Journal of Accountancy

Volume 32 | Issue 1 Article 1

7-1921

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The JOURNAL *of* ACCOUNTANCY

Official Organ of the AMERICAN INSTITUTE OF ACCOUNTANTS

Vol. 32 JULY, 1921 No. 1

Accounting for Electric Alloy and Tool Steel

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The use of electric furnaces for the manufacture of high-grade alloy and tool steels has increased very rapidly during the last ten years. This is evidenced by the fact that at January 1, 1921, there were 356 electric furnaces in the United States alone, as compared with 19 furnaces at July 1, 1913. Prior to the latter date crucible furnaces were used almost exclusively. The electric furnace is specially adapted to the manufacture of high-grade steels on account of the control that can be exercised over it during the refining of the metal.

Two factors tend to reduce the cost of electric steel as compared with crucible. In the first place, the same standard of finished steel can be obtained with the use of lower grades of raw material. Secondly, greater production can be obtained from the same capital investment and operating expenditure.

The operation in brief embraces the charging of scrap steel into the furnaces, melting down with electric current, adding the necessary alloys, refining and pouring into moulds. Upon cooling sufficiently the moulds are stripped from the steel and it is then in ingot form. The size of these ingots depends upon the form in which the steel is to be sold.

The ingots are reheated and rolled into billets. After cooling, they are pickled (immersed in an acid bath) and surface defects are then removed by grinding or chipping with pneumatic hammers. This produces a clean billet, which is ready to be either rolled or forged, usually to final size. Some orders require additional operations, such as rough-turning, cold-drawing or cold-rolling. It is also necessary to anneal and straighten

some grades of steel, depending upon the purpose for which it is to be used.

The product is largely consumed by the automotive industries for parts requiring great strength and toughness, also for high-grade cutlery, forging dies, drilling tools, taps, reamers, etc.

Control Accounts

The balance-sheet and income and profit-and-loss statement do not differ materially from those of any other manufacturing concern. All inventories should have their controlling accounts and the entire cost system should be controlled by the general books.

Because of the variation in analysis and quantity of steel on individual customers' orders, except standard grades of tool steel, it has been found advantageous to use a production-order cost system.

The tabulation below shows the control accounts and the nature of the detail supporting records.

Control account	*Detail accounts*
Finished stock	Classified by size and shape groups and sub-classified by grades within each group.
Material in process	Order cost ledger, by individual orders.
Raw materials	Raw material ledger, by individual stock accounts.
Supplies	Supplies ledger, by individual stock accounts.
Small stores	Small stores ledger, by individual stock accounts.

Finished stock is also known as warehouse account and embraces all steels which are of standard analyses and sizes, carried in stock for immediate shipment. This material is produced on special stock orders. Cost is accumulated on these orders the same as on customers' orders, and upon completion the material is transferred from material in process to finished stock at the manufacturing cost so obtained.

Raw materials embrace all classes of scrap, other metals and alloys which are used in the electric furnaces to produce ingots, as well as materials known as fluxes and recarburizers used during the refining of the molten steel.

The supplies account controls the value of all repair and other materials consumed in the different operations which do not form

any part of the finished product. They include electrodes for the electric furnaces, coal for heating furnaces in mills and forge shop, fuel oil for annealing furnaces, brick for relining furnaces and ladles and other similar supplies.

The materials included in the small stores account are smaller repair parts, bolts, nuts and laboratory and other supplies which perform the same function as supplies above mentioned, but are usually kept in a storehouse or section separate from the bulk materials.

The proper accounting for material in process, segregated at all times by individual production orders and detailed within these orders by sizes and degree of completion, yet always agreeing in the aggregate with the general ledger control, is by far the most difficult and yet most important accounting problem met in this industry. The information so obtained not only provides correct costs on individual customers' orders but furnishes the necessary data for the intelligent control of every phase of operation within the plant.

A classification of manufacturing accounts is used, and all labor, material, supplies and other charges to manufacture are made directly to these accounts, sometimes being charged to individual orders in addition when directly applicable and at other times being prorated to orders on the bases later described.

The manufacturing accounts are divided as follows:

Account Numbers	*Department and accounts*
	Operating departments
100 to 199	Electric-furnace department
200 " 299	Rolling mill No. 1
300 " 399	Rolling mill No. 2
400 " 499	Rolling mill No. 3
500 " 599	Pickling department
600 " 699	Chipping and grinding department
700 " 799	Forging department
800 " 899	Rough-turning department
900 " 999	Cold-drawing department
1000 " 1099	Cold-rolling department
1100 " 1199	Annealing department
1200 " 1299	Straightening department
1300 " 1799	(Reserved for future departments)
1800 " 1899	Inspection department
1900 " 1999	Shipping department

Account Numbers	*Department and accounts*
	Auxiliary departments
2000 " 2099	Electrical department (maintenance)
2100 " 2199	Mechanical department (")
2200 " 2299	Chemical laboratory
2300 " 2399	Physical laboratory
	Expense accounts
3000 " 3099	Locomotive cranes
3100 " 3199	Overhead cranes (outside of departments)
3200 " 3299	Transportation system
3300 " 3399	Gas
3400 " 3499	Water
3500 " 3599	Electric light and power
3600 " 3699	Compressed air
3700 " 3799	General plant overhead

Within the divisions above, the accounts are subdivided into the following groups:

Accounts	*Group*
1 to 9	Material (electric-furnace department only)
10 " 29	Producing labor
30 " 39	Power and fuel
40 " 69	Operating expense
70 " 89	Repairs and renewals
90 " 99	Depreciation

The groups applicable to each department and expense account are used throughout. All accounts that are common to several or to all of the above departments are given the same number, with the exception of the prefix number, which is the symbol of the individual department or expense account. Group subdivisions within departments facilitate analysis and comparison with other periods.

After all manufacturing charges for the month have been made to these classified accounts, the auxiliary departments and expense accounts are closed into the operating department accounts on the proper basis and in a predetermined sequence, in order that no charges shall overlap and that the auxiliary departments shall bear their proper proportion of the expense accounts.

The charges concentrated in the operating department accounts are then distributed to the orders in manufacture in the following manner:

Electric-Furnace Department

The unit of quantity in which steel is made is known as a heat, and each heat is melted on a separate customer's order, or on a plant order in the case of materials made for stock. The heat is then the basis for distribution of all charges in the electric-furnace department and these charges are applied on one of the four following bases:

a. Actual material used in heat.
b. Proportion of tonnage of heat to total tonnage produced.
c. Proportion of time (tap to tap) consumed in making heat to total time of operation.
d. Proportion of current consumed in making heat to total current (meter readings).

The electric-furnace department classification, account numbers and basis of distribution are as follows:

Account number	*Group and name of account*	*Basis of distribution*
	Material group	
101	Metal base (scrap)	A
102	Metallic additions	A
103	Alloys	A
104	Flux	A
105	Recarburizers	A
106	Unloading raw materials	B
	Producing labor group	
111	Charging labor	B
112	Melting labor	C
113	Mould labor	B
114	Ladle labor	B
115	Crane labor	B
116	Ingot-handling labor	B
117	General labor	B
118	Delays	B
119	Administration	C
	Power and fuel group	
131	Electric current	D
132	Electrodes and plugs	C
135	Gas for heating ladles	C
137	Fuel for stoves	C

Account number	*Group and name of account*	*Basis of distribution*
	Operating expense group	
141	Royalty on furnaces	B
142	Melting expense	B
143	Mould expense	B
144	Sinkhead expense	B
145	Ladle expense	B
146	Crane expense	B
147	Lights	B
148	Loss on steel scrapped	B
149	Chemical laboratory expense (proportion)	B
150	Physical laboratory expense (")	B
151	Water expense (")	B
152	General plant overhead (")	B
	Repairs and renewals group	
171	Furnace bottom repairs	B
172	Furnace lining repairs	B
173	Furnace electrical repairs	B
174	Furnace mechanical repairs	B
175	Mould repairs	B
176	Ladle repairs	B
177	Crane repairs	B
178	Other equipment repairs	B
179	Building repairs	C
180	Unloading furnace repair materials	B
	Depreciation group	
191	Furnace depreciation	B
195	Mould depreciation	B
196	Ladle depreciation	B
197	Crane depreciation	B
198	Other equipment depreciation	B
199	Building depreciation	C

Account 106—Unloading raw material. The cost of unloading all raw materials received at the plant is charged directly to operating cost, instead of to the raw material stock accounts. This simplifies the accounting and furnishes sufficiently accurate results.

Account 118—Delays. All idle time caused by breakdowns or other delay is charged to this account. This is quite a factor in some departments if not closely watched.

Account 119—Administration. This covers the time of the superintendent and assistant superintendent or general foreman of the department.

Account 148—Loss on steel scrapped. To this account is charged the loss on all steel scrapped in inspection or returned by customers when the defect is attributable to this department.

Account 149—Chemical laboratory expense.

Account 150—Physical laboratory expense.

Account 151—Water expense.

Account 152—General plant overhead. This represents the proportion of the charges of the auxiliary departments and expense accounts named applicable to the electric-furnace department.

The scrap resulting from ingot butts (short ingots made when pouring the last part of a heat) is returned to the scrap piles to be remelted; the market value of this material as scrap is credited to the individual heats and orders; and the total is used as a reduction of the gross cost of the department's operation.

Rolling mills No. 1, No. 2, and No.3. These are all controlled by one department and are usually designated by the size of the mills—for instance, 20″ mill, 12″ mill, 9″ mill, etc.—instead of by numbers; but a separate series of classification numbers is used in order to collect the cost of operation of each and the correct cost on orders.

The order is the basis for distribution of all charges in this department and these charges are applied on one of the two following bases:

e. Proportion of tonnage rolled on order to total tonnage rolled;

f. Proportion of time of mill on order to total time of operation.

The rolling mill No. 1 classification, account numbers and basis of distribution are as follows:

Account number	*Group and name of account*	*Basis of distribution*
	Producing labor group	
211	Charging labor	E
212	Heating labor	F
213	Mill labor	F
215	Saw, shear and hot bed	F
216	Handling labor	E
217	General labor	E
218	Delays	E
219	Administration	F

Account number	*Group and name of account*	*Basis of distribution*
	Power and fuel group	
231	Electric current—mill	F
232	Electric current—saw, shear, hot bed, crane, tables, etc.	F
236	Fuel for furnaces	F
237	Fuel for stoves	F
	Operating expense group	
241	Rolling expense	E
242	Lubricants	E
243	Lights	E
248	Loss on steel scrapped	E
249	Chemical laboratory expense (proportion)	E
250	Physical laboratory expense (")	E
251	Water expense (")	E
252	General plant overhead (")	E
	Repairs and renewals group	
271	Furnace repairs	E
272	Mill repairs	E
274	Saw, shear, hot bed, crane, table repairs	E
275	Electrical machinery repairs	E
276	Roll turning expense	E
278	Other equipment repairs	E
279	Building repairs	F
280	Unloading furnace repair material	E
	Depreciation group	
291	Furnace depreciation	E
292	Mill depreciation	E
294	Saw, shear, hot bed, crane, table depreciation	E
295	Electrical machinery depreciation	E
298	Other equipment depreciation	E
299	Building depreciation	F

There is no origin of direct material in this or any other department except the electric-furnace department. All other departments perform additional operations on the material originally produced.

The classification and distribution to orders in rolling mills No. 2 and No. 3 are practically identical to the above with the exception of the department prefix numbers.

The scrap resulting from crop ends (steel cut from ends after rolling) is returned to the scrap piles to be remelted, the market value of this material as scrap is credited to the individual orders and the total is used as a reduction of the gross cost of rolling-mill operation.

Pickling department, Annealing department.—The operations in these two departments are in the nature of processes. Several orders are processed at one time and a cost per ton, based on the total tonnage handled during the month, is applied to the individual orders.

Chipping and grinding department, Inspection department.—The time of chippers, grinders and inspectors is charged directly to the orders on which they are working, in addition to the proper account number in the respective departments. The balance of expense in the department is distributed to the orders in proportion to the direct labor so charged.

Forging department, Rough-turning department, Cold-drawing department, Cold-rolling department, Straightening department.—In all of these departments the operations are performed on equipment or machines of a special type. Charges are centered around these units and are distributed to orders on the basis of time spent on order to total time of operation.

Shipping department.—The expense of shipments is most readily distributed to orders on a basis of tonnage shipped.

General.—The monthly operating costs are posted to the material-in-process ledger, which is made up of individual order cost sheets specially designed to facilitate the costing of shipments.

As soon as costs have been applied to the material shipped on orders during the month the general ledger is closed and monthly statements are prepared.

Internal Check

Usual forms of internal check are observed for payrolls and other accounting records, but most stress is laid on the accuracy of material in process and stock accounts as reflected among the assets.

It is standard practice to manufacture a slightly greater quantity of steel than required on an order to provide for rejections in the inspection department; and, when the run of material is good, this excess, up to ten per cent., is usually accepted by the customer. In order that no surplus material on orders which have been completed, no obsolete nor inactive material in finished stock, raw materials, supplies, and small stores may accumulate, a vigilant watch must be kept and a positive form of internal check adopted.

Material in process.—Space is provided on the daily report of shipments, made by the plant to the accounting and cost departments, to show whether the shipment covers the total order, part of the order or the final lot of material. If the shipment covers the whole order or the final lot of material due, it must be accompanied by another form showing the disposition of any balance of material left on the order, and it must have attached the necessary transfers to scrap and to stock. If the information is not immediately available, the original copy of the report of shipments is forwarded to the accounting department for billing purposes, and the cost department copy with the information required follows. However, all delayed reports must be in on the last day of the current month.

When the shipments are costed, all completed orders are closed out and no balances are carried into the next month. In addition to the above precaution one or more men regularly follow up orders in process of manufacture, and it is their duty to prevent the accumulation of inactive material on those orders which call for shipment over a period of several months or longer.

Finished stock (warehouse account).—The detail records of this stock are on cards, indexed by grade of steel, each card covering the material still on hand from one heat of steel. It is remembered that all steel is melted by heats and these heats are numbered consecutively. The identity of the original heat is maintained on all material to its final shipment.

Upon the receipt of a new order by the plant these stock records are examined for material of a size and analysis applicable. Material conforming to specifications is immediately withdrawn and applied to the order. This location of physical material from the card records is one form of internal check.

One of the duties of the stock clerk is the preparation of a weekly report covering the actual balance on hand of certain grades of material. A schedule of the grades to be inventoried is supplied by the plant office, so arranged as to cover the entire stock, about twice a year, or more often if desirable. This report is compared with the card records and necessary adjustments are made. No values are carried on the card records at the plant office. A ledger of weights and values classified by size groups and grades is kept in the accounting department. A monthly report is made by the plant office covering the weight on hand of

each classification and necessary adjustments are made to the control records. Unimportant differences are disregarded.

Raw materials, Supplies, Small stores.—Weekly reports covering physical inventories of certain stocks, in accordance with a given schedule, are furnished in the same manner as described under finished stock above, except that no plant stock records are kept and the reports are checked directly against the detail ledgers in the accounting department.

General.—The necessity for annual or semi-annual physical inventories, always taken in a hurry and for this reason usually inaccurate, is eliminated and in their place is substituted a more sane, normal method.

It should be realized that the accuracy of inventory figures as reflected in a balance-sheet are as important as cash in bank, if not more so, considering that in this, as in most industries, they are far greater in amount. Being carried under working and current assets or similar caption, accuracy also demands that the constituent parts of the inventory be worthy of the title.

Compilation of Data from Original Sources

One of Harrington Emerson's twelve principles of efficiency calls for reliable, immediate, adequate and permanent records. It is generally recognized that reliable and adequate records are essential if it is worth while to make records at all. However, the necessity for immediate and permanent records, while not so self-evident, is equally important.

The problem confronting cost accountants in manufacturing industries is how to compile final and complete data at the end of the month before they fall in a class with ancient history. In the plant under consideration a wide use is made of machines in the compilation of information. With these the original reports are transferred to cards by means of punched holes which permit the sorting and tabulating machines electrically to classify and aggregate the various items recorded.

Labor.—A dual card is used for labor, both the original written record and the punched record being made on this card. One card is used for each man each day, the number, name and date being printed by addressing machine at one end of the card. The cards are placed in racks and used by the men as clock cards. Distribution of time to accounts and orders is made by the time-keepers and all the information is then punched on these cards.

When time is distributed to more than one account, additional cards are punched, one for each account. The accuracy of the information so punched is verified by comparison of adding-machine tapes with runs made on the tabulating machine.

At the end of each week the cards are sorted by machine, accumulating all charges to each account number or other division, and are run through the tabulating machine. The information compiled from the tabulating machine forms the detailed labor distribution.

After this the cards are sorted by man number and run through the tabulating machine to make the weekly payroll. From this record, which of course agrees in the aggregate with the labor distribution, the men are paid.

The monthly labor distribution is assembled from the weekly records with a split week at the beginning and end of the month when necessary.

Material.—A dual card is also used for material. For supplies and small stores the card is used as a requisition by the department requiring material.

The account number to which the material is to be charged is shown and the card is signed by the foreman or person authorized to draw material. When the material is delivered the card is so stamped and sent to the accounting department as a record of issues.

The classification number, account number, quantity and value of the material are punched on this same card. At the end of each month the cards are sorted by account number and run through the tabulating machine for supplies and small stores distribution.

The cards can be resorted by material classification numbers and posted as issues on the detail ledgers, except when it is desirable to do this currently.

All raw materials used are recorded by heats on a daily report and from this the classification number, account number, order number and quantity of material are punched direct to the cards. At the end of the month these are sorted by order number under each class of material and the quantities are tabulated. Prices for each class, based on material on hand at the beginning of the month plus material received subsequently, are applied. This forms the raw material distribution to orders.

Production.—Daily production reports are prepared for each operating department. A card has been designed on which the data for any department can be punched. For example, the detail required on production in the rolling mills embraces the

Order number,
Size and shape charged,
Weight charged,
Size and shape produced,
Weight produced,
Weight of crop ends,
Heating loss (weight),
Time on rolling mill.

At the end of the month the cards are machine-sorted and compilation is made with the tabulating machine by orders, showing the weight charged of each size and shape and the resulting weights of each size and shape produced, with the crop-end scrap and heating losses and the time on rolling mill. This information is needed for distribution of operating costs to orders.

Sales.—The card used for sales shows the

Invoice number,
Salesman's number,
Order number,
Classification number (representing size, group and grade of steel),
Weight of shipment,
Sales value,
Manufacturing cost,
Selling and administrative overhead.

It is then possible to classify sales by salesmen, orders or class of material, showing the sales value, manufacturing cost, selling and administrative overhead and the resulting profit or loss in each case.

General.—The use of the above method of tabulation speeds up the balance-sheet and other statements and makes practicable the collection of a mass of detail information which would otherwise involve too great an effort in time and expense.

Statements and Reports

The culmination of all cost and accounting effort takes form in comprehensive reports, which must permit the closest analysis of every phase of manufacture and sale.

The following described statements and reports seem to be those best suited to the industry and are readily available under this system.

Monthly balance-sheet, monthly statement of income and profit and loss.—The forms suggested by the federal reserve board for balance-sheet and profit-and-loss statements are acceptable and furnish the necessary detail. These should be set up in comparison with the preceding month. It is also interesting to compare profit and loss with the average for the year to date.

Monthly operating cost report.—This report embraces the total charges incurred in each operating department, set up in accordance with the regular classification of accounts. Tonnage produced, processed or on which work has been done is shown, with the cost per ton of each item of cost during the current month, prior month and average for year to date.

The summary of these department cost sheets will agree with the total charges to manufacturing or material-in-process account for the month.

Monthly sales, detailed.—In order to group sales of the same or similar size and grade a standard classification is used, and in the above report the sales by individual shipments are detailed in the order of their classification numbers, showing in addition the following.

Customer,
Order number,
Weight,
Selling price per ton,
Total cost per ton,
Profit or loss per ton,
Percentage of profit or loss to total cost.

Monthly sales, by class of material.—Using the standard classification mentioned, all sales under each class are grouped, showing sub-totals for the classes, comprising ingot sales, billet sales, mill No. 1, No. 2 or No. 3, bar sales, forging sales, cold-rolling sales, cold-drawing sales, etc.

The following information is shown.

Classification number and name,
Weight,
Sales value,
Manufacturing cost,
Total cost,
Net profit or loss,
Percentage of net profit or loss to total cost.

Monthly sales, by salesmen.—This report groups all sales by salesmen, showing the same information as under "sales—by class of material," above, and agreeing in totals with this report and with the monthly income and profit-and-loss statement.

Monthly report of loss on steel scrapped.—Profit in this industry depends as much upon yield as any other single factor. By yield is meant the percentage of steel originally melted for an order or for stock that is shipped. Yield is decreased by all steel scrapped in process or subsequently returned by the customer and scrapped.

A standard classification of causes for scrapping material is used and this report shows the weight of steel scrapped with the resultant loss under each class. The department to which the losses are chargeable is also shown. A supplementary sheet to this report summarizes these reports for each of the six months prior, showing in this manner the trend.

General.—The cost department supplements the above by more frequent estimated reports. These are used as temporary guides only and are disregarded as soon as the actual figures controlled by the general books are issued.