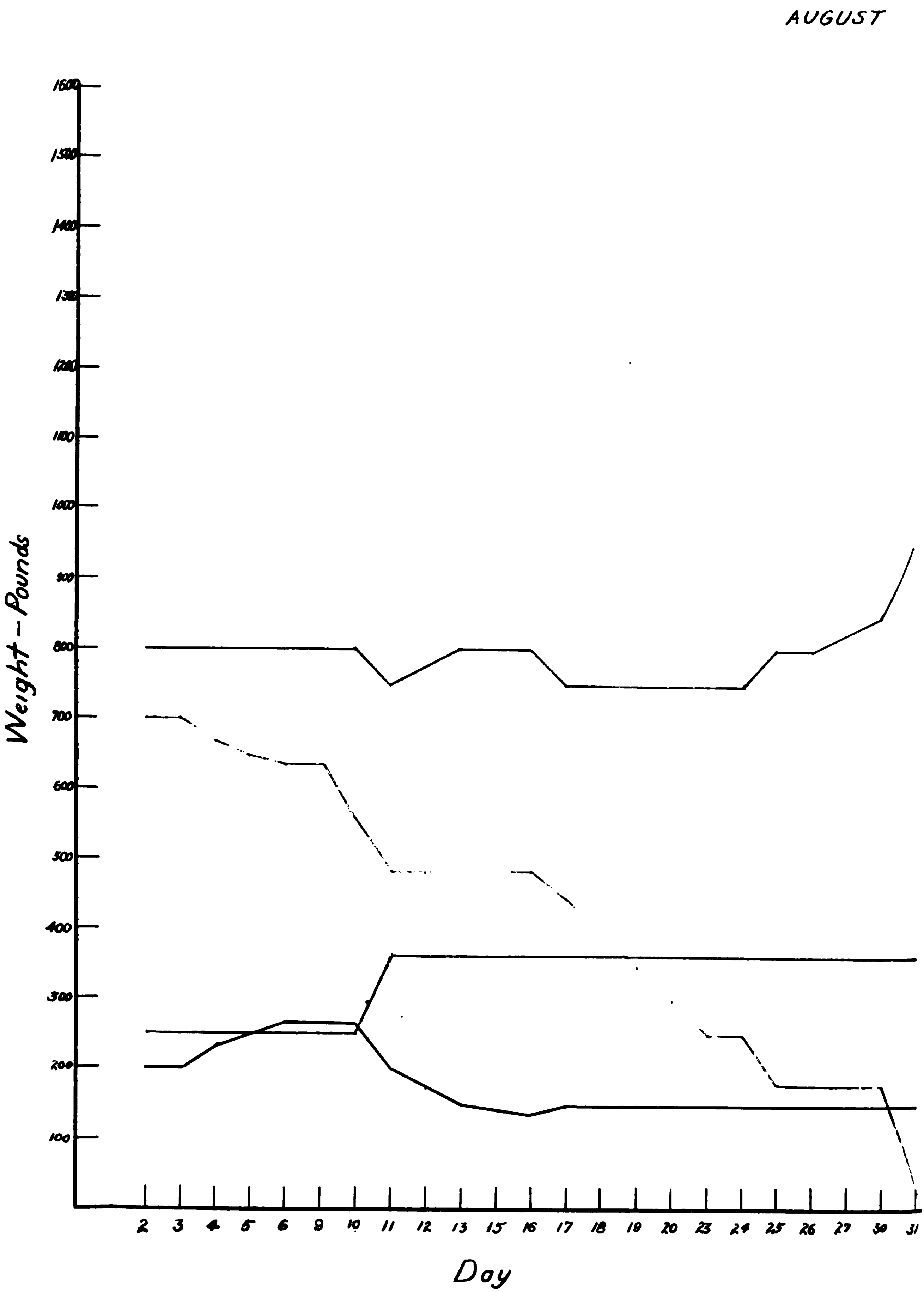
Cupola (72 in. dia. shell, lined to 54 in. dia.) rear view showing slag running into slag pot.

Tapping iron from cupola into mixing and de-sulphurizing ladle, then into delivery ladle.

Pouring iron from delivery ladle into Electric Furnace (C-16 1½ ton Moore 'Lectromelt Furnace)

Another rear view of the Electric Furnace.

The following data and graph sheets are of the charging mixtures, calculated analysis and analysis from the electric furnace for August, September, October, November, December, 1937, January, February, and March, 1938; also cupola analyses for February and March.


AUGUST
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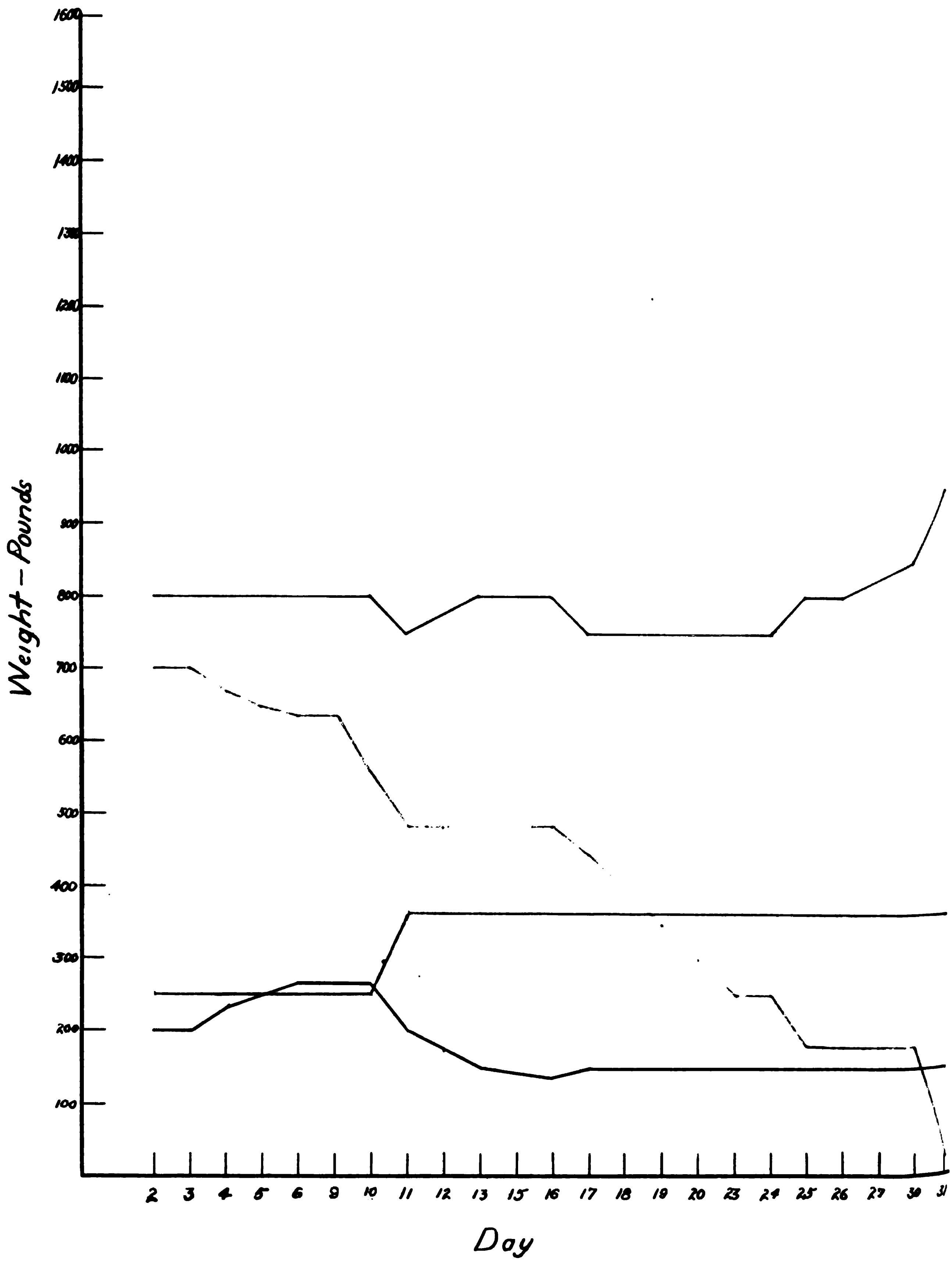
AUGUST, 1937

In order to increase the briquetted boring percentage and keep analysis in line, it was soon found necessary to decrease the plate steel.

It was found with an increase of borings we had a greater silicon and carbon loss. Plate steel being low in carbon (0.4%) and silicon (0.1%) the amount was decreased as shown on the graph when the borings were increased.

The increase of returns (scrap drums, spilled iron, cupola drops, etc.) was due to the amount on hand and to aid regulation of silicon. The small variation of silvery pig iron was necessary to regulate the silicon content.

AUGUST



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AUGUST 1937	CUPOLA CHARGE MIXTURE																	CHEMICAL ANALYSIS Average for Day								
	Weights – Lbs.														Calculated %			Cupola Iron %				Electric Furnace Iron %				
Day	COKE	LIMESTONE	PURITE	PITCH COKE	REGULAR PIG IRON	HI-PHOS PIG IRON	SILVERY PIG IRON	BORINGS	PLATE STEEL	RETURNS	CHROMIUM BRIQUETS	MANGANESE	SILICON BRIQUETS	TOTAL	SILICON	MANGANESE	PHOSPHORUS	TOTAL CARBON	SILICON	MANGANESE	PHOSPHORUS	TOTAL CARBON	SILICON	MANGANESE	PHOSPHORUS	SULPHUR
2	175	40	4	100	250		200	800	700	43	2	3	4	2000	2.45	.96	.103					[illegible]	2.17	.74		.154
3	235	40	6	50	250		200	800	700	43	2	3	2	2000	2.36	.96	.103					3.56	2.02	.69		.13
4	235	40	6	50	250		230	800	670	43	2	3	3	2000	2.56	.98	.098					3.53	1.89	.72		.135
5	235	40	6	50	250		250	800	650	40	2	3	5	2000	2.77	.99	.08					3.47	2.03	.68		.133
6	215	40	6	75	250		265	800	635	39	2	3	6	2000	2.89	1.00	.107					3.51	2.22	.70		.12
9	215	40	6	75	250		265	800	635	39	2	3	6	2000	2.89	1.00	.107					3.52	2.16	.75		.13
10	215	40	6	75	250		265	800	560	113	2	3	7	2000	2.98	1.00	.108					3.55	2.18	.70		.11
11	175	40	6	75	365		200	750	485	187	2	3	8	2000	2.84	1.06	.109					3.46	2.38	.78		.09
12	175	40	6	100	365		175	775	485	187	2	3	8	2000	2.71	1.05	.108					3.55	2.42	.88		.09
13	175	40	6	100	365		150	800	485	187	2	3	8	2000	2.60	1.03	.108					3.40	2.32	.87		.125
15																										
16	175	40	6	100	365		135	800	485	210	2	1½	6	2000	2.44	1.02	.108					3.55	2.27	.95		.13
17	190	40	6	100	365		150	750	445	279	2	1½	8	2000	2.62	1.03	.108					3.50	2.30	.96		.11
18																										
19	215	40	6	100	365		150	750	350	375	2		8	2000	2.64	1.03	.11					3.45	2.25	.98		.10
20	250	40	6	100	365		150	750	300	425	2		8	2000	2.67	1.03	.111					3.51	2.35	.99		.105
23	250	40	6	100	365		150	750	250	479	2		4	2000	2.49	1.03	.112					3.56	2.30	.99		.13
24	200	40	6	100	365		150	750	250	483	2			2000	2.29	1.03	.112					3.64	2.23	.96		.115
25	200	40	4	100	365		150	800	183	500	2			2000	2.35	1.03	.115					3.57	2.31	.91		.12
26	200	40	4	100	365		150	800	183	500	2			2000	2.35	1.03	.115					3.67	2.12	.88		.125
27																										
30	200	40	4	100	365		150	850	183	450	2			2000	2.37	1.03	.116					3.67	2.20	.86		.125
31	190	40	6	100	365		150	950	24	350	1			2000	2.41	.98	.114					3.61	2.17	.82		.12

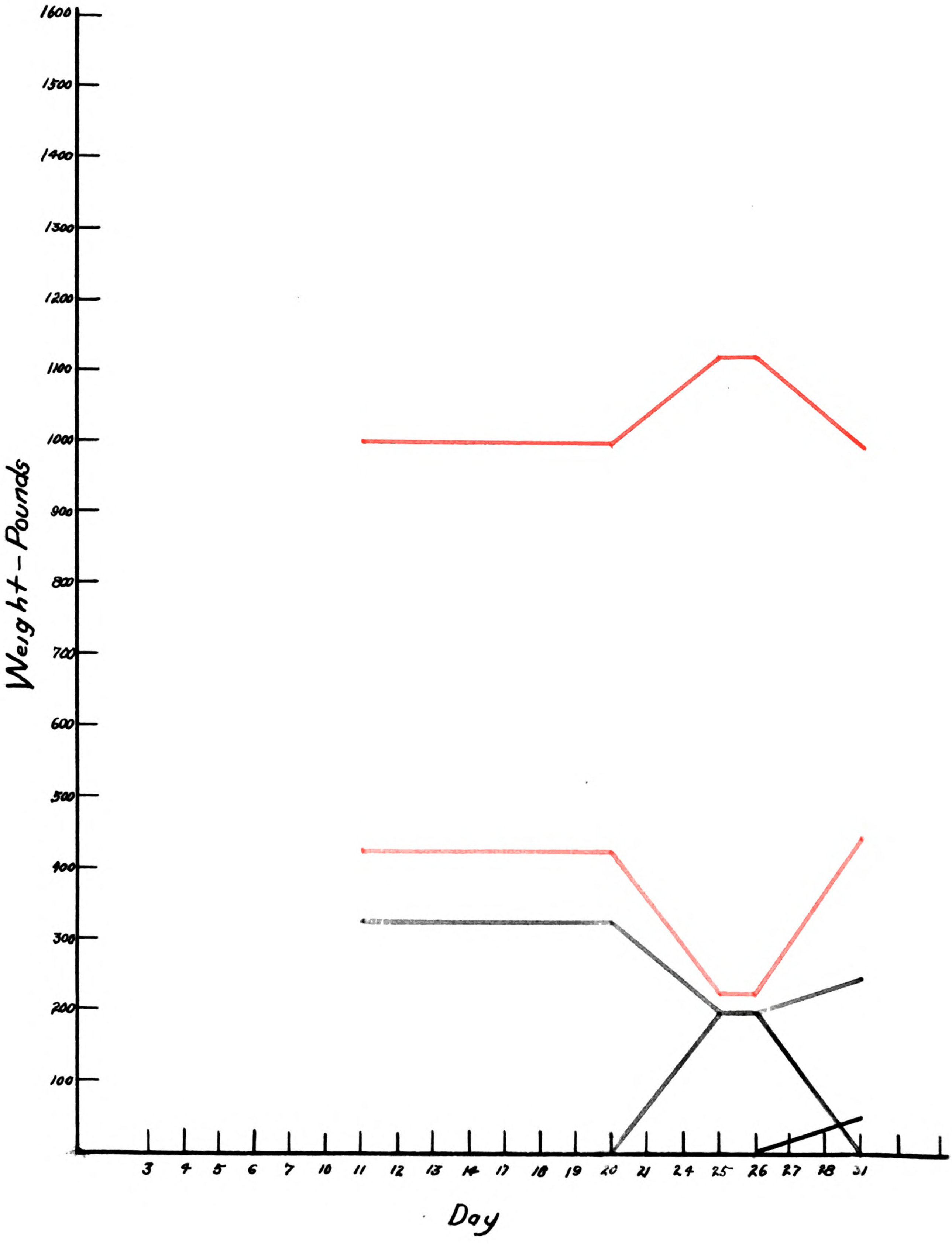
AUGUST, 1937

In order to increase the briquetted boring percentage and keep analysis in line, it was soon found necessary to decrease the plate steel.

It was found with an increase of borings we had a greater silicon and carbon loss. Plate steel being low in carbon (0.4%) and silicon (0.1%) the amount was decreased as shown on the graph when the borings were increased.

The increase of returns (scrap drums, spilled iron, cupola drops, etc.) was due to the amount on hand and to aid regulation of silicon. The small variation of silvery pig iron was necessary to regulate the silicon content.

JANUARY



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JANUARY 1937	CUPOLA CHARGE MIXTURE																	CHEMICAL ANALYSIS Average for Day								
	Weights - Lbs.														Calculated %			Cupola Iron %				Electric Furnace Iron %				
Day	COKE	LIMESTONE	PURITE	PITCH COKE	REGULAR PIG IRON	HI-PHOS PIG IRON	SILVERY PIG IRON	BORINGS	PLATE STEEL	RETURNS	CHROMIUM BRIQUETS	MANGANESE	SILICON BRIQUETS	TOTAL	SILICON	MANGANESE	PHOSPHORUS	TOTAL CARBON	SILICON	MANGANESE	PHOSPHORUS	TOTAL CARBON	SILICON	MANGANESE	PHOSPHORUS	SULPHUR
3																										
4																										
5																										
6																										
7																										
10																										
11	200	70	2	50		425		1000	325	248	2			2000	2.34	.96	.191					3.46	2.07	.66	.151	.157
12																										
13	200	70	2	50		425		1000	325	248	2			2000	2.34	.96	.191					3.55	2.09	.81		.145
14																										
17																										
18	200	70	4	50		425		1000	325	248	2			2000	2.34	.96	.191									
19																										
20	200	70	4	50		425		1000	325	248	2			2000	2.34	.96	.191					3.52	2.13	.85	.166	
21																										
24																										
25	200	70	4	50	200	225		1125	200	243	2	3	2	2000	2.30	1.03	.176					3.56	2.12	.82	.185	.14
26	200	70	4	50	200	225		1125	200	237	2	3	8	2000	2.60	1.03	.176					3.55	2.14	.79	.171	.133
27																										
28																										
31	200	70	4	50		450	50	1000	248	250	2			2000	2.38	.97	.185	3.56	2.38		.172	3.48	2.38	.71	.206	.14

JANUARY, 1938

Pig iron with a higher phosphorus content was used to give the iron more fluidity.

Regular pig iron;- silicon 2.8%, manganese 2.4%, P .13%

* Hi-Phos pig iron;- silicon 4.7%, manganese 2.32% P .342%

Also Olds boring briquets were again used for rejuvenation purposes.

Motor Wheel briquetted borings:

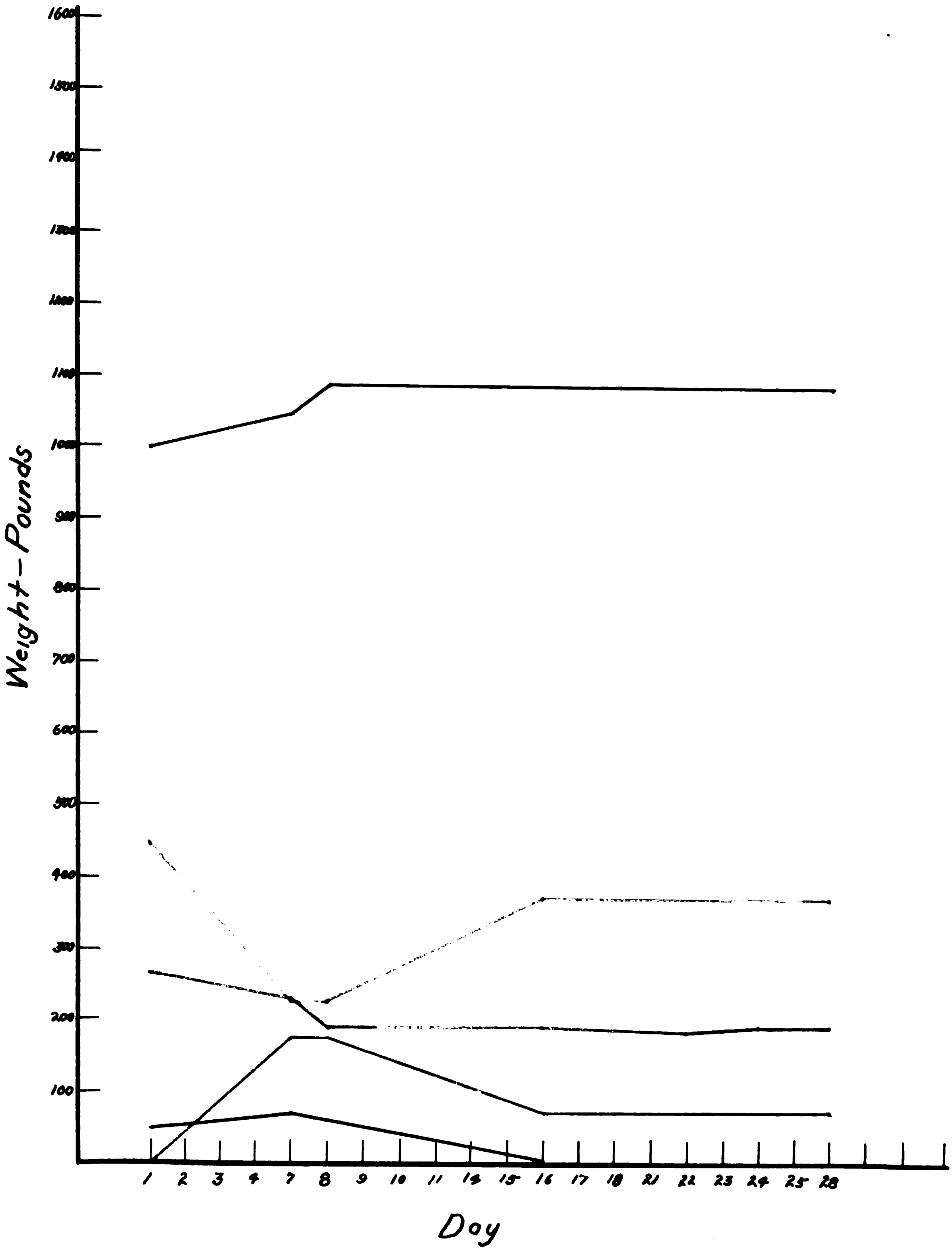
Silicon 1.9-2%, Manganese 0.6% Phosphorus 0.12%

Olds briquetted borings:

Silicon 2.4-2.5%, Manganese 0.6% Phosphorus .199%

* Our differentiation of pig iron.

FEBRUARY



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Day

CUPOLA CHARGE MIXTURE — Weights – Lbs

FEBRUARY 1938 Day	COKE	LIMESTONE	PURITE	PITCH COKE	REGULAR PIG IRON	HI-PHOS PIG IRON	SILVERY PIG IRON	BORINGS	PLATE STEEL	RETURNS	CHROMIUM BRIQUETS	MANGANESE	SILICON BRIQUETS	TOTAL
1	200	70	4	50		450	50	1000	268	250	2			2000
2	200	70	4	50		450	50	1000	268	250	2			2000
3														
4														
7	200	70	4	50	175	225	70	1050	230	245	2	3		2000
8	200	70	4	50	175	225	60	1090	190	255	2	3		2000
9														
10														
11														
14														
15	200	70	4	50	175	225	60	1090	190	255	2	3		2000
16	200	70	4	50	75	375		1090	191	260	2	3	4	2000
17														
18														
21	200	70	4	50	75	375		1090	191	260	2	3	4	2000
22	200	70	4	50	75	375		1090	189	260	2	3	6	2000
23	200	70	2	50	75	375		1090	191	260	2	3	4	2000
24	200	70	2	50	75	375		1090	195	260	2	3		2000
25														
28	200	70	2	50	75	375		1090	195	260	2	3		2000

CUPOLA CHARGE MIXTURE — Calculated % / CHEMICAL ANALYSIS Average for Day

Day	Calculated % SILICON	Calculated % MANGANESE	Calculated % PHOSPHORUS	Cupola Iron % TOTAL CARBON	Cupola Iron % SILICON	Cupola Iron % MANGANESE	Cupola Iron % PHOSPHORUS	Electric Furnace Iron % TOTAL CARBON	Electric Furnace Iron % SILICON	Electric Furnace Iron % MANGANESE	Electric Furnace Iron % PHOSPHORUS	Electric Furnace Iron % SULPHUR
1	2.45	.97	.18	3.31	2.06		.198	3.55	2.17	.80	.197	.131
2	2.45	.97	.18	3.35	2.21		.192	3.53	2.22	.79	.201	.136
3												
4												
7	2.41	1.02	.175	3.32	1.99		.162	3.44	2.13	.87	.168	.125
8	2.39	1.02	.175	3.34	2.11		.162	3.55	2.21	.95	.177	.140
9												
10												
11												
14												
15	2.39	1.02	.175	3.23	1.86			3.47	2.10		.182	.163
16	2.47	.99	.192	3.42	2.02		.168	3.55	2.11	.68	.174	.152
17												
18												
21	2.47	.99	.192	3.33	1.98		.197	3.51	2.13	.73	.196	
22	2.47	.99	.192	3.38	2.21		.184	3.55	2.24		.189	
23	2.37	.99	.192	3.37	1.99		.181	3.51	2.13		.174	
24	2.30	.99	.192	3.39	2.02		.187	3.55	2.12		.177	.163
25												
28	2.29	.99	.192	3.33	1.88		.184	3.49	2.20		.178	.178

FEBRUARY, 1938

Olds briquetted borings were used the whole month except for two days when the Reo briquetted borings were used.

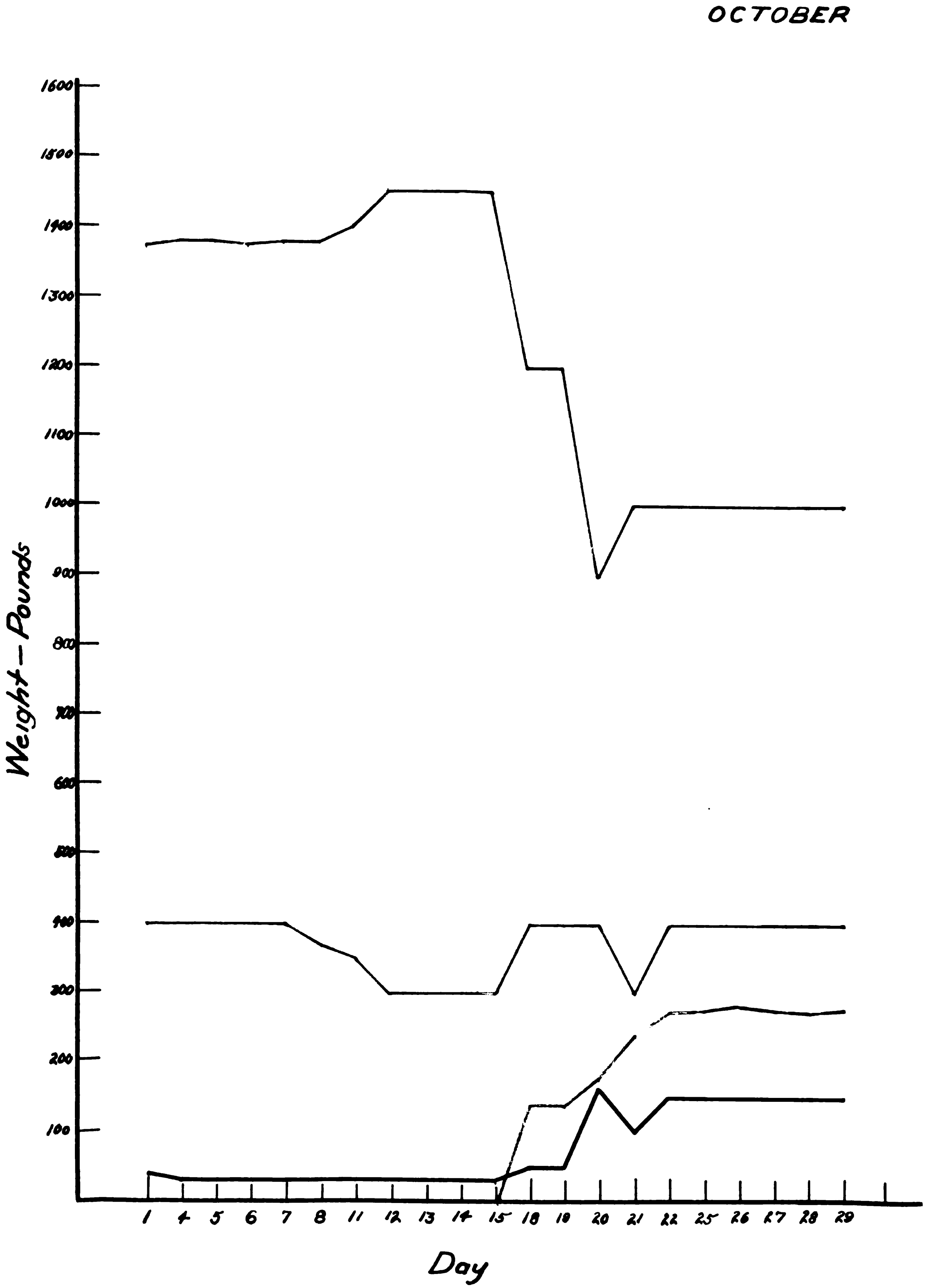
Reo briquetted borings:

Silicon 2.3% Manganese 0.6% Phosphorus 0.18%

January and February scrap loses were materially decreased. Whether that was due to the rejuvenation of our boring system by the use of Olds and Reo borings, along with increasing fluidity of our iron by increasing the phosphorus or changes made in our fluxing, heating, and spinning operations is open to argument. Anyway, our scrap loses were down and the use of briquetted borings were not under suspicion as before.

We were fortunate in being able to get hourly cupola analysis as well as the hourly electric furnace analysis, which gave us better control of our melting operations. Also gave more accurate idea of silicon loss due to briquets being used (under milder blast conditions due to decreased production).

In the near future we are hoping to have our laboratory set up so that we can take analysis every one half hour, alternating between cupola mixing ladle and electric furnace. We realize by now that to be able to use briquetted borings successfully it is essential that we keep all our elements in specified limits at all times.



OCTOBER
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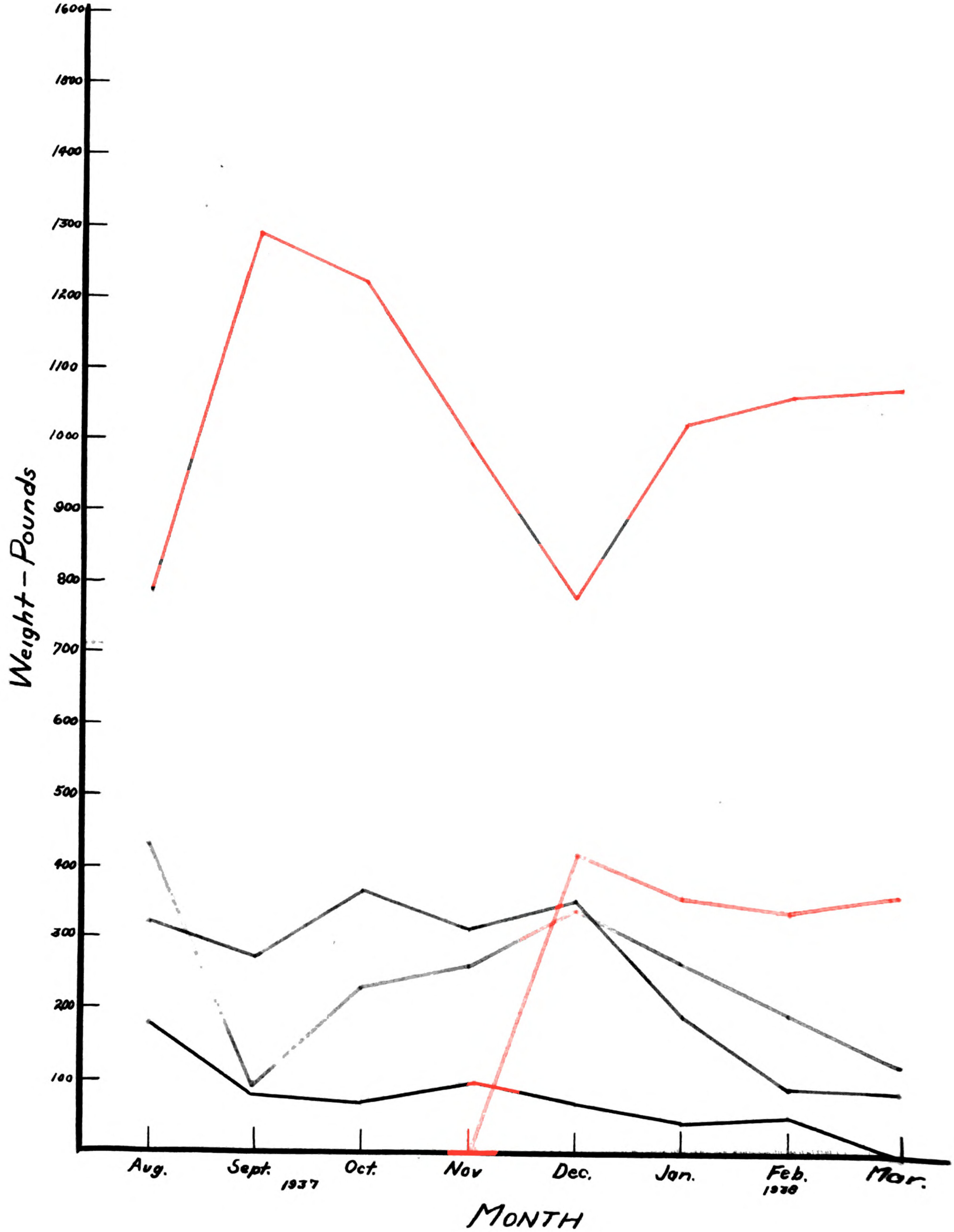
MARCH 1938	CUPOLA CHARGE MIXTURE																CHEMICAL ANALYSIS Average for Day									
	Weight - Lbs.													Calculated %			Cupola Iron %				Electric Furnace Iron %					
Day	COKE	LIMESTONE	PURITE	PITCH COKE	REGULAR PIG IRON	HI-PHOS PIG IRON	SILVERY PIG IRON	BORINGS	PLATE STEEL	RETURNS	CHROMIUM BRIQUETS	MANGANESE	SILICON BRIQUETS	TOTAL	SILICON	MANGANESE	PHOSPHORUS	TOTAL CARBON	SILICON	MANGANESE	PHOSPHORUS	TOTAL CARBON	SILICON	MANGANESE	PHOSPHORUS	SULPHUR
1	200	70	4	50	75	375		1090	195	260	2	3		2000	2.29	.99	.19	3.33	1.93		.175	3.48	2.12			
2	200	70	4	50	75	375		1090	195	260	2	3		2000	2.29	.99	.19	3.35	1.94		.185	3.52	2.12		.197	
3	200	70	4	50	75	375		1090	195	260	2	3		2000	2.29	.99	.19	3.33	1.98		.18	3.50	2.19		.184	
4																										
7	200	70	4	50	75	375		1090	195	260	2	3		2000	2.29	.99	.19	3.35	2.01		.175	3.57	2.11		.184	
8	200	70	4	50	175	275		1090	193	260	2	3	2	2000	2.32	1.06	.19	3.31	2.04		.173	3.57	2.09		.196	
9	200	70	4	50	175	275		1090	193	260	2	3	2	2000	2.32	1.06	.19	3.33	2.00		.172	3.55	2.07		.192	
10	200	70	4	50	75	375		1090	194	260	2	4		2000	2.29	1.13	.20	3.27	2.04			3.55	2.04	.88		
11																										
14	200	70	4	50	75	375		1090	194	260	2	4		2000	2.27	1.13	.204	3.16	1.95			3.56	2.06			.139
15	200	70	4	50	75	375		1090	194	260	2	4		2000	2.27	1.13	.204	3.11	2.04			3.57	2.10		.194	.17
16	200	70	4	50	75	375		1090	194	260	2	4		2000	2.27	1.13	.204	3.16	1.77			3.58	2.08	88		.177
17	200	70	4	50	100	350		1090	188	260	2	6	4	2000	2.26	1.10	.215	3.25	1.85		.193	3.50	2.10		.188	
18																										
21	225	70	4	50	100	370		1090	142	280	2	6	10	2000	2.39	1.03	.219					3.45	2.16		.213	
22	225	70	4	50	100	370		1090	142	280	2	6	10	2000	2.39	1.03	.219					3.48	2.15		.22	
23	225	70	4	50	100	390		1090	104	300	2	6	8	2000	2.52	1.06	.22	3.32	2.21			3.52	2.26		.21	.141
24	225	70	4	50	100	390		1090	104	300	2	6	8	2000	2.52	1.06	.22					3.43	2.25		.247	.148
25																										
28	225	70	4	50	100	425		1090	69	300	2	6	8	2000	2.54	1.07	219					3.48	2.24		.251	.142
29	225	70	4	50	100	425		1090	73	300	2	6	4	2000	2.55	1.08	.224	3.36	2.19			3.48	2.24	.855		.171
30	225	70	4	50	100	425		1090		369	2	6	8	2000	2.65	1.08	.224					3.52	2.37	1.11	.246	.158
31																										

MARCH, 1938

Average silicon loss in cupola for this month was 0.32% as against February loss of 0.39% average,

As stated in February comments we did not need to force our cupola as much which materially aids in reducing silicon and carbon losses.

Experience is showing us the desirability of buying pig iron made to our particular specification- 3.5%-4.5% silicon, 0.5-.75% phosphorus, 1.75-2.25% manganese, sulphur as low as is reasonably possible.



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Weight - Pounds
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Sept.
1937
Oct.
Nov
Dec.
Jan.
Feb.
1938
Mar.
MONTH

NOVEMBER 1937	CUPOLA CHARGE MIXTURE																	CHEMICAL ANALYSIS Average for Day								
	Weights – Lbs.														Calculated %			Cupola Iron %				Electric Furnace Iron %				
Day	COKE	LIMESTONE	PURITE	PITCH COKE	REGULAR PIG IRON	HI-PHOS PIG IRON	SILVERY PIG IRON	BORINGS	PLATE STEEL	RETURNS	CHROMIUM BRIQUETS	MANGANESE	SILICON BRIQUETS	TOTAL	SILICON	MANGANESE	PHOSPHORUS	TOTAL CARBON	SILICON	MANGANESE	PHOSPHORUS	TOTAL CARBON	SILICON	MANGANESE	PHOSPHORUS	SULPHUR
1	175	40	2	75	400		150	1000	215	162	2	3	8	2000	2.85	1.06	.112	[illegible]				3.58	2.15	.87		.112
2	175	40	2	75	400		150	1000	217	162	2	3	6	2000	2.75	1.06	.112	.				3.63	2.10	.93		.115
3	175	40	2	75	400		150	1000	219	162	2	3	4	2000	2.67	1.06	.112	.				3.59	2.14	.92		.115
4	175	50		75	400		150	1000	219	162	2	3	4	2000	2.65	1.06	.112	.				3.65	2.09	.96		.115
5	175	60		50	300		150	1000	277	262	2	3	6	2000	2.66	.97	.11	.				3.63	2.12	.98		.132
8	175	70		50	300		150	1000	219	262	2	3	4	2000	2.56	.97	.11	.				3.64	2.13	.81		.129
9	175	70		50	300		130	1000	299	262	2	3	4	2000	2.45	.96	.109	.				3.62	2.20	.97		.141
10	175	70		50	300		130	1000	297	262	2	3	6	2000	2.55	.96	.109	.				3.62	2.11	.93		.147
11	200	70	2	50	300		150	1000	277	262	2	3	6	2000	2.66	.97	.11	.				3.64	2.21	.		.126
12	200	70		50	300		110	1000	261	328	2	3	6	2000	2.48	.95	.109	.				3.71	2.20	.		
15	200	70		50	300		100	1000	257	330	2	3	8	2000	2.53	.94	.109	.				3.65	2.10	.97		.143
16	200	70		50	300		100	1000	259	330	2	3	6	2000	2.43	.94	.109	.				3.63	2.14	1.00		.144
17	200	70		50	300		80	1000	253	350	2	3	12	2000	2.63	.92	.108	.				3.64	2.14	.96		.148
18	200	70		50	300		60	1000	259	370	2	3	6	2000	2.24	.91	.107	.				3.69	2.16	.97		.153
19	200	70		50	300		40	1000	257	390	2	3	8	2000	2.24	.89	.107	.				3.77	2.12	.97		.144
22	200	70	6	50	300		40	1000	251	390	2	3	14	2000	2.54	.89	.106	.				3.70	2.15	.81		.142
23	200	70	6	50	300		40	1000	251	390	2	3	14	2000	2.54	.89	.106	.				3.63	2.14	.81		.13
24	200	70	6	50	300		40	1000	251	390	2	3	14	2000	2.54	.89	.106	.				3.58	2.12	.83		.156
25																										
26																										
29	200	70	6	50	300		40	1000	251	390	2	3	14	2000	2.54	.89	.106	.				3.59	2.14	.78		.124
30	200	70	6	50	300		40	1000	251	390	2	3	14	2000	2.54	.89	.106	.				3.60	2.13	.83		.129

NOVEMBER, 1937

Briquets were maintained at one thousand pounds as we had cut our briquet stock pile down and were using up our briquetted borings faster than the briquet machine was replenishing the pile.

We used 250-297 pounds of plate steel per charge which is too much steel to use with one thousand pounds of Motor Wheel borings (centrifuse drum)(Motor Wheel borings contain approximately 5-10% steel borings coming from the cutting of steel backs in two) also our returns may be roughly figured at this time as containing 50% steel (steel backs on scrap drums).

Example: November 19,1937

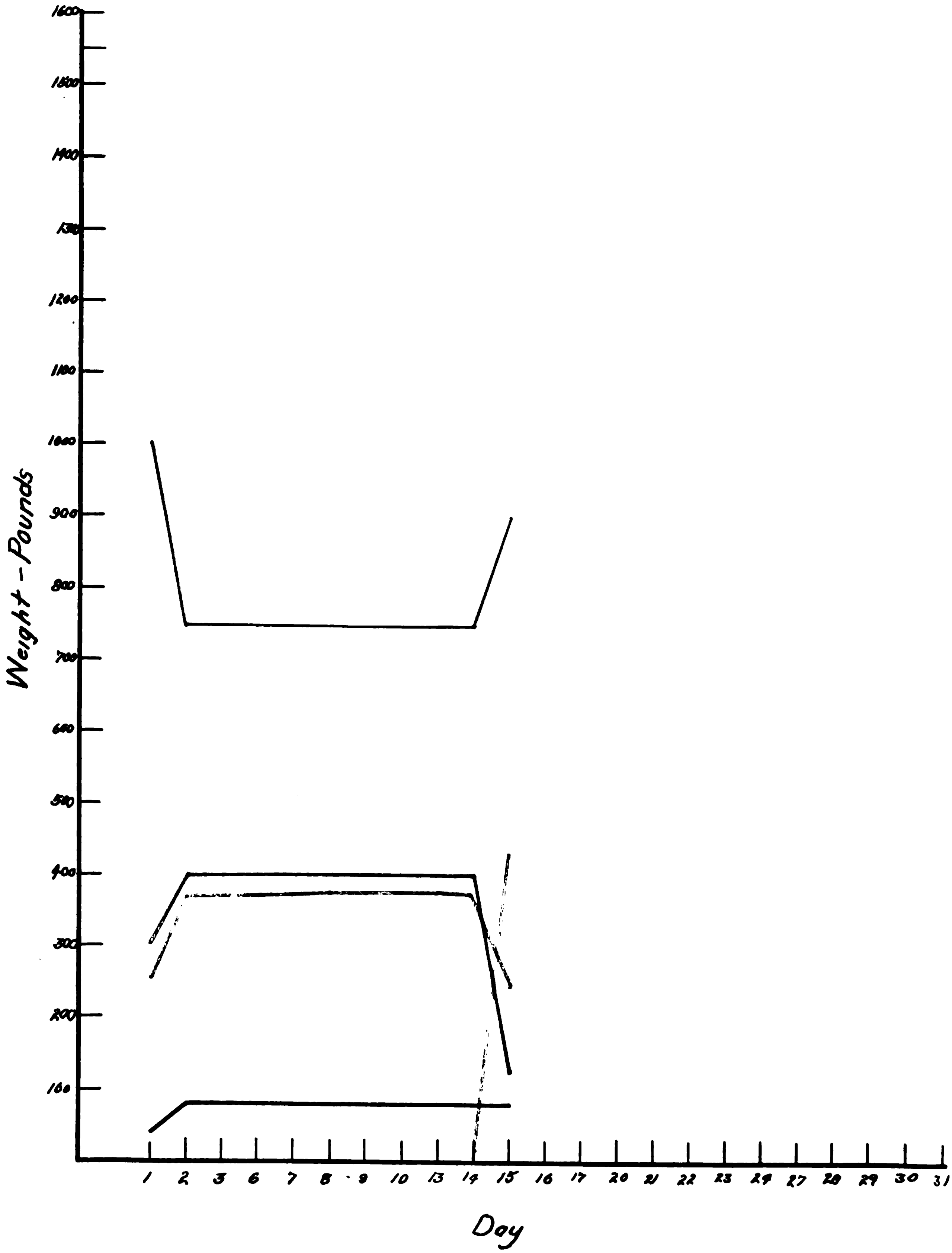
		Steel%	Steel lbs.
Motor Wheel Briquets	1000 lbs	10	100
Plate Steel	257 lbs.		257
Returns	390 lbs.	50	195
			552 lbs.

27.6% steel along with 50% briquets in a 2000 pound charge made it difficult to maintain our carbon and especially our silicon specification.

This experience convinced us that plate steel used must be sharply limited in order to have better control of the carbon and silicon. The carbon specification of the iron in the furnace is 3.5-3.7% and the silicon, 2.0-2.2%. Due to the inherent characteristic of briquetted borings to lose carbon and silicon, in addition to the plate steel are segregated as to source.

3. If the briquettes are coated properly with a low sulphur quick setting cement.
   a. To reduce oxidation.
   b. As a flux.
4. If a very good, consistent cupola practice is built up.
5. If hot blast is used properly to materially decrease silicon and carbon losses.
6. If sulphur is kept under control.
   a. De-sulphurizing cupola by proper fluxing materials.
   b. De-sulphurizing in mixing ladle with sodium carbonate.
7. If elements are maintained to give desired machineability and physical properties.
8. If the laboratory is equipped to give accurate and fast control information.
9. A well organized, well trained, efficient, hard-working melting personnel is very necessary and essential in melting briquette borings successfully.

DECEMBER


Weight - Pounds
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1 2 3 6 7 8 9 10 13 14 15 16 17 20 21 22 23 24 27 28 29 30 31
Day

DECEMBER 1937	CUPOLA CHARGE MIXTURE																	CHEMICAL ANALYSIS Average for Day								
	Weights - Lbs.														Calculated %			Cupola Iron %				Electric Furnace Iron %				
	COKE	LIMESTONE	PURITE	PITCH COKE	REGULAR PIG IRON	HI-PHOS PIG IRON	SILVERY PIG IRON	BORINGS	PLATE STEEL	RETURNS	CHROMIUM BRIQUETS	MANGANESE	SILICON BRIQUETS	TOTAL	SILICON	MANGANESE	PHOSPHORUS	TOTAL CARBON	SILICON	MANGANESE	PHOSPHORUS	TOTAL CARBON	SILICON	MANGANESE	PHOSPHORUS	SULPHUR
1	200	70	6	50	300		40	1000	251	390	2	3	14	2000	2.53	.89	.107					3.58	2.11	.88		.13
2	200	70	6	50	400		80	750	369	385	2	2	12	2000	2.53	1.00	.104					3.58	2.16	.82		.12
3																										
6	200	70	4	50	400		80	750	371	385	2	2	10	2000	2.43	1.00	.104					3.63	2.15	.80		.114
7	200	70	4	50	400		80	750	371	385	2	2	10	2000	2.43	1.00	.104					3.66	2.20	.87		.111
8	200	70	4	50	400		80	750	373	385	2	2	8	2000	2.33	1.00	.104					3.61	2.15	.85	.118	.12
9	200	70	4	50	400		80	750	373	385	2	2	8	2000	2.33	1.00	.104					3.62	2.14	.88	.123	.121
10	200	70	6	50	400		80	750	377	385	2	2	4	2000	2.28	1.00	.134					3.61	2.15	.89	.13	.102
13	200	70	6	50	400		80	750	377	385	2	2	4	2000	2.28	1.00	.134					3.57	2.17	.83	.13	.106
14	200	70	6	50	400		80	750	375	385	2	2	6	2000	2.38	1.00	.134					3.66	2.10	.83	.143	.101
15	200	70	2	50	125	425		900	242	300	2		6	2000	2.54	1.08	.154					3.61	2.13	.86	.15	.109
16																										
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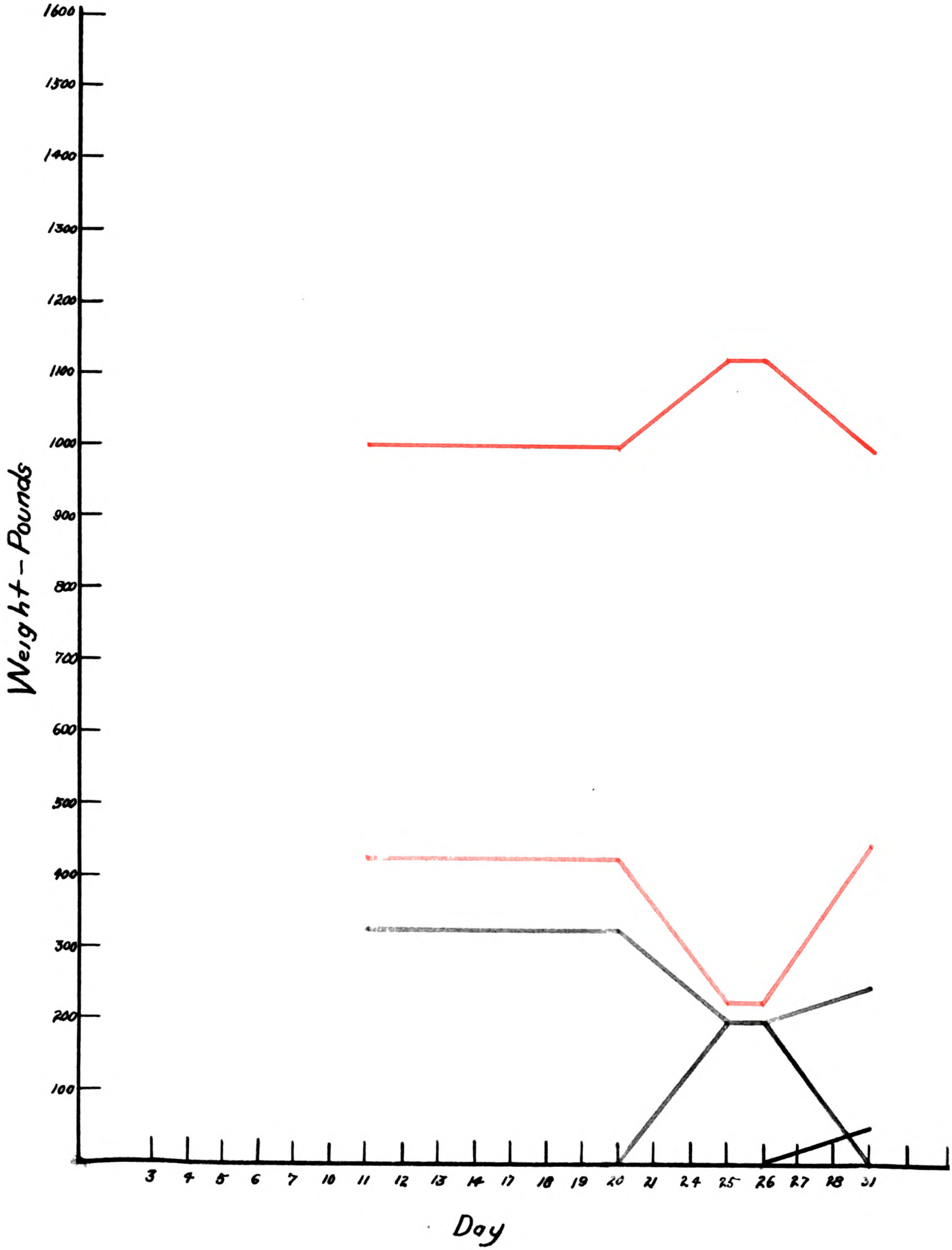
31																										

DECEMBER, 1937

Motor Wheel boring briquets were lowered from 1000 pounds to 750 pounds per charge due to the small amount of borings on hand. Also our scrap loses went up, the remelting and using of briquetted Motor Wheel borings were under suspicion.

December 10, 13 and 14, 1937 Olds briquetted borings were used in place of Motor Wheel borings to rejuvenate our boring system.

JANUARY



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Weight - Pounds
3 4 5 6 7 10 11 12 13 14 17 18 19 20 21 24 25 26 27 28 31
Day

	CUPOLA CHARGE MIXTURE																	CHEMICAL ANALYSIS Average for Day								
JANUARY 1937	Weights - Lbs.														Calculated %			Cupola Iron %				Electric Furnace Iron %				
Day	COKE	LIMESTONE	PURITE	PITCH COKE	REGULAR PIG IRON	HI-PHOS PIG IRON	SILVERY PIG IRON	BORINGS	PLATE STEEL	RETURNS	CHROMIUM BRIQUETS	MANGANESE	SILICON BRIQUETS	TOTAL	SILICON	MANGANESE	PHOSPHORUS	TOTAL CARBON	SILICON	MANGANESE	PHOSPHORUS	TOTAL CARBON	SILICON	MANGANESE	PHOSPHORUS	SULPHUR
3																										
4																										
5																										
6																										
7																										
10																										
11	200	70	2	50		425		1000	325	248	2			2000	2.34	.96	.191					3.46	2.07	.66	.151	.157
12																										
13	200	70	2	50		425		1000	325	248	2			2000	2.34	.96	.191					3.55	2.09	.81		.145
14																										
17																										
18	200	70	4	50		425		1000	325	248	2			2000	2.34	.96	.191									
19																										
20	200	70	4	50		425		1000	325	248	2			2000	2.34	.96	.191					3.52	2.13	.85	.166	
21																										
24																										
25	200	70	4	50	200	225		1125	200	243	2	3	2	2000	2.30	1.03	.176					3.56	2.12	.82	.185	.14
26	200	70	4	50	200	225		1125	200	237	2	3	8	2000	2.60	1.03	.176					3.55	2.14	.79	.171	.133
27																										
28																										
31	200	70	4	50		450	50	1000	248	250	2			2000	2.38	.97	.185	3.56	2.38		.172	3.48	2.38	.71	.206	.14

JANUARY, 1938

Pig iron with a higher phosphorus content was used to give the iron more fluidity.

Regular pig iron;- silicon 2.8%, manganese 2.4%, P .13%

* Hi-Phos pig iron;- silicon 4.7%, manganese 2.32% P .342%

Also Olds boring briquets were again used for rejuvenation purposes.

Motor Wheel briquetted borings:

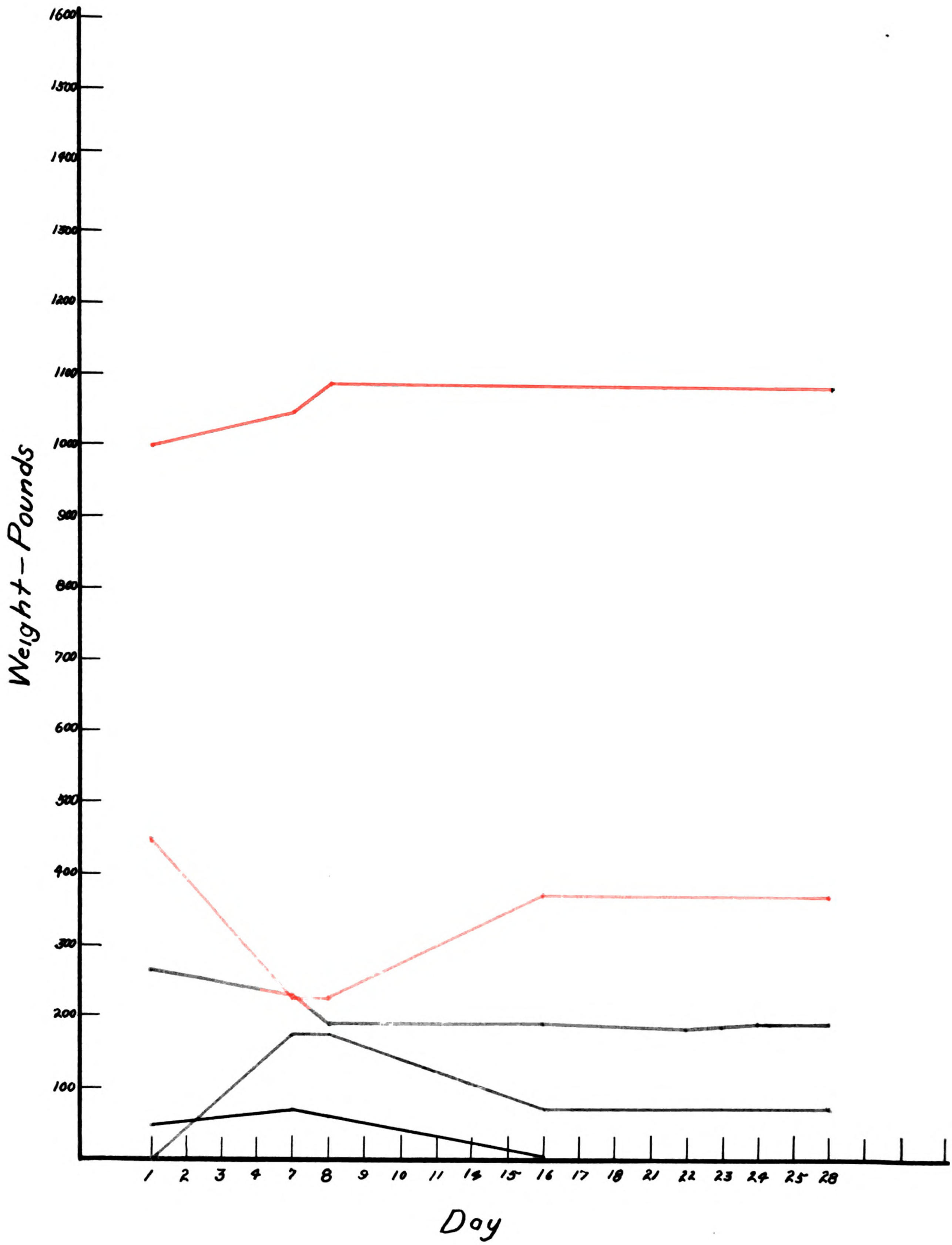
Silicon 1.9-2%, Manganese 0.6% Phosphorus 0.12%

Olds briquetted borings:

Silicon 2.4-2.5%, Manganese 0.6% Phosphorus .199%

* Our differentiation of pig iron.

FEBRUARY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Weight – Pounds
1 2 3 4 7 8 9 10 11 14 15 16 17 18 21 22 23 24 25 28
Day

FEBRUARY 1938	CUPOLA CHARGE MIXTURE — Weights – Lbs														Calculated %			CHEMICAL ANALYSIS Average for Day — Cupola Iron %				Electric Furnace Iron %				
Day	COKE	LIMESTONE	PURITE	PITCH COKE	REGULAR PIG IRON	HI-PHOS PIG IRON	SILVERY PIG IRON	BORINGS	PLATE STEEL	RETURNS	CHROMIUM BRIQUETS	MANGANESE	SILICON BRIQUETS	TOTAL	SILICON	MANGANESE	PHOSPHORUS	TOTAL CARBON	SILICON	MANGANESE	PHOSPHORUS	TOTAL CARBON	SILICON	MANGANESE	PHOSPHORUS	SULPHUR
1	200	70	4	50		450	50	1000	268	250	2			2000	2.45	.97	.18	3.31	2.06		.198	355	2.17	.80	.197	.131
2	200	70	4	50		450	50	1000	268	250	2			2000	2.45	.97	.18	3.35	2.21		.192	3.53	2.22	.79	.201	.136
3																										
4																										
7	200	70	4	50	175	225	70	1050	230	245	2	3		2000	2.41	1.02	.175	3.32	1.99		.162	3.44	2.13	.87	.168	.125
8	200	70	4	50	175	225	60	1090	190	255	2	3		2000	2.39	1.02	.175	3.34	2.11		.162	3.55	2.21	.95	.177	.140
9																										
10																										
11																										
14																										
15	200	70	4	50	175	225	60	1090	190	255	2	3		2000	2.39	1.02	.175	3.23	1.86			3.47	2.10		.182	.163
16	200	70	4	50	75	375		1090	191	260	2	3	4	2000	2.47	.99	.192	3.42	2.02		.168	3.55	2.11	.68	.174	.152
17																										
18																										
21	200	70	4	50	75	375		1090	191	260	2	3	4	2000	2.47	.99	.192	3.33	1.98		.197	3.51	2.13	.73	.196	
22	200	70	4	50	75	375		1090	189	260	2	3	6	2000	2.47	.99	.192	3.38	2.21		.184	3.55	2.24		.189	
23	200	70	2	50	75	375		1090	191	260	2	3	4	2000	2.37	.99	.192	3.37	1.99		.181	3.51	2.13		.174	
24	200	70	2	50	75	375		1090	195	260	2	3		2000	2.30	.99	.192	3.39	2.02		.187	3.55	2.12		.177	.163
25																										
28	200	70	2	50	75	375		1090	195	260	2	3		2000	2.29	.99	.192	3.33	1.88		.184	3.49	2.20		.178	.178

FEBRUARY, 1938

Olds briquetted borings were used the whole month except for two days when the Reo briquetted borings were used.

Reo briquetted borings:

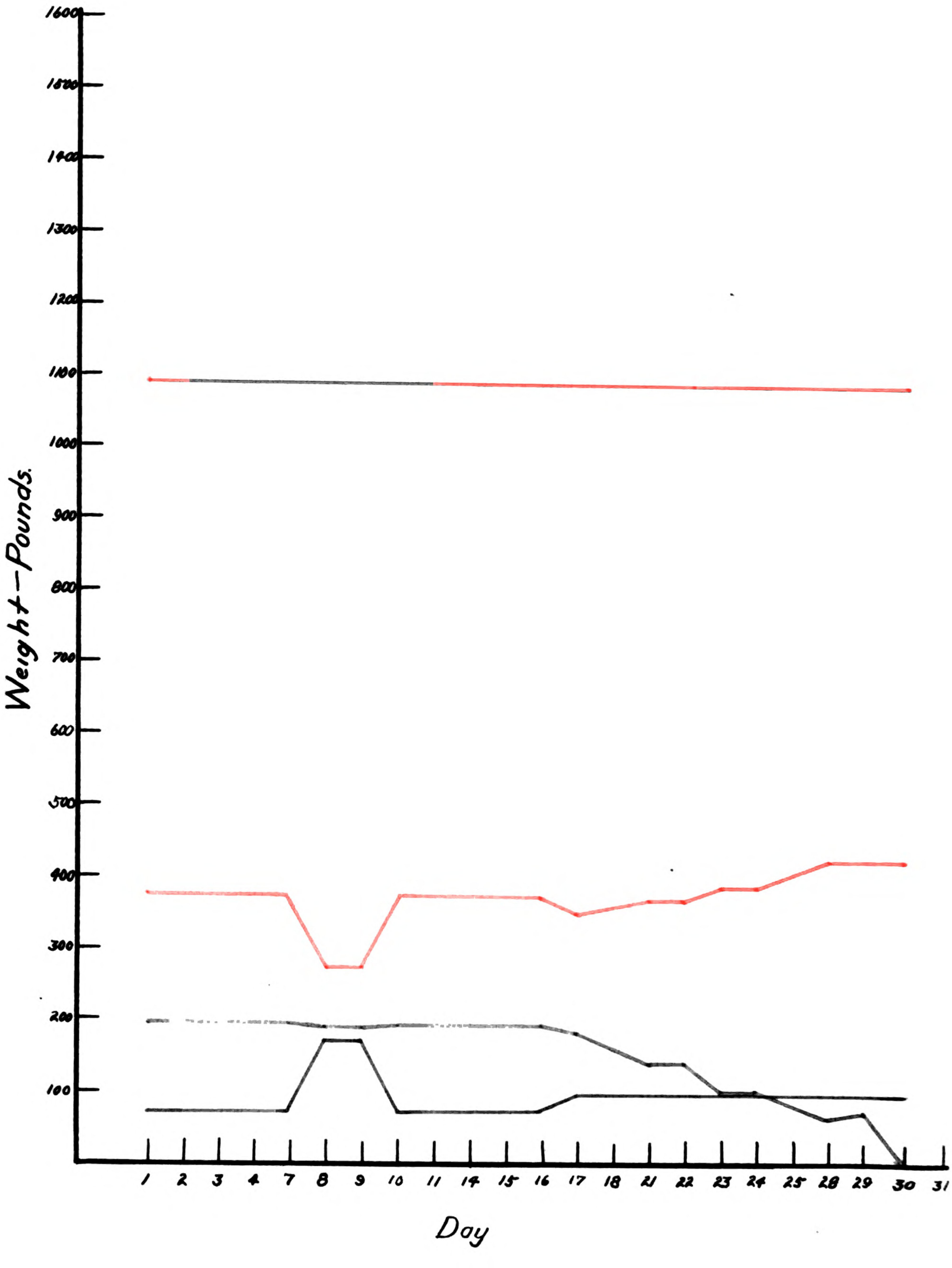
Silicon 2.3% Manganese 0.6% Phosphorus 0.18%

January and February scrap loses were materially decreased. Whether that was due to the rejuvenation of our boring system by the use of Olds and Reo borings, along with increasing fluidity of our iron by increasing the phosphorus or changes made in our fluxing, heating, and spinning operations is open to argument. Anyway, our scrap loses were down and the use of briquetted borings were not under suspicion as before.

We were fortunate in being able to get hourly cupola analysis as well as the hourly electric furnace analysis, which gave us better control of our melting operations. Also gave more accurate idea of silicon loss due to briquets being used (under milder blast conditions due to decreased production).

In the near future we are hoping to have our laboratory set up so that we can take analysis every one half hour, alternating between cupola mixing ladle and electric furnace. We realize by now that to be able to use briquetted borings successfully it is essential that we keep all our elements in specified limits at all times.

MARCH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Weight—Pounds.
1 2 3 4 7 8 9 10 11 14 15 16 17 18 21 22 23 24 25 28 29 30 31
Day

MARCH 1938	CUPOLA CHARGE MIXTURE																	CHEMICAL ANALYSIS Average for Day								
	Weight - Lbs.														Calculated %			Cupola Iron %				Electric Furnace Iron %				
Day	COKE	LIMESTONE	PURITE	PITCH COKE	REGULAR PIG IRON	HI-PHOS PIG IRON	SILVERY PIG IRON	BORINGS	PLATE STEEL	RETURNS	CHROMIUM BRIQUETS	MANGANESE	SILICON BRIQUETS	TOTAL	SILICON	MANGANESE	PHOSPHORUS	TOTAL CARBON	SILICON	MANGANESE	PHOSPHORUS	TOTAL CARBON	SILICON	MANGANESE	PHOSPHORUS	SULPHUR
1	200	70	4	50	75	375		1090	195	260	2	3		2000	2.29	.99	.19	3.33	1.93		.175	3.48	2.12			
2	200	70	4	50	75	375		1090	195	260	2	3		2000	2.29	.99	.19	3.35	1.94		.185	3.52	2.12		.197	
3	200	70	4	50	75	375		1090	195	260	2	3		2000	2.29	.99	.19	3.33	1.98		.18	3.50	2.19		.184	
4																										
7	200	70	4	50	75	375		1090	195	260	2	3		2000	2.29	.99	.19	3.35	2.01		.175	3.57	2.11		.184	
8	200	70	4	50	175	275		1090	193	260	2	3	2	2000	2.32	1.06	.19	3.31	2.04		.173	3.57	2.09		.196	
9	200	70	4	50	175	275		1090	193	260	2	3	2	2000	2.32	1.06	.19	3.33	2.00		.172	3.55	2.07		.192	
10	200	70	4	50	75	375		1090	194	260	2	4		2000	2.29	1.13	.20	3.27	2.04			3.55	2.04	.88		
11																										
14	200	70	4	50	75	375		1090	194	260	2	4		2000	2.27	1.13	.204	3.16	1.95			3.56	2.06			.139
15	200	70	4	50	75	375		1090	194	260	2	4		2000	2.27	1.13	.204	3.11	2.04			3.57	2.10		.194	.17
16	200	70	4	50	75	375		1090	194	260	2	4		2000	2.27	1.13	.204	3.16	1.77			3.58	2.08	88		.177
17	200	70	4	50	100	350		1090	188	260	2	6	4	2000	2.26	1.10	.215	3.25	1.85		.193	3.50	2.10		.188	
18																										
21	225	70	4	50	100	370		1090	142	280	2	6	10	2000	2.39	1.03	.219					3.45	2.16		.213	
22	225	70	4	50	100	370		1090	142	280	2	6	10	2000	2.39	1.03	.219					3.48	2.15		.22	
23	225	70	4	50	100	390		1090	104	300	2	6	8	2000	2.52	1.06	.22	3.32	2.21			3.52	2.26		.21	.141
24	225	70	4	50	100	390		1090	104	300	2	6	8	2000	2.52	1.06	.22					3.43	2.25		.247	.148
25																										
28	225	70	4	50	100	425		1090	69	300	2	6	8	2000	2.54	1.07	219					3.48	2.24		.251	.142
29	225	70	4	50	100	425		1090	73	300	2	6	4	2000	2.55	1.08	.224	3.36	2.19			3.48	2.24	.855		.171
30	225	70	4	50	100	425		1090		369	2	6	8	2000	2.65	1.08	.224					3.52	2.37	1.11	.246	.158
31																										

MARCH, 1938

Average silicon loss in cupola for this month was 0.32% as against February loss of 0.39% average,

As stated in February comments we did not need to force our cupola as much which materially aids in reducing silicon and carbon losses.

Experience is showing us the desirability of buying pig iron made to our particular specification-3.5%-4.5% silicon, 0.5-.75% phosphorus, 1.75-2.25% manganese, sulphur as low as is reasonably possible.