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## THE FRANKLIN INSTITUTE.

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### The Organization and Methods of a Modern Industrial Works.

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BY J. WILMER HENSZKY.

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The Baldwin Locomotive Works, in Philadelphia, is probably as good an example of a modern industrial works as we have in the country, and as I have been connected with this company for some years I will endeavor to give you an idea of how that plant is operated.

Baldwin Locomotive Works, at the present time, employ about 15,500 men, who are divided among twenty departments. The executive force consists of one superintendent, four assistant superintendents and twenty foremen. Owing to the extent of the works it is divided into two divisions, the eastern embracing all shops east of Fifteenth Street, and the western division taking in all shops west of Fifteenth Street, also new shops located at Twenty-sixth, Twenty-seventh and Twenty-eighth Streets. Each division

is in charge of an assistant superintendent, who works in conjunction with the foreman in his division.

In the eastern division the most important shop is the Erecting or Finishing Shop, located at Broad and Spring Garden Streets. This shop employs about 2,500 men, and has a capacity of fifty finished locomotives every week. To operate this department we have one foreman, two assistant foremen and twenty track foremen. Every track foreman is a specialist on a certain line, such as erecting, valve-setting, testing, etc., and has direct charge of the gang bosses and men who work under his supervision. The gang bosses, or contractors as we call them, are all picked men, the very best we can find, and have direct charge of the workmen. This same system of contracts is employed in every department throughout the works.

I will now explain our contract or piece-work system. Every department is a factory, manufacturing a certain number of locomotive parts. Through careful study we are able to ascertain the exact time and expense involved in making these parts; we then allow a certain amount of profit for the contractor in making price; he, in turn, gives out his work—piece-work—to his men at a slightly lower rate and makes the difference. There is a great diversity of opinion among manufacturers about the best way to pay labor. Some claim that you do not get the best results from the piece-work system because a piece-worker knows that he will not be allowed to make over a certain amount, and if he finds that he is making too much he will curtail his output sooner than run the chance of having his prices cut. This is true in some cases, but, under careful management, on routine work cannot occur. We expect and get more work per man out of our piece-workers than any similar concern in the world, and our men are allowed to make higher wages, and this, to my mind, explains why we never have strikes at Baldwin's.

In hiring a man we never ask whether he belongs to a union or not. We don't care. If he enters our employ he abides by our rules and regulations, which are posted in every department, and any attempt to incite trouble or dis-

satisfaction among the men is reported at once by his contractor and the man is dismissed.

A question that is often asked is; "Do you not have great trouble in procuring workmen who are skilled in the special lines of locomotive works?" We do. This is the question to which the Baldwin firm has given a great deal of attention in the past four years, and has led to the revival in our works of the old apprenticeship system, a brief outline of which may be interesting.

The apprentices are divided into three classes, first, second and third. To be a first-class apprentice a boy must be 17 years old and must have at least a grammar-school education. He serves four years. During this time he is allowed to stay on one class of work only three months, and is moved from department to department until he covers the entire plant. During the school season he is obliged to attend night-school two nights a week, taking up a special course in higher mathematics and mechanical drawing. He is paid from \$3.00 to \$6.60 per week during apprenticeship, and on completion of time receives a certificate and \$250. A second-class apprentice must be a high-school graduate and serve three years on same lines as first-class apprentice. He also attends night-school. He gets from \$4.20 to \$6.60 per week, and on completion of time receives a certificate and \$200. A third-class apprentice must be a graduate of a recognized technical school. He serves two years and does not take a night course. He gets from \$9.00 to \$12.00 per week and receives a certificate on completion of time.

We now have between 400 and 500 apprentices of the several classes, and it is proving of vast benefit to the works in providing a more intelligent and better class of labor than it is possible to get in any other way.

We claim that whether the apprentice stays with us or not on the completion of his time, he will always be a friend to the Baldwin Locomotive Works and look out for our interests, just as a college man does for his college. His training has made him a valuable man for railroad work, and one who will get ahead. It is a far-sighted business proposition.

A manager of a large shop has many other important matters to look after. If he is a progressive man, backed by a progressive firm, he wants to know the quickest and best way to get out work. Our firm encourages this among the foremen, and sends them all over the country to see how other people do work. If a foreman can prove that by the use of certain tools and appliances he can save time and expense, they are furnished him without question. During the past five years enormous strides have been made in this direction. By the aid of improved hydraulic and pneumatic tools hand-work has been reduced to a minimum, and on this alone nearly \$1,000,000 a year is being saved on the cost of work in the shops. We have also made great savings on time required to do work by the use of specially treated tool steel for machine tools. By means of these tools we have been able to increase the capacity of some of our machines from 30 per cent. to 50 per cent. Our best results have been obtained from the Burgess Special Steel and the Sanderson Special Steel. All our new tools are being made from these steels, as ordinary tool steel will not stand the high speeds at which our tools are now being run.

It is interesting to see the vast difference between an up-to-date railroad or locomotive shop in this country and a similar shop on the other side. It has been my opportunity to visit a number of these shops in England, Sweden, Finland and Russia, and it is surprising to note the condition of their equipment. Power cranes are very rare even in the larger shops and the machinery is of a type in use here twenty-five or thirty years ago. It is not strange, noting these conditions, that we can build locomotives in Philadelphia, ship them to any country in Europe, and put them in service on their railroads, 10 to 20 per cent. cheaper than they can build in their own shops.

As orders for locomotives are received, they are printed on lists and put out in the shops. Each list contains two weeks' work; they are dated with delivery dates for each class of work in the various departments.

"The designation of the different classes of locomotives as used by Baldwin Locomotive Works embodies the com-

bination of certain figures with one of the letters *A, B, C, D, E* and *F*, to indicate both the number and kind of wheels and the size of cylinders. Thus, a locomotive having one pair of drivers is classed *B*; that with two pairs, *C*; that with three pairs, *D*; that with four pairs, *E*, and that with five pairs, *F*. The letter *A* is used for a special class of high-speed locomotive with a single pair of drivers. A figure 4, 6, 8, 10, 12 and 14 is used as an initial figure to indicate the total number of wheels under a locomotive. A figure or figures following the initial figure indicates diameter of cylinders, and the figure or figures following a class designation represents the consecutive class number of a locomotive on which it appears. Thus, 8 26 *C* 500 indicates a locomotive with eight wheels in all, having cylinders 16 inches in diameter with two pairs of driving wheels, and the 500 locomotive of its class." As soon as lists are put out, the Drawing-Rooms get them and start at once to design the locomotive, furnishing bills of material to the Purchasing Department, which orders all material we do not make. Lists are also furnished to every foreman and contractor in the entire plant. The great advantage of these lists is that every man in the entire works is after the material he needs long before it is wanted in the Erecting Shop, and we are rarely subjected to delay on delivery dates. Every foreman has a book of lists—check-books we call them—in which he keeps an exact daily check of every piece of work made in his department. He, in turn, checks off the superintendents', who can tell by their books at a glance the exact condition of every locomotive part in the entire works.

An important factor in the management of a large plant is the system of accounts.

"The Baldwin Locomotive Works keep two sets of accounts, viz.:

"(1) Manufacturing Account.

"(2) Commercial or Financial Accounts.

"In the manufacturing books a ledger account is kept with each locomotive constructed and with each repair-work job. All materials and labor are charged to these accounts either directly or eventually on closing the books. The

principle is that no material or labor is paid for without being charged to an appropriate account.

"In the commercial books accounts of dealings with individuals and corporations are kept in the ordinary way. Both sets of books are closed annually and correspond exactly in their statements of expenditures and receipts.

"System of manufacturing accounts:

"In the general system of accounts by which the cost of construction of locomotives is ascertained each locomotive is charged as follows:

"A—*Materials*.—All materials used in the construction of the locomotives at the actual cost as fixed in the general contracts covering such purchases, or as paid for same at market rates.

"B—*Distributed Labor*.—All labor charged directly to the locomotives at actual cost of same, either by piece-work or day-work rate.

"C—*Expenses*.—All labor and materials incident to the construction of the locomotives, but which from their character cannot be charged direct. The cost of these is distributed to the locomotives in the proportion fixed by the amount of distributed labor as per paragraph B. Until this proportion is finally determined for each year it is based upon the accounts for the preceding year. The expenses include wages of managers, foremen, clerks, draughtsmen, stationary engineers, teamsters, laborers, watchmen, traveling engineers and messengers. They also include heating, lighting, repairs, insurance, taxes and other expenses on buildings, and tools, patterns and dies, defective work, printing, advertising, traveling expenses and all incidental costs connected with manufacture.

"D—*Disbursements for Freight and Delivering Locomotives*.—These consist of railroad charges for transportation to point of delivery."

The aggregate of the foregoing items is the cost of manufacture and delivery of locomotives.

One of the most important departments and one whose influence is felt over the entire works is the Test Department. This is equipped with two Tinius Olsen testing

machines for physical tests, and a complete chemical laboratory for chemical analyses, also with apparatus for indicating locomotives and stationary engines. Nearly all the material we use must first pass through this department, and be reported on before being accepted; this applies to all boiler steel, spring steel, tank steel, bar iron, cylinder iron, steel castings, oils, paints, etc. We have fixed standards for all these materials, which must be complied with before materials are accepted. The Test Department also has a corps of inspectors, who are stationed in the various rolling-mills and steel-plants we deal with, and whose duty it is to see that our mill specifications are lived up to, and that our orders are rushed through.

One of the important duties of a shop manager is the care of machinery. These machines represent thousands of dollars, and it is of the utmost importance that they be kept in perfect repair. To accomplish this we have in every shop a machine inspector or tool boss. This man is an expert on repair work, and has a gang of machinists under his supervision. As soon as a machine breaks, the fact is reported to the tool boss, who repairs it at once. A number of duplicate pieces of the most breakable parts of machines are always kept in stock, so that the machines are seldom down but for a very short time.

In every large plant, especially one having large smith shops and foundries, there is a constant danger of fire; to overcome this we have, I think, one of the largest volunteer fire departments in the country, having about 200 picked men scattered all over the works. We have twelve large Barr pumps and as complete apparatus as the city department. Every shop also is equipped with a sprinkler system, and has stand-pipes and reels of hose on every floor. Every few weeks we have fire drills, and it is remarkable how quickly our men can get into service. They put out on an average of two or three fires a month, and for several years have not had to call on the City Fire Department.

Another important matter is shop cleanliness. The sweepings must be run through separators, then loaded on cars and sent to firms who buy all our turnings.

Our sheet-iron scrap is carted to large scrap-bins built over railroad tracks in one of our yards. These bins have hinged bottoms; and when they are full, cars are run under them and loaded. This material is also sold, and proceeds from scrap and turnings amount to several hundred dollars a week.

The power of the works is handled by the Highway Department, which is also responsible for buildings, electric power and light and machinery repairs. We have four large power-houses, one at Broad Street, one at Sixteenth Street, one at Seventeenth Street, and one at Twenty-seventh Street, having thirty-one boilers generating 10,684 horse-power. Each power-house is in charge of a chief engineer, who makes a daily report to Highway office on a special form, giving an hourly account of steam and air pressures, and of the boilers, engines and compressors that were in service. By this means the foreman of the Highway Department is kept in contact with the power service throughout the entire works, and knows exactly how the pressures are being maintained at every hour of the day. We have 108 engines, pumps and air compressors, with 8,656 horse-power. All air compressors, dynamos for light and power and engines running them are located in power-houses, the other engines being located in the various shops.

As I have already stated, we employ 15,500 men, and to keep account of their time and wages is the work of our Time Department. Each man, on being hired, is given a number. The numbers for the men in each shop run in rotation. Each contractor has a piece-work book, in which he keeps a daily account of the time and wages made by each man in his gang. The time of all day workers is kept in a day-work time-book by the time-clerk. Once a week the Time Department takes the time records from the piece- and day-work books, entering the same on long printed sheets, giving the name and number of every man in each department. The piece-work books are gone over, and charges against each locomotive are entered to its cost account. The account of the wages due each man is then turned over to the Pay Department.

The Pay Department has pay envelopes stamped with the name and number of every man in the entire works. The amount of wages due is now stamped on each envelope. Our regular pay-day, with the exception of holidays, is on Friday, and every Friday morning the money is brought from bank. It has always been our custom to pay in coin, which is easier to handle, and clerks are less liable to make mistakes. The amount stamped on each envelope is then put in, the envelope is sealed and all are arranged in rotation, as to number, in an upright position, in specially constructed racks, each rack holding about 200 envelopes. These racks when filled are put in safes built for this purpose, and are now ready for the paymasters. We have two pay stations—one at Broad Street, in the Erecting Shop, and another at Seventeenth and Hamilton Streets. At the signal to quit work on Friday night, the men arrange themselves in long lines, according to number, at their respective pay stations, and at five minutes after 6 the line starts. We have eight paymasters, and run eight lines, the foreman of each shop, and his assistants, having charge of the lines his men are in. Each man as he passes the pay desk calls out his number to his foreman and his name to the paymaster, who passes him his envelope. It is possible in this way to pay our entire force in thirty minutes.

In conclusion, I will say that, to my mind, to get the best results from a shop you must have a unity of feeling among your men. Every man should be treated as a man, not as a machine. If a man comes to tell you about a supposed or a real wrong, he should be listened to, and given the proper advice. Your superintendents and foremen should not be shut up in offices to which the ordinary workman cannot have access, but should be as get-at-able as possible. This is, and has been, the policy of the Baldwin Locomotive Works, and to this policy their success, I believe, may, in large measure, be attributed.