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Cost Accounting for Cranes and Hoists

P. E. Stotenbur

NATIONAL ASSOCIATION
of
COST ACCOUNTANTS
Affiliated with The Canadian Society of Cost Accountants

Official Publications

Vol. IV Feb. 1, 1923 No. 10

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BUSH TERMINAL BUILDING
130 WEST 42nd STREET NEW YORK

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Montour Falls, N. Y.

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130 WEST 42nd STREET, NEW YORK CITY

The National Association of Cost Accountants does not stand sponsor for views expressed by the writers of articles issued as Publications. The object of the Official Publications of the Association is to place before the members ideas which it is hoped may prove interesting and suggestive. The articles will cover a wide range of subjects and present many different viewpoints. It is not intended that they shall reflect the particular ideas of any individual or group. Constructive comments on any of the Publications will be welcome.

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FEBRUARY 1, 1923

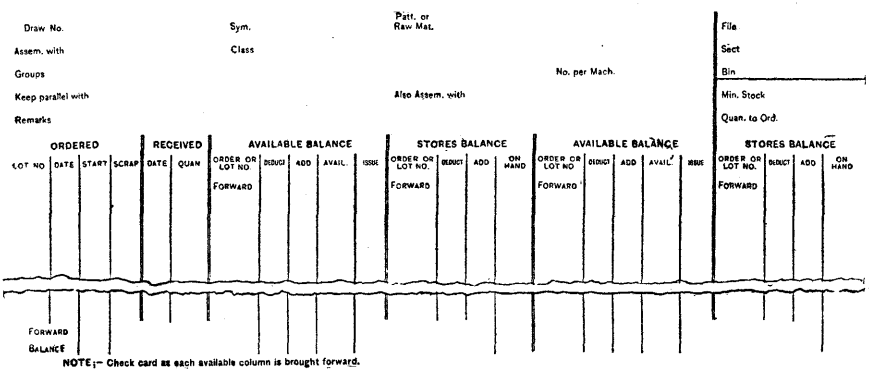
COST ACCOUNTING FOR CRANES AND HOISTS

The purpose of this article is to outline the cost system and present the essential forms devised to suit the requirements of a plant in which electric traveling cranes, bracket cranes, electric hoists, monorail hoists, trolleys and the like are manufactured. The nature of the production and the necessity of manufacturing both for stock and for customers' orders make for complexity, and systems to be workable must be adapted to the conditions. The policy adhered to in designing the system here to be explained has been to obtain the desired result in the most direct and workable way, thus making for such simplicity in cost finding as is consistent with the character of the product and the complexities of operating an extensive plant.

SHOP JOBS AND ORDERS

The production of the factory is divided into two main divisions, namely, the machining of individual parts in quantities for the replenishing of stock (called shop jobs) and the assembling of these parts for specific contracts or stock orders (called shop orders).

Shop orders originate in the sales department, either as the result of the sale of a contract, or for the purpose of providing in advance a stock of completed machines. These orders are sent to the stores office and the quantities called for are appropriated from the stock available, (See Form 1, page 3). If the available quantity of any of the parts called for is not sufficient to cover the order,



FORM 1—FINISHED STOCK CARD.

or if the available balance after appropriation drops below the standard minimum quantity, a shop job is started of sufficient quantity to bring the stock back to normal.

The shop job card (Form 2, page 4) is sent to the raw stock

FORM 208-5M-7-22

Class — Lot No. — Order No.

Dr. No.		Sym.	Pat. No.		Sec.&Bin	No. to Make
OPER.	MACH.	NO. FIN.	DATE FIN.	NO. PASSED INSPECTION	NO. SCRAP	NO. TO REP.
1						Date Mtl. Wanted
2						Date of Pur. Requisition
3						Where Ordered
4						Shipment Promised
5						Date Rec'd
6						Date to Start this Lot
7						Canvassed by
8						Checked by
9						Mtl. Req'd by Office / Shop
10						Date Mtl. Del. to Shop
11						Date Card in Despatch Office
12						Used with Dr. No.
13						In Stock or on Lot No.
14						
Finished Stores Location						

FORM 2—SHOP JOB CARD (FRONT)

clerk, who appropriates the raw stock against the available quantity. In case the raw stock has to be purchased, a purchase requisition is made out and sent to the purchasing department. All raw stock is maintained at a standard normal quantity except such stock as can be quickly procured.

Shop jobs are scheduled through the shop in such a way that all the individual parts necessary to complete the shop order are finished at approximately the same time in order that there may be no delays in assembling. A lacking sheet is made out for each shop order to enable the planning and production departments to know which shop jobs must be completed before the shop order can be assembled.

STORES RECEIPT

Dr. No.		Sym.		Date 192	
Filled by Insp.		Filled by Stores		No. Filled by Insp.	
Quan.	Order No.	Quan.	Order No.	No. Del'd to St. Rm.	
				Total No. Finished	
				No. Filled by Stores	
				No. Sent to Location	
				Total	
				Location	
				Parts have been received	
				and located as above	
				Signed	
				Inventory when stock is low	
				Total No. on hand	

FORM 2—SHOP JOB CARD (BACK)

The Office Program—Lacking sheet shows in the heading: Class, form, machine, number and date. The columnar arrangement is as follows: Lot number, wanted, number in lot, drawing number, symbol, name of part, pattern number, sent to shop, and a number of columns under the general heading "operation—machine number, date, progress."

A cost sheet (See Form 3, page 6) made out by the production department for each shop job is sent to the cost department. On this sheet is entered the time spent on the job as shown by the workmen's time sheets and the materials used, as shown on the stores requisition. The time on each operation is kept separate for the purposes of bonus payment and comparison with previous figures. When the shop job is completed the unit cost is calculated and the information in detail is transferred to a cost comparison card. This card shows fluctuations in cost of material, labor, burden, time, etc.

The parts called for by the shop order are requisitioned from stock by sending one copy of the shop order to the stock room. This lists everything required, even to bolts, pins, nuts, and other minor materials, and is the medium through which the entire cost of the

Form 4 5M 8-2

Labor Figured by

Labor Checked by

Material Figured by

Material Checked by

Recorded by

NEW

OLD

MACHINE PART COST SHEET

Weight	Rate	Material Cost	Labor Cost	% Burden	Burden	Shop Cost	Qua.	Total Shop Cost

Oper. No.	Mach.	Date	No. Fin.	Limit	Qua.	Cl. No.	Rate	Time	Amt.	Bonus
1										
Actual Set Up										
Divided Set Up										
2					Total Time & Cost					Av. Rate
Actual Set Up					Unit Time & Cost					
Divided Set Up										
3					Total Time & Cost					Av. Rate
Actual Set Up					Unit Time & Cost					
Divided Set Up										
4					Total Time & Cost					Av. Rate
Actual Set Up					Unit Time & Cost					
Divided Set Up										
5					Total Time & Cost					Av. Rate
Actual Set Up					Unit Time & Cost					
Divided Set Up										
6					Total Time & Cost					Av. Rate
Actual Set Up					Unit Time & Cost					
Divided Set Up										

Dr. No. Sym. Pat. No.

Class.

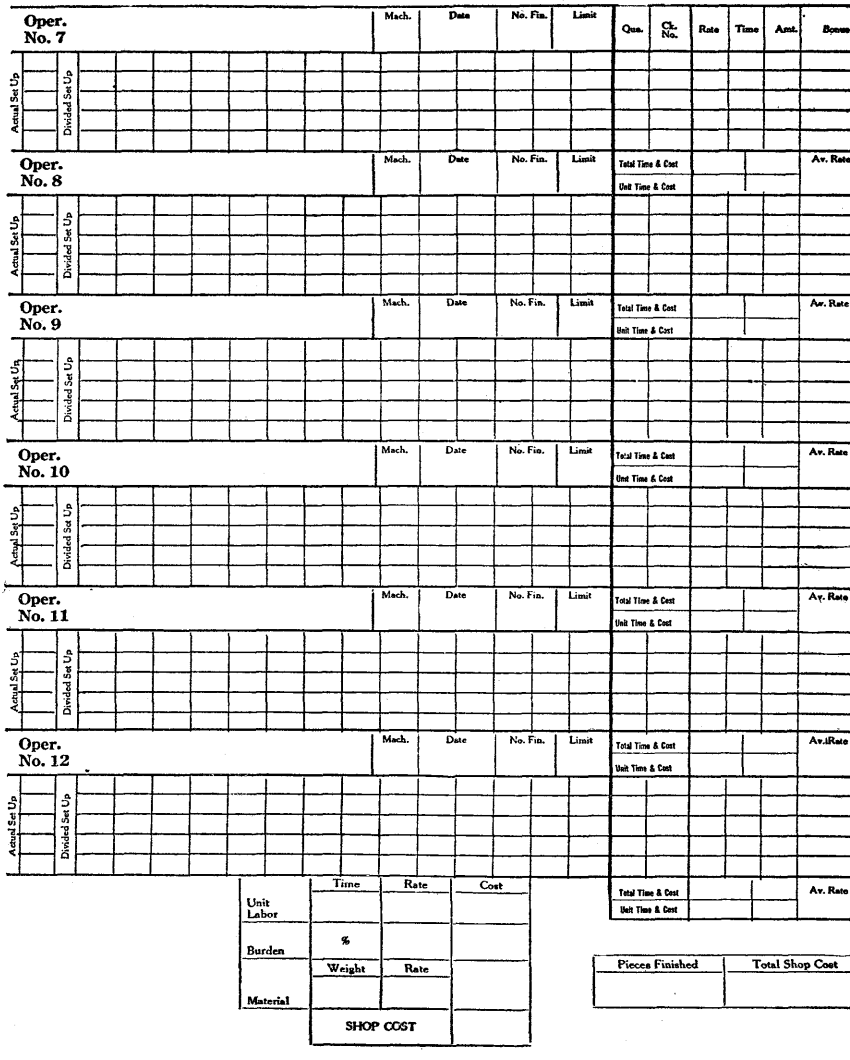
					TOTAL	Time	Cost
Lot No.	Mat	Date Started	Finished	No. Started	No. Fin.	UNIT	Time	Cost

FORM 3—MACHINE PART COST SHEET (FRONT)

shop order is calculated. The assembling time of the shop order is recorded on forms similar to Form 3—Machine Part Cost Sheet. When the shop order is completed the cost is calculated by pricing the parts listed on the order and adding to them the assembling cost including burden, and development charges.

A summary of manufacturing cost is gathered on Form 4 (See page 8) and from this record are made the charges and credits to the various perpetual inventory accounts.

The unit cost of each order is transferred to a comparative cost card for the purpose of noting fluctuations in the cost of similar orders.



FORM 3 (BACK)

Cost Summary of Hoist **Order No.**.....

	MATERIALS	FINISHED PARTS	Assembling Labor Burden	TOTAL	DEBIT	CREDIT
Electrical Apparatus					Order	S.E.A.
Resale Apparatus					Order	S.R.A.
Total Resale and Elec. Appar.						
Machine Parts					Order	S.F.P.
Structural Parts					Order	S.F.P.
Miscellaneous Materials					Order	S.M.M.
Rolled Steel					Order	S.R.S.
Total of Above						
Crating Materials						
Total other Mat. and Fin. Parts						
		Assembling				
Assemble Hoist						
Assemble Controllers						
Assemble Cable						
Assemble Coils						
Crating Mats. Labor						
Total Assembling Labor						
Total of Above					Order	W.A.M.S.
Development Work					Order	W.D.
Total Assemb. Labor Burdon						
Total Cost of Hoist.						

Limit Card No.....

Divisor..... Date Entered..... By.....

FORM 4

To simplify the requisitioning of the parts called for on the shop order, a system of grouping parts is employed. Groups are so made up that all parts on the groups may be used, no matter what combination of groups the shop order calls for. For instance, a hoist of either one, two or three ton capacity may be assembled by changing the gearing or motor. As the frames remain the same for all three capacities the parts of the frames are classified as a group. The one ton gearing may remain the same even though the form or style of frames change, so the gearing also is classified as a group.

The groups of parts making up a complete hoist are as follows: Hoist Motor, Hoist Frame, Drum, Main Gearing, Compound Gearing, Mechanical Brake, Brake Ratchet, Head, Electric Brake, Load Block, Cable and Controller. These groups are issued by number

instead of having to list perhaps hundreds of parts. The requisition is cut down to a few numbered items. The stores department keeps a card file of the groups, showing the parts required for each group and the place where located. Thus it is a simple matter to obtain them from stock when wanted. The cost department also keeps a file of group cards priced from the cost cards. When prices are changed, the figures on the group cards are also changed, thus keeping them up to date.

Certain small parts, such as bolts, nuts, screws, rivets, washers, cotter pins, keys, etc. are not issued for each order but are requisitioned in standard quantities for general use as orders are assembled.

Perpetual Inventory

A perpetual inventory is kept to show at the end of each month the stores and work in process balances. The sub-divisions of the inventory account are as follows: Stores consists of castings, rolled steel, electrical apparatus, miscellaneous materials, finished and semi-finished parts, plant improvement material, supplies, tools and scrap. Work in process consists of machine shop work, structural shop work, hoist assembling shop work, crane assembling shop work, development work, and plant improvement work.

The debits to the stores accounts are the purchases classified and recorded on the invoice register and charged to the accounts monthly. The finished and semi-finished parts stores account is debited with parts sent to stock from the shop. Credits are made to the accounts from the requisitions covering the material and parts issued to "work accounts" or "expense accounts."

Work in process accounts are debited with labor as shown by the distribution on the payroll, with material requisitioned from stock, and with the prevailing standard burden; credits are made when the work is finished and sent to stock, or is otherwise disposed of by shipment or by a charge to Plant Account.

The inventory accounts are checked annually or semi-annually in a very short time by taking balances from the stores cards which are constantly checked with the actual stock. This method eliminates the necessity of shutting down the plant for a period and probably results in a more accurate inventory than can be obtained when the shop employees make the count. Lot numbers, as shown below, are used to distinguish the different work in process accounts and the labor and material charges thereto.

Machine work—numbers 1,000 to 10,000 with a letter as a sufflx.

Structural work—numbers 1 to 1,000 with the letter "B" prefixed and a suffix.

Hoist assembling work—Order number and H suffix.

Crane assembling work—Order number and B suffix.

Development work—Serial number and D prefix.

Plant work—Serial number and C prefix.

Elements of Cost

The general subdivisions of the cost of production which are as follows need to be explained in some detail:

(1) Development costs.
(2) Shop costs (Subdivided into)
    Electrical apparatus
    Miscellaneous materials
    Finished parts
    Assembling cost
        Total shop cost
            1 and 2 combined represent "manufacturing cost."
(3) Sales expense
(4) General administrative expenses
(5) Installation
(6) Excess burden—(Necessary only when plant operates at less than full capacity.)
    The total of these elements represent "commercial cost."

(1) Development Costs.

The cost of developing the product before actual manufacturing can begin includes the engineering and drafting (direct labor and expense), the cost of patterns, jigs, tools, etc., and any other preparatory work. These costs are accumulated separately for each class, type or line of product, and are charged to the cost of that product when manufactured. The development costs on special products designed for customers' orders are included in the cost of such orders, whereas those incurred on standard types of product are included in the cost of that product on a pro rata basis determined by the estimated value or volume of output during a reasonable period of time. Development costs are kept on a form which shows in the heading the following information: development number, order number, started, finished, estimated cost, actual cost, title and the name of the person who requests the development. The columnar arrangement of the form is as follows: Date, drafting and engineering, experimental, tools, patterns, debit-month and to date, credit-amount liquidated, balance and date of credit. In these columns material, labor and burden are entered separately. At the bottom of the form the development number and the order number are shown.

(2) Shop Costs.

Shop costs consist of productive labor, productive material and indirect expense or overhead. As the first two elements are generally understood they will not be discussed here. The classification and distribution of indirect expense will be treated in detail.

Indirect expense consists of all the expense necessary to the operation, maintenance and administration of the manufacturing

departments, except those chargeable to the cost of development or plant account, or as productive material or direct labor.

These expenses are classified under the three general subdivisions of "General," "Power Plant" and "Direct Departmental." General expense covers all items which cannot be directly allocated to any one productive department and is therefore prorated over the productive departments on a percentage basis. This percentage is arrived at by adding the direct labor, direct departmental expense and power plant expense for each department and using the total of each department as the numerator of the fraction and the total of all departments as the denominator. This gives the percentage charge for each department as illustrated below:

Machine Shop:

Departmental Expense	$1200.00
Power Plant Expense	250.00
Direct Labor	1020.00
	$2470.00

Expense of All Departments:

Departmental Expenses	$8520.00
Power Plant Expenses	900.00
Direct Labor	7600.00
	$17020.00
General Expense	$3200.00

Amount of General Expense to charge to Machine Shop would be $2470 × $3200.00 = $464.39.

$17020

The power plant operating expense is charged to the productive departments in accordance with the amount of power consumed.

Direct or departmental expense, as its name indicates, is charged directly to each productive department.

A list of the items included in manufacturing expense is as follows:

General

Wages

1—Factory Supervision
2—Cost Department
3—Employment Department
4—Production Department
5—Accounting Department
6—Traffic Department
7—Efficiency Department
8—Purchasing Department
9—Receiving Department
10—Storekeeping Department
11—Shipping Department

12—Instructions to Apprentices
13—Watchmen
14—Overtime
15—Miscellaneous Departments
16—Inventory

Other Expense

17—Office Supplies
18—Shop Supplies
19—Unassignable Freight, Express and Cartage
20—Expense on Product
21—Hospital Service
22—Restaurant and Club
23—Accident Compensation Insurance
24—Defective Purchased Materials
25—Telegraph and Telephone
26—Traveling Expenses
27—Insurance
28—Local Taxes
29—Depreciation
30—Maintenance Land, Buildings and Equipment
31—Maintenance Patterns

Total General Expense

Power Plant

32—Operating Labor
33—Fuel
34—Lubricants
35—Other Supplies and Tools
36—Maintenance Building and Machinery
37—Insurance
38—Local Taxes
39—Depreciation
40—Power, Light and Heat Purchased

Total Power Plant Expense

Direct Departmental Expense. This classification is used for each productive department.

41—Foremen and Assistants
42—Inspectors
43—Crane Operators
44—Cleaners and Oilers
45—Laborers and Move Material Gang
46—Overtime Payments
47—Misc. Non-Productive Labor by Operators
48—Lubricants
49—Non-Durable Tools
50—Office Supplies
51—Shop Supplies
52—Defective Workmanship
53—Insurance
54—Local Taxes
55—Depreciation
56—Maintenance Land and Buildings
57—Maintenance Machine Tools
58—Maintenance Small Tools
59—Maintenance Fixtures and Equipment

Total Direct Departmental Expense

Some of the items in the above list need a brief explanation. Item 24—Defective Purchased Materials account collects the

cost of machining (including the burden thereon) up to the time that material was found to be defective. However, it does not include the cost of the material if it can be returned to the vendor. When either the workman, foreman, or inspector finds material to be defective he makes out a report (Form 5, see page 13) describing

REPORT OF SCRAPPED MATERIALS

Ck. No.	Name of Workman			Date	
No. Pieces	Dr. No.	Sym		UNIT COST	TOTAL COST
Pat. No.	Lot. No.	BALANCE IN LOT	Mat.		
Class			Labor		
			Labor F. C.		
ACTUALLY SCRAPPED ON OPER. NO.		PART OF OPER. FINISHED	Amount		
SCRAP CAUSED ON OPER NO.		WAS MATERIAL REPLACED BY SHOP			
Material	Wt. Each	Total Wt.			
Description of Defect					
Cause for scrapping---DEFECTIVE	WORKMANSHIP MATERIAL		Dept.		
INSP.	CHIEF INSP.	O. K. F'MAN.	CHARGE WORKMAN ?		

FORM 5

the nature of defect, the name of the workman who worked on same, and the cause for scrapping. It should be noted that this form is also used for reporting defective workmanship (item 52) referred to above. The report is first sent to the stores department so that new lots may be issued to replace the material if necessary. It is then sent to the cost department where it is priced in full to show the material, labor and burden charges after which Work in Process Account is credited with the entire amount. Charges are made to Scrap Metals Account for the material and to item No. 24, Defective Purchased Materials Account for the labor and burden. When the scrap material is sold or if it is replaced by the vendor, the Scrap Metals Account is credited.

Item 52—Defective Workmanship includes all losses due to the scrapping or repairing of defective parts. If the part is scrapped, Form 5 is used and is treated in the same manner as described above, except that the entire cost, other than the estimated scrap value, is charged to Defective Workmanship. Scrap value is charged to Scrap Metals Account.

If the part is merely defective and can be repaired the report is made on Form 6 (see page 14), which becomes an order on the production department to have the work repaired. The time of re-

pairing is accumulated, burden is added and the total is charged to Defective Workmanship Account.

REPORT OF DEFECTIVE MATERIAL

Chk. No.	Name of Workman			Date	
No. Pieces	Dr No.	Sym.	Order or Lot No.	Oper. No.	
In Dept. No.	Class				
			Labor Cost	Burden	Total
Description of Defect					
Cause for Defect—	Workmanship / Materials				
Date Work Repaired		By Dep't		Foreman	
Insp.	Chief Insp.	O. K. Foreman		Charge Workman?	

FORM 6

Item 47—Miscellaneous Non-Productive Labor by Operators includes all the time spent by machine operators or assemblers on cleaning machines, waiting for tools, waiting to have machine repaired, moving materials, etc., and the time which cannot be charged to product. This expense is indicative of failure to function, and if it runs high an investigation follows.

Items 29, 39, 55 comprise Depreciation, which is at best an estimate, but it should be made with care and charged to the departments using plant and equipment. The depreciation charged to General Manufacturing Account No. 29 is of course the depreciation of the non-productive manufacturing departments. The sales and administrative departments also are charged with the depreciation on furniture, equipment and buildings which they use. Some factories charge all depreciation to manufacturing and none to the sales and administrative departments. This is obviously wrong. The writer believes the following rates will be found to be on the safe side. The rates are applied to original costs and are in addition to maintenance expenditures and renewals as provided for in manufacturing expense accounts. They are based upon normal operating conditions and if night shifts are operated higher rates should be assessed.

Depreciation is credited to Depreciation Reserve Accounts in the customary way and is shown upon the Balance Sheet as a deduction from the original cost of the plant.

As no plant depreciates to zero when a certain amount has been charged off the depreciation stops and the balance represents the approximate scrap value.

The subdivision of Plant and the depreciation rates are as follows:

	% Depreciation	Total Reserve
A—Land	0	0
B—Buildings		
Wooden	10	75%
Corrugated Iron	10	75%
Brick and Wood (Mill Construction)	5	75%
Brick and Steel (Fireproof Construction)	3	75%
Reinforced Concrete (Fireproof Construction)	3	75%
C—Structures	12½	90%
D—Sprinkler System	12½	90%
E—Heating, Ventilating, etc	5	90%
F—Machinery	10	90%
G—Electrical Apparatus	10	90%
H—Ovens and Furnaces	10	90%
I—Power Plant Equipment	10	90%
J—Foundations and Installation of Machinery	12½	100%
K—Semi-Durable Purchased Tools	25	100%
L—Electrical Equipment (Small)	16⅔	100%
M—Small Purchased Tools (Inventory Periodically)	00	00
N—Shop Fixtures and Equipment	20	100%
O—Furniture and Appliances in Offices	20	100%
P—Fire Apparatus	20	100%
Q—Railway Track (renewal charged to Expense)	0	0
R—Rolling Stock	3 to 6	90%
S—Autos, etc.	25	90%

The above subdivisions are numerous and in a small factory may be combined to approximately the following:

1—Land and Buildings.
2—Machinery
3—Shop Fixtures and Equipment.
4—Power Plant Equipment.
5—Small Tools (Purchased).
6—Autos.
7—Office Furniture.

Jigs, Patterns and Drawings are not included in the above, in that they are classified as "Development."

Item 49—Non-Durable Tools represent the cost of such tools when taken from tool storage and placed in the tool crib for use in the shop. When purchased they are charged to plant account No. M. Records of such tools are kept on stock cards, which show the number of tools in stock and the number issued to the shop. Tools in crib and shop are not inventoried, as their value is doubtful; moreover as they have been previously charged to expense their inclusion in the inventory would complicate the accounting.

Tools are also requisitioned to workmen for their personal use. When leaving the employ of the company they must return them

or pay for them. Worn out tools may be exchanged for new ones. A simple form is used for requisitioning such tools. When issued for the first time the requisition reads "Furnish for the Account of Ck. No. 26;" when a worn out tool is returned for exchange the requisition reads "Furnish for Exchange of Ck. No. 26."

As tools are issued they are charged to expense. If a workman breaks or damages a tool the foreman is required to fill out a damaged tool report which is sent to the tool crib with the tool. Periodically, these reports are looked over by the assistant superintendent, and if any workman appears to be careless he is asked to appear before the superintendent and show cause if possible why such breakages occur. If his record does not improve he is liable to dismissal. These reports are filed for future reference in the employment department, where scrap work reports are also filed.

Overhead Distribution

Owing to the nature of the product and the simplicity of the method, overhead is distributed upon the basis of productive labor cost. When applied to departments saparately, each department having its own overhead rate, the method is fairly accurate. As a rule the low paid workman operates a low priced machine, and as the value and complexity of the machine increases so does the wage of the operator and therefore the burden charge.

The wages paid the workmen on the assembly floors are uniform as each operator is a specialist in his line and one operation requires as much skill as another.

The method of determining the departmental rate may be illustrated by working out the example previously given:

Machine Shop:

Departmental Expense	$1200.00
Power Plant Expense	250.00
General Expense	464.39
Total Burden	$1914.39
Direct Labor of Department	$1020.00

By dividing the total burden by the direct labor cost of the department the result is the rate of 187.7%.

The burden rates are calculated over a sufficiently long period to obtain a fair average as the departmental expense charges fluctuate from month to month. The rates are checked monthly and if widely inaccurate they are changed in accordance with the experience shown by the past few months.

The burden is applied to work in process accounts monthly at the standard rates and the difference between the standard burden

and actual burden is set up in reserve accounts. If the standard burden has been over-applied the balance is a liability, if it has been under-applied the balance is an asset. This balance is never allowed to accumulate greatly on one side or the other as the rates are adjusted to prevent it.

At the end of the year the balance in reserve is charged or credited to Profit and Loss as may be required. Inventories are calculated at the burden rate shown to be the proper average for the year.

Excess Burden

When a plant is operating at less than full capacity, the burden is sure to be excessive in proportion to output, due to idle machines, and the non-productive labor is required both when running at full and at reduced capacity. This excess burden should not be applied to the shop cost of production thereby inflating the value of the inventory, but should be charged to an excess burden expense account and treated in the similar manner as sales and administrative expenses. This procedure shows the normal manufacturing cost while the Excess Burden account is an index of the efficiency, or rather of the percentage of normal capacity at which the plant is running. For example:

Full Capacity Productive Payroll	$40,000.00
Actual Burden	$50,000.00
Ratio	125%
Reduced Capacity Productive Payroll	$30,000.00
Actual Burden	$45,000.00
Ratio	150%
Standard Burden @ 125%	$37,500.00
Difference, or Excess Burden	$ 7,500.00

Sales and Administrative Expenses

Sales Expenses embrace all expenditures incurred in the sale of the product and are charged off each month as they occur.

Subdivisions of such expenses are as follows:

Sales Expenses
- General Sales Dept.
  - Salaries
  - Traveling Expense
  - Entertainment
  - Supplies
  - Depreciation
  - Service Work
  - Miscellaneous
- Branch Offices
  - Salaries
  - Traveling Expenses

Rent
Postage
Telephone
Office Supplies
Miscellaneous Expense
Automobile Expense
Club Expense
Depreciation

Advertising Department
Salaries
Photographs
Catalogues and Circulars
Trade Paper Advertising
Miscellaneous Supplies
Miscellaneous Expenses
Depreciation

Administrative Expenses are those which cover the general administration of the plant and sales force, such as the salaries of the President and General Manager, educational work, expenditures on sports, etc. These items also are charged off each month. Subdivisions are as follows:

Administrative Expenses
Salaries
Meetings of Directors
Technical School and Education
Sports and Amusements
Insolvent Accounts
Legal Expenses
Contributions
Miscellaneous
Depreciation

INSTALLATION

Installation cost listed as item 5 on page 10 represents the cost of installing the product at the customer's factory, and usually includes only such expenses as the salary and traveling expenses of the superintendent of erection.

DIVISOR

The cost of each order shipped is calculated only as far as the manufacturing cost. The additional expenses are not included owing to the fact that the commercial cost, if calculated, would fluctuate considerably from month to month, as the sales for any two months are never alike. For instance, if the shipments for the month were $200,000 and the Selling, Administrative and other expenses over and above Manufacturing Cost were $20,000 the ratio would be 10%. However, if the shipments only amounted to $120,000 the ratio would be 16 2/3%. Therefore, in order to compare the costs of similar contracts it is advisable to omit the variables. To this end it has been found convenient to find the ratio of the manufacturing cost to sales price, producing what is called a divisor. This divisor furnishes a means of ascertaining

the profit on the order based on average shipments over a long period. For instance, supposing an order selling for $1000 returned a manufacturing cost of $800, the divisor would be 80%. Now, supposing the administrative and selling expenses averaged over a period of one year was 10% of sales for that year. The profit would be determined by deducting 10% from $1000 leaving $900. From this figure the manufacturing cost or $800.00 would be deducted, leaving $100 profit, or 10% of the sale price.

Plant Account

The various classifications of the plant account have been mentioned in a previous section under depreciation.

The method of accumulating the cost of a plant improvement or addition follows the same general scheme used for orders, except that a separate series of lot members distinguish this work from the other. All expenditures are recorded on cost sheets and when finished the cost is summarized on a plant sheet. A record of the depreciation and repairs is also kept on this sheet.

Plant orders originate either by order of the engineering department or shop superintendent and are approved by the general manager. As far as possible the estimated cost is given. Order bills showing as closely as possible the materials required for the orders are made out by the engineering department and submitted to the shop.

Work Done for Employees

Work done for employees or friends of the company is controlled by an "H" series of job cards. The foreman in charge of the work records on such a card the labor and material required for the work. In addition the labor is turned in on time cards by the workman doing the work, and materials are requisitioned from stock on special requisitions which are charged to the H lot number. When work is finished the "H" card is sent to the cost department and compared with the labor and material charges sent in through time sheets and requisitions. If they agree the charge is passed; if not, the discrepancy is investigated and straightened out.

Materials Purchased by Employees

Materials purchased by employees from the company's stock are also controlled by four requisitions of distinctive colors. A white requisition is sent to the cost department where credit is made to the proper stores account; yellow and blue copies are sent to the time department, where the amount is taken from the employees' pay; the blue copy is put in the pay envelope receipted; and a pink copy is given to the employee to enable him to take the material out of the shop without being held up by the company's guards.

Bonus System

Numerous methods of bonus or premium payments of wages have been devised for varying needs and conditions. After trying several methods the following have been adopted by the company the system of which is being described in this article.

The machine shop operates under the "Halsey" system. This plan guarantees the workman his day-rate and in addition he receives a bonus equal to one-half of the time saved, multiplied by his hourly rate. If the workman does not make a bonus on some of the jobs, the losses are charged to his account and he receives only the excess of bonuses earned over losses for the week. If his bonus account for the week shows a loss he receives no bonus, but this loss is not charged against him the next week. Some factories do not charge the men with losses but credit them with their earnings. This method does not seem fair, because there are times when the workman may not feel like hustling to earn a bonus, saying to himself—"well tomorrow I will get busy." The company not only loses the benefit of the extra production but also pays a high rate for the small amount of work done. If, however, the workman is charged with losses he tends to keep hustling knowing that if he loses on one job, the loss reduces the bonus he has already made or may make during the week. If the rates are properly set, there can be no criticism of this method. Good judgment is required on the part of the foreman, in that the workman's losses may be due to trouble beyond his control, such as hard castings, faulty jigs, machinery needing repair, etc. In these cases the foreman requests the cost department to day-rate the job.

If some of the pieces finished have to be scrapped or repaired through the fault of the workman, these pieces are deducted from the total number of pieces finished and he gets credit for only the perfect pieces.

Great caution is exercised in lowering the rate already set. The method pursued is to ask the workman who usually gets that job if he does not think the rate is too high. If he agrees we ask him to sign a card stating that he is willing to have the rate lowered, and that he thinks the new rate is equitable. The change does not go into effect until 90 days after the request is made and it must be approved by the general manager.

The company also encourages the workmen to bring to the rate setter's attention any rates they think are too low. If, after investigation, it is found that the rates should be increased new rates are set. This method gives the workman confidence in the company's fairness, in that he sees there is no desire to set the limits so low that a fair bonus cannot be earned, except by maintaining a killing pace. The company feels that a workman is not a good machinist if he cannot earn a bonus of at least 15 to 20% of his day wages. Some exceptional workmen earn as much as 40 to 50%.

The structural shop operates under practically the same sys-

tem as the machine shop, except that the work is done by groups of men and the bonus earned on each job is split according to the time spent on the job by each man.

The hoist assemply shop operates under a system which to some may seem unjust, yet it has proved a great improvement over the Halsey plan. To make clear the method, and the reason for its use, it is necessary to explain that each subdepartment has a gang boss who supervises the men, sees that all the material is at the department for assembling, corrects errors, etc. When operating under the Halsey system the gang boss had to split his time over the jobs going through his department, even though he did not spend his time directly on them. Of course, part of his time may be spent actually on assembling, as he is not busy on supervision the entire time. This caused the workmen to protest because each thought the boss was loading up his job too much and he claimed he could not earn a bonus under those conditions. The foreman was then requested to charge all his time to supervision. This was all right for the workmen, but the boss became disgruntled because he could not earn a bonus. So the "Group" method was installed which operates as follows: The total bonus earned by the department for the week is divided among the workmen and boss of the department in direct proportion to the number of hours each man works during the week. If they all work a full week they all draw the same amount of bonus. This may seem unfair, due to the fact that some workmen are faster than others, but it has been found that the fast men either train the slow ones how to be fast or else ask to have them removed. This plan also has the advantage of keeping all the men busy all the time. If a workman has to wait for parts or his work is delayed through some cause or another, he immediately starts helping some of the other men. Under the Halsey plan if he had to wait for something on his own job he sat down. Now he helps the others.

Limits are set on operations as in the machine shop. The bonus is calculated in the same way except that the department is the unit doing the work instead of the man.

Bonus for Non-Productive Workmen

Many methods have been evolved for increasing the output of the productive workmen and the reduction of productive costs through the application of bonus systems, but little or no effort has been made to apply the same principles to the non-productive departments. This is probably due to the lack of an equitable basis for the application of the bonus. The system outlined here is not entirely equitable, nor is it ideal, but it has produced fairly satisfactory results. In a plant where there is no bonus for the non-producers they become dissatisfied if they cannot see their way eventually to a job in the productive departments. When they hear of the bonuses earned by the machine operators and assem-

blers they naturally want to have the opportunity to earn more themselves.

After a careful study of the ratio of the non-productive labor and other expenses to that of the shop production payroll (which had maintained a very uniform average for a long period) a ratio was established and it was announced that if this ratio could be reduced an amount equal to 50% of the reduction would be distributed among the non-productive workers in proportion to the pay they drew for the period, the period being one month. If overtime were worked the workmen would be credited with the standard number of hours only inasmuch as he received 50% extra for the overtime—a sufficiently generous bonus for the extra hours.

The items of expense for which non-productive workers are in part responsible are:

1—All shop and office non-productive labor.
2—Cost of small tools issued to the shop for use by operators.
3—Supplies of all kinds used in shop and office.
4—Spoiled work.
5—Expense on defective castings.

The workers who participate in the distribution of savings are, all shop and shop office non-productive workers, including foremen and excluding executives. Roughly they include the following:

Inspectors
Cleaning and Oiling Gang
Move Material Gang
Loading Gang
Auto Truck Men
Repair and Maintenance Gang
Dispatch Office
Production Department
Foremen
Purchasing Department
Sales Department Clerks
Administrative Dept. Clerks
Advertising Dept. Clerks
Stores Department
Efficiency Department
Tool Crib
Tool Makers and Repairers
Shipping and Receiving Dept.
Pattern Makers
Test Department
Watchmen
Accounting Department
Cost Department Clerks
Employment Department Clerks
Drawing Room

This list includes some productive labor such as that of draftsmen, tool makers and pattern makers, but inasmuch as they do not participate in any other bonus it was found advisable to include them among the non-productive workers.

Posters were placed throughout the shop explaining the system and how the bonus could be earned and some of the results of its operation have been as follows:

The stores department which controls the stock of supplies and tools sees there is a need for such articles before they are issued. The foremen are also very careful not to requisition supplies unless absolutely necessary.

Each non-productive department keeps track of its poor workers and if they do not come up to a proper degree of efficiency they are fired. As the efficiency of the non-productive departments increased some of their workers were transferred to productive departments or discharged.

The foremen and inspectors watched the operators more carefully to see that they reduced the scrap cost and defective castings cost to a minimum.

The bonus system described in this article has been in use for a number of months and has worked out very satisfactorily, having resulted in very good bonuses for workmen and reduction in overhead for the company.

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