

CHIEF ENGINEER'S FILE No. 236

THE BALTIMORE AND OHIO RAILROAD COMPANY
Engineering DEPARTMENT.

Report On
Ore Handling Machinery

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Office of General Manager,
Baltimore, Md.

Jan. 30, 1911.

Prepared in Dec 1909
Subject to revision

Mr. A. M. Schoyer,
General Superintendent.

Dear Sir:-

Complying with your request of July 22nd, 1909, the Committee to report on Ore Handling Facilities for Erie and Cleveland submitted separate reports on the future requirements for docks at Erie and Cleveland.

We submit the following supplemental report as to the kind of machinery:

When the matter of new ore handling machinery for Ashtabula Harbor was under consideration, several reports were submitted to Mr. Peck, as follows: June 14th, September 26th and December 14th, 1905. The merits of the different machines were canvassed at the time, and we have now to consider the development during the past four years.

Three makes of machines were considered in 1905, as follows:

Hulett Ten-Ton Unloader;
Brown Five-Ton Unloader;
Hoover & Mason Six-Ton Unloader.

The Hoover & Mason machine was adopted largely on account of the bins and roller arrangement which admitted of such rapid loading of cars that this could be done on one track without separating the cars, thereby reducing the switching.

Since the construction of our Ashtabula Plant, all ore handling installations made by the United States Steel Corporation have been of the Hulett type. An effort was made to secure a copy of the report made by the Committee of the United States Steel Corporation, with a view of ascertaining the reasons which induced it to use the Hulett Unloaders, but we were unsuccessful in securing a copy of the report, and waiting for this report has caused us a delay of several months. We had, therefore, to secure the information through personal investigation and numerous interviews with different parties in regard to the merits of the different machines.

Hulett Unloaders have been installed as follows:

Five, Ten-Ton Unloaders at Gary, in 1900; two, Ten-Ton Unloaders on the American Steel & Wire Co. dock at Cleveland; one, Ten-Ton for the Wicks Wire Co. at Buffalo; three, Ten-Ton machines are being built for the Corrigan-McKinney Co., for use at Cleveland; four, Fifteen-Ton Unloaders in 1909, by the United States Steel Corporation on L. S. & M. S. Ry. Co. dock at Ashtabula; and four, additional Fifteen-Ton machines for the L. S. & M. S. Ry. Co. dock at Ashtabula.

In addition to the above machines, one Fifteen-Ton Hulett has been ordered by the Pittsburgh & Conneaut Dock Co. for Conneaut, and two Fifteen-Ton Huletts have been ordered by the C.H.&D. Ry. for Toledo.

Since April, 1906, the Brown Hoisting Machinery Co. has installed six unloaders at Fairport; four unloaders with weighing device on the N. Y. P. & O. dock at Cleveland; four unloaders for the New York Central Lines at Buffalo; and three unloaders for the International Harvester Co. at Chicago. All of the above were built in 1907.

We do not know of any Hoover & Mason unloaders having been installed since the construction of our Ashtabula Plant.

We consider the weighing of the ore at the machines to be an essential complement of any plant to be built on our Docks. Weighing the ore is not done at any plant constructed by the Steel Corporation, excepting the one at Ashtabula on the Lake Shore Docks. At Ashtabula the weighing device on one machine only has been made to work in a satisfactory way, and we have been unable to get any records at this plant under the conditions of weighing ore.

Our present investigation has been made with a view of comparing the performances of modern machines with the performances of the Hoover & Mason plant on our Dock No. 10 at Ashtabula. This investigation has been made along the following lines:

1. TONS HANDLED PER MACHINE PER HOUR.
2. POWER CONSUMPTION PER TON HANDLED.
3. REPAIRS TO MACHINERY PER TON HANDLED.
4. WEIGHING AT THE MACHINE.
5. DAMAGE TO VESSELS DUE TO UNLOADING.
6. FIRST COST OF MACHINERY.
7. TOTAL COST OF OPERATION PER TON HANDLED.
8. TRUCK ARRANGEMENT.

These items do not necessarily rank in value in the order given above. In our judgment, the most essential items are, (a) weighing at the machine, which affects (b) the truck arrangements; and (c) cost of switching; the cost of switching being one which affects the revenue of the Railroad Co. only.

1 - TONS HANDLED PER MACHINE PER HOUR.

Hulett Ten-Ton Unloaders

The record for one machine for one hour is 700 tons, made during the early stages of operation on a modern 10,000-ton boat. At Lorain, four machines unloaded a 10,000-ton boat at the rate of 466 tons per leg per hour, net time, including cleaning up, which is the best record furnished us.

There was no weighing. Other records of over 400 tons per leg per hour have been made.

Records of the five Ten-Ton Unloaders at Gary were furnished by Mr. C. C. Thorp, Vice President of the Indiana Steel Company, as follows:

One machine, one hour, - - - - -	345 Tons Per Hour.
Five machines on one boat (Net Time) - - - - -	1,807 " " "
" " " " " (Gross Time) - - - - -	1,491 " " "
Season of 1909, 1,921,816 tons in 11,639 Hrs. - - -	165 " " " per leg.

Bullet Fifteen-Ton Unloaders:

These machines were installed in August, 1909, and have been in the hands of inexperienced operators. No effort has been made to establish records for fast unloading. The operations of the machines as observed indicate that they ought to handle 400 to 450 tons per leg per hour throughout the season, provided the track arrangement, weighing devices and switching are such as to weigh the ore and remove it promptly.

The new Fifteen-Ton Unloaders for Comacant will be placed on the Dock with the four Brown machines and work in conjunction with them. It is stated that four Browns with the one Fifteen-Ton Bullet Unloaders will equalize the unloading now done at the dock by four Ten-Ton Bullets.

Brown Machines:

The best record was made at Fairport where six legs unloaded a modern 10,000-ton boat at the rate of 327 tons per leg per hour, gross time, from start to finish. A number of boats have been unloaded at the rate of 300 tons per leg per hour, the ore not being weighed. The four machines on the Erie dock at Cleveland have not done so well, the ore is weighed but our observations lead us to believe that the best results are not obtained. These machines, with proper track arrangement and facilities for weighing and taking away the ore, ought to do just as well as the Hoover & Mason machines at Ashtabula.

Hoover & Mason, Dock No. 10 Ashtabula:

The best record made with six legs was 412 tons per leg per hour, gross time, from start to finish, in a modern 10,000-ton boat. A number of Class "A" boats have been unloaded at the rate of from 300 to 330 tons per leg per hour, gross time. During the Season of 1909, from May 14th to September 29th, 61 Class "A" boats, with a tonnage of 592,300, were unloaded at the rate of 267.7 tons per leg per hour, gross time.

The record for the Season of 1909, is as follows:

Total tons handled - - - - -	5,166,385 Tons.
Gross Time 2,633.55 hours.	
Net " 2,082.00 "	
Lost " 551.55 "	
Tons per leg per hour (Gross Time)	200 "
" " " " " (Net Time)	253 "

The effect of including all delays, is shown by the following record, made in 1909, on 76 boats:

Total tons handled - - - - -	755,521
Total Time of boats at dock, hours, - - - - -	485
Time lost, not chargeable to machine, hours, - - - - -	254
Tonnage handled per leg per hour, incl. delays, - - - - -	259
Tonnage handled per leg per hour, excl. item #5, - - - - -	334

The following is a record of some performances of individual unloaders, from start to finish, on Class "A" boats:

Steamer	Date	Machine	Tonnage	Average	
				Gross Time	Net Time
D.J. Morrell	July 24	No. 2	2,241	352	380
W.A. Hawgood	" 24	No. 5	2,072	389	402
W.C. Mather	" 26	No. 2	1,904	333	367
J. Laughlin	Aug. 7	No. 5	2,504	466	481
A.W. Thompson	" 20	No. 2	1,911	356	386

The following table contains the information obtained from all sources, relative to tons handled per machine per hour under different conditions:

Description of Record	Bulett		Brown: H. & H.	
	Ten-Ton	15-Ton	Ashtabula	
	Lorain	Gary	Ashtabula	
One Machine for One Hour	641	445	900	493 : 472
One Machine, start to finish, Net Time	480	417	637	395 : 481
One Machine, start to finish, Gross Time	479	353	572	341 : 466
Set of Machines, start to finish, Net Time	466	361	510	388 : 442
Set of Machines, start to finish, Gross Time	464	298	420	327 : 412
Set of Machines, start to finish, on a number of boats, Net Time	10 boats: 460		10 boats: 463	359 : 369
Set of Machines, start to finish, on a number of boats, Gross Time	10 boats: 400		10 boats: 407	308 : 397
Gross		100		200
Net		165		252 : 254

In making any comparisons of records of ore unloading, it is necessary to know the conditions under which the record was made. The following items affect records: Supply of cars; switching; ore weighed or not weighed; ore stored or loaded in cars; style of boat unloaded; number of shovellers in boat, etc. We have taken into consideration all these matters in looking up the records and in making our comparisons.

2 - POWER CONSUMPTION.

It is impossible to get exact information for all machines for the reason that few plants are equipped with registering devices, and further that on account of current being furnished from a power plant for different purposes, an arbitrary division is sometimes made. A fair estimate of power for the Hulett Ten-Ton is 0.40 K. W. Hours per ton, and for the Hulett Fifteen-Ton, 0.35 K. W. Hours per ton. The records of the Brown Machines at Fairport indicate that for the Year 1908 the consumption was 0.363 K.W. Hours per ton, and for 1909 0.341 K. W. Hrs. per ton. We have accurate information for the Hoover & Mason machines at Ashtabula. The consumption during 1908 was 0.472 K.W. Hours per ton, and for the Season of 1909 0.42 K. W. Hours per ton, the lowest record being 0.406 K. W. Hours per ton for August, 1909.

The information we have indicates little difference in power consumption between the Ten-Ton Hulett and Hoover & Mason unloaders per ton of ore handled. The Brown machines appear to consume a little less power, and this is probably due to the fact that the bucket on the Brown machines weighs 12,000 lbs. as against 15,500 lbs. for the Hoover & Mason bucket, and the trolley weighs 64,400 lbs. as against 105,000 lbs. for the Hoover & Mason trolley.

It costs \$0.02177 per K. W. Hour to furnish current at Ashtabula Power Plant. Taking an extended period of time, the cost per ton for power for Unloaders was \$0.00912 per ton and \$0.0072 per ton for ore handled by the Bridge.

Applying our cost to produce power to the amounts of power required by the different machines, we have the following result:

Hulett Ten-Ton Machine - - - - -	Cost per ton, - -	\$0.0088
" Fifteen-Ton Machine, - - - -	" " " , - -	0.0077
Brown Five-Ton Machine - - - - -	" " " , - -	0.0077
H. & M. Six-Ton Machine - - - - -	" " " , - -	0.0092

On the basis of handling 4,000,000 tons in a season, the cost of power would be for:

Hulett Ten-Ton Machine - - - - -	\$ 35,200
Hulett Fifteen-Ton Machine - - - - -	30,600
Brown Five-Ton Machine - - - - -	30,800
H. & M. Six-Ton Machine - - - - -	36,800

Size of power plant is largely dependant upon the peak loads obtained in the operation of the unloading machinery. Therefore, there will not be as much of a saving as indicated by the above figures on account of a reduction in power consumption. The only items affected by such a reduction would be the consumption of coal, oil and waste.

3 - REPAIRS TO MACHINERY PER TON HANDLED.

Statistics for this item are difficult to get, as all operating companies are unwilling to give accurate information relative to their operations. From a statement of the cost of handling ore, said to have been compiled by a Committee of the United States Steel Corporation, prior to the purchase of the plant for the Lake Shore Dock at Ashtabula, and from a similar statement prepared by us for the Hoover & Mason plant on Dock No. 10, Ashtabula, the cost for repairs is as follows:

Machine	Location	Built	REPAIRS PER TON		
			1907	1908	1909
Hulett	Lorain	1906	0.0169		
	Comacant	1898-9-00	.0159		
Brown	Comacant	1906	.0135		
	Fairport	1907	.0098		
	Cleveland		.0289		
Hoover & Mason	Ashtabula	1907	.0153	.0198	.0169

The 1909 figures for Dock No. 10 are not complete, and will be increased by the repairs to be made this winter. The figures for 1907 and 1908 are low for the reason that Hoover & Mason spent considerable money on the plant, for which no charge was made to the Railway Company.

Below is the record for expenditures for repairs on the Hoover & Mason plant at Cleveland, built in 1908; it should be stated, however, that the machine is of different design from our Ashtabula Plant:

Year	\$	per ton handled.
1903		.0043
1904	7,436	.0105
1905	17,377	.0153
1906	28,627	.0206
1907	27,303	.0101
1908	19,370	.0209

4 - WEIGHING

Hulett:

The ore from vessels is dropped into a 70-ton hopper, arranged with two compartments of 35 tons each. At the bottom of each compartment is a horizontal disc, revolved by an electric motor.

A larrie, supported on scales and equipped with a 40-ton hopper for carrying ore either to cars or to the storage trough, runs on an inclined track located under the track on which the stiff leg moves. The operator of the larrie car can control the scales and do the weighing, but this arrangement does not prove satisfactory in rapid operation, and it will be necessary to have separate men for weighing.

The Unloaders at the Central Furnace Plant at Cleveland are equipped with scales and disc, but these are seldom used. We are advised that they are not a success - particularly the discs.

The plant on the Lake Shore Dock at Ashtabula is similarly equipped, but but they were not in operation during our visit.

Brown:

The machines on the N. Y. P. & O. Dock at Cleveland are equipped with a 200-ton hopper for each unloader, to the bottom of which is attached undercut gates similar to the gate used on the coal machines. The hopper is supported on the scales and the weighing is done by the gate operator. The operation of the gates is positive, and with the exception of sticky ore, very good control over the flow of ore is obtained.

Hoover & Mason:

Each unloader on Dock No. 10 is equipped with a hopper, with two compartments, of about 80 to 90 tons capacity and supported on scales. At the bottom of the hoppers are two large cylinders, operated in opposite directions by electric motors so that the ore flows from the hoppers between the cylinders into the cars.

The weighman walks along a platform at about the level of the body of a car and reads a conveniently located dial with large figures. The cylinders are operated from the same platform. One man with two labor assistants does the weighing and loading into cars for six machines.

If the ore sticks on either side of the hopper, the flowing ore has a tendency to drop to one side of the center of the car, necessitating trimming.

5 - DAMAGE TO VESSELS.

There seems to be good grounds for the claim that the grab bucket causes more damage to boats than the stiff leg, for in the former case the operator is located 50 feet above the ore and he does not have the same control over the lateral movement of the bucket that is obtained in the stiff leg machine, where the operator is only a few feet from the bucket at all times, and can regulate all of its movements with precision.

The Steel Corporation is more particular about this feature than the other vessel owners, and being in control of large shipments of ore, it behooves the ore handling company to cause as little damage to boats as possible.

From the information we have been able to collect, the amount paid out for damages to vessels to the owners does not amount to much. The only definite information is from a statement by Mr. Hulett, from which we find damage to vessels, per ton handled, to be:

For Hulett Machines:

Comcast, 1907	-----	\$ 0.0011
Lorain, 1907	-----	0.0002

For Brown Machines:

Comcast, 1907	-----	\$ 0.0008
Fairport, 1907	-----	0.0003

Although Mr. Hulett emphasizes this point in discussing his machine, the figures he furnishes can hardly be said to favor his claim. Nevertheless, we are of the opinion that there is less likelihood of damage to vessels by the Hulett machine than by the others. The risk is not great until the cleaning up period is reached, at which time a bucket dropping into the hold is likely to cause more damage than when a bucket drops on a pile of ore. However, it is well to avoid, as far as possible, damage to vessels in unloading.

6 - FIRST COST OF MACHINERY.

The bids received in 1906, for the three makes of machines considered for Ashtabula, were:

Hoover & Mason - - - - -	\$262,320, or \$43,720 per leg;
Brown Hoist - - - - -	341,000, or 56,833 " "
Hulett (10-Ton) - - - - -	255,000, or 42,500 " "

The Hoover & Mason machines will have to be made stronger and heavier so that the cost for such a plant to satisfy our requirements will now be higher.

It is believed that the different makes of machines will cost now about as follows:

Hoover & Mason- - - - -	\$ 60,000 per leg;
Brown Hoist - - - - -	70,000 " "
Hulett (15-Ton)- - - - -	115,000 " "

Note: The Hulett machines now being built cost \$110,000 per leg. We would require greater capacity in the larries and bins and some changes in other details which would increase the cost to probably \$115,000 per leg. To this should be added a haulage system, cost \$50,000.

For a plant of 6 Hoover & Mason, or 6 Brown, or 4 Hulett, the annual charge for interest and depreciation, at ten percent for both, would be for:

	<u>Without Haulage</u>	<u>With Haulage</u>
Hoover & Mason machine - - - - -	\$36,000	
Brown - - - - -	42,000	
Hulett- - - - -	46,000	\$49,000.

The cost, per ton, due to interest and depreciation, based on handling 4,000,000 tons in a Season would be for:

Hoover & Mason machine - - - - -	\$ 0.009	
Brown - - - - -	0.0105	
Hulett- - - - -	0.0115	@ 0.0122

7 - COST OF OPERATION.

Assuming a plant consisting of four 15-ton, or four, 10-ton Hulett, or six Brown or Hoover & Mason, then the cost of these items affected by the type of machine would be as follows:

Men Employed	Number of Men			Rate of Wage	Total Per Month
	Day	Night	Total		
HILTE					
Operators	4	4	8	\$105	\$ 840
Barrie Car	4	4	8	90	640
Scallan	4	4	8	70	560
Oilers	4	4	8	80	640
Machinists	3	2	5		470
General Repairmen	4	0	4		290
Electricians	2	2	4		320
Total	25	20	45		3,760
HOOVER & MASON					
Operators	6	6	12	105	1,260
Barrie Car					
Scallan	6	6	12		657
Oilers	2	2	4	80	320
Machinists	8	5	13		1,020
General Repairmen	8	3	11		802
Electricians					
Total	39	26	64		5,031

The number of men and amount of wages for 6 Brown Machines will be practically the same as for 6 Hoover & Mason Machines.

The above tables show cost for 26 working days of two ten-hour shifts each. Reduced to a ten-hour working period we have labor cost for:

Four Hilett Machines to be	52	\$ 72.30
Add wages of laborers in hold of vessel, five for each machine at 28¢ per hour		56.00
Total		\$128.30
Six Brown or Hoover & Mason Machines, we have 5,031 + 52		\$ 97.71
Add wages of laborers in hold vessel, 6 x 5 = 30 at 28¢ per hour		84.00
Total		\$181.71

Assuming that machines on basis of a season's business have an average capacity per leg in tons per hour, on Class "A" boats, as follows:

Bullett 10-Ton Machine, - - - - -	375
Bullett 15-Ton Machine, - - - - -	450
Brown - - - - -	270
Hoover & Mason, - - - - -	270

and applying cost of operating as above, we have the following table of results:

	Bullett, 4, 10-ton	Bullett 4, 15-ton	6 Brown or 6 Hoover & Mason
Average capacity per leg per hour, Tons	375	450	270
Average capacity of plants per Hour, Tons	1500	1800	1620
Average capacity for 10 hours, Tons	15000	18000	16200
Labor cost for 10 hours	128.30	128.30	181.71
Cost per ton handled	.0085	.0071	.0112
Cost to handle 4,000,000 tons, labor only	34,000	29,400	44,800

SUMMARY

Summing up what precedes relative to cost of plant, fixed charges, cost of power and cost of labor for which we have definite knowledge, and eliminating cost of switching and also cost of repairs and damages to vessels, for which we do not have comparative figures, and which cannot materially affect the result, we have the following statements of cost:

(A). Cost per ton.

	Hoover & Mason	Brown	Bullett 10-Ton	Bullett 15-Ton
Fixed Charges	0.009	0.0105	0.0105	0.0115
Cost of Power (*)	.0022	0.0077	0.0088	0.0077
Labor Handling	0.0112	0.0112	0.0085	0.0071
Total	0.0224	0.0294	0.0278	0.0263

(B). Cost for 4,000,000 Tons.

	Hoover & Mason	Brown	Bullett 10-Ton	Bullett 15-Ton
Fixed Charges	\$36,000	\$42,000	\$42,000	\$46,000
Cost of Power (*)	36,000	30,800	35,200	30,800
Labor Handling	44,800	44,800	34,000	29,400
Total	117,600	117,600	111,200	106,200

(*) See note, Page 5, Paragraph 6.

The preceding statements of cost show that it does not matter much which make of machine we buy, provided that the weighing and loading of the ore into cars can be done by simple devices and simple track arrangement.

8 - TRACK ARRANGEMENT.

The track arrangement affects the expense of the Railway Company. A simple track arrangement means a reduction in the switching service to be performed.

The simplest track arrangement known to us is the one on Dock No. 10 at Ashtabula, where all of the loading is done on one track. There are two tracks under the machine, only one of which is used for loading. On the Lake Shore Dock at Ashtabula, there are five tracks under the machines, four of which are used for loading, although loading can be done on any of the five tracks. At Comeaut, Fairport and other places where Hulett and Brown Machines are used, there are from three to five tracks under the unloaders. Although the machines on the Lake Shore Dock at Ashtabula have been in use but a few months, we understand that on account of the large number of switching engines found necessary, that a rope haulage system is contemplated. We do not think that such an installation will get rid of the difficulties that have arisen. It simply removes the trouble from one place to another, with the addition of another factor to be taken care of. It costs, in round numbers, to operate one engine, including interest, repairs, depreciation, wages and fuel per day of 24 hours - - - - - \$ 50
 For 300 working days, cost will be - - - - - 10,000
 On basis of 4,000,000 tons handled
 cost of switching per ton per engine
 used will be - - - - - 0.0025

The cost of switching per ton on the Lake Shore Dock at Ashtabula is at least double the cost of switching on our P. Y. & A. Dock.

Mr. Hulett advocates a rope haulage system with his machines. A Haulage system is in use at Comeaut. An argument in favor of the rope haulage, in addition to reducing the switching charge, is that the smoke from the switching engines damages the machinery and also at times interferes with the operators overhead.

Attention is called to the fact that more tracks and ground are required for a layout with Hulett Machines than with the Hoover & Mason. Where there is ample ground, this would not be important, but with a narrow piece of ground available it would make a great difference in storage capacity, as to which plan is adopted. Space given up to loading tracks curtails the space available for storage purposes. With a development such as contemplated by us at Erie or Cleveland, the additional tracks required for a Hulett layout would be at least 2500 feet and the ground occupied would amount to about an acre and a half, representing an investment of about \$5000.

CRITICISMS OF MACHINES.

Hoover & Mason:

Favorable-

- .. The method of discharging from bins to cars by means of rollers is the best in use, although eccentric loading of cars sometimes occurs.
- The weighing device, while as good as any, can probably be improved.
- The six machines load cars on one track only.

Adverse-

The Hoover & Mason buckets are very heavy, but they are subjected to severe service, and it is doubtful if they can be made lighter. They should be equipped with manganese lips.

Future unloaders should be more carefully designed and have additional motor capacity.

The workmanship should be improved in many parts, as it is not equal to that of the Brown Hoisting Machinery Co., and the Wellman-Seaver-Morgan Co., manufacturers of the Hulett Machine.

The arrangement of hoisting ropes should be changed if possible to reduce wear and frequent breakages.

Brown Hoist:

Favorable-

Design and workmanship very good.

The arrangement of hoisting ropes where connected to the bucket, is better than Hoover & Mason, resulting in less wear and fewer breakages than in the Hoover and Mason rigs.

The traversing mechanism for both the trolley and the rig are very good.

Adverse-

Buckets are too light. We are advised that they have to be strengthened where used at Comenut, Fairport, etc.

The method of discharging from bins to cars less positive than Hoover & Mason. Cars can be loaded on one or more tracks.

Hulett:

Favorable-

The latest unloaders are well designed and the workmanship is good.

It has some advantage, on account of its reach, in working in hatches, which are spaced 24 feet on centers.

The smaller machines have advantage over the larger ones in cleaning up.

Does less damage to boats in unloading.

Requires smaller working force; therefore, less operating cost.

Affords greater safety to men working in the hatch than the gravity type.

Adverse-

Capacity of larric should be increased from 30 to 40 tons to provide for larger cars of the H-21 type.

Weighing and loading not as simple as Hoover & Mason, but has the advantage of allowing dumping into bins without affecting scale weights.

Requires a number of tracks for loading cars; consequently, more switching.

Conclusions:

Two, 5-ton or three 5-ton gravity unloaders will have an advantage in cleaning up over one 10-ton or one 15-ton Hulett.

A gravity machine, combining all the good points of the Brown and the Hoover & Mason machines, will handle ore as fast and as economically as the Hulett Unloaders.

