The great diversity of interpretation of the term "reasonable" was particularly apparent to the writer of this paper recently, when he served as chairman of a *Committee for the General Industries* to suggest "Reasonable Equipment for a Works Dispensary" under the Compensation Act in Pennsylvania. Every physician on the committee had his own conception of "reasonable," based on his personal contact with industrial surgery and medicine, and suggested a somewhat different selection of equipment. It was the consensus of opinion in the committee, however, that the industrial physician in charge in each plant should have latitude in the selection of the required equipment, subject to the approval of the compensation board, on the grounds that what is reasonable in one industry might be excessive or inadequate in another.

Car Handling on Ore Docks

Rope Haulage vs. Electric Locomotives

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THE problem of handling cars at plants where the loading or unloading is accomplished with rapidity, and consequently entails the handling of a great number of cars in a short space of time, such as prevails in the handling of ore and coal on the Great Lakes, has been successfully solved by two methods, one of which is "rope haulage," and the other by the use of electric locomotives.

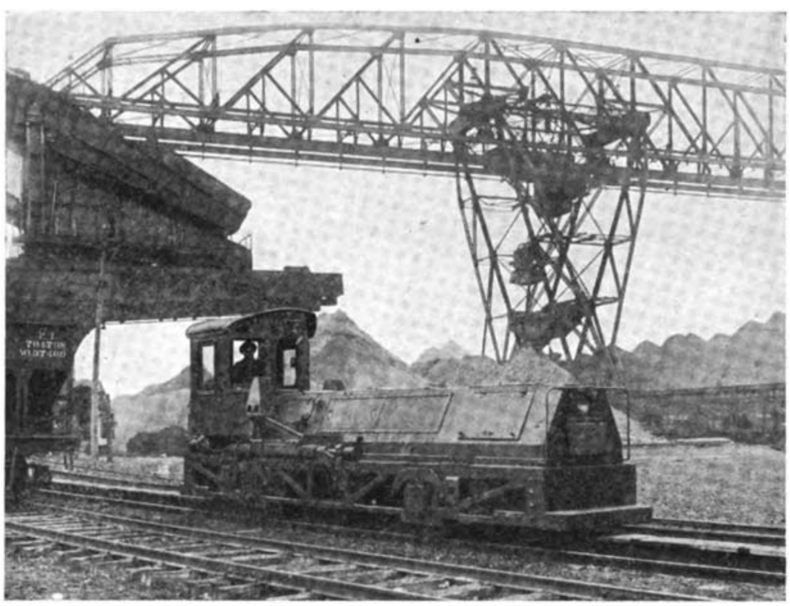

FIG. 1—25 TON BALDWIN-WESTINGHOUSE POLING LOCOMOTIVE

Adhesive weight, 50 000 pounds. Each axle is equipped with an independently geared 112 horse-power, 250 volt, 384 ampere motor. Gauge of track, 3 feet 6.5 inches; diameter of drive wheels, 36 inches; rigid wheel base, 12 feet; length over end frames, 26 feet 8 inches; width over all (exclusive of poling parts), 5 feet 6.5 inches. Maximum momentary tractive effort with 25 percent adhesion, 12 500 pounds; tractive effort for one hour at approximately 7.4 miles per hour, with 250 volts at the motor, 10 800 pounds. Equipped with HL electro-pneumatic control and pneumatically-operated brake rigging with shoes on all wheels, and also with hand brakes.

The cars of ore and coal at the Lake Erie docks were formerly handled entirely by steam locomotives, and are today to a considerable extent. These cars are handled in trains of twenty or more cars and, as the individual cars must be spotted positively at a given point, the operation precludes the application of the air brake and, as a consequence, the steam locomotive loses its efficiency. The capacity of the loading or unloading machinery is contingent upon the movement of the cars, and efficient spotting is naturally essential.

The modern loading machines are electrically driven, and as the cars pass directly under the structure the gases and smoke from the steam locomotive are not only seriously detrimental to the electrical parts, but interfere with the operator in the discharge of his duties. Other disadvantages and expense are presented by reason of the fact that the steam locomotive operates on the same track with the cars.

Rope haulage has been in use for a number of years, but was not generally considered an entire success until the year 1911, when an improved system was installed by the Lake Shore & Michigan Southern Railway on its ore docks at Ashtabula Harbor, Ohio. The ore-unloading machinery on these docks consists of four Hulett solid-arm, clam-shell buckets of 15 tons capacity each, capable of making a round trip per minute. With the four machines working at maximum capacity, 72 cars are loaded and ready for road movement in an hour.

Seven steam locomotives were required in this operation prior to the above installation. There are four loading tracks beneath the unloaders, or one track for each machine. A 1.5 inch steel cable is laid on top of the ground between two of the loading tracks and is held in alignment by guide sheaves spaced at regular intervals. This cable moves at a given speed of about 0.6 miles per hour from drums located in a power house convenient to the stretch of loading tracks. Grips with a hook for engaging the car are used to transmit the movement to the car. The men operating these grips are required to let go of the cable at each guide sheave and grip the cable again on the other side. The space in which they are required to work must necessarily be a narrow one, and the operation is consequently more or less dangerous.

There is no elasticity to rope haulage, as all cars must move at the speed of the cables, and the operators must be skilled in their manipulation in order to get results in proper spotting. The return of this cable to the power house enables car movement to be reversed in case a car has passed its point of loading. In the four-track layout at Ashtabula there are two distinct cables used, each serving two tracks and two unloaders.

During operation there is a droppage of ore to the dock, through which this cable must run, increasing the wear and enhancing the chances of breaking the cable. In such an event all four machines are required to work on the two tracks until repair is made, slowing down the entire operation considerably.

In an endeavor to overcome some of these disadvantages in providing a haulage for the cars in connection with the ore dock of the Pennsylvania Company at Cleveland, the first thought was the construction of a narrow-gauge track between two loading tracks, with the cable running in a slot way, the grip being in a suitable car to protect the operator from falling ore and weather conditions. This car was to have arms situated at a proper point on each side, controlled by air to lower and raise and thus engage the end sill of the car.

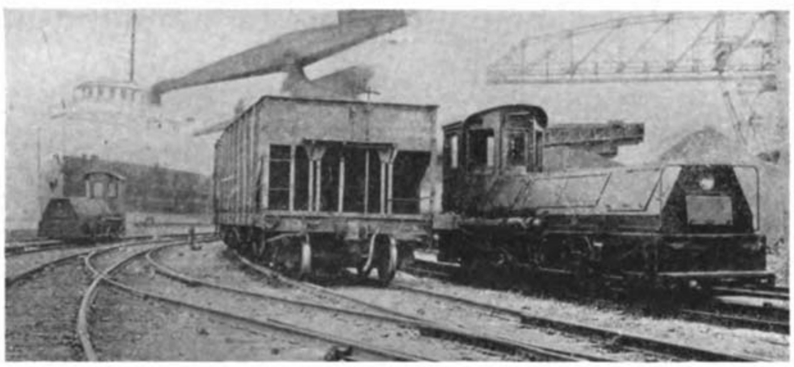

FIG. 2—POLING LOCOMOTIVE
With pneumatically-operated poling device in position for pushing cars.

Such an arrangement, however, did not seem to overcome the main difficulties, and the progression of thought evolved the electric locomotive, with third rail. A narrow-gauge track between two loading tracks, with return third rail covered by a two-board walk supported on standards, gives a safe runway for the locomotives. Droppage of ore does not crowd beyond the running rails or interfere with the contact shoes. No labor is required in or about the cars, and the operator consequently is not hampered in his operations. The development of this thought was through a committee of experts, and the product of their labors has now been in operation four years.

The Pennsylvania Company's ore docks in Cleveland are equipped with four Hulett solid-arm unloaders of the same pattern as those located on the Lake Shore docks at Ashtabula, but of larger capacity. These machines have a clam-shell capacity of 17 tons, and consume from forty to sixty seconds on a round trip. The ore is hoisted from a vessel and deposited in a hopper of 75 tons capacity. Under this hopper is located a small car on a runway which covers the four loading tracks below. This car is equipped with a weighing hopper of fifty tons capacity. The operator draws the load into this hopper from the receiving hopper and weighs his load, then runs his car over any one of the four loading tracks on which the railroad car is placed. This car has been carded, and as soon as the load drops into it and the weight is recorded the car is ready for road movement.

The dock proper is 900 feet long and the third-rail system extends on the west end in the empty car yard about 500 feet, and into the loaded car yard on the east end, about 150 feet. Steam locomotives place the empty cars on the four tracks to a point where the electric locomotives can engage them. The loaded cars are shoved out at the other end, to where steam locomotives haul the trains away.

There are three electric locomotives on this dock, but only two of them are required for the work. The third locomotive is a spare. It is used to keep the empty car supply shoved up to the point of loading but, as stated, is not actually required in the operation, as two of the electric locomotives will keep the four unloaders working at their maximum capacity.

Each electric locomotive is manned by an operator and a helper, the latter being of the day-labor class of pay. The helper rides upon the top of the locomotive, and in this position has a clear vision over all the operation and assists his operator in the car movement. His duties also cover the coupling and uncoupling of the cars. The cars are handled in strings of ten coupled together in the operation under the plant, but it is frequently necessary for these locomotives to draw into the clear as high as 35 empty cars, and shove out 20 loaded cars. The empty cars, as well as the loaded cars, pass over a curve of 15 degrees at each end of the electric line.

Two of the best records of unloading at this dock were made in July, 1915, as follows:—

July 2—Str. Jas. A. Farrell, 11 083 tons, 226 cars in 3 hrs. 35 min.
July 23—Str. Thos. F. Cole, 10 859 tons, 220 cars in 3 hrs. 35 min.

Each of these vessels spent three hours and forty minutes at the dock from the time it tied up till it cast off. The electric locomotives brought up the empties, spotted them and shoved out the loaded cars—226 and 220, respectively—without any assistance.

These locomotives were put into operation in the spring of 1913, and the navigation season is approximately eight months. In the four seasons to date these locomotives have handled 322 000 cars that were billed out with ore, in addition to a great number of cars that naturally pass through the plant which cannot be loaded,

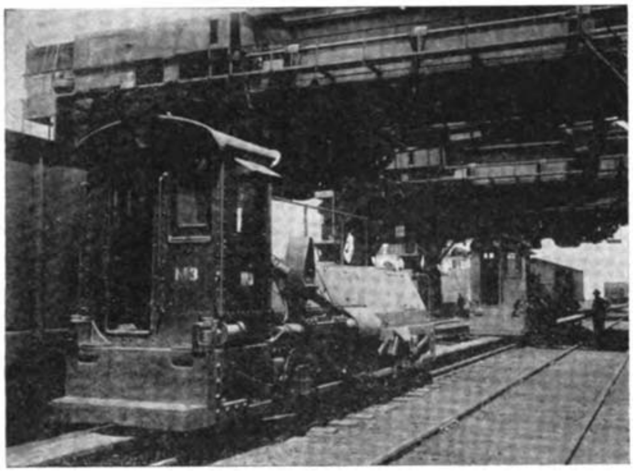

FIG. 3—LOCOMOTIVE ON CLEVELAND ORE DOCK OF PENNSYLVANIA LINES WEST

Runs on tracks parallel to those of the cars it handles and pushes them in either direction with an arm which is seen at the side; this arm is raised and lowered by compressed air controlled from the cab.

because of bad condition, foreign, etc., the number of which was not kept. During this period there has been no delay whatever, due to failure of the locomotives, and the maintenance has consisted only of the usual overhauling at the close of each season. This dock is in operation 23 hours per day for six days a week for eight months.

The electric locomotives can bring 35 empty cars up at a speed of approximately ten miles per hour around the curve, and can attain the same speed in pushing 20 loaded cars around the curve at the opposite end. In spotting cars they are most efficient. The arm engages the car at the end sill and, with cars coupled together, complete control is had of the entire string. For handling a single car a cable with hook attachment is provided.

The unloading machinery being overhead, the electric locomotives come into play most advantageously in acting as a hoist for repair parts during the closed season.

The operation of the electric locomotives in the season of navigation for one year is given below. These figures are based upon the movement of each loaded car 800 feet. Of course, all cars are moved more or less beyond this figure, dependent upon the location of the vessel at dock, and the service of the steam locomotives in placing empty cars and pulling away the loaded cars. The number of cars is the actual number of cars billed out with a load and does not account for any unloaded cars which passed under the machines, such cars being of quite a large number.

1—Total number cars loaded, 56 463.
2—Average load per car, 46.5 tons.
3—Total tonnage placed in cars, 2 624 979 tons.
4—Total locomotive cost $\begin{pmatrix}\text{Per car } 0.1335 \\ \text{Per ton } 0.00287\end{pmatrix}$—$7538.10.

Operation,	per car, 0.0979;	per ton, 0.0021 —	$5528.63
Maintenance,	per car, 0.0159;	per ton, 0.00034—	899.59
Insurance,	per car, 0.0031;	per ton, 0.00007—	175.16
Power,	per car, 0.0166;	per ton, 0.00036—	934.72

5—Average tonnage hauled in one day (20 hrs.), 13 531 tons.
6—Average cars hauled in one day (20 hrs.), 291 cars.
7—Total tonnage hauled per mile in one day (20 hrs.), 2050 tons.
8—Cost of power per engine per day, $1.75.
9—Current in line, 1980 amperes at 250 volts.
10—Cost of upkeep per day per engine, $1.54.
11—Total cost per ton hauled, $0.00287.
12—Total cost per ton per mile, $0.0189.

In the item of maintenance has been charged the idle time of the operator and his helper when the electric locomotives are not working and these men are engaged in looking over their machines. This is not a just charge against maintenance, but the maintenance figure includes the complete overhauling at the close of the season, as well as this item.

As compared with rope haulage it readily can be seen that the locomotives are much more efficient, the elasticity in the movement alone accomplishing this. They have many other advantages, such as the ability to replace cars on track, haul materials, etc., that place them so far ahead of rope haulage as to be incomparable.

In first cost the electric locomotive also leads, as in rope haulage it is necessary to have a distinct power

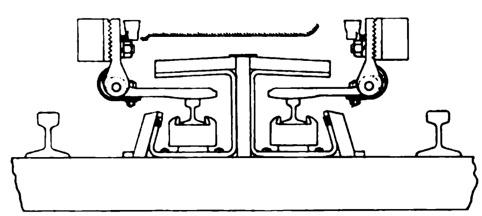

FIG. 4—THIRD-RAIL SHOE LAYOUT

house at practically a positive location. In cost of operation and matter of safety the electric locomotive also excels, as can be seen from the description of the work involved.