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Manufacture of Castings for Railroads

BY R. T. RISK

The following thesis attempts to give in some detail the results of research into that department of the steel industry which is concerned with the manufacture of miscellaneous steel castings for railroad cars.

MANUFACTURING PROCESSES

Raw materials consist of the ingredients which go to make up steel. These are low and high carbon scrap steel, scrap wheels, pig iron, coke, limestone, manganese, silicon, etc. These materials are brought into the yard in cars by locomotive, where they are unloaded into numbered bins. Some cars are unloaded by hand, but most of them are unloaded by means of steam derricks. One "heat" usually consists of 50,000 pounds of material, exclusive of limestone, which acts as a flux, and tempering alloys such as manganese and silicon which are used in small quantities. The materials are loaded in pans which are approximately 4 feet long, 1½ feet wide, and 1 foot deep. Three of these pans rest on a small flat car. After the pans are loaded and weighed, they are shoved upon the furnace platform where an electrical charger picks up one pan at a time, injecting it into the furnace, emptying it and then withdrawing it.

The steel is made by the open-hearth process. The furnace has a large bed lined with fire brick and sand on which the charge is placed. By the aid of a regenerative heating system, a higher temperature is obtained than otherwise would result. Gas is used as fuel and is heated before entering the furnace by passing through a checkerwork of hot fire brick. The heated gas is passed into the furnace through a pipe, while air that has been similarly heated enters through another flue. The burning gas passes over the charge on the furnace bed and the hot gaseous product escapes through checkerworks which are a duplicate of those used to heat the gas and air. One set of checkerwork is thus raised to a high temperature by the hot combustion products, while the other is being cooled as it heats the gas and air about to enter the furnace. About every twenty minutes the direction of the gas and air is reversed by means of a system of valves, so that gas and

air pass through the recently heated checkerwork while the flame from the furnace passes through the one just cooled.

The scrap steel is placed on the bottom in order to protect it from the oxidizing action of the flame. The manganese and silicon are oxidized by the flame, while the iron is furnishing oxygen to consume the carbon. The process consumes from six to eight hours and is watched and controlled most carefully by the operator. Samples of metal are repeatedly taken from the furnace and examined to determine when the impurities have been removed and the carbon has been reduced to the desired amount.

While the heat is being made, the foundry is busy making molds with which to take care of the heat.

Patterns are brought to the foundry from the pattern shop where they were made from drawings and specifications furnished by the mechanical engineering department. There are two patterns for each casting, one for the upper half and one for the lower half. On top of the pattern is placed an iron flask varying in size to fit the pattern—the pattern forms the bottom and the iron flask the sides. Sand is packed into this frame on the pattern by means of air rammers or machines called sandslingers. The frame with the packed sand is then lifted off the pattern by means of an air hoist. Another crew of men is engaged similarly in making a mold for the upper half of the casting, which is called the cope, the lower half being called the drag. Cores are then inserted into the molds by finishers who secure them firmly by means of long wire nails. These cores are made by coremakers in the core department a day or two prior to use in the foundry. Cores are made by packing sand in core boxes of sundry sizes and shapes in accordance with the pattern of the mold which they supplement. Most of the cores are baked in the ovens until they become very hard before they are transferred to the foundry.

The two molds are then put together and set along side of others to await the tapping of the heat. When the heat is ready it is tapped into a large ladle supported by a 60 ton overhead crane. As soon as the heat has run into the ladle, the crane carries it to the first mold in a long line. The ladleman by means of a lever opens a small opening in the bottom of a ladle through which the molten steel runs into the mold. When one mold is filled, the crane carries the ladle to the next one and so on until the slag is reached in the bottom of the ladle. The hot castings are pulled out of the molds by means of chains from the cranes and carried

to one end of the foundry. This is known as the "shakeout." Here by means of pneumatic hammers all the sand is jarred loose from the center of the casting. The castings are then loaded on a flat car and carried to the cleaning and machining department. Here they are loaded on small flat cars and run into annealing furnaces, where they are heated to a certain temperature in order to temper the steel. When the castings are taken from the annealing furnaces they are ready to be cleaned and machined. Rows of chippers with pneumatic chisels cut off all rough edges. Here small cracks are welded and castings not too badly warped are straightened by presses. Inspectors then examine the castings which, if they pass inspection, are weighed, sorted and placed on a track. Here they are examined by inspectors representing the railroads who are the purchasers of the castings.

ACCOUNTING RECORDS

The accounting for the head office is divided into four departments classified as the voucher division, the billing division, the sales-ledger division and the general division.

In the voucher division a voucher-record system is used to audit and record accounts payable. Vouchers are of two kinds; those prepared by the purchasing department covering materials received at the various plants, and those prepared by the voucher division covering miscellaneous supplies and expenses and general office expenses.

When an order for material is placed with a supplier an acknowledgment of acceptance is required by the purchasing agent. When this is received it is checked against the order as to price, quantity and terms, and, if in accord, it is filed and kept for one year to be available should any controversy regarding payment arise. When the material is shipped, an invoice in duplicate is mailed to the purchasing department. The invoice is entered in a purchase ledger and also, if a carload lot, in a carload record. The invoice is then sent to the works for approval as to receipt of material, quantity and quality. The purpose of the purchase ledger is to record the date invoice is mailed to the works, the date returned and the date vouchered. The record is also used for checking shippers' statement of accounts.

The carload record shows shipper's name and address, date of order, order number, material, quantity ordered, price, F. O. B. point, terms, delivery date and analysis. This record is to guard

against error in delivery, over-shipments and the misapplication of material against the order.

Invoices, having been approved by the works, are returned to the purchasing department to be checked and vouchered. From here they are sent to the accounting department to be audited and recorded in the vouchers-audited record. The vouchers then go to the treasury department for payment, where payment is entered in the cashbook.

Works miscellaneous invoices are vouchered by this department after reference has been made to the works miscellaneous orders and copies of contracts. The voucher is sent to the accounting department for auditing and then is entered in the vouchers-audited record.

Postings to the general ledger are made from the vouchers-audited record.

Freight bills are paid at the various works by cheques drawn on a common freight account maintained at one bank. That account is always kept at a fixed amount. Upon receipt of copies of freight vouchers from the works each day, a reimbursing voucher is prepared in favor of the bank in which the freight account is deposited.

The most important work of the billing division is to invoice and record all sales as covered by shipping reports from the various plants. Upon receipt of a customer's order by the order department, it is referred to the sales engineering department for pattern numbers, etc. It is then referred to the sales department for prices and F. O. B. points. The order is then acknowledged to the customer and two carbon copies of the orders are compiled.

One of these is forwarded to the works, and from the other copies are made for general office use. One copy is sent to the accounting department with prices and F. O. B. points and with a copy of the acknowledgment attached. One copy is sent to the traffic department for routing; one copy to treasury department for credit purposes which is returned to the order department; one copy to sales department; and one to the order department.

The accounting department, on receipt of orders which are reported by the order department by order numbers, checks the list to see if all orders are attached. Prices and F. O. B. points are checked with the acknowledgment, and then the orders are filed in binders according to the order numbers.

Shipping reports are the basis of all charges for materials sold. These reports are mailed to the head office the same day that materials are shipped. Shipping reports, on receipt by the head office, are given to a pricer who checks them against the order. The price and F. O. B. point are then inserted, with other information such as account number, number of invoices, who is to receive copies, etc. The shipping report is then forwarded to a checker who checks them against the orders as to prices and F. O. B. points. All shipping reports, on which freight charges are prepaid or those shipped "collect", for which company is liable, are sent to the traffic department, where the freight rate covering the liability is inserted.

The comptometer operator then verifies the total pieces and weights and makes the extensions showing the amount charged to the customer and the necessary amount of freight reserve.

Shipping reports are next invoiced to the customer in accordance with the billing information. Invoices are then separated from the carbons by the checker and then checked to the shipping report. Quantities, amounts, prices and extensions are checked by a comptometer operator who also verifies the freight deductions and reserves. Invoices are then mailed with bills of lading and inspection reports to the customer. Shipping reports are then separated from the sales ledger copy of invoice. The shipping reports are listed by adding machine as to amount, freight reserve, out freight, miscellaneous sales and prepaid freight, and are summarized on a form. The same procedure is followed in respect to sales-ledger copy of invoices, and a summary is made which should balance with the summary of the shipping reports. The sales-ledger invoices are then sent to the sales-ledger division. At the end of the month a general sales summary is made up from the daily summary of sales taken from shipping reports. Entries are made in the general ledger from this summary.

The work of the sales-ledger or accounts-receivable division consists of posting all invoices made from shipping reports received from the various plants. The details of the work of this division are separated into three classes of accounts: accounts receivable, railroad claims and bad debts.

Railroad claims consist of company claims against carriers for overcharge in freight rate, error in weight or material lost in transit. Claims covering outbound shipments, which are filed

by the traffic department, are credited to the customer's account and debited to an account "railroad claims". Claims filed on inbound shipment are held in file and not entered on records until paid, when the proper works account is credited with the payment.

Invoices for one day arriving from the billing division are sorted alphabetically and divided according to the various sales ledgers by the bookkeeping machine operators. The invoices are then posted to the individual customers' accounts. The total of invoices posted as shown by the machines must tally with the summary of invoices which accompanies the invoices from the billing division. The total is then posted to a control sheet. A summary is kept of the total invoices posted each day and at the end of the month the total charges to customers' accounts are posted to the general ledger.

Remittances arrive in the ledger division from the treasury department, accompanied by a list of the customers and amount of the cheques remitted.

A remittance slip is made up for each customer in duplicate, showing the amount due, freight deducted and the net amount received. The original remittance reports are returned to the treasury department, attached to the individual cheques. Postings to the customers' accounts are made from the duplicate remittance slips. When the cheques have been returned to the treasury department they are entered in the cashbook. Each day the total cash posted to the sales ledger is checked with the total deposits for the day.

At the end of the month monthly statements are made up in triplicate, one copy going to the customer, one to the treasurer and one being retained by the bookkeeper.

The control ledger is kept by the head of the sales-ledger division. When a day's sales have been posted, the total of sales posted to each ledger is posted to the control account in that ledger. The same applies to total cash remittances, credit memoranda, journal entries, etc. The grand totals of the day's sales, cash remittances, etc., are then posted to the control ledger. The control ledger at the end of the month should balance with accounts-receivable account in the general ledger.

In the general division the financial statements of the company, such as the balance-sheet, profit-and-loss statement, application-of-funds statement, etc., are prepared monthly.

Here journal entries are compiled from various works forms in addition to journal entries prepared by the billing, sales-ledger and voucher divisions. The journal entries of the different divisions are submitted to the head of the general division, whose duty it is to scrutinize them and satisfy himself as to their correctness, after which they are sent to the comptroller and assistant comptroller for their approval.

The theory of accounting between the general office and works makes it necessary that for each debit to general office account on the works ledger a corresponding credit entry be made to works ledger account on the general ledger. These two accounts should always be in agreement except for adjustments in transit between the head office and the works.

In this department journal entries are also compiled from various reports received from the different works. For example, the total cost value of salable, shop and exhibition castings produced during the month obtained from monthly summary of cost of production reports received from plants is charged to finished-products account and credited to works ledger account. The cost of shop castings is charged back to the works because it is an element of cost, while the cost of exhibition castings is charged to an exhibition expense account. Other journal entries made up in this division in reference to the works concern miscellaneous shipments and charges, inter-works sales, workmen's compensation expense, capital and other general office expenses and various adjustments in inventories, sundry reserves, etc.

Records of physical properties and their reserves for depreciation are kept in the following manner:

A separate equipment ledger is maintained for each plant. Each property group has a ledger sheet or sheets on which are entered a description of the equipment, date installed and cost. All similar pieces of machinery and equipment having the same rate of depreciation are grouped together. Provision on this record is made for annual depreciation estimate.

Changes in the respective property records are made annually from a report of additions and discards compiled monthly by the plants. Depreciation is based on a fixed rate in the property-record ledgers, but actual depreciation is taken on a tonnage basis. This rate is found by dividing the average annual tonnage for the past three years into the estimated depreciation per property record for the previous year. Depreciation is

then taken monthly by multiplying this rate by the tonnage produced.

No depreciation is provided in the current year for any equipment purchased or installed during the year, but it will be computed from the beginning of the subsequent fiscal year.

Only equipment costing in excess of a fixed sum is charged to a capital account. The cost of small replacements is charged to repairs. When a large replacement is made, which constitutes a decided improvement (such as a tile roofing replacing a composition one) the cost is charged to capital account.

The records kept at the individual works may be divided as to wages, stores and materials and accounting.

First, in respect to wages, clerks, department heads, foremen, etc., are on the salary roll and are paid twice a month by cheque. All other employees are on the plant payroll and are paid on either an hourly or a piecework basis. The salary payroll is kept by the confidential secretary to the works auditor. A cheque is deposited to the payroll account for the total amount of the payroll and salary cheques are made out against this amount.

Each employee rings a clock card on entering and leaving the plant. Each department has its timekeepers, and a service card is made up by these timekeepers for each man on the works payroll. This service card will give the number of hours the employee has worked, the rate per hour and the total remuneration for the day. If the employee is a pieceworker, the timekeeper will put on the service card the pattern number of the product on which the employee has worked, the number of pieces he has made and the rate per piece, which will give the amount due the pieceworker for the day.

The different departments which employ pieceworkers will have a list of piece-work rates for each pattern. This is usually made out by the department foreman and approved by the works manager. The time-office, which is under the supervision of the cashier, will have duplicates of the piece-work rates so that on the following day, when the service cards are turned over to the time-office by the various department timekeepers, the piece-work rates can be checked in order that workmen may not be overpaid.

The timekeeper in the general time office checks all hourly and piece-work extensions on the service cards. He collects the time cards of the employees daily. On the time card is a column in which he enters the number of hours from the service card which

the employee has worked the previous day. As he enters the number of hours he checks the time card to see if the rings show as many hours as are given on the service card. At the same time he checks the rate per hour as shown on the top of the time card with the rate used on the service card. For piece-workers, the time card has a money column in which is entered the amount of money earned by the piece-worker for the previous day's work. When the timekeeper has finished entering the service cards, he gives them to the payroll clerk who enters the hours or amounts opposite the various employees' names in a payroll book. At the end of the payroll period the timekeeper collects all the time cards for that period and employees are given new time cards for the next period. The timekeeper then calculates the number of hours each employee has worked, putting the total at the bottom of the time card and multiplying it by the rate to get the total amount due each employee. Piece-workers' cards are merely footed to obtain the sum due them. At the same time the payroll clerk is making the same calculations in his payroll book. The time cards then are checked with the payroll book. If there are any discrepancies between the two records, the service card must be looked up in order to determine which record is to be corrected. When the time cards and the payroll sheets are in agreement the payroll sheets are footed to get the total amount of the payroll. Cheques are made out from the time cards and checked to the payroll book. Employees receive their pay cheques twice monthly. When the employee receives his cheque he must be identified by his foreman and must sign his clockcard. The service cards when they leave the time office go to the distribution clerk in the main office.

All classes of labor in the various departments are assembled under separate account numbers for the purpose of controlling cost, e. g. 110 foremen, 111 clerks, 112 helpers, etc. The distribution clerk assigns the various account numbers from the description as shown on the service card. These labor charges are assembled under the account numbers which have been assigned and are posted to a summary of labor distribution by departments. At the end of each period these charges are summarized on a report of labor distribution, the total of which become a debit to cost account and a credit to payroll account. When the payroll is made up, there is a charge to payroll account and a credit to cash.

When the works require material or stores, the works supply agent requests the purchasing agent at the general office to place an order with a supplier for the materials or stores. When the order is placed the supply agent receives a copy of it from the purchasing agent, and this is his authority for receiving shipment. When the supply agent receives notice of shipment from a supplier he makes up a material-received report in triplicate, which contains the name of supplier, car number and initial, order number and description of material. The original, duplicate and triplicate are sent to the yard clerk to await arrival of shipment. When the car is received, the yard clerk weighs it and attaches a scale ticket to the material-received report, which is then filled out with the information required and the original is sent to the comptroller at the head office. The remaining copies are held until the invoice is received from the general office. When the yard clerk receives the invoice he approves it by placing on it a stamp of approval. The yard clerk then lists the approved invoices in triplicate, the original list going to the comptroller, the duplicate with invoices attached going to the purchasing agent at the general office and the triplicate with duplicate invoices to the cost clerk at the works. Postings to the works ledger are made from the triplicate list of approved invoices, inventory account being debited and general office account credited.

A book inventory is kept by quantities. This subsidiary ledger, or stock-pile record, has an account for each pile. All material received is entered in this record from the original material-received report.

All material going to the melted-metals department to make up a heat is weighed and entered on a heat report in triplicate, one copy going to the melted-metals department, one going to the works office and one being retained by the yard department. Postings are made to the various accounts in the stock-pile record from the heat report for materials used.

When stores are received a material-received report is made out by the storekeeper. The original is sent to the comptroller and the duplicate and triplicate are retained until invoices are received. The invoices are stamped "approved", and a list of approved invoices is then made up and the same procedure is followed as in the handling of material-received reports for bulk material. The postings to inventory accounts in the work ledger are also handled in the same manner as postings for bulk material.

This list of invoices also includes items of intangible nature such as purchased power, purchased water and service charges.

The subsidiary stores ledger is kept according to each class of stores received. This record is kept by quantity and value. All receipts are posted directly from the invoices and each class of stores is handled as a separate account. This subsidiary stores ledger should agree with the inventory accounts in the work ledger. An inventory is taken at the end of each month and any discrepancies discovered are adjusted.

All requisitions for stores issued must be authorized and signed by proper parties whose signatures have been registered at the store room. All requisitions are priced and valued from information taken from the subsidiary stores ledger. Stores-ledger accounts are then credited from the requisitions.

The bulk-material clerk compiles from the heat reports a summary of material used, on which are listed the quantities of materials by inventory accounts under the heading of the department which is to be charged. This report is then priced by the cost clerk, and after its extension it becomes the basis for posting the credits to the inventory accounts in the works ledger. Contrary to these credits will be a debit to the cost account. A summary of stores used is also compiled in a like manner from reports compiled in the storeroom from requisitions. This is used as a basis for credit postings to the stores-inventory accounts and for debit posting to cost account.

All miscellaneous charges, such as purchased power, water, etc., are charged to the works ledger account "Cost account, other charges." Subsidiary accounts to this control account are kept by departments, to afford a means of cost control. At the end of the month this account is closed into the cost account.

In order to prevent fluctuation in monthly costs caused by extraordinary labor and material costs, repairs to open-hearth furnaces, machinery, etc., a reserve is set up taking into cost a repair charge in proportion to production. A monthly credit to this reserve is based on a fixed rate per ton of production. The charge is made to cost account. As large repairs are made this reserve account is charged. Charges applicable to the current month, for which no invoices have been received, are charged to their respective accounts and credited to unaudited-bills account.

At the close of each month, labor, stores and material and other charges or overhead having been closed into the cost account and

the cost account in turn having been closed into the general office account, a trial balance is taken. This trial balance, with a statement of cost supported by various schedules giving the detail of the cost, is then sent into the head office. As explained in the discussion of head office accounts, this cost is charged into finished-castings account in the general ledger and works ledger account is credited.

After the works costs have been placed on the general ledger, the general division of the head office prepares a balance-sheet and monthly profit-and-loss statement, using the following forms:

BALANCE-SHEET—FORM

CURRENT ASSETS

Cash
 Bank accounts (general office)
 Works working funds
U. S. government securities
Accounts & bills receivable
 Accounts receivable (customers)
 Bills receivable and interest accrued
 Accounts receivable suspense
 Traveling expense funds
 Advances out of works auditors' funds
 Outward freight reserve
 Returned castings reserve
Inventories
 Bulk materials and stores
 Work in process
 Finished castings
 Total current assets

DEFERRED CHARGES TO OPERATIONS

 Sundry patents
 Insurance premiums
 General operating expenses

REAL ESTATE

BUILDINGS

PLANT

MACHINERY

TOOLS

PATENTS AND GOODWILL

 Less reserve for depreciation
 Total

CURRENT LIABILITIES

 Accounts payable
 Audited vouchers

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Discount & royalty reserves
T. B. D. freight
E. B. A. deductions
Out freight pre-paid reserve
Unaudited bills (general office)
Unaudited bills (works)
Payroll accrued
Works payroll accrued
Unclaimed wages
Bonus fund reserve
Provision for federal income & other taxes
Federal income tax reserve
Corporation taxes
Real-estate and personal property taxes
Total current liabilities
SUNDRY RESERVES
Furnace building reserve
Metal flask renewal reserve
Workmen's compensation reserve
CAPITAL STOCK
Total

PROFIT-&-LOSS ACCOUNT—FORM

Gross sales
Tons
Per ton
Deductions:
Discount and royalty
Outward freight
Miscellaneous allowances
Total deductions
Per ton
Net sales
Per ton
Manufacturing cost of sales
Per ton
Depreciation
Per ton
Expenses while closed
Per ton
Gross profit or loss from operations
Per ton
Selling expense
Per ton
Administrative and general expense
Per ton
Total
Per ton

Net profit or loss from operations
Per ton

Add: Miscellaneous income:
Interest, discount and exchange
Income from investments
Miscellaneous P-&-L (works)

Total profits and income

Deduct:
Interest charges on borrowed money
Balance of profits and income
Deduct: Reserve for federal income tax
Net profit carried to surplus

The future of this phase of the steel industry is entirely contingent on the future of the railroads in this country. At the present time, the railroad industry is facing a crisis due to the general business depression prevalent throughout the country and the increased competition furnished principally by busses and trucks, vessels using the inland, lake, and coastwise waterways and by pipe lines. The railroads form the backbone of our transportation system and the services furnished by them are essential, but statistics show that the freight and passenger traffic of the railroads has failed to grow commensurately with other business.