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THE

COST OF MANUFACTURES

AND THE

ADMINISTRATION OF WORKSHOPS,

PUBLIC AND PRIVATE,

BY

CAPTAIN HENRY METCALFE,

Ordnance Department,
U. S. A. (Retired)

THIRD EDITION.

FIRST THOUSAND.

WITH APPENDIX SPECIALLY ILLUSTRATING AN APPLICATION OF THE METHOD TO PRIVATE MANUFACTURES.

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TO THE MEMORY OF

COLONEL JAMES G. BENTON,

ORDNANCE DEP'T, U. S. A.,

WHOSE EXAMPLE WILL OUTLIVE ALL MONUMENTS AND PRAISE.

CONTENTS.

PART I.

CHAP.

Fundamental laws ..... I.
Introduction ..... II.

PART II.

Present organization of an arsenal ..... III.
Arsenal book-keeping generally ..... IV.
Present system, external relations ..... V.
Present system, internal relations ..... VI.
General objections to present method and outline of a better one ..... VII.

PART III.

Proposed organization of an arsenal ..... VIII.
Instruments of proposed system ..... IX.
Proposed system, external relations ..... X.
Proposed system, internal relations, viz.:
1. Orders ..... XI.
2. Labor charges ..... XII.
3. Material ..... XIII.
Proposed system, duties of stock clerk ..... XIV.
Proposed system, duties of cost clerk ..... XV.
Application of proposed system to private shops ..... XVI.

PART I.

INTRODUCTORY.

CHAPTER I.

FUNDAMENTAL LAWS.

Laws regarding property accountability, 7. Ordnance regulations, 8. Definition of Ordnance and Ordnance Stores, 8. Duties of Ordnance Officers, 8. Issues of O. & O. S., 9. Returns, etc., required from ordnance establishments, 9. Transfers of O. & O. S., 11. Money accountability, 12. Internal relations of officers of an arsenal, 12. Ordnance property regulations, 12. Property accountability, 13. Records required, 14.

CHAPTER II.

INTRODUCTION.

The existence of a science of administration inferred from that of its correlative art, 15. The science of administration is based upon experience, 15. Comparison between personal experience, which is of the memory, and that which is general and may be formulated, 15. Experience should be based upon the continuous comparison of observations, 16. Requirements of correct observation, 16. Critical observation of an administration directed principally to its cost, 17. Components of cost; their determination by analysis and their recombination into comparable forms, 17. Ultimate relation between experience and applied art, 17. Object of this book: 1st, as to formulating experience by truly recording causes of cost; 2nd, as to reducing labor of administration while

increasing extent and minuteness of its scope, 17. History of working of original system at Frankford Arsenal and at Benicia Arsenal, 18. Its simplicity in practice, 21. History of proposed improvements, 21. Principles guiding improvement, 22. Application on sliding scale, 23. Criticism of present methods defended, 23. Originality of system, 24.

PART II.

PRESENT METHODS DESCRIBED AND CRITICISED.

CHAPTER III.

PRESENT ORGANIZATION OF AN ARSENAL.

Schedule, 27. Anomalous relations between C. O. and O. S-K., 27. Consequence in practice, 29. Unconsumed expenditures, 30. Two theories of relations between co-ordinate powers, 31. Discussion of status of C. O., 31. And of officer in charge of manufactures, 32. Deputies of officer in charge and of O. S-K., 32.

CHAPTER IV.

ARSENAL BOOK-KEEPING GENERALLY.

Schedule showing constitution of arsenal, 34. Industrial department with its internal relations, 35. Military department with its external relations, 35. Trusteeship, 36. The data of arsenal book-keeping, 37. Comparison of accounts for labor and material, 38.

CHAPTER V.

PRESENT SYSTEM, EXTERNAL RELATIONS.

Definitions, 41. Abstracts, 41. Agencies, 42. Vouchers, 42. Nomenclature and classification of material, 43. Compilation of abstracts, 47. Preparation of property return, 48. Criticism of present methods of preparing property return, 49. Preparation of current service return, 54. General remarks on present system of accountabiliy, 55.

CHAPTER VI.

PRESENT SYSTEM, INTERNAL RELATIONS.

Method of giving orders and recording them, 57. Objections, 57. Accounting for labor, 59. Procuring and accounting for material, 65. Determining cost of product, 70. By foremen, 72. By clerk, 74.

CHAPTER VII.

GENERAL OBJECTIONS TO PRESENT METHOD.

Combination tools, 76. Outline of a good system, 78.

PART III.

PROPOSED SYSTEM DESCRIBED.

CHAPTER VIII.

PROPOSED ORGANIZATION OF AN ARSENAL.

Schedule, 83. Duties of officers, 83.

CHAPTER IX.

INSTRUMENTS OF PROPOSED SYSTEM.

I. MATERIAL INSTRUMENTS.

Cards, 85. Ticket punches, 91. Stamps, 92. Racks, 92. Pigeon holes, 92. Trays, 96. Post-office, 96.

INSTRUMENTS OF PROPOSED SYSTEM (continued).

II. SYMBOLIC NOMENCLATURE.

Components of cost, 97. Nature of symbols, 97. Extent of analysis, 98. Symbol for Shop-Order or expense account, 99. Symbol for character of expenditure, 99. Plant and work, 99. Symbol for objects of expenditure, 105. Staple products, 106. Pieces, 106. Components, 106. Members, 106. Notation for objects, 107. Oberlin Smith on Notation, 110. Examples in notation of objects, 118. Small-arms, 119. Ammunition, 123. Symbol for operation performed, 126. Example of notation of operations in a machine-shop, 128. Practical examples in symbolic notation, 130.

CHAPTER X.

PROPOSED SYSTEM, EXTERNAL RELATIONS.

Expansion of functions of C. O. as regards material, 134. Resulting effect on organization, 135. Changes suggested in established form, 136. Consolidated arsenal return, 138. Tables of abstracts, 140.

CHAPTER XI.

PROPOSED SYSTEM, INTERNAL RELATIONS.

1. Orders for work.

Shop-order book, 142. Standing orders, 142. Supplementary orders, 144. Order tickets, 144. Practical use of order tickets, 146.

CHAPTER XII.

2. Labor charges.

Inside the arsenal, 153. Outside the arsenal, 156. Examples, 157. Shop expenses, 166.

CHAPTER XIII.

3. Material card.

Description, 168. Use of card, preliminary, 171. Requisitions, 174. Stores in charge, 175. Rules for use of card, 176. Cases in practice, 179.

CHAPTER XIV.

DUTIES OF THE STOCK CLERK.

Outfit, 243. Journal and ledger slips, 244. Manner of posting cards to slips, 248. Papers combining accountability for cash and property, present system, 250. Proposed system, 256, 260.

CHAPTER XV.

DUTIES OF THE COST CLERK.

Outfit, 266. Wages tables, 266. Service cards, 272. Material cards, 274. Cash accountability, 275. Recoveries, 284. Reconciling cost with disbursements, 289. Analysis of cost, 292. Miscellaneous papers, 298. Pivate work, 308.

CHAPTER XVI.

APPLICATION TO PRIVATE SHOPS.

Discrimination of sources of expense, 309. Selections from this book applying to private shops, 310.

APPENDIX..... 311

ILLUSTRATIVE DIAGRAMS, TABLES AND FORMS.

	PAGE.
Annual abstract	11
Present arsenal organization	27
Arsenal book-keeping	34
Single abstract (of fabrication), general form	42*a*
Double abstract, general form	42*b*
Present nomenclature of abstracts	45
Property return	54*a*
Inventory	54*b*
Time books A; B; C;	60
Proposed arsenal organization	83
Correspondence card	90
Pigeon holes and racks	93
Swinging trays	94, 95
Symbolic tree	104
Proposed nomenclature of operations,	133
Analysis of abstracts and use of material card	140
Order ticket	145
Shop-order book	150
Service card	151
Examples in use of service card	157
Punch marks	179
Examples in use of material card	181
Journal slips	245
Ledger slips	247
Certificate of inspection	251
Voucher	252
Abstract of purchases, monthly, present form	254
Abstract of purchase, monthly, proposed form	258
Register of fly bills, proposed	263
Wages table, proposed	267
Time book	270
Cost sheet, proposed	277
Credit sheet, proposed	280
Appropriation sheet, proposed	283
Recovery record, proposed	285
Analysis of services, proposed	293
Analysis of material, proposed	295
Analysis of cost, proposed	297
Return of hired men	299
Statement of expenditures	301
Abstract of disbursements	304
Report of work	307

PART I.

INTRODUCTORY.

CHAPTER I.

LAWS AND REGULATIONS.

The following extracts comprise all the essential regulations bearing upon the accountability for public property at the Arsenals:

I. REVISED STATUTES.

"The Chief of Ordnance shall, half-yearly, or oftener, if so directed, make a report to the Secretary of War of all the officers and enlisted men in his department of the service, and of all ordnance and ordnance stores under his control. Every officer of the Ordnance Department, every ordnance storekeeper, every post ordnance sergeant, each keeper of magazines, arsenals and armories, every assistant and deputy of such, and all other officers, agents, or persons who shall have received or may be intrusted with any stores or supplies, shall quarterly, or oftener, if so directed, and in such manner and on such forms as may be directed or prescribed by the Chief of Ordnance, make true and correct returns to the Chief of Ordnance of all ordnance, arms, ordnance stores, and all other supplies and property of every kind, received by or intrusted to them and each of them, or which may in any manner come into their and each of their possession or charge. The Chief of Ordnance, subject to the approval of the Secretary of War, is hereby authorized and directed to draw up and enforce in his department a system of rules and regulations for the government of the Ordnance Department, and of all persons in said Department, and for the safe keeping and preservation of all ordnance property of all kinds, and to direct and prescribe the time, number, and forms of all returns and reports, and to enforce compliance therewith."—*Section 1167, Revised Statutes of the United States.*

II. ORDNANCE REGULATIONS.

* * * * * * * *

3. The Chief of Ordnance, under the Secretary of War, is, by law, charged with the examination and settlement of the property accountability of all officers or other persons in the military establishment, to whom ordnance and ordnance stores are intrusted.

* * * * * * * *

13. The general denomination "ordnance and ordnance stores" comprehends all cannon and artillery carriages and equipments; all apparatus and machines for the service and manœuver of artillery; all small arms, accoutrements, and horse equipments; all ammunition, and all tools, machinery and materials for the ordnance service; * * * materials for shoeing, and all horse equipments and harness for the artillery; and in general all property, of whatever nature, supplied to the military establishment by the Ordnance Department.

14. Officers of the Ordnance Department are charged with procuring all ordnance and ordnance stores for the use of the military establishment. These stores are procured by fabrication in the arsenals, armories, or other ordnance establishments, by contract, or by open purchase.

* * * * * * * *

16. The commanding officer of an armory, arsenal, depot, or other ordnance establishment, under the direction of the Chief of Ordnance, makes and publishes the rules for its internal government, procures the necessary materials and tools, engages the workmen, assigns their grades, and appoints the necessary foremen.

* * * * * * * *

18. The commanding officer of an armory, arsenal, or other ordnance establishment extends to the junior officers under his command every facility and encouragement in the performance of ordnance duties, assigning to each some portion of the manufacturing and administrative work—for which each will be held responsible—and keeps them constantly advised of the orders

and instructions received, and the correspondence conducted in administering the affairs of the command, both as a manufacturing establishment and a military post.

* * * * * * * *

27. Orders for the issue of stores from an armory, arsenal, or other ordnance establishment, are addressed to the commanding officer thereof by the Chief of Ordnance, who turns them over to the officer responsible for the property, and directs the issue.

* * * * * * * *

57. The following inventories, returns, statements, reports, etc., from armories, arsenals and other ordnance establishments, are required to be forwarded to the Ordnance Office not later than the date specified in each case, viz.:

Annually.

An inventory of all stores on hand at the post June 30. To be forwarded on or before August 31.

A return of all ordnance, ordnance stores, etc., received, issued, and remaining on hand during the year ending December 31, with the necessary vouchers. To be forwarded within sixty days after the expiration of the year.

A return of all ordnance stores, tools, and draught animals in current service during the year ending June 30. To be forwarded on or before August 31.

A report, in a condensed form, of the principal operations of the post during the year ending June 30, including an account of experiments, of the construction and repair of buildings, machinery, stores, etc. To be forwarded on or before August 31.

Quarterly.

Abstracts of receipts and issues of ordnance, stores, etc., with vouchers. To be forwarded not later than April 20, July 20, and October 20.

A classified abstract of ordnance, ordnance stores, etc., fabricated during the quarter, showing quantity, kind, and cost. This is required in addition to the copy required as a voucher with the

property returns. To be forwarded within fifteen days after the expiration of each quarter.

Monthly.

A statement of the principal serviceable stores on hand To be prepared on the last day of each month and forwarded not later than the next day.

A return of hired men, giving the names of all employees, the time worked, their respective duties, wages, and amounts earned under each appropriation, with certificates explaining any extra time worked, or other unusual occurrence. To be forwarded not later than the 5th of the ensuing month.

A statement of manufactures and other work done during the month (Form 35). To be forwarded not later than the 5th of the ensuing month.

Weekly.

A report of the ordnance, ordnance stores, etc., received and issued during the week.

58. The property accountability of the ordnance and ordnance stores at armories, arsenals, and other ordnance establishments is shown as follows, viz.:

A complete return is made annually on December 31.

Abstracts of receipts and issues, with vouchers, made on March 31, June 30, and September 30.

The vouchers pertaining to each abstract are numbered from No. 1 upward, the whole year forming one series.

* * * * * * * *

59. Abstracts in detail are not required with the Annual Property Returns in addition to the Quarterly Abstracts sent for March 31, June 30, September 30, and those for the quarter ending December 31, due with the Annual Return; but the footings of the Quarterly Abstracts are exhibited in the following form, viz.:

Annual abstract of articles (purchased, issued, received, etc., as the case may be) during the year ending December 31st.

	*	*	*	*	*	*	*	*	*
In first quarter, 187									
In second quarter, 187 ...									
In third quarter, 187									
In fourth quarter, 187									
Total in year.....									

* Names of articles arranged according to classes.

* * * * * * * *

64. The commanding officer of an armory, arsenal or other ordnance establishment transmits to the Chief of Ordnance, prior to August 31st of each year, a return according to Form No. 1, of all ordnance, tools, machines and other stores, including public animals in current service, and, at the end of each month, turns over to the storekeeper all finished articles fabricated during the month, and other stores not required in the current service.

65. All returns of property are made according to the forms prescribed in these regulations. In all the vouchers and abstracts accompanying a property return, the articles arranged in the same order as in the body of the return.

* * * * * * * *

67. The commanding officer of an armory, arsenal, or other ordnance establishment, turns over to the storekeeper invoices of stores received, to be receipted for by him, and furnishes him abstracts of articles fabricated, purchased, repaired, etc., from which the storekeeper makes the proper returns. All articles purchased, fabricated, or repaired, are inspected under the direction of the commanding officer before being paid for or turned into store.

68. Materials to be consumed or expended at an armory, arsenal, or other ordnance establishment, are issued on written

orders from the commanding officer to the storekeeper, who makes quarterly abstracts (Form 5) of such issues, which, when certified to as correct by the commanding officer, are his vouchers.

* * * * * * *

72. When ordnance and ordnance stores are issued by one officer to another the required invoices and receipts pass between them, and their property returns show the transaction.

* * * * * * * *

84. The object of a system of money accounts is to insure the application of public resources to their prescribed ends; and this is effected by furnishing those to whose supervision such transactions are committed by law, with the data or evidence upon which they can base an intelligent and correct judgment touching the fidelity with which the trust confided has been executed.

* * * * * * * *

87. The ordnance storekeeper disburses the public funds upon pay-rolls or other accounts, certified to as correct by the commanding officer of the armory, arsenal, or other ordnance establishment, each voucher showing upon its face the sum total in words and figures; and, under his direction, has the care and custody, and makes the returns of the ordnance and ordnance stores, except those in current use, for which, including draught animals, the commanding officer is accountable.

88. When there is no storekeeper, or in case of his absence, the commanding officer of the armory, arsenal, or other ordnance establishment, is accountable for all the ordnance property and funds at the post, unless authorized by the Chief of Ordnance to devolve the accountability on a junior officer.

* * * * * * * *

III. Ordnance Property Regulations, 1877.

* * * * * * *

2. The ordnance storekeeper at an armory, arsenal, or other ordnance establishment is responsible for all ordnance and ordnance stores, excepting such ordnance tools, machines, or other stores, including public animals, as are required for the current

service of the post, which are in charge of the commanding officer thereof.

3. The commanding officer of each post is accountable for all ordnance and ordnance stores at the post, not issued to the company or detachment commanders, or not in charge of an officer of ordnance or an ordnance storekeeper.

* * * * * * *

12. The object of making a return is to present, at stated times, in a condensed form, according to a well-arranged system, an exact account, duly vouched for, of all the property with which an officer is properly to be debited, and also of all property with which he is to be credited. The difference between the two gives his exact accountability.

* * * * * * *

20. At armories, arsenals, or other ordnance establishments, where purchases and fabrications are made, abstracts of each are prepared, covering all vouchers under each head accumulated during the quarter, according to Forms 6 and 7. These abstracts are entered on the returns in the order indicated above.

21. Where ordnance stores, previously borne on the return as unserviceable, have been repaired during the quarter, or when important repairs have been made during the quarter to stores previously reported as serviceable, either under the authority of a duly authorized inspector or that conveyed by the Regulations of the Army, a list of stores so repaired and transferred from unserviceable to serviceable during the quarter is made out and entered as follows:

First. On the debit portion of the return, immediately after the abstracts of fabrications and purchases; or, if there are none, after the receipt of stores, taking up all serviceable articles under the proper headings.

Second. On the credit portion of the return, using the last line, and entering all unserviceable articles in their proper columns. The principle being to add all the serviceable stores to the officer's responsibility, and from it to subtract all the unserviceable ones.

* * * * * * *

27. Ammunition and material for manufacture or repairs are the only ordnance stores which are "expended," taking the meaning of the word as used in a quarterly return. When ammunition or material for repairs or manufacture has been expended, an abstract of such expenditures is prepared; the total of such expenditures, as shown by this abstract, is entered after the words, "Expended as per abstract;" the date is that of the last day of the quarter, and the number the next to that of the last voucher entered. In the abstract is stated explicitly whether the stores have been expended in practice, in action, or for repairs, and the amount expended under each head respectively.

* * * * * * *

48. At armories, arsenals, or other ordnance establishments, special books are kept corresponding respectively to the various abstracts required by the Ordnance Office to be entered in the quarterly return. These books are as follows: for "Stores received from the Army," "Received from contractors," "Received from sundry persons," "Fabrications," "Repairs," "Purchases," and "Stores taken up;" the sum of all the entries in each forming the total to be accounted for at the post.

In like manner for "Issues to the Regular Army," "Issues to the volunteers and militia," "Issues to forts and permanent batteries," "Sales to officers for their personal use," "Issues to sundry persons," "Condemned stores," arranged under the various heads of repaired, broken up, sold, or dropped; "Expenditures," under the heads indicated by the business of the post; "Issued for current service," and "Stores lost or destroyed," etc., etc., the sum of these entries forming the total accounted for.

Whether all, or how many, of these books are required, is decided by the extent of the business at, and the importance of, the post; but every means are taken to be able to present to an inspecting officer, at any time, full and satisfactory records of the current transactions of the establishment.

CHAPTER II.

INTRODUCTION.

It may be stated as a general principle that while Art seeks to produce certain effects, Science is principally concerned with investigating the causes of these effects.

Thus, independently of the intrinsic importance of the art selected for illustration, there always seems room for a corresponding science, collecting and classifying the records of the past so that the future operations of the art may be more effective.

The administration of arsenals and other workshops is in great measure an art, and depends upon the application to a great variety of cases of certain principles, which, taken together, make up what may be called the science of administration.

These principles need not be formulated, nor even recognized as such, and they vary with the conditions which call them forth; so that while their essence may be the same, the special rules of conduct derived from them may, in various circumstances, be widely different. Yet, for each set of conditions their character is the same, and in all they constitute what is known as our experience.

Some men have the gift of so arranging their experience that it is always ready with an answer to whatever question new conditions may propose. But such men are rare and are seldom found in subordinate positions. In any case their knowledge goes with them when they depart, instead of remaining, as it should, and in great measure might do, as one of the most valuable earnings of the business in which it was acquired.

For this purpose it should be formulated, if a way were found, so that its record might be plain to whoever had the right to read it.

Now, since the operations of good administration are in their nature gradual, and for their successful issue depend rather upon uniform attention to their progress than upon occasional violent efforts to adjust them to the current of affairs, it will be seen that the most useful teachings are those gained from a continuous record of events; for these may be expected to recur with time, while great catastrophes can seldom be provided for, or, in fact, prevented, better than by the daily discharge of the duties pertaining to direction.

If there be a science correlative to the art of administration, it must, like every other physical science, be founded on the comparison of accumulated observations.

Since the accuracy of the knowledge sought can be no greater than the exactness of the data from which it is derived, in order to make a proper comparison it is important that the observations be as free from error as possible, and that they be measured by a common standard.

Errors of observation may be divided into two general classes; the instrumental, and those due to the personal bias of the observer; the former referring to the standard itself, and the latter to the application of the standard and the record of the measurement.

Whatever be the standard of measurement, it suffices for comparison if it be generally accepted, if it be impartially applied and if the results be fairly recorded.

In regard to personal errors of observation it is generally admitted that truth is most nearly approached when, having observers of equal goodness they are most numerous, and when they individually know least of the immediate consequences of what they report.

Hence the most truthful records will be had when each observer's share of the work is reduced to a minimum; for the number of observers being the greatest possible, each one will have so much the less to do, and being, therefore, better able to do his share, each will feel more responsible for the accuracy of the aggregate result and will besides be most likely to have

his bias neutralized by the opposing tendencies of the other observers.

Now, efficiency being admitted, the excellence of an administration is universally measured by its cost.

This cost is composed of the sum of the costs of each of its actions; so that to properly value an administration we require to know both what it has done and the cost of doing it.

The greater the detail of this knowledge the greater its value; for the more exactly then can causes of past expenditure be traced back from their effects, and the more certainly may estimates of future cost be based on what is already known and established.

Success in manufacturing depends almost entirely upon accuracy of estimate.

The extent to which the analysis of cost and product may be carried need only be limited by the expense of making it or by the power of comprehending and comparing the results which it affords.

To utilize such an examination two processes are necessary, one inductive and the other deductive; for the product and its cost having been analyzed as far as convenience will permit, the resulting items must be recombined into forms admitting of a comparison from which may be deduced certain general rules for the future conduct of affairs.

Then will Experience take definite form and become indeed a teacher; thus Science be the handmaid of the art.

It is the object of this book to show how the cost of administration may be determined, both in gross and the remotest details, by such impersonal, invariable means that their record may be looked upon as being as nearly absolutely true as that of any other similarly extended series of observations.

Together with this comes a method of administration which reduces its labors to a minimum and yet immensely increases its scope, by recording, in whatever minuteness of detail may ever be required, full information as to services performed and as to material in all stages of manufacture, received, expended and remaining on hand.

Furthermore, its records will be made continuously from day to day, it may be from hour to hour, so that, being disposed of in detail, the turmoil and anxiety of periodical accounting will be unknown.

Few will deny the advantages of such a scheme; many will consider it utopian. To such I offer the following account of what it has done.

While in charge of the workshops of Frankford Arsenal, in order to keep track of the list of shop, or work orders, of which 80 to 100 were always in hand, I began a book in which they were entered as received from the Commanding Officer and crossed off when completed. This worked for but a short time, when it became so inconvenient that I was led to give to each order a serial number as a symbol by which it was to be known.

To communicate these orders to the foremen came the order tickets, correspondingly numbered and distinguished as described in the text. The analysis of the character of the work, and of the objects and operations came later, and led to the Time Card now in use at Frankford Arsenal, the idea of which was remotely derived from that in use at the National Armory during my service there. This carried the labor question as far as it was considered at Frankford Arsenal, and completed by far the easier portion of the task.

For the reasons stated in the text, the question of material gave much more trouble. One form of card after another was tried, each one more simple and comprehensive than the last, until the form of Material Card now used at the arsenal was devised.

The plan was unfolded to the foremen by a lecture on the 18th of June, 1881. Seven working days afterwards I was detailed to other duty and have never since had anything to do with the working of the system at the Arsenal. Yet, as official reports lately made declare, it continues to give satisfaction and is followed substantially as it left my hands.

I have much for which to thank Colonel Lyford and Captain Michaelis, the former for the support given as Commanding Officer

to the operation of a scheme, the development of which he did so much to encourage; and the latter, my successor in charge, both for his interest in its continuance and for improvements from which I have borrowed the suggestions noted in the text.

Still, I think it will be acknowledged that it must have had considerable intrinsic vitality to have endured so well my early removal from its charge. I am fain to believe that it was because it met a real want, not only that it furnished the Commanding Officer with superior information without abridging in any way his prerogatives, or that it relieved the foremen of all their clerical labors; but that besides these and above all other advantages it gave the foremen an assurance that good work done cheaply would be known as such and that a method was provided by the certain and automatic action of which their work would be surely gauged.

Foremen, as a class, are necessarily among the most intelligent of men and are as quick as any to appreciate the advantages of a good tool. Direct methods suit them best; they like to work as a dog digs a hole, disposing immediately of present necessities and throwing what they have accomplished behind them, out of sight and mind. They do better and more trustworthy work when not required to record their own performances, and are all the better able to appreciate the efforts of others who can classify and arrange their results for future reference.

Then, besides, clerks and storekeepers were relieved from the keeping of many books, books which for evident reasons were very imperfectly kept by foremen and storekeepers, and which if correctly prepared by clerks were of necessity based upon the incorrect data given by the others. For example, how expect books to be accurately kept in winter time in storehouses in which fire is not allowed?

The adoption of the last model of cards did away with the following books and papers kept by foremen:

1. Reports of fabrication.
2. Reports of material returned to store.
3. Stock books of all kinds.

4. Requisition books for materials to be purchased or to be drawn from store.
5. All time books.
6. All statements of costs.

And the following by storekeepers:

7. "Stock" day-books.
8. "Material" day-books.
9. Stock ledgers.
10. Memorandum orders.
11. Teamsters' receipts.

And the following by clerks:

12. Register of orders of supply.
13. Invoice book.

(As an illustration of what this amounted to, I have in mind an establishment employing not many more than 100 men, where the books required to transact the morning's business number 18 and weigh about 60 lbs. This includes only those carried to and from the office more or less every day, and does not include those kept permanently at either end of the route.)

A few books on the ordinary plan of Day-book, Journal and Ledger were added, but these were afterwards abolished by Captain Michaelis, who wisely extended the principles of the card system, so as to make the book form of record unnecessary. These were kept by the Cost Clerk, a new creation.

I do not remember that any new books were added to those kept by the other clerks; but, on the contrary, by the use of the ledger form, devised by Mr. Fries, the Stock Clerk, he was enabled to deal single-handed with the enormous variety of material on hand at the Arsenal, embracing thousands of different names. This had previously required the attention, for prolonged periods, of about two-thirds of the clerical force.

The Cost Clerk knew nothing of the shops when appointed to them. He was employed at $2.00 per day, and had two boys, of about fourteen, to assist him in keeping the accounts and taking care of the shop store-room, also new. This force was certainly insignificant, compared with the results achieved, particu-

larly so, when it is remembered how many new items were dealt with, and how much more information was available than ever before.

Owing to the kindness of Colonel J. McAllister, commanding Benicia Arsenal, I have been allowed to apply the system here. In beginning, where everything was new, I was forced to simplify and reduce the work as much as possible, for I had most of it to do myself; in consequence, when I got a helper, I was able to teach him his duties in about a week's time.

The comparatively crude means adopted, forming the basis of the improvements hereafter described, have worked as great a change as at Frankford. The foreman has no books to keep, and all the clerical work, much more than formerly, is done by a soldier who is employed for the greater part of his time as a copyist in the Ordnance Storekeeper's office.

Thus it will be seen that the results claimed have not been achieved at a sacrifice, but that each advance in expansion and efficiency has been accompanied by a gain in simplicity and directness.

While doing this work, I had been educating myself to a fuller comprehension of the possibilities of the system, so that, starting to explain the Frankford system as I had left it, I found my subject unsatisfactory, and discovered creeping in exceptions and inconsistencies which I knew would be confusing to those who might have to undertake the work afresh. I soon determined that such special rules were but a sign of incomplete investigation and that the necessity for them must be removed.

In consequence, both Time and Material cards were revised. The former was adapted to piece work as well as to time work by the day or by any of its subdivisions, and also to rendering an account of services by whomsoever performed; and the new Material card was placed in such accord with the Ordnance Property Regulations that it sometimes seems their latent spirit. The most radical change lay in limiting the cards to a single entry each; this simple matter led to most important consequences.

Every transaction with material that could be imagined has been traced to its conclusion by certain uniform rules, every anomaly being considered due to some intrinsic defect in the rules, which being eliminated, they were re-applied until further exceptions seemed impossible.

These rules were:

1. To reduce all writing to a minimum by the use for all purposes of the same general kind of one comprehensive tabular form, completed by a simple symbolic notation and certified by characteristic punch marks.

2. To make each card a representative unit, capable of combination with others, according to any one or more of their common features; thereby attaining by the mechanical operation of sorting, the results otherwise achieved only by the tardy and laborious processes of book-keeping.

3. To avoid transcription by providing that the same card shall be dealt with by as many consecutive agents as require it, thereby saving time and preventing errors in copying.

4. For the preservation of the cards and their record to trust rather to their equivalency with the units they represent, and with which they are convertible, than to mere rules of conduct concerning their employment; and so, by depending upon the cards for all the temporary purposes for which books are now employed, to make books unnecessary except for final records.

5. To disregard the number of cards consumed by using them singly as an immediate record of all transactions deemed worthy of note, in view of the ultimate saving in labor and the absolute avoidance of confusion due to their unrestricted employment for such purposes.

6. To render entirely unnecessary the removal to the workshops or storehouses of any records or correspondence pertaining to the external relations of the arsenal.

7. To make the cards so full of meaning that no one understanding the principles on which they were based could ever go amiss in using them; that no special rules should be required for special cases, but that the part of each user should be fixed by

evident principles of general application: in a word, to make the cards suffice for all purposes to all who had to use them.

The departures from the letter of the Regulations are so slight that in view of the concluding portion of par. 48, Property Regulations, 1877, p. 14, it seems not unreasonable to hope that they may be condoned.

The principles on which the system is founded are so broad that though it may fully comply with every precaution required of trustees of public property, it seems none the less applicable to the smallest shop in the land. But it would not be necessary, nor even advisable, to follow their application in every case to the extent required by the uses of the Ordnance Department. However far this may be done, it seems plain to me that the results which those who have charge of workshops seem universally to desire can be attained in no other way so economically as by this Mechanical Book-keeping.

It seems as proper for a reformer to show that a change is needed as to explain the changes he proposes to make: so wholesome is conservatism, that a new thing should not only be shown to be good, but that which it proposes to replace should be proved to be relatively bad. I have been forced, therefore, not only to criticize much in our present methods that seemed bad; but I have also, for want of other sources of general information, been obliged to explain that which I criticized. I need hardly say that my only object has been to make evident the evils from which not only we of the Ordnance Department have been suffering, but which, in some form, few of the private workshops of my acquaintance have escaped.

Having been compelled to do the greater part of this work thousands of miles away from, and years after leaving the scenes and circumstances most in mind, it is to be expected that many inaccuracies will be found in my statements of details. Still I believe that it is all true in spirit, if not of all of the places considered, at least of some of them. It is hard to select examples which shall be typical and not appear invidious or exaggerated; but I have done my best to make sure that all the examples shall

be at least possible and as true to the facts as my own memory and the concurrent testimony at my command would permit.

The use of cards in workshops as well as in libraries, is no new thing; others besides the men with whom I have worked have been driven to appreciate their advantages and have turned them to more or less account. But the administration of private workshops is in general limited by responsibilities so immediate and self-contained, that I doubt whether there are any where as strict an accounting has been made as is required by our trusteeship of public property. Indeed, had it not been for the rigorous exactions of the Ordnance Regulations, I doubt whether I would have been led to formulate a scheme as comprehensive as I hope that this will be found. It is their spirit which has led me through this self-imposed task, and it is in extending its influence that I find my reward.

I have to thank William Sellers & Co. of Philadelphia for suggesting the manner of distributing miscellaneous expenses and the use of the ticket punch for signatures; also for much information and encouragement, the details of which have escaped me. Besides those whose names appear in the body of the report I wish particularly to thank Lieut. A. H. Russell, of the Ordnance Department, for his assistance, and Mr. H. T. Fries, Stock Clerk at Frankford Arsenal, to whose familiarity with existing requirements and to whose zeal in meeting them I am under obligations which it is difficult to express and impossible to repay.

HENRY METCALFE.

BENICIA ARSENAL, CALIFORNIA, *May*, 1884.

POSTSCRIPT.— A change of station to Watervliet Arsenal has enabled me to revise the MS. prepared in California by the light of a wider experience.

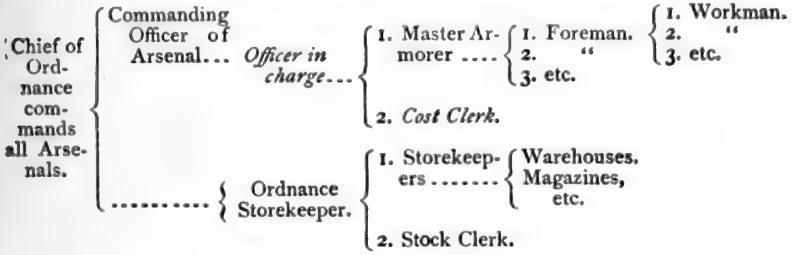
PART II.

DESCRIPTION AND CRITICISM OF PRESENT METHODS.

CHAPTER III.

PRESENT ORGANIZATION OF AN ARSENAL.

Schedule showing the relations of the principal officers and employees of an arsenal as at present organized.



We have first the Commanding Officer, who represents the proprietor and stands for the arsenal in its relations with the outside world.

His only subordinate distinctively recognized by the regulations as charged with separate responsibilities, is the Ordnance Storekeeper. He is supposed to have charge of all material not in use; to receive all material, whether received from external or internal sources, and to issue it only on the written order of the Commanding Officer. He is also generally the paymaster, disbursing on similar written orders, but the two functions are not necessarily combined in the same individual.

So important are deemed his duties as custodian, that the storekeeper is required to give bonds, except when temporarily chosen from the active list of ordnance officers by the Chief of Ordnance.

The table illustrates the anomaly of his position, for while subordinate to the Commanding Officer, he is not appointed by him and is only discharged from his responsibilities by the approval of their common superior, the Chief of Ordnance. As

an officer he is an inferior; as an agent he is an equal — a relation which is as hard to design graphically as it is difficult to describe.

The Ordnance Storekeeper appears to be intended as a sort of check on the Commanding Officer, just as in primitive societies two or more officers may hold different keys to the same money chest; each expenditure requires the united action of both agents; fraud is impossible without collusion.

This does well enough when the agents are of equal powers; but the precaution is apt to lead to confusion when one of the parties is, so to speak, both a rival and a superior to the other.

The principle of co-ordinate control may, however, be conveniently applied when money only is concerned, even under the peculiar relations above stated. Such transactions may be deliberate, for the certainty of payment is, to the creditor, almost equivalent to the actual transfer of the cash. No harm is done, no clashing of interests follows, say, a day's interval between the approval of a voucher by the Commanding Officer, and its payment by the Ordnance Storekeeper. Transactions with money, too, require deliberation, for mistaken payments are with difficulty corrected.

But it is different with material. Here, on the one hand, the actual delivery of the material in the shortest possible time is often important; and on the other hand, as material is less portable than cash, so may errors due to its too precipitate expenditure be more readily corrected, if a way of determining them readily could be found.

Administratively speaking, the main objection to a dual responsibility such as has been described, lies in the conflicting interests of the two agents in question. The interests of the Commanding Officer tend generally to his getting the material he needs in manufacturing as promptly as possible from the storehouse to the workshops. Here delay works harm, and his own interests suffer if he permits it.

The interests of the Ordnance Storekeeper are directly opposed: he does not care how much the material may be required

elsewhere, so long as he runs no risk from its leaving his charge without warrant.

Now, if the Commanding Officer were a permanent fixture in the shops, no harm would result in practice, for whatever his agents needed from the storekeeper, he could procure. But he is not and should not be a fixture. The mere ordering of supplies from store is too small a matter to interfere with the higher duties of his office: he should be as little confined by such merely clerical duties, and as free to give at all times to all portions of his command the active supervision which any of it may require, as if no such person as the storekeeper existed.

What are the consequences of the existing dual administration? Strictly speaking, the Commanding Officer should only draw exactly what material he requires for any particular purpose. If he needs a pound of bar iron to make a forging, a quart of oil to mix some paint, he must draw just that pound of iron, just that quart of oil, and no more, and must give his written order for it in each case. Of course, this condition is impossible, so that in practice supplies are drawn from store in bulk, either when purchased or soon after, and, as a means of accounting for their disappearance from the accounts, are immediately "expended" on the most probable objects: no other way seems possible. The portion not actually consumed is kept in the shops or about the post on no one's papers: it may be used, wasted or stolen; no one can ever tell. Practically it is used for miscellaneous repairs about the post, until, at the end of the fiscal year, if a proper inventory is made, it is taken up on the papers as "found on post, in excess of quantity called for by the return." If no inventory is taken, it accumulates until the appearance on the return of issues of material of which none was previously reported on hand, requires either the adjustment of the papers to meet this special case or the taking of a new inventory. I once took up thus about 4,000 pounds of bar steel, worth from twenty-five to forty cents a pound, the result of years of "expenditure," and yet we were constantly buying more.

If this be true for small stores like steel, oil, tools, etc., that

may be handled, how much more true is it of bulky stores like lumber and coal? No pretense can be made of drawing these from the storehouse as required: they are the big fish breaking through a net, which only serves to entangle the fishermen.

Then, the question of properly charging material so expended in bulk is an embarrassing one, for if duly charged to those other jobs on which it is actually expended, it will be twice "expended," and the papers would show that more was used than was received. On the other hand, if it were charged but once when first expended, it would appear that some fabrications were made without material, which would not only be inaccurate, but would be misleading to those who would in future have to depend upon such acts of record. The effect on foremen and others is also bad. They often say, "*That* material should not be charged, for it has already been paid out of another job," and are thus led to extravagance.

The only alternative seems to be in the nature of a compromise, by the Commanding Officer ordering from store in bulk, such supplies as may be needed for such necessities as he may be able to anticipate. But this, like the requirement that foremen shall make requisition for all that they need in season to be acted on during certain office hours, is an inconvenient provision, and one tending to defeat the very purposes of organization. Not every want can be anticipated; so that when out of office hours a want arises, how is it to be met? We do not wish to make the Commanding Officer, or as has been sometimes done, one of his subalterns, a prisoner in the office, so as to have him ready to act upon such irregular demands; we do not wish to incur the loss and delay caused by making the foreman wait until the next office hour; we do not wish by emptying the storehouse into the shop to do away with its important function. So an irregular measure is resorted to: the material is taken from store, subject to the future approval of the Commanding Officer. As a matter of course this is always given. He has might as well as reason on his side, and the Storekeeper has very properly to submit to necessities of which he may not judge.

But the track of these irregular transactions is not always kept, and as the Storekeeper feels that his rights have been invaded, and the integrity of his methods violated by the Commanding Officer, he leaves to him justly enough the responsibility thus assumed, and relies upon such precedents for his justification should fault be found with the correctness of his accounts.

A system based upon responsibilities so easily abrogated must abound in inconsistencies and in the end be only delusive.

It will be seen that all this trouble comes from following out a natural supposition, that the members of the organization are like the branches of a tree which can communicate together only through the parent stem. This is well enough for fixed objects like trees, but for moving organizations, constantly running a race with time, it will not suffice.

To preserve that harmony of action which is the essence of good administration, all communication to and from the outside world should be through the Commanding Officer. But behind him, in the internal economy of the establishment, he is supported by official subordinates over whom his control is so continuous and absolute, that he may, not only safely, but to his advantage, permit their free intercommunication; defining clearly the scope of each one's duties and holding him responsible for the results of their performance. Since whatever the results may be, they are subject to his immediate correction in point of labor misapplied, and as to material misused, it does not pass from his control.

An illustration is found in any household; if none of its servants were permitted to assist each other without the express orders of its head, the head of the house would become an upper servant, and in case of his absence confusion would prevail. In practice it is invariably found necessary while requiring all orders and purchases concerning the outside world to go through the master of the house, to make such general rules as to permit and require the co-operation of the servants, each in his sphere of duty, in executing the orders of the common head.

So, by wisely abstaining from the constant exercise of the full powers with which he is clothed, and by not identifying himself

with any one department, the Commanding Officer becomes the critic of them all; but a critic with power to act, which is more than most critics have, and a responsibility to meet, which the harmonious action of his command enables him to face to the best of his individual ability.

No commanding officer can do the work of all his subordinates, but he may so systematize their labors that, while he need not assume the work of any, he may still hold each accountable for his own share. If he confines himself to working where his work will tell the most, and gives others the same chance, he cannot fail to find their interest and energy increased and his own labor diminished while its efficiency is largely enhanced.

To assist the Commanding Officer in the active management of the shops, he often details an officer to superintend them; he is known herein as the Officer in Charge. As has been before said, this officer is theoretically the inferior of one who is both superior and co-ordinate to the Ordnance Storekeeper; practically, he and the storekeeper are, in many respects, co-ordinate inferiors to a common head, the Commanding Officer. Both functions, and indeed all three, may be united in the same person; but their responsibilities are widely different. To illustrate, I would say that the Ordnance Storekeeper is the Commanding Officer's left hand, while the Officer in Charge is the Commanding Officer's right hand. The left hand holds the purse, while the right hand disposes of the treasure it contains; the left hand holds the scabbard, while the right hand draws the sword; the one has a passive charge, the other an active duty.

Granting this, which is no idle image, it follows that the custody of all the material of the Post, not in use, should be with the Ordnance Storekeeper; while the care of the material in use, and the means of using it, should be with the Officer in Charge; each acting personally or by deputy.

The Officer in Charge has for his deputies:

1. The Master Armorer, or as he is sometimes called, the Master Workman. He is a sort of permanent lieutenant to the

Officer in Charge, co-ordinating the energies of the foremen under him, and in his superior's absence taking his place. His special practical experience is joined to the theoretical knowledge of the Officer in Charge, generally with the happiest results. He also serves to carry matters along without essential change until new officers in charge have become sufficiently familiar with the work.

2. After the Master Armorer come the various foremen and the workmen under them.

3. At Frankford Arsenal, and also at Benicia Arsenal since the partial application of this system, there is also the Cost Clerk, with such assistants as he may require to make out the factory records. The cost clerk belonging so intimately to the shops, may well have in his charge the store-room attached to them.

The Ordnance Storekeeper has beneath him various assistant storekeepers in charge of the magazines and warehouses, and the Stock Clerk. The former receive, care for and issue all stores and supplies; the latter keeps the records of the office as regards material passing through the Storekeeper's hands, whether received or issued. These records are kept in the form of the Property Return made through the Commanding Officer to the Chief of Ordnance.

These are the principal agents with whom this paper has to deal; there are some others whose duties are more or less allied to the subjects under discussion, as the chief clerk and the cash clerk; but a knowledge of their functions is not essential here.

CHAPTER IV.

ARSENAL BOOK-KEEPING.

Requirements of Arsenal Book-keeping.

An arsenal comprises so many different functions that it is well, before going further, to discuss them somewhat in detail. For this purpose the accompanying table serves to show that the arsenal consists of two distinct departments which are usually under one management, although nothing but convenience requires them to be so combined.

1. As a manufactory, it requires a certain record of all orders for fabrication, with a prompt and accurate return of their completion. Also, a ready reference to work in hand, so that a general idea of its duration may be had; and a ready reference to work not yet begun, so that labor awaiting employment may be at once directed to its proper object.

It requires a prompt report of work done by each workman on every job, both so that he men be duly paid, and the cost of the job be truly ascertained. As a manufactory it requires prompt procurement of articles required from the outside world; and to prevent unnecessary purchases, a full knowledge of what is on hand and available for use.

As a manufactory, an arsenal may also have certain specialties or staple products like that of the National Armory for arms; Frankford Arsenal, cartridges; Rock Island Arsenal, leather work; Watervliet Arsenal, gun carriages; to which, in addition to its general functions, especial attention may be wisely directed.

But like every other factory, beyond and above all these requirements, because embracing them all, it needs a knowledge of the true cost of its product. This is what establishes the relation between effort and effect, between promise and performance; it is the balance by which all industrial processes are weighed and finally valued.

2. In its relation to the Military power an arsenal comprises, generally speaking, two independent functions: first, it is a military post garrisoned by troops which must be cared for like any other portion of the army; second, it is a magazine for arms and munitions of war, which require a certain force to receive

and issue them, and to overhaul and preserve them from injury and decay.

These troops and storehouses require a large amount of clerical labor in preparing the reports and estimates demanded by the superior military authorities.

In its external relations the Arsenal has a dual responsibility: first, to the Chief of Ordnance for the general management of its affairs; and second, through him to the Treasury for its disbursements. The arsenal is required to furnish the Chief of Ordnance with full and frequent information as to its affairs, as a factory, as a garrison, and as a magazine; so that through him, Congress and the people may know how the public money has been spent, and that the arsenal may be best prepared to meet whatever calls its geographical position may expose it to. These reports relate to the progress of work which has been ordered, and to its cost; to the condition of the garrison; the number and rating of the civil employees, and to the quantities of each special kind of material received, issued, and remaining on hand.

The magnitude of this undertaking may be imagined when it is known that the returns of most large arsenals embrace several thousand kinds of material, each of which has to be accounted for under its own name.

As to the disbursements, the arsenal reports to the Treasury, not only its disbursements in bulk, but those authorized *by each appropriation* of Congress. The Chief of Ordnance similarly requires accounts to be kept with his allotments of the general appropriations among the different arsenals.

It is thus seen that the book-keeping covers a large field: the work involved may be imagined by any one who has seen some large business turned over to an assignee, to be managed in trust. Now, the management of an arsenal is always in trust; but it is a double trust, being first from the Treasury to the Chief of Ordnance, and from him to the Commanding Officer; each trustee has another to watch him.

Where the accounts assuming and discharging this grave responsibility require the most attention, is in the details regard-

ing the internal economy of the arsenal, for these are the very source and origin of all the changes which require the rendition of accounts.

These details are often regarded as insignificant, and they are perhaps not worthy of comparison with many of the higher problems with which the ordnance officer has to deal; but for him whose duty brings him close to them, they assume a great importance, because unless they are properly handled they take up so much of his time that he has none left for the other problems; his energy is wasted in constantly repeated efforts to do that which has always seemed to him before, must somehow be done of itself.

This work of collecting data to serve for revising tariffs of piece work, for the preparation of estimates, for statements of the cost of finished work and the like, has seemed, in the years which I have served in and about Ordnance workshops, as part of the unwelcome price I had to pay for opportunities elsewhere enjoyed.

"They order," said I, "this matter better in France;" so thinking that the force of competition had stirred private manufacturers, at least, to a sense of its importance, I made inquiry of such as came in my way with the purpose of finding a more simple mode of reckoning than that followed in the Department, and yet one that should be at least equally exact.

Except in the workshops of Messrs. William Sellers & Co., I found that our methods did not suffer by comparison. I found several establishments in which methods somewhat similar to those herein described had been adopted, but none that I now remember in which they had been carried further than was required for merely present purposes. A loose system of averaging results seemed to be the rule, leading sometimes to selling machinery by the pound, and at others to simply making things as cheaply as possible, and selling them at the market price without regard to the fact that the circumstances of the shop might make sales even at market prices detrimental if they were made at a loss.

The refuge for this state of things is everywhere sought in

piece work; but this supposes either a long succession of orders of the same kind by which the price may be tentatively determined, or a knowledge on one side or the other of what price is the fair one from the start. Practically, such information can only be obtained by a comparison with similar work already done, the details of which it is intended by this system to preserve.

Labor and Material.

Although the cost of material forms such a small part of that of the finished product of our workshops, the most casual inquirer is struck by the disproportionate amount of time and money spent upon the records relating to material. The differences noted hereafter are caused by differences regarding the procuring, the employment, the accounting for, and the relinquishment of labor and material.

Labor.

In regard to the procurement and discharge of labor, the utmost simplicity prevails; the commanding officer hires whom he sees fit, for as long as it may be expedient.

The responsibility for labor engaged, lies solely in its proper employment; it ceases with the employment, and requires for its record only such simple accounts as may satisfy the claims of the employed, and exhibit the distribution of their time.

Material.

In distinction to that pertaining to labor, the responsibility for material involves a very wide, because a *continuing*, responsibility. To make this clearer, let me explain as follows:

Sufficient labor for the needs of the workshop is supposed to be on hand, ready for such direction as the foreman chooses to give it; when done, it is accounted for in time, charged for in dollars and cents, paid off, and the matter is at an end. Like gas, when no longer required, the supply is cut off; there is no waste, no remainder.

But public property held in charge is a trust, for which an account may at any time be required. Until wholly consumed,

as by fire, the responsibility for material never ceases; it may change its name, as by fabrication, but it still deserves to be accounted for under its new name. How this is, the following examples will show:

Suppose that the material is first received as lead; in due course of manufacture it becomes bullets; the bullets lose their identity in becoming cartridges; these may be fired, converting the bullets into scrap lead; and finally, this being melted together with that resulting from the operations of manufacture, it becomes once more pig lead.

So with oil and whiting, which with labor added becomes putty; then with lumber, screws, nails and paint added, pass into the condition of boxes, and finally disappear as packed ammunition. The same is true of lead and oil passing into the condition of paint, and so on.

To make our accounts good they must take note of every one of these changes, for it may be cheaper for us to buy our putty, boxes, etc., as such, instead of making them in the shops;—if so, we should be able to know it. The growing specialization of small industries makes just such questions more important every day. The first remark of the traveling salesman is, "We can sell you those things at a profit, for less than it costs you to make them."

We now see what is meant by the continuing responsibility imposed by the possession of material. It is a load which may be shifted under different names, but from which one can never be wholly relieved until it is consumed as by fire or is transferred to another's keeping.

As a further illustration of the difference in the treatment of charges for labor and material, it is easy to see that labor is always a charge, while material may be either a charge or a credit to some account. Thus the components of a fabrication are proper charges to it, but if diverted to another product must be credited to balance the account.

Furthermore, material should, if possible, be procured by timely contracts, so as to gain the advantage following the com-

petition in prices between dealers. The contracts should be based upon the expectation of large and immediate deliveries, that the fluctuations of the market need not be allowed for by an increase of price, and that the expenses attending numerous small deliveries may be avoided. Yet, these matters must be so managed that the funds be not drawn upon so heavily in the early part of the season, that the contingencies to which all manufactures are subject will be unprovided for. Labor requires none of these precautions.

When received, material should be at once accounted for, and should be so kept that all expenditures from it will be recorded, and of necessity charged to some account. Yet, at the same time, the material must be so accessible, that it may be had for proper purposes as freely as in any private workshop in the land.

The necessity for anticipating the want of material and for recording the results of its procurement and use, is thus seen to be accountable for the relatively great portion of our records that it occupies.

I imagine that, whether heeded or not, the same relations exist in all workshops, down to the smallest private foundry, in which the processes are the fewest, the materials the crudest and the least varied, and where the disposition of the material concerns no one but the proprietor.

What study I have given to the subject convinces me that a proper treatment of material is the key to success in those branches of administration with which this paper has to deal; with that well settled, everything else follows; without it, no system can work satisfactorily.

CHAPTER V.

PRESENT SYSTEM.

A. *EXTERNAL RELATIONS.*

(PROPERTY ACCOUNTABILITY.)

DEFINITIONS.

Property Returns.

A property return is a periodical tabular statement with appended vouchers, of all recorded transactions with public property during the interval of time to which it belongs.

There are two returns now made, one by the Ordnance Storekeeper, known generally as the Property Return; and one, usually much more restricted in its scope, made by the Commanding Officer and known as the Current Service Return. The following discussion applies particularly to the Property Return.

As to the actual steps to be followed in making these returns the Regulations are not explicit, but the same general practice seems to be followed at the different arsenals. To speak as exactly as possible, I shall refer to the method now followed at the Benicia Arsenal, as it is that with which I am most familiar, and as far as my experience goes, a fair type of the rest.

Vouchers.

Starting from the base of the pyramid of which the Return is the top, we find a large number of individual vouchers of various kinds, which are the first written evidences of the transactions to be recorded. They can all be divided into two general classes, viz., receipts and issues.

Abstracts.

In the extended transactions of an arsenal the individual receipts and issues are so numerous, that, to facilitate their

examination, those of like nature are grouped together into "abstracts." The form of these abstracts varies according as they relate to transactions with one, or with more than one, person or purpose. They may thence be called single or double abstracts respectively.

A single abstract is a mere classified list of names. A double abstract in one in which both names* and agencies† are classified, the names generally in the top horizontal row, and the agencies in the first vertical column, p. 46. To borrow an illustration from geometry, a voucher may be said to correspond to a single point; a single abstract to correspond to a line made up of points, and to be a paper of one dimension; and a double abstract to correspond to a surface determined by co-ordinate lines, and to be a paper of two dimensions. It is as hard to conceive of an abstract classifying information as to more than two headings at once, as it is to conceive of a surface of three dimensions or of a space of four. Any attempts to make an abstract serve such alien purposes can only prove useless or confusing.

Material.

By material I shall mean all property dealt with, whether so-called "raw," or in the form of Ordnance Stores complete for issue, or incomplete.

Nomenclature and Classification of Material.

Nomenclature.

Inasmuch as the names on the return represent in a peculiarly strict sense the articles to which they belong, it is essential in all official papers that the names of material be correctly given.

An extended nomenclature, found in the Property Regulations, pp. 180–227, assists in giving to the same objects invariable names; although embracing some 7,000 names, it is of course

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* *Names.*

By names, I shall mean the official names of the material concerned.

† *Agencies.*

For want of a better term, I shall call the persons or purposes involved "agencies."

PRESENT FORM. (10½" x ?.)

GENERAL FORM OF SINGLE ABSTRACT.

ABSTRACT OF FABRICATIONS AT *Arsenal* IN *Second* QUARTER, 1883.

Articles.	Quantity.	Price	Per.	Amount.	For what purpose.
Class 2.					
Metal field carriage for steel rifle gun, cal. 3.20	1	$952 50	*Piece...*	$952 50	*For issue.*
Metal field limber for 3.20" B. L. rifle	2	656 41	*Piece...*	1,312 82	*For issue.*
Class 7.					
Currycomb with leather handle	1	25	*Piece...*	....	*Experimental.*
	1	1 34	*Piece...*	1 59	*Equipments for Cavalry Board.*

PRESENT FORM. (16″ x ?.)

GENERAL FORM OF DOUBLE ABSTRACT.

ABSTRACT OF[1] _____, BY _____, FOR THE QUARTER ENDING _____, 188 .

Date.	No. of voucher.	[3] _____ _____	[2]											
188 .														
		Total[4].....												

I certify that the above is correct.

_____ _____,
_____ _____.

NOTES.

[1]. If used for receipts, fill up with the words "Receipts from the Army." If used for issues, say "Issues to the Regular Army," "Issues to the Volunteers," "Issues to the forts and batteries," as the case may be—*a separate one for each.*

[2]. Arrange the articles under their proper classes, the classes following each other in order.

[3]. Say "From whom received," or "To whom issued," as the case may be, or for Abstract of Expenditures, under which class of expenditures the articles were consumed.

[4]. Say "Total received," or "Total issued," as the case may be.

PRESENT SYSTEM.

incomplete, but it affords an excellent frame-work for the placing of such new names as practice constantly requires.

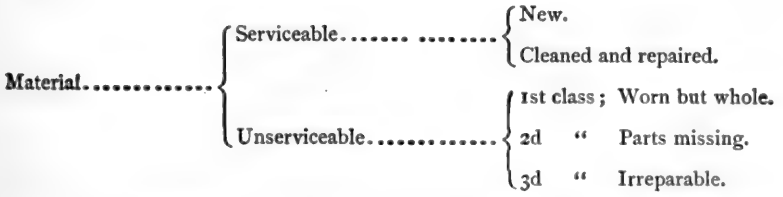
Classification.

To avoid as far as possible the consequences of error in naming material and for convenience of reference these names are classified as follows:

1. The names are placed in Part I, or in Part II of the Return, according as they refer to stores completed, or to the raw materials, tools, etc., required in their production.

2. The names in each part are grouped together in similar "classes," and the names in each class are arranged alphabetically according to their distinctive or family names. Thus bradawls are called "awls, brad," etc. The effect of this is to bring all the awls, whether armorers', brad, pad, saddlers', seat, stocking or strap, together on the return; making the aggregate result as to the awl family correct, however this aggregate may be actually distributed among the varieties named. It will be seen that the awls also find their way into the tool class, so that if some should happen to be called, say, "scribers," the mistake could the more easily be found and corrected.

3. A further classification of names according to the condition of the material is often required: this is generally made by notes appended to the names, or by the use of colored ink. According to this requirement material may be divided as follows:



The classification is carried out as fully as above described only for arms advertised for sale; for other material the Property Return only concerns itself with the difference between serviceable and unserviceable material.

Classes of Parts I and II.

Names forming Part I of the Property Return, comprising Ordnance and Ordnance Stores for issue, are divided into ten general classes, as follows:

Ordnance and Ordnance Stores.

1. Cannon.
2. Carriages.
3. Artillery implements.
4 and 5. Artillery projectiles partly or fully prepared for service.
6. Small arms.
7. Leather work and accoutrements.
8. Ammunition.
9. Miscellaneous articles for army use.
10. Parts of the above.

Part II of the Return embraces all stores which properly come under the head of materials, machines, tools, animals, etc. These are classified as follows, the classes being distinguished herein from those of Part I, by using letters instead of numbers in referring to them.

Materials, etc.

A. Cloth, rope, etc.
B. Forage.
C. Ironmongery, etc.
D. Leather, etc.
E. Lumber and building materials.
F. Material for heating, lighting, polishing and cleaning.
G. Material for office use.
H. Material for laboratory use.
I. Paints, oils, dyes, etc.
K. Miscellaneous.

X. Machines and parts of same.
Y. Inspecting instruments.
Z. Tools and utensils.

ABSTRACTS.

To distinguish the abstracts they are either lettered or numbered, according as they refer to receipts or issues: see table following, and also in chap. X.

The abstracts are attested as follows: A, 1 and 2 being based on invoices and receipts signed by other parties outside the Arsenal, are signed by the Ordnance Storekeeper. But all the other abstracts, dealing as they do, except abstract C, with the internal affairs of the Arsenal, are signed by the Commanding Officer.

Abstracts of Receipt.

DESIGNATION.	RECEIVED FROM.	FORM.	SIGNED BY
A.....	Army, Forts, etc.....	Double....	O. S. K.
B.....	Fabrications	Single.....	C. O.
C.....	Purchases	Double....	C. O.
D..... ...	Transfers between classes, etc.....	Single.....	C. O.
E.....	Current service, and from taking up articles found on post in excess of return.....	Single.....	C. O.

Abstracts of Issue.

DESIGNATION.	ISSUED TO, OR FOR.	FORM.	SIGNED BY.
1.....	Army, forts, etc.....	Double....	O. S. K.
2.....	Militia	Double....	O. S. K.
3.....	Sales.....	Double....	C. O.
4.....	Dropped from return.....	Single.....	C. O.
5.....	Expenditures as in fabrication, and issues to the current service return	Double....	C. O.
6.....	Transfers between classes, etc.....	Single.....	C. O.

AGENCIES.

In the double abstracts, A, C, 1, 2, 3, the agencies are the officers, forts, firms, states, etc., whose accompanying vouchers, arranged in chronological sequence, are referred to by their num-

bers in the margin of the abstract. In abstract 5, which has no vouchers, it is the custom to distribute the expenditures among the following agencies:

1. In experimental firing and salutes.
2. In making small arm ammunition.
3. In repairs and preservation of Post.
4. In fabrication, repair and preservation of stores.
5. In running steam engine, repairing tools and machinery.
6. In office duties and lighting of Post.
7. On account of public animals, and repairs of wagons, carts and harness.
8. In erection, repair and preservation of public buildings.
9. In repair and preservation of armament of forts.
10. In repair and preservation of field and siege carriages, and Ordnance stores.
11. In fixing cannon ammunition.
12. Issued for current service at the Post.

These agencies occupy the first left-hand column of the abstract; so that the names of the material expended on them being inscribed on the top line, the quantities which will be found at the intersection of each line and column will show the quantity of each material expended for each particular purpose. The footings of the columns give the total quantity of each kind of material expended, irrespective of the agency to which it was applied.

VOUCHERS.

Vouchers should always bear the signature of some other person than that of the officer making the return.

Thus, his evidences of receipt are the invoices which he receives from consignors of material, and his evidences of issue are the receipts of those to whom he consigns it.

The vouchers belonging to abstracts A, C, 1, 2, 3, 4, are evidently external to the economy of the arsenal, and explain themselves by the signature of the other party to the transfer of property recorded. So, in his dealings with the Commanding Officer, the Ordnance Storekeeper's vouchers are the former's

invoices and receipts; these, to save the multiplication of papers, are generally given in bulk, in the form of certain quarterly abstracts signed by the Commanding Officer.

Vouchers belonging to the abstract of expenditures (5), and to all the single abstracts, belong to the internal economy of the arsenal, and are explained in full only by such records as the Commanding Officer may choose to keep. These are generally as follows: Abstract B is based on the monthly reports of fabrication and other work done; and the other abstracts are compiled from the remarks on various requisition books, store books and vouchers, showing the purpose or nature of the transactions they record.

Compilation of Abstracts.

1. The single abstracts are consolidated from the individual vouchers by any convenient arrangement that the clerk may devise; generally a rough list of names arranged by interpolation in approximately alphabetical order is made from the vouchers, and the corresponding quantities entered opposite the names from the vouchers in turn. The names and the total quantities, when fairly copied, form the abstract required.

2. The double abstracts are generally made up from the vouchers whose serial numbers appear in the column next to that containing the agencies.

The preparation of a double abstract is a comparatively easy matter if the vouchers on which it is based have their items arranged in the regular sequence of names.

It is first required to compile from the different vouchers a classified list of all the names of material which they contain. This is the most difficult and important part of the task, for on its accuracy and completeness all the rest depends. After transcribing this list on the head line of the abstract which is reserved for names, the insertion of the quantities under each name by transfer from the vouchers follows.

But if the names on the vouchers have not been classified, great trouble results, for in transcribing the names from the vouchers

to the abstract the clerk has to skip from one part of it to the other and between classes in the same part, with much loss of time and great liability to error. Also in making the classified list of names, confusion is apt to follow the omission or misplacing of any of them; for the whole arrangement depending on the regular sequence of the names, an omission in the order is equivalent to an admission that the name omitted does not appear elsewhere. The case resembles that of a dictionary or city directory.

If we had a form of abstract comprising the name of every material dealt with as is the case with many of the abstracts of the Quartermaster's and Commissary Departments, this trouble would be avoided; but the great variety of material handled by the Ordnance Department renders such an arrangement impossible.

Preparation of Return.

The quarterly abstracts A, B, C, 1, 2, 3, etc., having been prepared as specified, are consolidated into the annual abstracts A, B, C, etc., p. 11. These annual abstracts are further consolidated into annual statements of receipts and issues, respectively: the former bears the designation of the annual abstracts of receipt (lettered abstracts) in the column of agencies; and the latter that of the annual abstracts of issue (numbered abstracts). These two statements thus give the total quantity of each item named which was received or issued during the year.

The return is now made up by adding to the quantities reported on hand by the last return, the quantities shown by the annual statement of receipts as having been since received; thus giving the total quantity to be accounted for. From this is deducted the quantities shown by the annual statement of issues as having been issued since the last return; thus leaving a total remaining on hand to be accounted for.

Since the return distinguishes between serviceable and unserviceable material of the same name, both its scope and the labor required in preparing it may be very greatly increased.

CRITICISMS,

Abstract of Purchases, C.

Abstract C, which is made up from the cash vouchers, is signed by the Commanding Officer as a sort of consolidated invoice of all the material which he has bought during the past quarter, whether the Ordnance Storekeeper has actually handled it or not.

From this arises a sort of constructive receipt on the latter's part, imposing a responsibility often assumed after the material for which he receipts has been consumed. His willingness to accept the responsibility is accounted for by the fact that it is generally immediately discharged by the simultaneous expenditure of the material in question; his function has then been merely a clerical one, in recording the acts of the Commanding Officer. If some equally convenient way were found, I doubt whether such irregular transactions would be required.

The following objections present themselves to thus mixing the accountabilities for cash and property:

1. By taking the evidence of purchase as the sole evidence of receipt, we deprive ourselves of several aids to correct accountability; for a receipted cash voucher, say, for material purchased, is in reality only evidence as to the satisfaction of so much of the creditor's claim against the government; it is only secondary evidence as to the items of material actually transferred to the debit account of the purchaser.

The primary evidence as to what items were really bought is found in the fly, or firm bill, which usually accompanies the goods purchased, and which acts, therefore, both as an invoice as to items and as a demand for their equivalent in money. But in practice this primary evidence is lost to sight as soon as it has served the merely local purpose of furnishing the information required for the preparation of the cash voucher.

After the cash voucher is so prepared, it is sent to the creditor with a cheque. But his responsibility for the correctness of the items on the voucher having been impaired by their handling by the purchaser, he is naturally only concerned with getting the value originally demanded, having received which, he signs the

receipt, and thus completes the evidence upon which all subsequent accounts are founded.

Few creditors would feel bound to correct any errors as to the items of such an account, provided they themselves received their due; so that, practically, the whole matter is left to the discretion of the purchasing officer. If an unscrupulous person, he may buy a coat and call it candles, and no one need be the wiser, particularly since the candles are, for the reasons stated, "expended" as soon as they are received, and, what is more, are expended without increasing the expense of anything in particular.

It is easily seen that this practice is opposed to the essence of accountability, which receives no statement unsupported by such independent testimony as the requirements of practice permit.

2. The defenseless position of the Ordnance Storekeeper is also worthy of note; for if, from any reason, say the relief or death of the Commanding Officer, or from some of the disagreements to which all organizations are subject, the Commanding Officer should fail to sign the quarterly Abstract of expenditures, the Ordnance Storekeeper would be left badly in the lurch; for while the cash papers imposing the responsibility are made out monthly, the abstracts discharging it are quarterly papers. A similar case often happens in practice. Since purchases are "taken up" as a consequence of their purchase, but are only dropped or "expended" from the Return after having been drawn from store by the written order of the Commanding Officer, it happens that bulky articles like coal and building materials, which never actually pass under the Storekeeper's control, are often consumed on their arrival without any note being made on the store book that would lead to their expenditure on paper. Consequently, the end of the year finds the Storekeeper with a large amount of material charged against him, but which has disappeared from view. Whatever statements may then be made as to the objects on which it was expended must depend upon memory alone, and be largely conjectural.

3. Another trouble results from this mixing of property and

cash papers. It is axiomatic that material should not be paid for until received; but the converse of the proposition does not hold, for all material must be received before it is paid for. How long it is received in fact, before it is "received" on the cash vouchers, depends upon a great many contingencies. At this arsenal, owing to the necessity of sending certificates of inspection to Washington for approval, at least two weeks must elapse. On contracts on which no payment is made until completion, many months may pass.

Delays due to the time consumed in transmitting funds and in making out the necessary papers also intervene, so as to separate still further the actual from the constructive receipt. This often requires a separate abstract to be made of materials received, but not paid for.

This involves not only a radical departure from the established rule already described, but of necessity the searching of an entirely different set of records, for the cash vouchers not furnishing the information required, it must be sought in the books showing the receipts into store. Now, since these have all to be gone over for this extraordinary purpose, the question arises, whether it would not be better to keep the accounts in the first instance, so that the quantities "received" should be based upon receipts solely, and not partly on purchases and partly on receipts.

4. Since stores may not be taken up until paid for, but are often needed for use or issue as soon as they are received, it may easily happen that material procured at the end of one year may be issued, say to another post, on the return of that year, but not be acknowledged as a purchase for a year after. When this happens with a new material, or when more of a given material has been issued than was reported on hand, the result is anomalous, if not confusing. But this is not all; it leads to delaying the issues to prevent such a result, or to keeping back in an irregular way the papers explaining them

5. As another illustration of the impolicy of making a receipt necessarily depend upon a purchase, let us take the case of troops

supplied from a given arsenal, but so situated as to make the transportation of bulky material a troublesome and expensive matter. Let us take Fort Gaston in the forests covering the northern part of California as in want of scantling for making targets, or the Light Battery stationed at the Presidio as in want of coal, as examples, both being supplied from this, Benicia, Arsenal.

In these cases the regulations present the following dilemma:

A. To buy the material in San Francisco, pay for its transportation to the Arsenal, and then immediately reship it to its destination, possibly within sight of the spot from which it originally came; or

B. To let the requiring officer select what material he wants, to pay the bill approved by him, and then by fictitious entries on the Return assume and discharge a responsibility which has never existed in fact. It is difficult to say which of these alternatives is to be preferred.

But if, on the other hand, purchases and receipts were dealt with separately, one being a cash paper and the other a property paper, like abstracts A and D in the Quartermaster's Department, such a transaction would be perfectly plain and straightforward. The purchase at the Arsenal would be explained, if necessary, by reference to the obligation assumed by the requiring officer on his own property return. Then the regulations would cease to be obstructive to natural methods, but would properly fulfill their true functions, by directing all proper actions to sure and speedy ends.

These objections are in part modified by the present method of making payments on "certificates of inspection," explained chap. XV; but the difference is only of degree. The payment is not made now until approved by the Chief of Ordnance, nor does he approve it until the receipt of the material has been acknowledged by the signature of the Ordnance Storekeeper. But in practice the latter is often obliged to sign for things of which he has never had personal knowledge or control. His attention is not necessarily called to them until long after they

have been consumed, until, in fact, it becomes necessary or convenient to make out the accounts.

The Storekeeper will be wise, then, not to sign until the preceding signatures have been completed, for by par. 67, Ordnance Regulations, the Inspector is the agent of the Commanding Officer, if he be not, as he sometimes is, the Commanding Officer himself.

In any case, the acknowledgment of receipt of material by an employee or subordinate is not conclusive when such independent testimony as the invoice given by the fly bill of the dealer can be obtained.

Abstract of Sales, 3.

Turning to the parallel abstract, that of sales, we find occasion for the same uncertainty; although, as the government does not give the credit which it requires of private individuals, the mischief is less felt.

Abstracts relating to the Current Service Return, abstracts 5 *and E.*

Turning to these abstracts on page 45, it will be observed as a significant fact, that so little is property once put into current service expected to be returned to store, that issues of it for that purpose are grouped with such expenditures as those of powder for firing salutes, of forage, and of material consumed in manufactures of different kinds. Receipts from current service by the Storekeeper are also classed with unexpected "finds" of property about the post.

With a proper system it would be quite as easy to return property to store for safe-keeping as to draw it from store for use; and whether in store or without, its accountability would be maintained.

Annual Property Return.

To diminish the size of the abstracts and for other reasons, it is not unusual to discontinue purchases and issues for a week or so toward the end of the year. Notwithstanding this aid to the accountant, by which he can only profit at the expense of other

equally important agencies, the papers are so voluminous that sixty days after the expiration of the year are allowed for their completion.

Assuming their correctness and their completion in season, what is the net result of the labor they require?

I would reply, a schedule which is true but once a year, and which then only refers to what existed two months before. As a periodical reckoning it may have value; as an actual exhibit it is of no account.

When the ever-recurring question comes—"How much of this have we on hand?" who ever thinks of consulting the last return, and of summing up the various transactions which have since affected its showing? In practice, it is easier and quite as accurate to go to the storehouse and make a count, or else to rely on the memory of the assistant storekeeper for the information required.

Inventory.

It is, I presume, on account of this well-grounded want of confidence in the property return, that the inventory is taken. Except at small establishments, unless the inventory were compiled from the very return it is intended to check, even the two months allowed would hardly suffice, without causing grave interruption to the more serious business of the post. It thus serves, practically, as a second return, no better than the last; and, except that it has no vouchers, no worse.

(NOTE.—It took 18 men six months to make an accurate inventory of the public property at Benicia Arsenal, when the command was transferred from Captain McAllister to Colonel Wainwright, in 1864.)

Current Service Return.

(See par. 3, 64 and 87, Ordnance Regulations, and Ordnance Property Regulations, chap. I.)

This return, although probably intended to be made on lines parallel to those of the Property Return and to cover materials as well as Ordnance stores and machines, in practice has become merely an accounting of tools, machines and generally of "plant" in current service.

PRESENT FORM. (16" x 10½".)

RETURN OF ORDNANCE AND ORDNANCE STORES RECEIVED, ISSUED AND REMAINING ON HAND AT ..... ARSENAL DURING THE YEAR ENDING DECEMBER 31, 188 .

Articles.	On hand from last return.			Received during the year.			Total on hand and received during the year.	Issued and otherwise disposed of during the year.			Remaining on hand.		
	Serviceable.	Unserviceable.	Total.	Serviceable.	Unserviceable.	Total.		Serviceable.	Unserviceable.	Total.	Serviceable.	Unserviceable.	Total.

PRESENT FORM. (14" x 10".)

INVENTORY OF ALL STORES ON HAND AT ..... ARSENAL AT THE CLOSE OF THE FISCAL YEAR ENDING JUNE 30, 18 .

Articles.	Number serviceable.	Number unserviceable.	Total on hand.	Value of the serviceable stores per piece, pound, &c		Value of the unserviceable stores per piece, pound, &c.		Aggregate value of all stores.		Remarks. Explanatory of the condition of the unserviceable stores.
				Dol's.	Cts.	Dol's.	Cts.	Dol's.	Cts.	
			Am't br't for'd.							

PRESENT SYSTEM.

It differs from the other return in that the Commanding Officer who signs it, signs also all the vouchers to it. These include the abstracts representing transfers to him from the Storekeeper; and also an abstract of such articles for which he is responsible as are lost, returned to store, worn out or destroyed.

He thus becomes the arbiter of his own accountability, and his return might, as far as the responsibility it imposes is concerned, be replaced by a simple unauthenticated statement of his liabilities.

The difference between his position and that of the Storekeeper need not be dwelt on, yet there is no reason to suppose that one should be held to a stricter reckoning than the other.

I would also call attention to par. 64, Ordnance Regulations, page 11, which directs the Commanding Officer to return to the Ordnance Storekeeper at the end of each month "the stores not required in the current service." That is, that although they have been expended, *i. e.*, consumed on paper along with the powder used in firing salutes, yet being actually still on hand, unconsumed, they must be hauled back to the storehouse on the monthly settling day, to be taken up on the papers with other property found about the post; to be "re-expended" whenever the current service may require them.

General Remarks.

As a symmetrical means of supplying information to the superior military authorities, it would be difficult to devise anything more simple and beautiful in its general plan, than the present system. It may be compared to a pyramid, the apex of which is the Return, resting on the Annual Statements of receipts and issues; these being supported by the annual abstracts of receipts and issues; these by the separate quarterly abstracts; and these finally by the individual vouchers "*en masse*." All that is generally seen of the pyramid is above ground, where the force of superior criticism has gradually moulded it into a natural symmetry. My objection is that the process has not been carried far enough down; that many of the data which are

assumed to be correctly prepared are insecurely founded, and that hence the whole structure is radically weak.

My hope is to explain acceptably a system by which all these data may be based on one uniform foundation, and that by the variety of interests with which they are involved they may be bound together into one consistent whole, worthy of the shapely structure they support, and by the extension of whose lines their own limits were determined.

CHAPTER VI.

PRESENT SYSTEM.

B. *INTERNAL RELATIONS.*

(ADMINISTRATION.)

GIVING ORDERS.

Orders are given in writing for important work, and verbally for minor matters.

If given in writing, the orders are sometimes entered in a "fabrication book" showing date, authority, purpose, Commanding Officer's signature, and finally a column for the date when their completion is reported.

Sometimes the orders are in letters or notes to the Master Workman or foremen; and often, particularly in large orders which have been long discussed and for the beginning of which no certain time is set, the written order is omitted altogether.

However the orders may be given, they are generally entered by the foreman in a memorandum book in the order in which received. His intention is to keep this book with him as a reminder of what work is incomplete, finished jobs being crossed off as they are done. These being reported to the office, the date of completion is entered on the fabrication book, and the circle is complete.

This seems at first sight a very natural and sufficiently perfect way of keeping track of orders; but it is open to the following grave objections:

1. The entry is only a memorandum; nothing depends on it; nothing prevents work from beginning before the entry is made, or from continuing after it is crossed off as complete.

2. Beginning and ending with himself, as the foreman's entry

does, there is nothing to mark the delivery of the order, nor to qualify its asserted completion.

3. Being for his personal information only, the tendency is so to abbreviate the entries as to make them unintelligible to any one else. In case of his absence, sudden sickness or death, the workings of the whole shop may thus be greatly disturbed or suspended.

4. The book makes no provision for distinguishing jobs in progress from those on which no work has been done; nor does it exhibit to the foreman or to his superiors the state of the work in his shop at any given time. All this has to be carried in his head.

5. There being nothing to record his failure to make an entry or to cross off a completed job, the omission can only be detected when in the first case the work ordered is needed elsewhere, and in the second case when it is done twice over.

6. So, should an entry be overlooked, or while only executed in part, crossed off as if completely done; or should an order be amended or suspended while in progress; or should he wish to record its product, either in gross at once, or by successive deliveries; in these, as in a host of other cases, his memory must still be his main guide. In spite of his book he would still have to remember what to look for, where to find it, and what it meant when found.

There is a certain economy of attention by which the more active is a man's work, the less is he capable of contemplation; and foremen's heads may be put to better purposes than having to bear this constant burden of solicitude about their clerical work.

7. Passing from the foreman to his book, we find in an arsenal of any size that the great number of orders always in progress makes the task of keeping track of them within the book almost as great as if no book were had. For example, suppose the foreman starts with a fresh book; the trivial orders are soon crossed off, and by degrees the important ones are left—mere oases scattered in a waste of entries more or less effete, which has to be slowly traversed every time new work is to be given

out or completed work crossed off. An effort is made from time to time to consolidate the incomplete entries and start anew in a fresh place; but the same results are sure to follow: the most space is finally occupied by what matters least, and the most important part is hidden by the most irrelevant.

8. When there is more than one department, a special order book is sometimes kept for each foreman, into which are copied the orders which specially concern him; but as it can hardly ever be foretold into which department an order may not go, such a plan can only serve an uncertain purpose and lead to indefinite results. At the best, it removes the difficulty only a step beyond that already discussed.

9. There is another practical objection to the use of an order book which is of far greater importance than may at first appear, that is, the impossibility of its being in two places at once. It is needed at the office for the entry of orders, and it is needed at the shop for reference to these entries, often at the same moment. It will be found that with the delays in its transmission, added to the time it is actually in use at the "other" place, the occasions of its being on hand when wanted at either place seem very rare. If the book is retained at the office, it requires frequent absences of the foreman from his proper work, and it involves the doing of his clerical work at least twice: once in a memorandum of some form, and once in the office book.

It would be better if some means were found by which whatever record was needed should be on hand whenever and wherever wanted; that whatever work of record was required should for a single cause be done but once; and that its effect should be positive, determinate and distinct.

Keeping Account of Labor Charges.

The timekeeper, generally the foreman, goes about the shop towards the close of the day and asks each workman how he has spent it; according to the workman's recollection he enters the time reported in a book, as hereafter described.

Note.—An exception to this practice existed in my time at the National Armory, where, in some departments, each workman entered on a little slip of paper in his own

language, the manner in which his time had been employed. This and the time were copied into the time book; but nothing more was done with the tickets. This practice was the germ of the system herein developed.

There are two general forms of time book; one, form A, in the nature of a pay-roll, in which the time made by each man during each day is entered in gross; and forms B and C, in which an attempt is made to show how the time so reported has been employed.

FORM A.

Time book for month of April, 1874.

NAMES.	DAYS OF THE MONTH.							Total days.	Wages per day.	Am'nt.
	1	2	3	4	5	6	to 31			
J. Smith.....	1	½	¾	0	0	1¼	.....	3½	$2 00	$7 00
A. Jones.....	1	0	1	1	1	1	.....	5	5 00	25 00
T. Brown.....	1	1	1	1	1	1	.....	6	75	4 50

Form B occupies a page for each day, and a line for each man. To save copying the names anew each day, it is customary to paste a fly slip on the back of the first page, which, being unfolded, serves for all successive pages and also gives more room for the daily record of employment.

FORM B.

Work Report for April 2d, 1874.

NAMES.	Occupation.	Total days.
John Smith.....	¼ hour cleaning engine, ½ hour sawing wood, 1¼ hours filing brass for lathe bearings.....	¼
A. Jones	Absent	0
T. Brown.....	½ day on shop fixtures, ¼ general jobbing, ¼ helping smith.....	1

FORM C.

Time book and Report of Work in the Machine Shop, for April, 1874.

JOHN SMITH, *at* $2.00 *per day of* 8 *hours.*

EMPLOYMENT.	DAYS OF MONTH.							Total hours.	Total days.	Am'nt.
	1	2	3	4	5	6	to 31			
Repairing mowing machine.....	1	...	...	...	...	...	2	3	$\frac{3}{8}$	$0 75
Cleaning engine....	...	...	2	...	...	...	6	8	1	2 00
Sawing wood.....	1	...	4	...	...	...	1	6	$\frac{3}{4}$	1 50
New lathe.....	6	...	2	...	3	...	1	12	$1\frac{1}{2}$	3 00
Shop tools.....	...	...	...	...	3	...	.....	3	$\frac{3}{8}$	75
Total hours.....	8	*a*	8	*a*	6	*a*	10	32	4	$8 00
" days.....	1	...	1	...	$\frac{3}{4}$	...	$1\frac{1}{4}$	.....	4	.....

Form C, which is a combination in form as well as in name, was in use at the National Armory during my service there. Its great advantage over form B is the greater space it affords for inserting the names of employments upon which the workman has been engaged. It also permits the use of a smaller time unit, and consequently of a more exact definition of its record; for in form B the small space allotted for a description of the work, and the need of re-writing it every day tends naturally to the consolidation of entries; whereas in form C an entry once made stands good for the whole month, *provided that the workman always calls the same work by the same name.*

Leaving out of consideration form A, we find both B and C open to the following objections:

1. The workman has to remember so suddenly all the jobs he has worked on during the day, that he is very apt to make mistakes by lumping different jobs under one head; or by calling the same work by different names, or different work by the same name on different days.

2. He is apt to use general terms loosely, charging his time, say, to "Miss. Repairs," "Shop Fixtures," "Jobbing," etc., instead of giving it definite names by which its exact nature may be hereafter distinguished.

3. In case the workman is absent, during all or part of the day, there is nothing but the memory of the foreman to rely upon as to the fact. For example, the workman may be marked "absent" when present, or may be credited with some time when absent; in neither case will the error be discovered until the pay-roll is signed, nor even then unless the workman has kept his own time, and unless in the latter instance he has been honest enough to forego the advantage given by the foreman's mistake.

4. Besides such errors in stating the gross amount of time, the following mistakes are not infrequent in the distribution of the time: In form B, the foreman, being cramped for room if he has many entries to make on one line, is led to abbreviate them or to condense them, so as to save himself trouble.

5. In form C, also, he is not unapt, in order to save himself the trouble of writing new headings, by no means an easy thing while walking about the shop taking time, to charge the man's time to an old heading, or to merge it with some other job worked at on the same day.

6. With the best intentions possible, he will also make mistakes by inadvertently placing the figures on the wrong line, and even sometimes in the wrong column; and generally, he is subject to all the errors attending verbal transmission of important information, aggravated by the interruptions which it is a foreman's regular business to meet.

At the end of the month these time books go to the main office, where the clerks use them in making out the pay-roll, and afterward in allotting the various charges among the appropriations to which they belong. But the latter part of this work is, from the nature of the case, very imperfectly performed. In the first place the entries are confusing and in themselves *indefinite;* and again, clerks, from the nature of their occupations, are incompetent to judge fully of the meaning of these entries,

made as they are by mechanics, and abounding in technical terms. So the deciphering of these entries falls, as does the statement of work done and the cost of the fabricated product, upon the foreman, again burdening him with work which he is not fitted for, and interfering with the free exercise of his proper functions.

Here his frequent inexpertness with figures comes in to make the result uncertain; or he may be so interested in keeping the cost of a certain work within a given estimate, that his report will be misleading. Meanwhile there is a hurrying between the shops and the office, with inquiries, statements and explanations so thick, that for a few days after the first of the month life is a burden to all concerned.

So it happens that when any special estimate or report is demanded, unless perfect confidence be had in the intuitive knowledge of expenditures, both past and contemplated, which foremen, by virtue of their office, seem often expected to possess, the whole ground has to be gone over anew; and from the beginning every time have these piles of manuscript to be deciphered in the light of memory alone.

In spite of appeals to the memory of the workmen, who, to meet them, often keep little books of their own, what wonder is it that such work is most wearing in the performance, and most unsatisfactory in the result?

Then suppose that fragmentary information should be required: for example, the gross cost of an order having been reported, including the drawings, patterns, tools, modifications of machinery and the time always wasted in the experimental working of new devices, one may be, and often is, required to ascertain the cost of duplicating the product of the first order, the plant required being on hand.

It may be also required, knowing the cost of work done by a high grade of labor necessarily employed in experimental efforts of a tentative nature, to estimate what it would cost to repeat the work on a larger scale by the aid of cheaper labor. In the ordinary case the future need for such information is not provided for; the workman does well if he even charges his time in

bulk to the proper order. So nothing but sheer memory remains to supply this information; unless, in anticipation of such an inquiry, a special effort has been made at the start, and some special record has been kept for this purpose alone.

I have known this work to be repeated for the sole purpose of finding out certain data relating to its first performance.

The need for these special efforts is a reproach to any management. They sap the energies of all concerned; and instead of allowing those whose equanimity is of the greatest importance to the successful supervision of their work to confine their attention to the general view, it compels them to strain their minds and burden their memories with details of but passing importance.

Such records should be made almost automatically, and so readily as to be almost simultaneous with the events recorded. Once made in their simplest form, they should never be repeated in the same form; but every time that they are handled should be more and more consolidated and concentrated toward the attainment of the given end.

I have spoken of the temptation to "charge off" labor, so as to diminish the cost of certain work. This is a common subject of criticism by private parties in competition with government workshops. They say, "You make cartridges, or guns, or ships at such a reported cost; but where is your balance sheet to prove the truth of your figures? Where are the many items, small in themselves, but in the aggregate often amounting to the total cost of the labor employed, which we cannot 'charge off,' but have to pay for, if not out of one pocket or 'appropriation,' then out of another?" Such criticisms may be met by special balance sheets showing all expenses and the products resulting from them, as was so admirably done at the National Armory in 1879; but more prompt replies are constantly required, both in gross and in detail—replies which ordinary methods of book-keeping do not appear able to afford without considerable trouble, cost and loss of time.

The principal faults found with the present methods of time-keeping are generally as follows:

1. The uncertainty and indefiniteness of the labor charges.

2. The limited use made of these charges, owing to the difficulty of collating them, of referring to them, and of interpreting them.

3. The improper amount of clerical labor required of foremen in compiling these charges, both as to the effect on the usefulness of the foremen, and as to the uncertainty of such work when done by unfamiliar hands.

Procuring and Accounting for Material.

There are many methods employed, alike in their general aspects, but with such differences in practice as local and personal peculiarities have developed.

The following illustration may serve as a general example of the evils attending the use of books as ordinarily employed:

1. Let us take the simplest case first, and suppose the material to be in store, and the foreman to know it. He makes an entry on the "store book;" the Commanding Officer signs it; the book goes to the Ordnance Storekeeper or one of his assistants, who sends the material, and the book, when he can get it, to the foreman. The latter receipts for the material on the margin of the original entry; the material is "expended" on the books of the storekeeper, and the transaction is at an end.

2. When there is nothing suitable in store, or the foreman thinks there is not, he makes his wants known on the "purchase book." As this book is kept in the office, he goes there, taking a memorandum of his wants; they are thus written twice (1, 2). They are then approved by the Commanding Officer (3); written on an order blank (4); copied on a duplicate stub (5); signed again by the Commanding Officer (6), and sent to the dealer (7). Meanwhile the margin of the purchase book is marked with the name of the dealer (8). The supplies come back with the bill, which is copied into the Inspector's book (9) and initialed by him after inspection (10).

After the material has been inspected, the following is the course required to get it out of store: The foreman, having ascertained by repeated inquiry that the stores have come, and still desiring them, writes them again on the store book (11), and after being again approved by the Commanding Officer (12) the book goes to the storekeeper, who takes the material and the book, when he can get it, to the foreman, whose receipt (13) ends his share of the business.

The initialed bill then goes to the Ordnance Storekeeper, who receipts for the stores on the duplicate stub (14). The assistant storekeeper also keeps a record, of a more or less perfect kind, of all receipts into (15) and issues from (16) his storehouse.

So much for the transaction as it regards the internal economy of the arsenal. The external requirements are met as follows: From the stubs receipted by the Ordnance Storekeeper and the bills received from the dealer, is made out a Certificate of Inspection (17), signed by the assistant inspector (18), then by the Commanding Officer as principal inspector (19); then the material is receipted for again by the Ordnance Storekeeper (20); then approved by the Commanding Officer and forwarded to the Chief of Ordnance for payment to be authorized (21); then returned by the Chief of Ordnance for payment (22). Vouchers in duplicate (23, 24) are then made out, approved by the Commanding Officer (25, 26), and the creditor's receipt affixed to each (27, 28) after payment.

The purchase is then entered in duplicate on the Monthly abstract of purchases, a cash paper (29, 30); and again in duplicate on the Quarterly abstract of purchases, a property paper (31, 32). This imposes a responsibility on the Ordnance Storekeeper, so he hastens to credit himself with the expenditure of the same items on the abstract of Expenditures, also in duplicate (33, 34).

Here, at last, the identity of the purchase disappears, being merged in that of other purchases of the same material, which are consolidated, as before described, through both sets of

Annual abstracts and Statements into the receipts, issues and balances shown by the Annual Return. The name has been written about fifteen times.

I do not cavil at these methods, which only show the extent to which a faithful observance of the regulations has in one case at least been carried; but I seek to improve the regulations themselves, by facilitating the transactions which they require recorded; by defining and augmenting the responsibilities which they are meant to impose; and by greatly diminishing the labor which they now compel.

For, leaving out of consideration the trusteeship of an arsenal administration, and considering it simply as a workshop, subject to the same conditions and necessities which prevail elsewhere, it will be evident that up to at least the first sixteen acts recorded, there has been done an unnecessary amount of writing, at a considerable cost of delay,—delay due, not only to the time consumed in the routine performance of these acts, but following the failure of any one of the six agents named to properly second the acts of his predecessor in the series.

The Commanding Officer has to approve three times acts done to carry out his own orders. Does it not seem, that in his own jurisdiction, at least, his approval of an order should carry with it that of the means required for its execution?

The consequence of such a multiplication of precautions is, that when stores are urgently needed, the prescribed forms are disregarded, and the stores are gotten and used as they would be in any private establishment, and the papers are made right afterwards. Would it not be better to have no knots to cut or unravel, but a simple, exact method for every case, so easy to follow that no one would want to leave it for another?

Returning to the example: the Commanding Officer may suspend his action on some request, or may refuse it altogether, at any one of the three stages in which he acts. But how is the foreman to know it, except by laboriously searching the books of the office, whenever he may have a chance? The Commanding Officer may intend to ask for explanations; but in the great

volume of small things which this very method forces on him, naturally often forgets it.

Or suppose that, having refused a request, and having changed his mind, he turn back the pages of the book and finally approve it; unless he at once calls the clerk whose business it is, the chances are many that the special act of approval will be overlooked in the mass of ordinary entries surrounding it.

Now suppose that everything has gone well, and that the stores have been received and inspected, and have been taken to the shop, the book being at the office for fresh entries, no one knows for what the supplies were ordered. The foreman goes to work, uses up the material, and finds out next day that what was anxiously expected for the use of A, B, C, has been sacrificed to the remote necessities of X, Y, Z.

Then as to the inspection. The assistant inspector is supposed to pass upon both quality and quantity of the stores he examines; but in reality, since the needs of a manufacturing arsenal embrace almost every known form of material, he is unable from human limitations to judge of the quality of them all; so, with the best intentions on his part, unless a special effort be made and the services of an expert be enlisted, the chances are that inferior oils, paints, steel, green lumber, poor leather and the like will be accepted. It is then nobody's special business to complain; the workman feels that his duty is done when he makes the best use of the material put into his hands, and the trouble only comes to light too late to be remedied.

Would it not be better to have the stores inspected by the man asking for them, as he knows best what he wants?

Owing to our large supply of old stores, and to the scantiness of our appropriations, it is advisable that instead of purchasing fresh supplies, those already on hand should be used whenever practicable. It often happens that old materials are on hand which would answer the foreman's purpose almost as well as new ones, if he knew of their existence. But he has no stated means of finding them out; none in fact but by desultory conversation with the storekeepers, or by accidental observation while in their

warehouses. As he has no business there, he generally finds it easier to ask to have purchased what he wants, than to hunt it up in a store, and then have to ask for it besides.

It may be said that the Commanding Officer or some one in the office should look over the requisitions and supply what is needed from the stores on hand; but neither he nor any one else in a large arsenal can, under the present system, stand effectively between the demand and the supply, knowing both what there is to spare, and how nearly it may serve the purpose for which something else is asked for.

Would it not be better to give the foreman an incentive to become acquainted with the resources of the arsenal, so that the requisition may be started straight at first, rather than to let it go wrong and trust to correcting it afterwards, particularly since the natural tendency of routine is to the mechanical approval of what is recommended by subordinates worthy of confidence ?

This suggests the query as to the necessity of the Commanding Officer's burdening himself, and hampering the course of business, by requiring his preliminary approval of so many of the functional acts of his subordinates. Does it not seem, that even as he trusts his foremen with the immediate direction of the costly labor under their charge, so he could trust them, for the day at least, with the use made of the less valuable material which they require, and permit them to take from the stores on hand what they need to execute his wishes, subject to his approval after the act ? The stores will not be necessarily destroyed, they will be as much under his control with the foremen as they were before with the Ordnance Storekeeper, and any abuse of privilege can in the end be more effectually checked by a timely reproof than by a chronic condition of apparent distrust.

Meanwhile, the workmen will not be kept waiting; and the foreman, not having to burden his mind with prospective wants long before they actually arise, will not be tempted to avoid this care by accumulating an irregular surplus which deprives the arsenal as a whole of what he thus exclusively controls. His

freedom of action being the greater, so will the responsibility as to the net result of his actions be.

We have so far been occupied with the process of drawing material from store, and with all the checks preventing its improper expenditure; but in spite of all this care, there is no similar provision made for returning to store what is unsuitable or surplus, except by going back over all the books and canceling or modifying the entries relating to the transaction. Should a set of quarterly papers intervene, the chances are, that to avoid the trouble and complication of accounts resulting from the changes, the supplies will be kept "expended" in name, but really awaiting some other application.

Having facilitated the procurement of material by an improvement on the means above described, it will still be necessary to provide for its return; in fine, to treat the supply in store like water, considering the storehouses as tanks provided with the most direct system of pipes, having the fewest turns and the simplest valves, and so arranged that while any responsible person could always draw what he wanted so easily that he would not be tempted to take more than he required; yet that every such act would of necessity be indelibly recorded and accounted for. Also to arrange matters so that it would be so easy to drain the overflow back into the tank from which it came, that one would rather take that course than have it about the shop.

Determining Cost of Product.

General Considerations.

Good administration, in our case, has been defined as the doing of good work cheaply, and the test of a good product to be its cost.

Almost any establishment can do good work when supplied with good workmen, tools and material, but it is not impossible to do work too well, to make disproportionate efforts to accomplish insignificant results. Experience shows this to be often true, particularly as regards the manufacture "at home" of articles made more cheaply as specialties elsewhere.

Competition with his rivals may force the business man to realize this; but the public officer can only be reached by a sense of pride leading him to compare his results with each other and generally with those of like character about him. Its efficiency being granted, his work is well done in proportion as it is cheaply done.

But how tell if it is cheaply done? Nothing seems more easy; nothing is really more difficult. How many are the worthless devices whose only claim lies in their asserted economy! How many manufacturers have unwittingly sold goods below cost; and how many have persevered in wasteful processes, saving their pence while wasting their pounds, until they found themselves insolvent!

True, the government officer is not so directly subject to outside competition. His troubles lie within, and are often born of his own zeal; his interest in the working of his own methods, often as potent as any love of gain, may blind him to their remote but certain consequences.

What he needs is a constant, impartial monitor, which he may consult as he would a clock; telling him not only how much he has spent, but how and where it has gone.

The ordinary method of determining cost is elsewhere described. Owing to the uncertainty of the result, when accounts are not balanced, the subject does not seem to have received the attention which it deserves.

This determination can only be made valuable by being made certain; it can only become certain, by being made comprehensive; and this only by charging all expenses automatically to *some* account, and making all of these accounts tell in the finished product.

Then we shall be on firm ground; and knowing the special causes of cost, may retrench or expand where it may seem most advantageous, having a certainty that the effects of whatever steps are taken will be conclusively brought to view.

PRESENT METHOD OF DETERMINING COST.

As far as my experience goes, this is done either by foremen or clerks.

By Foremen.

1. Cost of labor.

The foreman cons the time books and picks out from them the items appearing to correspond to the job whose cost he is computing. It has already been explained, page 61, how difficult this is.

What it really means in practice can only be appreciated by one who has actually performed the work. Such questions as these arise: Two firing rests having been ordered for separate parties, say a month apart, and half a dozen men having worked on them at different times during four months, one of the rests is completed, and as it is for sale, its cost must be immediately determined. How detect among the mass of entries covering this long record how the work has been divided between the two rests? It is impossible.

But suppose that the work has been properly named every time, when is the unfortunate foreman to stop hunting items? Not until he has gone through every page of every time book since the job was started. Even then, an interruption or the need of his books elsewhere will upset his calculations and probably drive him to an estimated account of labor, as being on the whole about as accurate as the unverifiable statements of his books.

A better illustration of this difficulty may be found in the case of the completion in part of an order calling for large numbers of a certain article. Suppose the order be to make 1,000 halters, and at the end of the month all are cut out, 100 finished, and the rest in various stages of completeness in the hands of different workmen. How may the cost of the 100 halters be determined? Surely not from the books; everything there is simply charged to "halters."

It may be said to keep a special account of the time taken to cut out, or sew, or rivet, 10, 20, or 50 halters; and from that to

determine the cost of each operation and hence that of the product. Nothing can be more illusory then such a proceeding; it makes no allowance for the time consumed in preparing work and tools; for the inevitable loss of time in changing from one job to another, and for the waste. It is like attempting to determine from half a dozen foot tracks the general direction in which he who made them was traveling.

In practice nothing can be surely known of the cost of any job until it is completed; and yet foremen and others are expected to keep within their estimates!

So with piece work; the price for it can only be set blindly, or by competitive bidding, unless a broadly comprehensive view of the subject be first obtained. Even if awarded to the lowest bidder, it is probably better in the long run to know for about what price he can afford to do it properly, than to risk wasting the temporary profit gained by excessive reduction, in disputes with the contractor over the quality of his work, with the added risk of delay in the production of other dependent parts.

2. Cost of material.

Leaving out such cases as one in my own experience, in which no material was charged to a job actually containing several hundred pounds of iron, the foreman estimates the material consumed, and either guesses at its value, or, if of an earnest turn of mind, goes to the office and gets one of the clerks to hunt it up among the records.

Here his labor generally stops; his natural desire to make the best possible showing may lead him to confine himself to the bare total cost of labor and material, omitting all charges for miscellaneous expenses, such as superintendence; clerk hire; power; use and wear of tools, machinery and buildings; oil; waste; heating and lighting; laborers, watchmen, teamsters and the like. These expenses, however, are generally covered by adding a certain percentage, as follows:

a. An arbitrary charge, depending on the circumstances of each case.

b. A percentage on the gross cost of the job.

c. A percentage on the value of the labor, with or without an additional percentage on the value of the material.

d. A price, varying with the time actually employed on the job.

The latter mode, which is that used at William Sellers & Co.'s great establishment, is the method which I prefer, for the expenses named bear a closer relation to the quantity of labor than to the value of the material or to the quality and cost of the labor employed. For the running expenses of the shop, say while turning shafting, being a function of time, are the same whether the shafting is of iron, steel or bronze, and whether the lathe is tended by a boy or a high-priced tool maker. See Chapter XII.

By Clerks.

1. The labor items are picked out as before described; but unless with the aid of the foremen and others more closely concerned with the origin of the charges, are necessarily even less apt to be correctly stated than when the foremen attend to them.

2. The account for material is made up principally from what the records go to show was procured expressly for the job in question, either from store or by purchase.

The fault of this is evident; for on the one hand, no provision is made for taking account of suitable material already on hand in the shops and consequently used for this special purpose; nor on the other hand is allowance made for a failure to use all of the material so purchased or otherwise procured.

The first case is evident; the second may require the following illustration: Supposing an order required for its execution that certain castings be procured; let us say that they should be of malleable cast iron, which generally takes about a month to prepare. The natural course is to order a sufficient excess of castings from each pattern to provide for the chance of any of them proving defective, and so to prevent the great delay likely to follow the discovery of the imperfections after work on the castings has begun. If the castings should all prove good, is it fair for the clerk to follow the only course which his ignorance

of the true case permits, and charge them all against the job? If any other course were open, manifestly not; but he has no other resource unless he consults the foreman and they go over the subject together under all the disadvantages before described.

As a refuge from such difficulties the tendency is natural to report costs as they might be, or should be, or as they once were, rather than as they actually are.

CHAPTER VII.

GENERAL OBJECTIONS TO PRESENT METHODS, AND NEEDS OF A GOOD SYSTEM.

Objections to Present Methods.

From what has been said, it will appear that there is a certain conflict between the needs of the Arsenal as a manufactory, and those belonging to it as a public trust; yet that neither of these requirements is fully satisfied by existing methods. As a factory its actions are not as free as is required for profitable work; as a storehouse its methods are not as precise as they are expected to be for the safe keeping of its contents.

I believe that the cause of this imperfect working lies in the impossibility of successfully combining many functions in one instrument, whether human or inanimate.

The independence of function has long been a maxim in the construction of machinery; and the principle should be as true for book-keeping, which is only construction of another sort.

Without referring to proverbial expressions which epitomize this idea, consider any of the combination tools which are so constantly being invented, but which, however attractive at first, one so seldom buys a second time.

Take one of the best of them, the tack hammer with a claw at its further end. Its sole advantage is that you save the cost of one handle; its disadvantages are that to get one piece you must buy both; that either end is in the way when you want to use the other; that only one person can work with it at one time; and that, like the rest of its kind, its construction is a series of compromises between real efficiency, stability and economy, and the appearance of these qualities only.

Many proprietors consider it an economy to make a foreman keep his own books, combining the functions of hammer and claw in one man. In some jobbing and repair shops I have known of this taking half the foreman's time. Now, considering what he is there for, would it not be better to simplify the accounts so that a clever boy could keep them, and let the foreman, who is the head of all the men, the acknowledged brains ruling the motion of a hundred hands, have full power to direct their movements and co-ordinate their energies most profitably?

A good foreman is rare enough, but one who is also a good clerk is rarer still. Is it the fault of the supply or of the demand?

Passing now to inanimate instruments, to most people the word "accounts" suggests at once *books*. But looking at it without prejudice, is not an account book a combination tool? Does it not contain a mass of unnecessary information for the sake of having the little which is really required; and if from a mistaken sense of economy it is to be used for entry and record by several sets of people, is it not carrying the combination idea still further and in the wrong direction still? Then when accounts lap into different books, is it not like having several tack hammers and claws with only one handle for the lot? and is not confusion going to follow their use by the different men waiting to work with them?

On the other hand, see how much of the most important business of the world is done without books: checks of draft and deposit, negotiable bills of lading, warehouse receipts, notes and even baggage checks and railroad tickets, which have superseded the former process of "booking" for a journey; these things are not kept in books, but are loose and pass from hand to hand, suiting every one's convenience and to no one's harm.

"But they are loose and fugitive, mere evidences of wealth, likely to be lost," says the Mexican, trudging behind his silver-laden mule. "They may be," says the financier, "but it is every holder's interest to keep them until he can exchange them for something at least as good; it is to this we trust for their preservation, but even granting their occasional loss, far better in the end is that than to be fettered as you are by your fears." This

is a fair statement of the case between books and the cards, of which an account will be given later on.

OUTLINE OF THE NEEDS OF A GOOD SYSTEM OF BOOK-KEEPING.

1. For fair competition with private workshops, whose responsibilities are, so to speak, self-contained, the system must be as easy and untrammeled as in the smallest shop in the land, in which, if anything is wanted, the "boss" gets the money out of the till and steps across the street and buys it.

2. Yet it must be so arranged that the accounts shall always bear the closest scrutiny; that all expenditures may be distinctly represented on them; that all losses and wastings be charged to some general account, which will enhance the cost of the special products nearest connected with it, so that generally all expenses under the appropriations of Congress by which they are allowed may be certainly traced and surely accounted for.

The responsibility for a correct use of the money and means in the Commanding Officer's hands is not solely limited by his discretion, but is a grave trust, concerning which the accounts should be so simple and easily kept as to afford him at any moment trustworthy information of the state of the work in progress and of the funds available for its continuance. Then he and his subordinates may bend their energies to the more important portions of their duties, confident that the routine part of the work is going on without default.

3. In order that the system may not be burdensome to the polity which it is intended to serve, it must be simple and easily managed by a low grade of clerical labor, otherwise its cost would be apt to outweigh the advantages which it proposes to afford.

4. Yet it should not be thought that the work of the clerks can be done by foremen or workmen.

The workman *acts.*

The foreman *regulates* the workman's acts.

The clerk *records* the acts of both.

5. Although workmen and foremen should not act as clerks, yet, from the nature of the case, they must give the first account

of the nature of their acts and of the objects on which they are performed. Every workman knows better what he is doing or has been doing than does any other person, clerk or foreman, in the factory. Every man who wants supplies, knows better what he wants and why he wants it, than any one else can tell him.

So, the first acts of record, the first accounts of service, and the first requests for material should be made by the man most competent to judge of their fitness. These acts should be subject to proper revision, but no amount of it can supply the initial tendency to truth which is found in the independent statements of those most closely connected with the acts which they record.

6. Finally, the system should be such, workmanship apart, as to demonstrate the efficiency of the administration by the true cost of its finished product.

PART III.

DESCRIPTION OF PROPOSED METHOD.

CHAPTER VIII.

PROPOSED ORGANIZATION OF AN ARSENAL.

	Subalterns:	Responsible for—	Accounted for on—	Assisted by—
Commanding Officer.	1. Paymaster.....	Values.....	Cash papers...	Pay Clerk.
	2. Storekeeper	Units of property..	Store return...	Stock Clerk.
	3. Executive Officer..	Units of property and values.	Current service return.	Stock Clerk as to units. Cost Clerk as to values.

I would divide the Arsenal into three general departments, each independent of the other, but all directly dependent upon the Commanding Officer. Several functions might be united in the same person, and in the smaller arsenals the Commanding Officer might perform them all, as he does now in strictly military matters.

His assistants would be:

1. The Paymaster; responsible for values only, for which he accounts on his cash papers, with which this discussion is not yet concerned.

2. The Ordnance Storekeeper; responsible for units of property, for which he accounts on the arsenal Store return and its accompanying papers, prepared by the Stock Clerk.

3. The Executive Officer; responsible for both units and values, accounting for the former by the Current service return, and for the latter by properly balanced statements of the cost of articles fabricated or otherwise transformed. The former accountability is cared for by the Stock Clerk, and the latter by the Cost Clerk.

By sharing the services of the stock clerk between these two officers in preparing papers which have so much in common, much work can be saved, and the result of what work is done be made more accurate.

The Officer in Charge of the shops, as he is now called, corresponds most nearly to the Executive Officer proposed; but instead of his present merely local standing I would propose to put him on the same footing as his congener, the Ordnance Storekeeper, and make his position like that of the Executive Officer of a man-of-war, or the Captain of a navy yard,—the official right hand of the Commanding Officer. If I am not mistaken, such an officer has been established at some of the large posts garrisoned by the line of the army.

By this arrangement the Commanding Officer would be identified with no one department, but would be the critic of them all; and his officers would be working in parallel lines to accomplish the purposes of their common head. (See p. 31 and Chap. X.)

CHAPTER IX.

INSTRUMENTS OF THE PROPOSED SYSTEM.

I. Material Instruments.

Cards.

Several years ago, while on a visit to that gifted man, the late Captain William Prince, U. S. Ordnance Department, I found him preparing an index on what seemed a novel and most ingenious plan.

He wrote the title of each of his books on one of a number of small cards, and then underlined or checked off such catch words as he might select on each card. Each book was thus disposed of in turn, and when the cards containing catch words had been rewritten with the catch words in front, the cards were sorted alphabetically, and then simply copied in order into a book, giving an index by titles, authors and subjects, with such cross references as appeared suitable.

Since then I have learned how the same card system is applied in the Boston and other public libraries, not only to afford this mere facility in indexing, but to serve as the foundation of a system of book-keeping as well.

In general terms, as I understand the system, each book is represented by one card, giving title, author's name, and possibly a synopsis of its scope. These cards are sorted in drawers, according to subjects, and are arranged in each drawer alphabetically.

The drawers in a certain chest represent the books on hand: they are there ready for consultation and for the corrections and additions which the catalogue of any living library constantly requires. No perplexing array of supplements is there, each one already obsolescent as soon as it sees the light; the chest of drawers is the true representative of the contents of the library at any given moment.

When a book is wanted, the corresponding card is given to the librarian, is put by him into a drawer representing the outs, arranged, it may be, alphabetically by subscribers, and the transaction is at an end.

The success of the scheme depends upon having a single, simple representative unit, capable of combination and arrangement in any desired variety of forms. Like mosaic work or printer's type, if the units are true, they can be combined into an endless variety of patterns, and the result will still be true and stable.

The corresponding feature in the card system herein proposed is, that for every act or name to be recorded, there shall be a separate card; so that, the cards being combined or classified, the acts or names they represent will be so, too.

For this purpose I propose the use of single cards for all initial records, and their gradual consolidation by the simplest mechanical means, until they are finally transcribed into the permanent books of record.

The independence of a representative unit of record is the basis of the system I propose, combined with the use of a nomenclature by which all acts and their purposes may be set forth by the actors in such form as to be intelligible to those whose proper office it is to enroll and classify them.

The objection to this plan which will occur to many, will be to the great number of cards which the execution of such a scheme will require. In regard to this quite natural objection, leaving out of question the benefits which actual practice has shown to follow the free use of the cards, I have to make the following reply:

The objection may be to the number of cards *per se*, 1, or to the consequences of having so many of them. The consequences may be as to the cost of the cards themselves, 2; as to the time spent in writing on them, 3, with the disadvantages following the use of illiterate labor, 4; as to the means of handling and condensing the great numbers likely to accrue in extensive operations, 5; and as to the likelihood of their loss, 6.

1. Considering the objections to the number of cards *per se*, the following considerations apply, and also serve to express analogically some of their advantages:

Generally speaking, the lower in the scale of combination is the unit, the easier it is to treat it independently in forming such new combinations as may be required. This applies to many examples in every-day life. Take for example the printer's type, divided into single letters; how much better it lends itself to forming the great variety of words it is intended to multiply and preserve, than if whole words or even their constituent syllables were cast as single pieces like the ideographic characters of the Chinese or the hieroglyphics of the old Egyptians!

In fact, was not the germ of Guttenberg's invention, not that of printing only, with which he and his associates are credited, although it is as old as the use of the signet ring, but the printing with *movable letters?*

So in building construction, consider the economical advantages following the use of small portable bricks. What would be thought of the believer in ideographic writing or in monolithic building who opposed modern methods because they require "too many letters," or "too many stones?" So with chemistry, a science which, like the higher mathematics, may be said to have been created by an atomic nomenclature.

2. As to the cost of the cards, it may possibly be greater than that of the books now used; but this is a question which can only be determined by experiment on a scale large enough to pay for their printing in large quantities. I understand that the last contract for postal cards was let at less than five cents per hundred.

3. As to the time lost in filling them up, it may be greater than that required for a workman to find the foreman, tell him his needs, and have the foreman write them down, but this is doubtful.

4. Illiterate workmen are rarely employed in work requiring a careful subdivision of their time; but when this is otherwise, it should be easy to provide a time-keeper, or to require the writing to be done by some of their comrades or superiors.

5. Cards in blank are to be supplied to all requiring them, in such abundance that no transaction need ever fail of immediate record for want of a book to put it in. Entries are to be made in pencil. By means of rubber type, the electric or cyclostilic pen, and stamps of various kinds, it is intended to reduce the writing in any one instance to no more than that required to make the necessary entries in the usual books. It is as easy to write an entry on a card as it is to write it in a book; but once written on a card it need never be written again, while with books every re-handling implies transcription with increased chances of error.

The cards, on the contrary, are to be passed from hand to hand of those concerned, each one deriving from the card such information as he requires, and then passing it on toward the office, where they all finally converge for consolidation and record.

The successive consolidation of the cards depends upon the facility with which they may be assorted according to any one of the various classifications which may be desired. By this sorting, items of the same class are always found together, and their several aggregates directly determined. Having answered one question, the cards may then be resorted according to another inquiry, and so on.

The cards are carried where needed within the Arsenal by a sort of local post-office.

Sorting is done in racks or pigeon holes with temporary numbers; signing is done by ticket punches; and the final filing of cards whose race is run is done in trays, all of patterns to be hereafter described.

6. By making the card, before it reaches the office, the medium of exchange for local utilities, and by providing safe and simple means of transit thither, it is practically never lost. But since this immunity cannot reasonably be supposed to continue indefinitely, it is well to explain that even if lost, the consequences are not more serious than if under the present system an entry were forgotten. That this is never done, who shall say?

The following are the cards required to carry out the system:

1. The order card or ticket.
2. The service card.
3. The material card.
4. The correspondence card.

The first three are fully described hereafter.

The Correspondence Card.

This card, forming no essential part of the system proposed, is used as a very convenient means of asking and answering the thousand and one little questions constantly arising between the different departments of any large administration, concerning which it is not so essential to have an immediate reply as it is to ask the question or to make the statement while the need of it is fresh in one's mind. They are memoranda set in motion.

One side is blank and the other bears a double column of the titles and their abbreviations belonging to the persons most apt to correspond. One column is headed "From" and the other "To," so that a line drawn obliquely across the space between serves both as a signature and an address.

To continue the course of the card, as is often necessary, so that question and answer may explain each other, the recipient continues the line horizontally towards the left to his own title and then obliquely again to the next in order of receipt, and so on. To designate the originator of the question he should draw the line through his own name.

The messenger always takes the card to the person whose abbreviated title is nearest to the end of the line. Blank spaces are left for the insertion of such special names as may not be on the printed list. The same arrangement is used in forwarding other cards requiring action by different sets of hands.

The actual card is about $4\frac{1}{4}$ in. x $5\frac{1}{2}$ in.

Example showing use of Correspondence Card.

FACE OF CARD.

Showing succession of correspondence.

How soon will the Navy Cartridges be done?

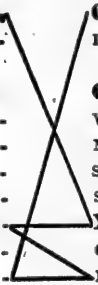
I don't know, do you? Answer C. O. direct.

In about three weeks from the time the copper comes.

BACK OF CARD.

Showing its course between correspondents.

COURSE OF THIS CARD.



From.	To.
~~COMMANDING OFFICER.~~	C. O.
CHIEF CLERK,	101
ORDNANCE STOREKEEPER.	O. S-K.
WAREHOUSES,	W.
MAGAZINE,	M.
SHOP-STORE,	S-S.
STOCK CLERK,	S. C.
EXECUTIVE OFFICER,	X. O.
COST CLERK,	C. C.
MASTER ARMORER,	M. A.
FOREMAN OF—	
MACHINE SHOP,	201
STEAM, WATER, GAS,	205
CASE SHOP,	301
LOADING SHOP,	401
CARPENTER SHOP,	501
PAINT SHOP,	601
LABORERS,	701
BALLISTIC OFFICER,	B. O.
FOREMAN OF—	
BALLISTIC DIVISION,	801
OFFICER OF THE DAY,	O. D.
COMMISSARY,	C. S.
QUARTERMASTER,	Q. M.
ADJUTANT,	A.
DET'M'T COMMANDER,	C.

NOTE. — *In starting card, draw line through your name.*

Keep lines showing course, continuous.

Abbreviations of Title.

Each shop or department is supposed to contain not over 99 workmen. Then, each department is supposed to have a representative number, which may well be given in the order followed by the work. Thus at Frankford Arsenal

1 stood for the office;
2 for the machine shop;
3 for the case shop;
4 for the loading shop;
5 for the carpenter shop;
6 for the paint shop;
7 for the laborers or outside department.

This arrangement would be varied according to the work of the place. Frankford Arsenal is selected throughout this discussion as a type, not only for its associations, but because the intrinsic complexity of the operations which are there recorded makes it probable that a method which is suited to its special needs will also serve more elementary organizations by omitting such portions as they do not require.

The men are numbered according to the department in which they are employed; thus the chief clerk is 101, the next clerk 102, and so on; the foreman of the machine shop is 201, and the machinists 202, 203, and so on. A man's number thus tells at a glance where he belongs.

But numbers are not exclusively used for this purpose. The officers of the arsenal, the principal clerks, and the keepers of the principal magazines are known by their initials, as seen on the back of card. This does not prevent their being borne by their numbers also on the rolls of the department to which they belong.

Lastly the outside world is designated by Z. This includes every person or agency not under the jurisdiction of the Commanding Officer.

Signatures by Punching.

The ordinary railroad ticket punch affords the means of affixing a positive, permanent, distinctive, and ready signature to all cards

requiring exact authentication. These punches are provided for all those whose titles appear on the back of the correspondence card; their marks, like the abbreviations, are as soon learned by all hands as are the owners' names.

Stamps.

Dating stamps are much used as a means of tracing delays, etc. They are of the pattern of the ordinary line dater, consisting of rubber type, printing as follows: "Mar. 16, 1884." They cost only $2 complete, and should be at every foreman's desk.

The stock clerk should have a consecutive numbering stamp. When automatic, this can be bought for about $30; it runs up to 1,000,000. The stock and cost clerks should have each a dating stamp, combined with one indicating the entry by them of the information given by the card.

Since so much depends upon sorting and arranging the cards, the following special mechanical appliances have been devised.

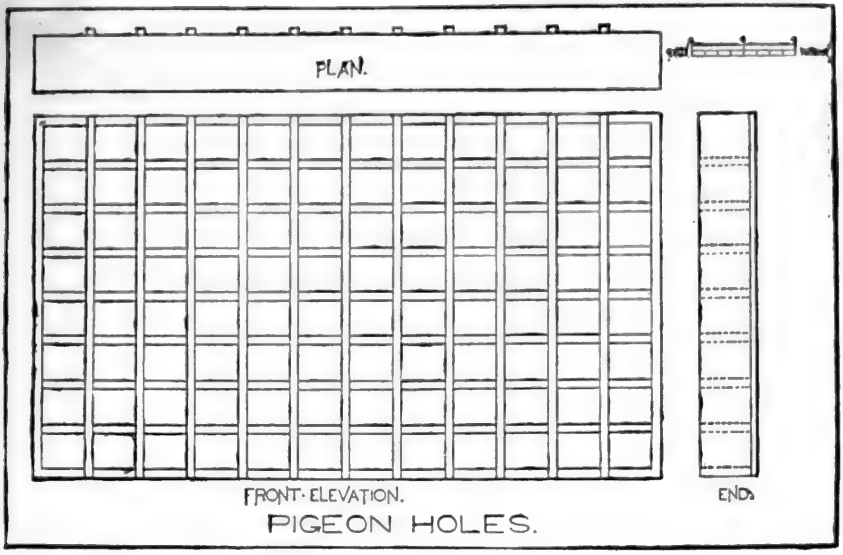
Racks.

These are intended for displaying single cards. They consist of vertical wooden strips about 1 inch x $\frac{3}{4}$ x 4 ft. long, with slanting saw kerfs about 1$\frac{1}{2}$ inches apart along the narrow edge, into which the cards are slipped. The order rack for a large arsenal should not hold less than 100 cards. It is conveniently placed against the wall; its topmost cards should be within easy sight and reach. The strips should be grouped by shops, so that a glance will tell what work is going on in each of them.

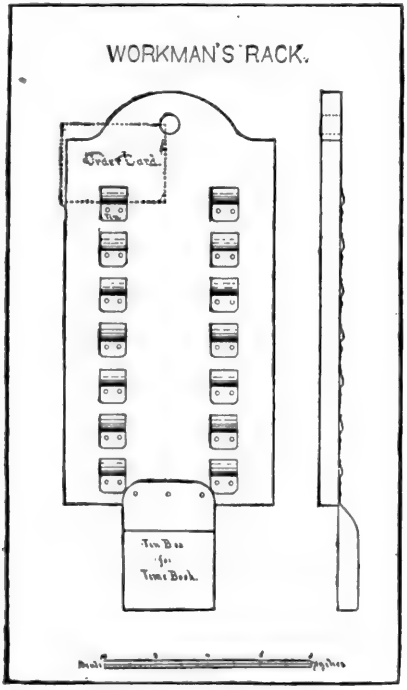
Pigeon Holes.

These are simply formed of a series of shelves about 4 inches apart; their width is one or two inches less than the length of the cards to be contained in them. The compartments are formed by vertical strips nailed against the face of the shelves, so as to admit the cards freely between them. The back may well be formed by the wall.

Over each pigeon hole is partly gummed a target paster bearing

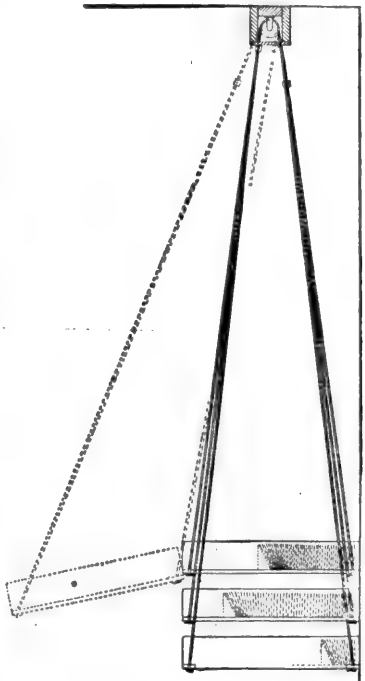


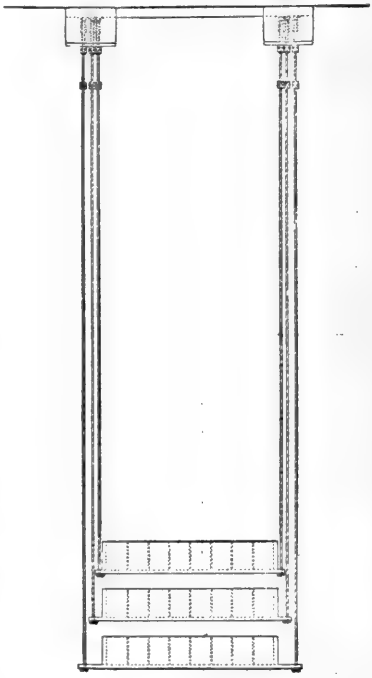
PIGEON HOLES.



WORKMAN'S RACK.

SWINGING TRAYS.

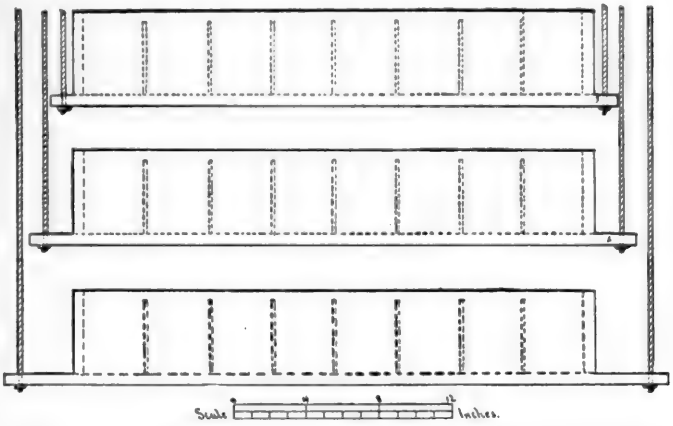


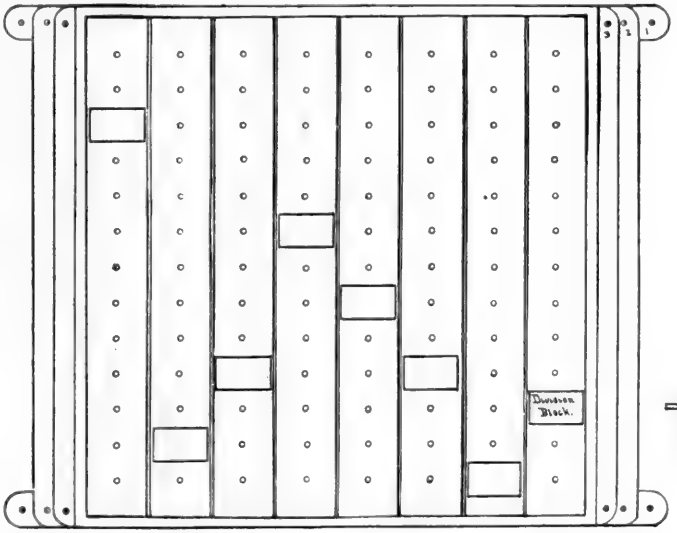


- Middle tray swung out for examination of contents.

Scale 0 10 20 30 40 Inches.

DETAILS OF SWINGING TRAYS.





the number of some unfinished job. This is so arranged that when the job is finished, the paster may be torn off, carrying the number with it.

Trays.

It is often desired to have large accumulations of cards belonging to completed jobs so arranged as to be readily consulted. For this purpose the swinging trays, elsewhere shown, are very convenient.

The device is like an ordinary chest of drawers, except that instead of sliding the drawers out and in, they are swung on the rollers from which they hang. The stops shown at (*a*) on the cords prevent the trays from tipping in one direction, while they permit them to tip freely in the other, so as to expose their contents in the most convenient way for examination.

To examine the contents of the top tray, the front of it should be depressed, carrying with it the trays lying beneath; the lower trays should be swung out first, and then tipped. They are divided by partitions parallel to the plane in which they swing, so that being filled at first in the end of each compartment furthest from the front, the weight of the contents brings the stops naturally against the pulleys, and preserves the tray in a horizontal position, to which, when released from the inclined position suitable for examination, they tend of themselves to return.

This arrangement is simple, cheap, and is found in practice to be very convenient.

Post-office.

In order to secure the prompt and safe distribution of the cards, the following postal system was devised:

By each principal desk is a box with two divisions labeled "In" and "Out." These boxes are visited once an hour, or oftener, by the office orderly for the office, and an errand boy for the shops, and their contents collected and distributed in each jurisdiction.

For passing the mail from one jurisdiction to the other, the mail pouch is hung upon a movable hook, connected with a sign outside the building, which sign, by the weight of the pouch

acting on the hook, is then exposed, displaying "To the Shops" or "To the Office," as the case may be. It is made the duty of any employee, passing by, to carry the pouch to its destination, where its contents are distributed by the means already described. In practice there is generally enough casual passing to and fro to make special trips unnecessary.

This, then, forms the entire plant of the system: cards, racks, punches, stamps and a very few books of final record.

II. Symbolic Nomenclature.

General Remarks.

We have seen that the true cost of the product is made up of three components, viz.:

1. Direct charges for labor.
2. Direct charges for material.
3. Incidental charges for miscellaneous expenses.

The following are the means adopted to make these charges definite and independent of the variations due to ordinary description:

For both services (labor) and material, a system of symbols is used which specifically indicates not only on what job the expenditure has been made, but the character of the expenditure, and even in some cases to which operation on what component of the product the outlay should be charged. These symbols are provided for on all cards in the spaces headed S-O.; C.; O.; and N. See chapters XII and XIII.

S-O. stands for Shop-Order; C. for Character of expenditure; O. for the Object on which made; and N. for the Number of the operation for which the expenditure was required.

The idea is to keep a strict account with each job by such a simple and invariable method that the same work will always be called by the same name, and that the resulting cost may be readily analyzed by names as minutely as it may ever be required without expecting clerks to have mechanical knowledge, or requiring mechanics to do the work of clerks.

Experience shows that symbols are readily learned by all con-

cerned; in fact their simplicity, definiteness and brevity are such that men generally prefer to use them alone without filling up the space left for such short explanatory remarks as may serve to verify their correctness or further define them. One reason for this seems to be that they actually name the fundamental purpose of the outlay, instead of merely suggesting it, as is usually done, by stating the object worked on and allowing its purpose to be inferred.

The mass of information afforded by the symbols may be utilized in gross or detail, as may be desired. There is no obligation to use it all, nor does the use of any portion of it imply even the consideration of any other. The information is there, already digested and capable of being assimilated to form truthful replies to whatever questions may be asked. This has been accomplished by starting the charges aright; by recording their exact purpose at the moment when it was best known.

Nor does the amount of detailed information hamper the accountant in attaining immediate gross results. This idea is illustrated in the conventional tree shown on a succeeding page. The higher we carry the analysis, the clearer is the definition; but this does not prevent a ready, though ruder, determination at any lower point. We may simply fell the tree; we may lop off its main branches; or we may first fell it and dissect its members at leisure. Thus the accountant may simply report the gross cost of the job; he may separate the plant; or he may ascertain the cost of each or any of the many operations performed on its component parts.

Where the analysis ends, the system must begin, that is, that the first charges for labor and material must be as specifically stated as the analysis may ever require the cost to be given. Hence the first steps in the procurement of material or in charging for labor are preferably made by the workman himself, subject to correction by his foreman. There the task of both ends; the subsequent combination of the symbols is an easy matter to the accountant, who can now treat them mechanically, without necessarily knowing anything of the processes which they represent.

The apparent complexity of the symbols is diminished by

reflecting with how small a portion of them each class of workmen, and particularly each individual workman, has to deal.

EXPLANATION OF SYMBOLS.

1. **S-O.** *or Shop-Order.*

This indicates the job for which the expenditure was made; it is identified by its serial number in the order book.

2. **C.** *or Character.*

The job being thus made known, an evident distinction arises as to the character or purpose of the work done on it. It may be permanent in its character, done, so to speak, to last for all time, or at least for the year with the accounts of which we are engaged; or it may be transient in its nature, of a necessity recurring every time the operation is repeated. The most evident illustration of this difference is found in the relation between a working drawing and the thing made in accordance with its requirements; let us say a machine constructed by virtue of Shop-Order No. 789.

The drawing once made answers for all similar machines to be hereafter made; they will all profit by its existence, and hence should bear their share of its cost instead of having the cost of the drawing go to swell unduly the charges for the first machine constructed.

That is, if other machines are actually so made. If but one is made, or is likely to be made, the cost of the drawing belongs to as much as that of any other part of the machine, and it should be so charged.

P. *Plant.*

We meet the difficulty at the *start* by charging the work and material on the drawing to S-O. 789, adding P. in the second column (headed C., Character) to show that the outlay belongs to the *Plant* of the order, so that the card reads 789, P.

Expenditures for patterns, gauges and special tools belong to this category, and are designated by using in the proper column the letter P, which may be taken to mean either *plant, permanent* or *preparation.*

W. *Work.*

Outlays, though, which are made upon the machine itself and which would have to be repeated every time such a machine was constructed, are represented by W., standing for Work.

The difference between P. and W. is that between the construction and operating accounts in railroad book-keeping.

(NOTE.—*Product* would perhaps be a better word than Work but for the fact that its initial letter is the same as that of Plant, the meaning of which is so apposite and well understood that an exact equivalent for it would be hard to find.)

Charges for fitting, assembling, painting and possibly boxing this machine would thus be charged to 789, W. Now, when the job is done, we may either give the cost of 789, including both P. and W.; or, deducting the cost of Plant, be prepared to state with exactness for how much such machines could be duplicated in future, the plant being on hand.

There is no room for the uncertainty and looseness arising from charging plant to the general shop account, nor for the wide differences otherwise existing under present methods, between the cost of the first and subsequent machines. The charges are made to the most probable order first, but are so identified as to be readily distinguished and separated afterwards if desired.

The same principle applies in standing orders. (Chap. XI.) Work permanent in its effects is indicated by P., and that merely done to keep things in running order by W. This distinction is easily observed until questions of repair arise; here it is often perplexing. Such questions are best settled with reference to the magnitude of the work involved, putting extensive repairs under P., and minor ones under W. What constitutes extensive repairs must be left to some one's judgment. It is best to indicate the category to which the expenditure belongs on the order authorizing it.

A. *Attendance.*

Charges are thus broadly separated into the P. and W. classes, but for closer analysis the latter may be further sub-divided as follows:

Besides the employees directly engaged upon the tangible product of an establishment, there are many whose services, although essential to the final issue, are easily lost sight of in computing its cost. There are foremen, clerks, engineers, firemen, porters, oilers and sweepers, and generally speaking those whose services are permanently required, independently of the amount of the output.

Their services, being recurrent, belong to the W. class, but for the sake of distinction from the operative labor which they organize and assist, they are designated by the letter A—Attendance. An example of the utility of this subdivision is found in manufactures by machinery in large quantities of staple products, such as cartridges, hardware, clothing, etc., where the division of labor has led to its constant employment in certain special lines.

Experience has shown the economy of having a cheap grade of labor to run a number of machines in charge of an experienced mechanic. The operatives return their time under W.; the mechanic under A. This gives a chance of ascertaining the true cost of operations in which the quantity of operative labor varies, and of those in which the cost of attendance may possibly unwittingly consume the saving due to the cheaper operative labor employed.

Were it not for the confusion likely to result from a use of the word "plant" otherwise than as described page 99, labor returned as A. might be called the "labor plant" of the establishment.

T. *Tools.*

Next comes as a component part of W., Tools, — symbol T.

In the manufactures above described great numbers of tools are consumed in the execution of the work: dies and punches, taps, files, etc. When the manufacture is sufficiently extended to make this consumption a matter of moment, its recurrence takes it from the region of plant, and makes it belong to W.

Tools in this special sense may be defined as the perishable portions of machines which act directly upon the objects of the special manufacture and are subject to consumption from wear during the execution of the order for which they are made.

As a matter of course, all moving parts of the machine are also subject to wear; but owing to the impossibility of properly distributing the resulting charges, and to the greater permanency of machines in comparison with the tools which they hold, the maintenance of the machines belongs to P.

It will be seen that charges for tools, as such, must be for objects of staple manufacture; when consumed in miscellaneous work, tools are charged to the standing order to which they belong under the head of W., simply. This follows the general rule that A. and T. belong to W., and may be considered as W., except when special analysis is required of its components.

Tree Diagram.

Many of the ideas expressed in this discussion are capable of representation in the accompanying diagram, the peculiar form of which is imposed by the impossibility of using suitably the brackets generally employed in graphical analysis.

We see the main constituents of cost, the direct charges for labor and material, combining to form the resulting product. This product is divided between Plant and Work, and while Plant remains untouched throughout, the higher we get on the tree, the more the Work element is divided.

First comes the offshoot for Attendance, and later, that for Tools; until, when the analysis is complete, all the elements are shown. The main difficulty lies in expressing the idea that Work, though capable of subdivision, retains its character unaltered in the undivided remainder.

The letters above show the symbols proper for each element of the analysis; and also, by means of brackets, indicate how T. and A. may be combined into W., by simply neglecting the differences between them.

The column of Shop Orders alongside is intended to show how far the analysis should be carried in recording charges. Thus, while we reserve the most extended analysis for the work concerning which the most exact knowledge is required,—the staple product of the particular workshop in question,—it is not intended that any charges for Tools, as such, shall be made for orders such

as 214, 215, 216 and 387.* Nor does Attendance enter on orders 217 to 223 inclusive, nor on the special orders which do not belong to the staple products of the arsenal. Such orders take no heed of these minor differences and only distinguish between Plant and Work in gross.

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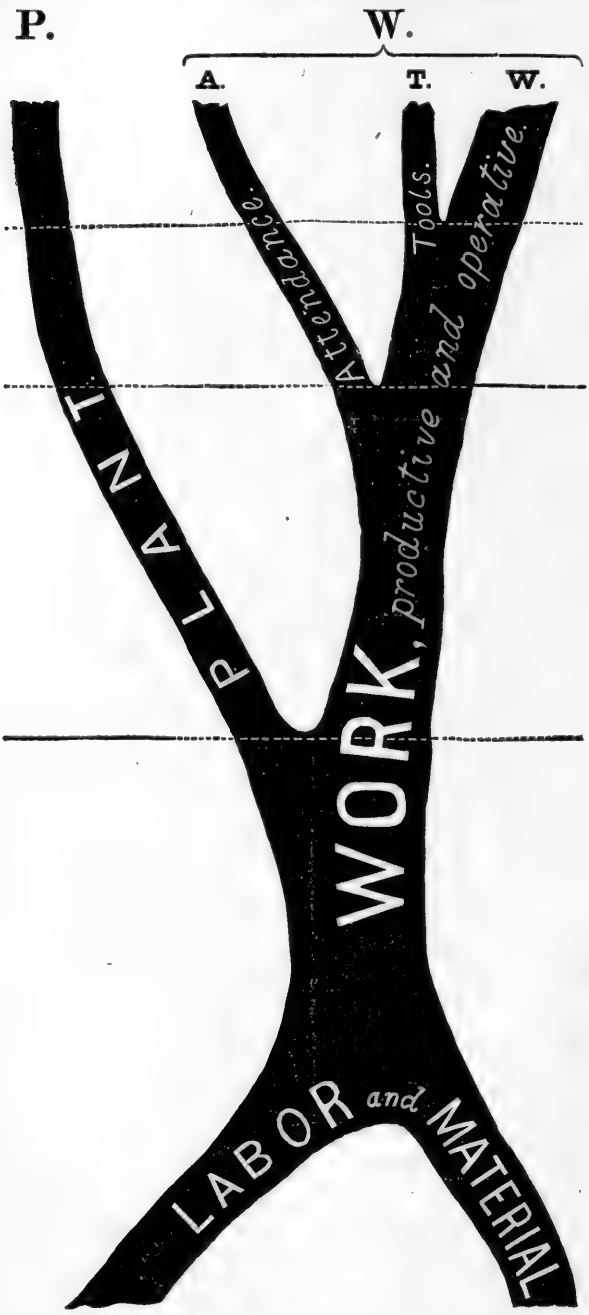
* For an explanation of these numbers see Chap. XI.



SHOP-ORDERS
TO WHICH
SYMBOLS OF **Character** APPLY.

For staple products *(yellow tickets)*, and No. 213.

Nos. 214, 215, 216, and No. 387.

All orders for local and issue work *(blue and red tickets)*, and Nos. 217–223.

BRIEF DEFINITION OF THE SYMBOLS OF CHARACTER.

P. refers to special tools, such as patterns, models, drawings and gauges, made under the general provisions of a special order, which will have a permanent useful value apart from that of the product of the order, after the order is filled. It also refers to machines, fixtures and tools in current service (except perishable tools solely for staple objects) held, and important repairs to the same made, under a standing order.

W. refers to labor and material required to execute a special or a general order from which no product follows but that which is actually called for therein. It also refers to the product.

A. refers specially to the labor of superintendence, and to that of clerks, porters, oilers and firemen.

T. refers specially to perishable tools used in making staple objects.

3. O., *or Object.*

Whether the third and fourth spaces, yet to be discussed, which refer to the specific object worked on and to the operation performed on it, are to be filled or not, depends entirely upon the value of the information which the filling of these spaces will give. If detailed knowledge is or may be required, there is no way of obtaining it correctly except from data given in like detail.

Where the object worked on is a staple object of manufacture it is given a symbolic name represented by a combination of letters and figures appearing on the Service and Material cards under the heading O., or object.

The necessity for symbols of objects, the difficulty of providing them, and the best way of overcoming that difficulty are so well described by Mr. Oberlin Smith, President of the Ferracute Machine Works, Bridgeton, N. J., in a paper read before the American Society of Mechanical Engineers, that I cannot do better than transcribe his article entire. See page 110. His paper has been of great assistance in this portion of my subject, and its principles have been found capable of an application far beyond its immediate scope.

Symbolic Nomenclature of Objects Pertaining to Staple Manufactures.

Definitions.

1. A staple product or staple is one of the principal productions of a given workshop, concerning which in all its parts definite economical information is wanted.

It comprises all the parts needed for a complete mechanical contrivance, assembled, and generally boxed ready for shipment.

Examples:

A carriage complete.

A set of harness, packed.

Muskets, cartridges, etc., packed.

2. A piece is that portion of a staple product which is not meant to be taken apart by ordinary means.

Examples:

Each spoke, or the tire of a wheel.

Each link of a chain.

Two or more elementary pieces united, as by welding or riveting, become a new piece.

Example:

A section of chain.

3. A component is a simple mechanical instrument formed by combining pieces in such a manner as to be easily taken apart.

Examples:

The felloes of a wheel united to form a rolling rim.

The sections of a patent hub, united to serve in distributing weight to the rim.

4. A member is similarly formed by combining components for the accomplishment of a definite mechanical purpose.

Examples:

The wheel for diminishing friction.

The pole for directing the vehicle.

The lock of a gun for firing the charge.

The barrel of a gun for containing and directing the discharge.

The box for containing the other parts united.

NOTE.—The line between members and components is necessarily an uncertain one and depends greatly upon the nature and number of the parts classified; convenience also enters. The difference is mainly that of complexity of function. Yet, a ramrod may be either a piece, a member or a component, according to the way it is regarded. In such cases it would be best to use the name highest on the scale, as it will give room for future additions. For example, page 120, the breech screw is named B. 30, although it is a single piece; this is done so that if this part should ever become composite, there would be room from 21 to 30 for the designation of each of its pieces, the component number remaining unchanged.

Notation.

1. When the Shop-Order number is not sufficiently explicit, the staple is designated by as many descriptive letters, not exceeding three, as may be required for the purpose.

Of these three letters the last one tells the particular class of staple referred to, and the first two define the pattern of that class.

Thus, among arms, S-F-R. means Spring-Field Rifle; S-N-R. Spe-Ncer Rifle; H-K-R. Hotch-Kiss Rifle; H-K-C. Hotch-Kiss Carbine, etc. R. and C. give the class, and the other letters the patterns.

For cartridge making, B. means ball, and O. blank, the two main classes of cartridges. F-R-B. means Folded-head-Rifle-Ball (cartridge understood); S-C-O. Solid-head-Carbine-Blank, etc.

These descriptive letters correspond to Mr. Oberlin Smith's machine symbols, page 116.

2. The member symbol is a letter; for examples of this and following cases, see lists hereafter.

3. The component symbol is a number ending in O., following the member letter, thus: A. 20; B. 30; A. 130.

4. The piece symbol is a digital number following the letter of the member to which the piece belongs, thus: A. 1; A. 2; A. 3; A. 14; A. 29, etc.

Remarks.

1. Related pieces are given consecutive numbers, forming groups, the summation of which into components is indicated by the next higher multiple of ten. Vacancies in the digital scale are left open for expansion. Thus, pieces 1, 2, 3, etc., are combined into the component 10. The pieces for the next component are numbered from 11 up, and the next component is 20, and so on.

To which set of ten the piece number belongs depends upon the number of the corresponding component; and this, as explained in the next remark, upon its place in the order of combination with other components to form the corresponding member. This establishes a common principle by which substantially the same notation might be determined by independent notators working on the same staple.

2. The union of any component to the principal component of the member to which it belongs is represented by adding 100 to the number of the former component. Thus, A. 120 means that A. 20 has been assembled to A. 10, etc.

This assumes in the order of assembling a certain sequence by which a number over 100 represents the combination of all the parts above it on the list. For otherwise the number of imperfect combinations represented would exceed the limits of simplicity. If such cases occur, they may be met by qualifying the symbolical statement by ordinary language, thus, " S-F-R-S. 170, without band springs," etc. See page 120.

The separate enumeration of each of the pieces or components in the combination would not answer the purpose, for we would lose the sense of fitness for joint action given by a joint symbol. For example, any one asking for a watch would be disappointed in getting only its loose components, the efficient working of which would depend more or less upon the manner in which they would be assembled. The tendency of modern machine work is to disintegrate the unity of " components " by increasing the interchangeability of their " pieces."

3. It will be readily seen that when the Shop-Order number is sufficiently descriptive, only the member symbol will be required. This limits the full symbol name to use in marking tools, patterns, drawings, etc., and for defining staple objects worked on under standing shop-orders.

4. Only so many symbols are given as are needed to identify the part. Thus, for receivers, breech-blocks, locks, band-springs, etc., which are common to both rifle and carbine, the descriptive initials R. and C. may be omitted. So with tools and appendages which belong to all arms alike, and with parts like barrels

in such stages of manufacture as to make their destination uncertain, the indications of pattern are also omitted.

For a similar reason a completed member requires no number, for it expresses the union of all its components. It is like the name of a family of which we call the members John Smith, Ann Smith, etc., and designate them collectively as the Smiths, whatever their number. To pursue the analogy, John Smith's leg would be a component of that member of the Smith family, and his foot a piece of that component, etc.

So, also, when members are united we drop the member symbol, because the combination can no longer refer to any one of them. Their union forms the staple in various stages of completeness, the most advanced of which we designate by the descriptive symbols only. Having advanced as far as possible, all further progress must be negative; consequently additions to the symbol of completeness indicate increasing degrees of departure from it. These additions are numbers progressively arranged.

5. I would reverse the last recommendation of Mr. Smith relating to obsolete objects, by giving to the *first* model of any object its plain number and designating any changes from that model by a suffix. The other method takes the back track too often.

For example, supposing the symbols to have been in operation for the last eleven years, the receiver, model 1868, would be S-F-B. 11; when shortened in 1870, it would have become S-F-B. 11, *a;* altered to cal. 45 in 1873, it would have been called S-F-B. 11, *b*, and changed by the memorandum of July 1, 1879, it would now be S-F-B. 11, *c*.

Such a course would deal with each change directly when it was made, would be historical, suggestive and most convenient in marking drawings, tools, patterns, gauges and obsolete components in store.

SYNOPSIS.

Proposed Symbolic Nomenclature of Staple Products.

Objects are designated by
- Numerals, ending in
  - Digits, indicating.. *Pieces.*
  - Ciphers, indicating *Components.*
- Letters, indicating..... *Members.*

These parts unite with others of the same kind to form the next kind below in order. Members unite to form the staple product.

Every minor object requires at least the member letter and a number to define it. To the member letter are prefixed as many descriptive letters, not exceeding three, as the lack of other means of definition, such as the Shop-Order number, may require.

Members omit piece numbers.

Staples omit the member letter and affix numbers indicating degrees of incompleteness.

[From the *American Machinist* of Sept. 10, 1881.]

NOMENCLATURE OF MACHINE DETAILS.

By Oberlin Smith.

A Paper read before the American Society of Mechanical Engineers.

That the nomenclature of machinery, and of the tools and apparatus with which it is constructed, is, in this country, in a state of considerable confusion, scarcely needs demonstrating. If we look from an international point of view, and include the other English-speaking countries—Great Britain and her colonies, the confusion becomes worse confounded. A reform is destined, in due time, to come, doubtless to be promoted in great degree by such societies as ours. This reform movement cannot be begun too soon, and should aim at giving brief and suggestive names to all objects dealt with, each object to have but one name, and each name to belong to but one object. A simple method of beginning such a reform would be a common agreement among all our engineering schools to use each technical word in but one sense, and with no synonyms.

A lesser field of reform, and one which lies more particularly within the jurisdiction of individual manufacturers, is the comparative designation of a number of sizes or kinds of the same machine. There is now no common understanding whether a series of sizes shall be numbered or lettered from the largest

down, or from the smallest up. The latter is undoubtedly the most natural and suggestive method, but usually becomes confused by want of careful forethought (when starting a series) in providing "gaps" for the insertion of future sizes. If a numerical series has been already started and become commercially established, the only systematic way to insert new sizes (either at the beginning or through the middle of the series) is to use fractional numbers. This, though awkward in sound and appearance, seems to be the only means of suggesting the comparative size of the article by its name. The use of arbitrary higher numbers between the others is, of course, worse than no numbers at all. The use of a series of letters does not supply this fractional loop-hole of escape, the euphony of A-and-a-half, K-and-three-quarters, etc., being somewhat doubtful. Another method in much favor is the use of "fancy" names, such as "Diminutive Giant," "Eureka," "Fire-fly," etc. These are far preferable to confused numbers, as they are not intended to convey any ideas between manufacturer and customer, and admirably succeed in their purpose. All this is a very difficult subject to deal with, and one in regard to which we can scarcely hope for any exact system. We can but point out to manufacturers two general principles to be followed: 1st, of leaving abundant *gaps*—that is, let a regular series run 10, 20, 30, 40, etc., instead of 1, 2, 3, 4, etc.; and 2d, of using the smaller numbers for the smaller objects. The second is similar in idea to the well-known Philadelphia house-numbering system, which has worked so admirably in practice, and which has been copied by numerous other cities.

The two foregoing paragraphs are intended respectively as but casual allusions to the technical and commercial nomenclature of machinery in general. The subject is too elaborate to be treated at length in this paper, the main purpose of which is to set forth the results of the writer's experience in establishing a system of names and symbols for all the component parts, commonly called "details" of machines, or, in fact, of any manufactured articles.

That some such system is necessary, no engineer who has

attempted to manufacture machinery by the modern system of duplicate (or approximately duplicate) parts, will, for a moment, question. The necessity for a specific name for each piece, which name is not, never has been, and never will be, used for any different piece of the same or any other machine, is evident, simply for purposes of identification. This identification is required mechanically at almost every stage of production. The name, or a symbol representing it, should be marked upon the drawings, the patterns, and the special tools pertaining to each piece, and, when convenient, upon the piece itself. Commercially, it is required on time cards and in indexes and pattern lists and cost books as pertaining to production. Pertaining to sales these names or symbols must appear in illustrated price lists, and in orders by and charges to customers. This our modern method of repairs, by selling duplicate parts, renders imperatively necessary.

The requisites for a good system of names and symbols are: 1st, *isolation* of each from all others that did, do, or may exist in the same establishment. 2d, *suggestiveness* of what machine, what part of it, and, if possible, the use of said part—conforming, of course, to established conventional names, as far as practicable. 3d, *brevity*, combined with simplicity. Of the importance of isolation to prevent mistakes and confusion; of suggestiveness to aid the memory; of brevity to save time and trouble, it is hardly necessary to speak.

Regarding the systems now in use in our best shops, this paper will not attempt detailed information. It is understood that the names are more or less scientifically arranged, depending, of course, upon the amount of study and the quality of the brains that have been expended upon them. In cases where symbols are used, supplementary to the names, they usually consist of letters or numbers, or (oftener) a combination of both. Many of them (both names and symbols) fail in symmetry and suggestiveness, because little attention has been paid to the names of the machines themselves, as regards the serial consecutiveness, hinted at in paragraph 2d. The quality of brevity often suffers severely, because the name and symbol must, in most cases, each have the machine name prefixed, to secure their perfect isolation. The

latter quality is rarely dispensed with, simply because the manufacturer's pocket would be too directly touched by the expensive resulting mistakes. A perusal of some machinery catalogues which give detailed lists of parts is very harassing to a systematic mind. They are apt to derive one part name from another, prefixing the latter as an adjective each time, until some such pleasant title as "lower-left-hand-cutting-blade-set-screw-lock-nut" is evolved. If there are symbols provided, they consist of some unknown combinations of letters part way down the list, and then change to arbitrary numbers, or perhaps to nothing at all. It will often be noticed also that no particular order appears to be followed in numerical arrangement, similar parts being scattered at random through the list.

The scheme to be described further on has been evolved gradually from the experience gained in managing a growing machine business. This scheme is far from perfect, and is probably inferior to others which have not been made public; but it seems to answer the purpose aimed at, viz., a comprehensive and elastic system which will accommodate itself to an unlimited growth and any variation in quantity or kind of goods manufactured. This, the methods we first tried would not do, being too limited in their scope.

It should be here explained that the word "we," as just used, refers to the above-mentioned machine works, with which the writer has long been connected; and the scheme in question will be spoken of as "our symbol system." To further define terms: "machine name" and "machine symbol" refer respectively to the name and symbol of the whole machine—or other article of manufacture; for it will be noticed that the system is applicable to almost any products, except those of a textile or chemical nature. "Piece name" and "piece symbol," in like manner, refer to the separate pieces of which the whole is composed. The terms "detail," "part," and "piece," have so far been used synonymously. It is doubtful which is really the best to establish as a standard, but we have adopted "piece" as best expressing the idea of one piece of material, reduced to the last condition of subdivision. In our practice, exceptions are made to this

requirement of homogeneousness in such cases as chains, ropes, belts, etc.,—also material glued or welded together—in short anything which may (like a man) be called *one piece*, because it is not intended ever to be taken apart. The character for equality (=) will be used to show connection between a name and its symbol. A brief glance at the history of our system shows that at first we (like many others) hit upon the plausible idea of using numbers for machine symbols and letters for piece symbols. The numbers were somewhat "gapped," but not to such an extent as we now should practice. Examples: If four sizes of pumps were symboled 1, 2, 3 and 4, their barrels might = 1-A, 2-A, etc.. and their handles = 1-B, 2-B, etc. If the next product made was a series of lathe dogs, they would probably be symboled 11, 12, 13, etc. Their frames would = 11-A, 12-A, etc., and their screws 11-B, etc. This all worked beautifully until the products became so complicated as to contain more than 26 pieces. After tampering a little with the Greek alphabet, which seemed calculated to scare our new workmen, and trying to use a mixture of small and capital letters, which looked too near alike, we fell back upon the clumsy device of repeating the alphabet, with letters doubled or tripled.

When we finally abandoned the above plan, several methods were carefully studied. The next most obvious was to use letters for machines and numbers for pieces. This allowed any quantity of the latter, but limited the machines to 26, even with no gaps provided. A certain modification of this method is, perhaps, more in use than any other system. In it letters are used for different sizes or styles of a certain kind of machine, and used over again for some other kind, *ad infinitum*. This answers the purpose, because there are not likely to be more than 26 varieties of one machine. It has, however, the fatal objection of requiring the whole machine name prefixed to each symbol, in all cases where the symbol stands alone, and does not happen to be written with the others of the set in tabular form. As the general name of a machine usually consists of at least two words, a complete piece symbol becomes too long for convenience in labeling. Examples: Force pump, K—26; Lathe dog, H—2.

Another system consists in using numbers for the machines and numbers for the pieces. This gives isolation and brevity, but no suggestiveness. A serious objection to it is the danger of blurring the numbers together, or of transposition in writing or reading them; also in the fact that either number cannot be used alone, as it can in the case of letters and numbers.

A similar system to the above consists in the use of letters for both symbols. It has the same disadvantages, and the additional one of a limitation in the quantity of letters at disposal.

Our system, as finally decided upon, is as follows:—Machine names and piece names are determined by the designer, in general according with the principles already pointed out, being, of course, made as brief and suggestive as possible, with no two machine names alike, and no two piece names alike in the same machine. In this nomenclature no positive laws can be followed but those of common sense and good English. A *machine symbol* consists of a group of *three* arbitrary *letters*—capitals. A *piece symbol* consists of an arbitrary *number* and follows the machine symbol, connected by a hyphen; thus FPA-2 might symbolize the force-pump handle before alluded to—smallest size. The machine symbol may be used alone when required, as FPA.

As thus described, these symbols fully possess the qualities of isolation and brevity. To make them also suggestive, some attention must be paid to what letters to use. In practice, we aim to make the first two letters the initials of the general name of the machine, and the last letter one of an alphabetical series which will represent the sizes of the machine. An example of this is shown in the symbol for the smallest-sized force pump FPA. If there is any chance of a future smaller or intermediate size, gaps should be left in the alphabetical order. This "initial" method cannot always be strictly followed, because of such duplicates as FPA for force pump and foot press. The remedy would be to change one initial for one beginning some synonymous adjective, that is, foot presses might be symbolized TPA, assuming that it stands for treadle press. Usually the least important machine should be thus changed. From this it will be seen that, in defining the theory of this scheme, the words "arbitrary letters"

were purposely used. The idea is to make the system thoroughly comprehensive. There might be such a number of machines having identical initials that the letters would be almost arbitrary. In practice, the designer can usually succeed in making the symbols sufficiently suggestive.

In considering how many letters to use in a symbol, considerations of brevity advised two, suggestiveness three or four. Two letters did not allow of enough permutations, nor indicate well enough the kind and size of machine. Three seemed amply sufficient in the first respect, as it provided over 17,000 symbols. If, for any reason, in the future four letters should seem desirable, the addition of another would not materially change the system. If three letters hyphened to a number of one, two or three digits should seem bulky, remember that this symbol can stand by itself anywhere and express positively the identity of the piece. Its comparative brevity is shown by comparing the second and third columns of the following table (A). In the different lines an idea is given of the application of the system to a variety of products not usually made in any one shop.

TABLE A.

1st. Full name of machine and piece.	2nd Our symbol for it.	3rd Symbolic name as often used.	4th. Characters in Col. 2.	5th. Characters in Col. 3.	6th. Excess of Col. 5 over 4.
6″ x 4′ Engine Lathe, spindle head	ELA—4	Engine Lathe, A—4	4	13	9
No. 4 Power Press, frame	PPD—1	Power Press, D—1	4	12	8
7″ x 14″ Steam Engine, crank shaft	SEG—51	Steam Engine, G—51	5	14	9
Buckeye Mowing Machine, left axle nut	MMD—81	Mowing Machine, D—81	5	16	11
No. 3 Glass Clock, main spring,	GCC—105	Glass Mantel Clock, C—105	6	20	14
One-hole Mouse trap, choker wire	MTA—3	Wooden Mouse Trap, A—3	4	17	13

TABLE B.

FPL No. 3 FOOT PRESS. Weight.

Piece No.	Same as	Piece name	Material.	Quantity.	Rough weight.	Finished weight.	Aggregate finished weight.
1	.....	Frame.....	Cast Iron.	1	220	200	200
2	.....	Gib	"	1	10	9	9
3	.....	Side Bar.....	"	1	45	40	40
4	.....	Front Leg	"	2	30	30	60
5	.....	Back Leg.....	"	1	40	40	40
6	.....	Treadle.....	"	1	17	15	15
7	.....	Lever	"	1	85	80	80
8	FPH-8	Lever Weight.....	"	4	5	5	20
9	.....	Pitman	"	1	12	10	10
10	FPH-10	Clamp Sleeve	"	2	3	2¼	4½
21	.....	Lever Pin.....	Steel.....	1	2½	2	2
26	FPJ-26	Treadle & Pitman Bolt	Iron.....	3	¾	½	1½

Table B is a specimen of part of a page of our "Symbol Book," in which are recorded any machines which have arrived at such a state of perfection and salability as to be marked "Standard" on our drawings.

This table almost explains itself. The piece numbers in 1st column do not have the letters prefixed, because the latter stand at the top of the column. "Same as" means that the piece is identical with a piece belonging to some other machine, and can be manufactured with it. If it is common to several machines in a set, the smallest of the set in which it occurs is given. The "quantity" column tells the number of pieces of a kind required. The last "weight" column, added upward, shows total weight of machine. The piece numbers are "gapped" after each kind of material, and also at the ends of "groups," as described further on. This is to allow for future changes and additional pieces; also that other nearly similar machines having more pieces may in general have the same piece numbers.

The order in which the pieces are numerically arranged cannot follow positive rules in all cases. In our list of instructions (too long to be here quoted) we direct a classification by *materials*. In each class we group pieces of the same general character, in regard to the prevaling work to be done upon them, and in natural "machine shop" order; *i. e.*, first planing, then drilling or boring,

then turning. We also aim to place the heaviest and most important pieces first. Between each group we "gap" the numbers.

Regarding position in naming pieces, we assume a front to the machine (where the operator is most likely to be placed), and define direction tersely as "forward," "back," "right," "left," "down," "up." The adjectives of position prefixed to piece names are, of course, derived from these words, as "upper," "lower," etc. A perpendicular row of similar pieces, say 5, would be rated upper, second, third, fourth and lower. A number of different-sized pieces of similar name may, in like manner, be prefixed smallest, second, third, etc.

Before closing, a brief reference to certain (two) supplementary symbols may not be out of place. One is a small letter after a piece symbol (as FPL-21-a), signifying that the piece is obsolete, the standard FPL-21 having been altered. After a second alteration, the last obsolete piece would be suffixed "b," and so on. Thus duplicate pieces of old-style machines can be identified and supplied to customers. The other symbol referred to is to indicate the number of the operation in the construction of a piece, and is written thus: FPL-21-1st, FPL-21-2d, etc. Its use is of great value on detail drawings, time cards and cost records.

OBERLIN SMITH.

SYMBOLIC NOMENCLATURE OF "OBJECTS."

In order to test the correctness of the principles above enunciated, and to illustrate their meaning, they are applied in detail to the most complex cases with which I am familiar; viz., the manufacture of small arms and of metallic ammunition. For a general application of symbols see the end of this chapter.

I. *Application to the Manufacture of Small Arms, as described in Ordnance Memorandum 22.*

DESCRIPTIVE SYMBOLS.

1. Of class (kind of arm).

Rifle	R.
Carbine	C.
Revolver	P. (pistol).
Shot gun	G. (gun).

2. Of pattern.

Springfield	S-F.
Spencer	S-N.
Smoot	S-T.
Smith	S-M.
Hotchkiss	H-K.
Lee	L-E.
Chaffe-Reece	C-R., etc.

NOTE. — Some of these guns are not in O. M. 22, but are given as illustrative examples of the treatment of similar names. The descriptive symbols are written in the inverse order above given; thus S-F-R; H-K-C, etc.

MEMBER SYMBOLS.

Stock and parts	S.	Principal members.
Barrel and parts	B.	
Lock and parts	L.	

Bands Tang screw Side screws	F.	Fastenings between principal members.

Rear sight	T.	Appendages.
Ramrod	U.	
Bayonet	W.	
Tools	Y.	
Packing box	X.	

Symbolic Nomenclature in Detail of the Parts of the Springfield System.

Full name of part.*	Full symbol. Letters.	Num'ls.
Stock:	S.	
Wood part (one piece)	S-F-R-S.	10
Tip	"	11
Tip screw	"	12
Tip screw and tip (component)	"	20
Same plus parts above	"	120
Ramrod stop (one piece)	"	30
Same plus parts above	"	130
Band spring (one piece)	S-F-S.	40
Same plus parts above	S-F-R-S.	140
Guard plate	S-F-S.	41
" bow	"	42
" " nut	"	43
" " swivel	S-F-R-S.	44
" " " screw	"	45
Trigger	S-F-S.	46
" screw	"	47
Assembled guard	"	50
Guard screw	"	51
Same plus parts above	S-F-R-S.	160
Side screw washer	"	61
Same plus parts above	"	170
Butt plate	"	71
" " screw	S-F-S.	72
Same plus parts above, assembled stock	S-F-R-S.	
Carbine butt plate	S-F-C-S.	71
" " " cover	"	72
Carbine butt plate cover spring	"	73
Carbine butt plate cover friction spring	"	74
Carbine butt plate cover pin	S-F-C-S.	75
Carbine butt plate cover screw	"	76
Carbine butt plate tang screw	"	77
Carbine butt plate, assembled	"	80
Swivel bar	"	61
" " " base, front	"	62
Swivel bar, assembled to bases	"	64
Swivel ring	"	65
Swivel bar and ring on stock	"	170
Barrel:	B.	
Rifle barrel proper	S-F-R-B.	1
Front sight and bay't stud,	"	2
Same plus above parts	"	10
Receiver proper	S-F-B.	11
Ejector stud	"	12
" " riveted to receiver	"	20
Same plus above parts	"	120
Breech screw (one piece)	"	30
Same plus above parts	"	130
Breech block (one piece)	"	31
Cam latch	"	32
" " spring	"	33
Breech lock cap	"	34
" " " screw	"	35
Thumb piece	"	36
" " riveted to 32 and 34	"	37
Breech block complete	"	40

* When no particular arm is mentioned, the rifle is understood.

Symbolic Nomenclature in Detail, etc.—continued.

Full name of part.*	Full symbol. Letters.	Num'ls.
Firing pin	S-F-B.	41
" " screw	"	42
Extractor	"	51
Ejector spindle	"	52
" spring	"	53
Hinge pin	"	61
Same plus above parts (assembled barrels)	S-F-R-B.	
Carbine barrel proper	S-F-C-B.	1
" " front sight stud	"	2
Same plus parts above	"	10
Carbine front sight	"	11
" " " pin	"	12
Same plus parts above	"	120
Etc., etc., etc.		
Lock:		
Lock plate	"	1
Bolster screw	"	2
Same riveted to lock plate,	"	10
Main spring (one piece)	"	20
Tumbler	"	21
Main spring swivel	"	22
" " " rivet	"	23
NOTE.—These parts really belong to the tumbler, although called in part after the main spring.		
Tumbler swivel and rivet, riveted	S-F-L.	30
Bridle	"	31
" screw	"	32
Sear	"	41
" screw	"	42
Sear spring	S-F-L.	43
" " screw	"	44
Hammer	"	51
Tumbler screw	"	52
Same plus parts above (assembled lock)	S-F-L.	
Fastenings:	F.	
Upper band	S-F-R-F.	1
Gun sling swivel	"	2
Stacking swivel	"	3
Swivel pin	"	4
Upper band complete	"	10
Lower band (one piece)	"	20
Tang screw, " "	S-F-F.	30
Side screw, " "	"	40
Carbine band	S-F-C-F.	1
" " swivel	"	2
" " " pin	"	3
APPENDAGES.		
Rear sight:	T.	
Base	"	1
" spring	"	2
Same plus part above	"	10
Base screw	"	11
" leaf	"	21
Joint pin	"	22
Slide	"	23
" spring	"	24
" " rivet	"	25
Leaf, assembled	"	30
Sight, assembled, rifle	R-T.	
" " carbine,	C-T.	
NOTE.—The sights are alike until graduated, and hence are simply designated as T. 1; T. 23, etc.		

* When no particular arm is mentioned, the rifle is understood.

Symbolic Nomenclature in Detail, etc.—continued.

Full name of part.*	Full symbol. Letters.	Num'ls.
Ramrod:	U.	
For rifle (one piece)	R-U.	
For carbine, jointed; joints 1 and 2	C-U.	1
Same, joint 3	"	2
" complete	C-U.	
Bayonet:	W.	
Blade	"	1
Neck and socket	"	2
Same welded to blade	"	10
Clasp	"	11
" screw	"	12
" and screw	"	20
Bayonet complete for all arms	W.	
Tools:	Y.	
Screw driver, large blade,	"	1
" " small "	"	2
" " rivet	"	3
" " assembled	"	10
Tumbler and b. s. punch, large blade	"	11
Same, small blade	"	12
" rivet	"	13
" assembled	"	20
Combination screw driver, large blade	"	21
Same, small blade	"	22
" tumbler and b. s. punch	"	23
Same, rivet	"	24
Same, assembled	Y.	30
Headless shell extractor	"	40
Packing box:	X.	
Sides of rifle box	S-F-R-X.	1
Top and bottom	"	2
End pieces	"	3
Top cleats	"	4
Handles	X.	5
Empty box	S-F-R-X.	10
Corner pieces	"	11
End linings		12
Inner linings	"	13
Set of wooden linings	"	20
Tin linings	"	21
Tin and wooden linings complete	"	30
Muzzle clamps	"	31
Butt "	"	32
Top "	"	33
Bayonet "	"	34
Set of packings complete,	"	40
Box complete	S-F-R-X.	
Finished arm, more or less complete:		
Rifle complete, with tools, bayonet, etc., boxed	S-F-R.	
Same, without box	"	1
" " tools	"	2
" " bayonet	"	3
Etc., etc., etc.		

* When no particular arm is mentioned, the rifle is understood.

II. *Application to the Manufacture of the Staple Products of Frankford Arsenal as described in First Pamphlet on the Shop-Order System, January, 1881.*

DESCRIPTIVE SYMBOLS.

1. Of class (kind of product).

Ball cartridge	B.
Blank cartridge	O.
Target pasters	Q.
Cannon primers	T. (tubes).
Fuzes	Z.

2. Of pattern—

OF CARTRIDGE.

1. Referring to arm for which designed.

Rifle	R.
Carbine	C.
Revolver	P. (pistol).
Shot gun	G. (gun).

2. Referring to construction.

Folded-head case	F.
Solid-head case	S.

OF CANNON PRIMERS.

Electric primers	E.
Friction primers	F.

OF FUZES.

Time fuze	T.

NOTE.—The descriptive symbols are written in the inverse order above given; thus, F-R-B., E-T., T-Z., etc.

MEMBER SYMBOLS.

The individual cartridge, primer, fuze, etc., of which case, bullet, powder, primer, etc., are the components	A.
Paper package or its equivalent	K.
Wooden packing box or case	X.

Symbolic Nomenclature in Detail of Staple Products of the Frankford Arsenal.

NOTE.—The rifle cartridge, solid head, is taken as the type, departures from which are noted as they occur. Folded head substitutes F. for S. throughout.

Full name.	Full symbol. Letters.	Num'ls.
Case (one piece)	S-R-B-A.	10
Primer cap for all arms	S-A.	11
" fulminate	A.	12
" anvil	S-A.	13
" foil	"	14
" assembled	"	20
Cup anvil	F-A.	11
Fulminate	A.	12
Primed anvil	F-A.	20
For revolver amm'n the same, substituting	F-P-A.	
Primed cases, (R. or C.)	S-A. or F-A.	120
Primed cases, revolver	S-P-A. or F-P-A.	120
Powder	A.	21
Wads for carbine	S-C-B-A.	22
Paper cups (R. or C.)	S-O-A.	23
Bullet (R. or C.)	A.	31
" revolver	P-A.	31
Finished cartridges, more or less complete.		
Blank cartridges, loose (R. or C.)	S-O-A.	
Blank cartridges, loose, revolver	S-P-O-A.	
Ball cartridges, loose, rifle,	S-R-B-A.	
" " " carbine	S-C-B-A.	
Ball cartridges, loose, revolver	S-P-B-A.	
S-R-B-A. packed complete,	S-R-B.	
Same, packed in paper only,	"	1
Etc., etc.		

NOTE.—The primers F-A. 20 and S-A. 20 may in some circumstances be used in either kind of case indifferently. I have taken the usual practice.

Full name.	Full symbol. Letters.	Num'ls.
Paper package or its equivalent	K.	
Body	"	1
End	"	2
Wrapper	"	3
Twine	"	4
Assembled body	"	10
Comb	"	11
Packing piece	"	12
Body assembled with packing for use	S-B-K.	
Wooden box (R. or C.):	X.	
Sides	"	1
Ends	"	2
Bottoms	"	3
Lid	"	4
Handles	"	5
Assembled	"	10
Painted	S-B-X.	
Electric primer:	E-T.	
Body	E-T-A.	1
Branch	"	2
Body and branch as'bled,	"	10
Wooden block	"	11
Copper wire	"	12
Platinum wire	"	13
Copper and platinum wire soldered	"	14
Poplar strip	"	15

Symbolic Nomenclature in Detail, etc.—continued.

Full name.	Full symbol. Letters.	Num'ls.
Gun cotton	E-T-A.	16
Assembled block	"	20
Assembled primer, empty,	"	120
Powder	A.	21
Loaded primer, loose	E-T-A.	
Packed in wooden boxes	E-T.	
" " tin canisters	"	1
" " paper packages,	"	2
Friction primers:	F-T.	
Body	F.T-A.	1
Branch	"	2
Body and branch assembled	"	10
Wire	"	11
Friction composition	"	12
Assembled primer, empty,	"	120

Full name.	Full symbol. Letters.	Num'ls.
Powder	A.	21
Loaded primer, loose	F-T-A.	
Packed in wooden boxes,	F-T.	
" " tin canisters	"	1
" " paper packages,	"	2
Time fuze:	T-Z.	
Body	T-Z-A.	1
Composition	"	11
Priming	"	12
Fuze complete, loose	T-Z-A.	
Packed in wooden boxes,	T-Z.	
" " " blocks,	"	1
Target pasters:	Q.	
Paper discs	Q-A.	1
Packed in paper boxes	Q.	

Remarks.

The descriptive symbols may be affixed to all member symbols, as occasion may require, and new descriptive symbols may be devised to suit new manufactures.

Conversely, the descriptive symbols should be dropped when the Shop-Order number sufficiently defines the object for which the time or material is expended, or when their use in full would give an erroneous idea of specialty.

Thus, if Shop-Order No. 49 refers to making a certain number of folded-head rifle ball cartridges, 49-A. 1 defines the particular cartridge case quite as well as 49-F-R-B-A. 1, and much more briefly. For a similar reason powder is known throughout as A. 21, and fulminate as A. 12; because these articles are common to all classes of ammunition.

In referring to the cup anvil made for either the rifle or carbine cartridge, and noted in connection with the number of a standing Shop-Order (Chap. XI), we would write it simply 213-F-A. 11. If the pistol cup anvil were meant, we would write 213-F-P-A. 11, reserving the general title for the more important ammunition.

In fine, we must always use the Shop-Order number and the member symbol with its numerical suffix when this is required; to these we must prefix only as many descriptive symbols as are needed to thoroughly define the object in question.

4. **N.** *or Operation.*

Under this heading on the cards is to come the symbolic number of the operation requiring the expenditure which the card reports. It was formerly restricted to the staple objects which we have just discussed; but by the use of more general tables, to be described, it may be used for general work.

A good system of symbolizing operations is very important, for upon the exact knowledge of their comparative cost will be founded the most important economical reforms.

The system should be simple, comprehensive and flexible. Simplicity can be best attained by a proper classification, grouping together operations of the same class. Their symbols will thus be most easily remembered, since, as a rule, the same class of workmen will use the same class of symbols. Also, mistakes in notation will be of less consequence, since the errors will tend to confine themselves to the limits of the group. See page 43.

Comprehensiveness is given by spacing the groups so far apart that they may be extended without danger of overlapping. See Mr. O. Smith's remarks on "gaps," page 111.

Flexibility is attained by permitting a certain internal development of individual symbols within a group.

If we assume that an operation is intended to make some change in the condition of the object operated on, we are forced to base our classification upon the means employed to effect that change, because the other variables—the operators and the objects operated on—have already been classified separately.

In the accompanying example I have endeavored to apply these principles to the wants of an Arsenal. The effort amounts only to a suggestion, for every shop will need data not

given here, and will omit some of those enumerated. See graphical table of operations, page 133.

We begin by the simplest way of changing an object, viz., by exposing it to some influence, such as heat, which will change its constitution; or to some process which will change its condition externally, as by pickling. From this class of operations we pass by slight degrees to those where more active means are employed, as in painting, oiling, etc. To such operations generally we give a series of symbolic numbers, beginning with 101.*

We now come to more active means of attack, such as those which make a change in the shape of the object. This lot includes generally workers in sheet metal, like tinners, etc. In this I assume a distinction between a change in shape and a change in form: we have iron, say, in the *form* of sheets which may be fashioned into a variety of *shapes*. This group is numbered from 201 upwards.

Changes of form are more serious and are effected in two general ways:

1st. By plastic processes, such as are enumerated in the following list from 301 up.

2d. By cutting of the various kinds described in groups 400, 500, 600, 700.†

The next step in complexity relates to the means employed to unite component parts together. These are numbered from 801 up.

Then comes the 900 group, relating to unclassified operations. It will be seen that many of these require the highest grade of labor. This resemblance between the grades of labor in the same group is accidental, and though by no means conclusive, is quite reassuring as to the general correctness of the analysis.

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* As a parallel change to that of condition might have been named that of situation, comprising the means used to move objects from place to place by hand, by team, by power, etc. But as this group of operations would only require four or five out of the 99 numbers allotted to it, and for other evident reasons, it is placed in the same class with others relating to changes of condition.

† If there were not so many cutting processes to be provided for, it would be more consistent to unite all cutting operations in one group, 400. But as the tendency of machine work seems to lie in this direction, I have left all the room possible for extension. The classification of cutting tools is from Rankine.

When there is a series of operations of the same kind performed on one object, like the five draws in cartridge-making or the eleven millings of the breech block, the exact stage of work may be indicated by a suffix as follows: Third draw, 350, 3; or 350, *c*; or 350, third; and the eleventh milling as 650, 11; or 650, *k*; or 650, eleventh, as may be directed. This course admits of variations in each set of operations within a group without interfering with the sequence of the other sets.

NOTE. — Operations upon tools, etc., required to produce staple objects of manufacture, are to be indicated according to the operation for which the tool is made, and not according to the operation which happens to be necessary to make the tool suitable for its work. For example, tempering a die for swaging bullets would be referred to swaging bullets instead of tempering, because it is more important to know all the items of cost for swaging bullets than it is to know the cost of tempering dies. The tempering may, however, be also indicated in the separate space left for detailed statement. But operations for other than staple objects may be indicated by the symbol for the mechanical operation actually performed; thus, tempering cold chisels would be, say, 213, T., 111. This course will prevent the use of vaguely synonymous terms describing occupation, and will afford exact ground for analysis without regard to the particular shop or department in which the work happens to be done.

ANALYSIS OF OPERATIONS.

CLASS I.

Symbols of Operations causing Changes in Condition.

Heating	101	Polishing	134
Drying	102	Burnishing	135
Annealing	103		
Tempering	111	Oiling	141
Case-hardening	112	Puttying or filling	142
		Painting	143
Pickling	121	Varnishing	144
Cleaning	122	Whitewashing	145
Washing	123		
		Stamping	151
Blacking in oil	131	Printing	152
Browning	132	Stencilling	153
Plating	133	Etching	154

Changes of Situation.

Moving by hand	191	Moving by power	193
" " team	192		

CLASS 2.

Symbols for Operations causing Changes in Shape.

Straightening 201
Bending 202
Forming 203
Folding 204
Indenting 205
Winding 211
Twisting 212
Blocking into shape 221
Mandreling 222
Spinning 223

CLASS 3.

Symbols for Operations causing Changes in Form by Plastic Means.

Moulding 301
Casting 302
Rolling 311
Forging 312
Swaging or pressing 313
Drawing (like wire) 321

CLASS 4.

Symbols for Operations causing Changes in Form by Cutting.—I. *Shearing.*

Shearing proper 401
Punching, inside, including trimming, 411
" outside, " " 412
Combined punching and cupping (double action press) 451

CLASS 5.

II. *Paring Tools producing Surfaces of Revolution.*

Turning 501
Clamp milling 502
Screw " 503
Thread-cutting, male 504
Boring 521
Drilling 541
Counterboring 542
Countersinking 543
Reaming 561
Thread-cutting, female 571
Burring 581

CLASS 6.

III. *Paring Tools producing Ruled Surfaces.*

Planing 601
Slotting 602
Broaching 603
Sawing 621
Milling, straight or curved lines 651
Profiling 661

CLASS 7.

Symbols for Operations causing Changes in Form by Scraping Tools.

Scraping	701	Tumbling	713
Filing by hand	711	Grinding	721
" rotary	712	Lapping	722

CLASS 8.

Symbols for Operations causing Changes in Objects by uniting them.

Welding	801	Basting	841
Melting together	802	Sewing	842
Brazing	811	Mixing	851
Soldering	812	Assembling (includes loading)	852
Gluing	813	Packing	853
Nailing	831	Assorting and other operations expressing *dis*-union	891
Screwing	832		
Riveting	833		

See remark, page 127.

CLASS 9.

Symbols for Miscellaneous Operations.

Superintending	901	Gauging	922
Designing	902	Inspecting	923
Recording (clerks)	903		
		Miscellaneous work	991
Fitting or finishing	911	" hand work	992
		" machine work	993
Weighing	921		

EXAMPLES IN PRACTICE.

I have retained the following list, which is substantially that issued at Frankford Arsenal for the use of the shops, so as to show to those familiar with both methods how much more clearly the new plan works.

Shop-Orders 49 and 107 are supposed to refer to the manufacture of certain quantities of the old service folded-head, and of the new solid-head, cartridges, respectively. S-O. 8 requires the making of a special machine for the use of the shops, which

after it is done will be charged at its cost to S-O. 213. Shop-Orders 91, 247 and 368 refer to special manufactures made for issue, sale, etc. The others are standing orders. See Chap. XI.

Examples in Practice of Method of Recording Charges and Credits for Labor and Material.

Name of Material and Nature of Service in full.	*Purpose of the Expenditure of Labor and Material, expressed by Symbols.*			
No.	S-O.	C.	O.	N.
1. 10,000 lbs. sheet copper, 0.90 thick.	107	W.	A. 1	
2. Tempering cherry for bullet dies.	107	P.	A. 31	313
3. Making three pair bullet dies.	107	T.	A. 31	313
4. Adjusting bullet machine.	107	A.	A. 31	313
5. Making bullets.	107	W.	A. 31	313
6. 10 lbs. steel for machine shop tools.	214	P.		
7. Proof house work.	387	W.		992
8. Repairs to proof house instruments.	387	P.		991
9. Cleaning large planer.	214	W.		122
10. 10 lbs. waste for same.	214	W.		122
11. Drawing for new burring machine.	8	P.		902
12. Patterns " " "	8	P.		992
13. Milling C.-bore, new burring machine.	8	P.		651
14. Forgings " " "	8	W.		312
15. Slotting bed " " "	8	W.		602
16. Making a drawing for Ordnance Office.	91	W.		902
17. Making a pattern for sale to inventor.	247	W.		992
18. Making folded-head revolver heading tools for stock.	213	T.	F-P-A. 1	204
19. 7 drawing dies for service ball cartridge.	49	T.	A. 1	321
20. Repairs to messenger wagon.	215	P.		
21. Driving messenger wagon.	215	W.		192
22. Putting on new gas burners in shop.	219	P.		
23. Inspecting gas meter.	219	W.		
24. Running engine.	216	A.		901
25. Oiling shafting in loading-room.	213	A.		141
26. " " machine shop.	214	A.		141
27. Repairing belts on draw presses.	213	W.		992
28. Bushing counter-shaft of boring mill.	214	P.		501 or 521
29. Master workman's time.	213	A.		901
30. Foreman of case shop, half time.	49	A.		901
31. " " "	107	A.		901
32. Running draw presses on cannon primers.	368	W.	A. 1	321
33. Running draw presses on cartridges.	49	W.	A. 1	321

EXAMPLES IN PRACTICE, ETC.—*continued.*

Name of Material and Nature of Service in full.	*Purpose of the Expenditure of Labor and Material, expressed by Symbols.*			
No.	S-O.	C.	O.	N.
34. 100 lbs. musket powder.	49	W.	A. 21	852
35. Supplying powder to loading machine.	49	W.	A. 21	852
36. Loading cartridges.	49	W.	A. 21	852
37. Paint'g boxes for solid-head cartridges.	107	W.	X. 10	143
38. " " service cartridges.	49	W.	X. 10	143
39. " " target pasters.	713	W.	X. 10	143
40. Making paper boxes for target pasters.	713	W.	K. 10	211
41. Cutting pasters into boxes.	713	W.	A. 1	412
42. Shoeing a horse.	215	W.		992
43. Dressing cold chisels.	214	W.		312
44. Determining trajectories, Sharp's rifle.	387	W.		902
45. Testing daily work by firing, foreman.	107	A.		923
46. Assisting in same, workman.	107	W.		952

CLASSIFICATION of the most Important Mechanical Operations of an Arsenal or Machine Shop.

						Operations.	
Operations affect objects by	1. Causing change of	1. Condition by				Class 1.	Heating, etc.
		2. Shape by				Class 2.	Straightening, etc.
		3. Form by	1. Plastic means by			Class 3.	Molding, etc.
			2. Cutting by	1. Shearing tools for		Class 4.	Shearing, etc.
				2. Paring tools, producing	1. Surfaces of revolution by	Class 5.	Turning, etc.
					2. Ruled surfaces by	Class 6.	Planing, etc.
				3. Scraping tools for		Class 7.	Scraping, etc.
	2. Uniting them by					Class 8.	Welding, etc.
	3. Miscellaneous means, viz.					Class 9.	Superintending, etc.

NOTE.— For fuller list see page 128.

CHAPTER X.

PROPOSED SYSTEM.

A. *EXTERNAL RELATIONS.*

It will be seen from what has been said that the main difficulty in the present system arises from the overlapping of the really distinct accountabilities of the Commanding Officer and the Ordnance Storekeeper; and that the Current Service Return has dwindled in size and importance because of the facility with which the officer making it could rid himself of whatever responsibility it imposed.

The responsibility of the Commanding Officer for supplies in current service is in its essence precisely like that of the Ordnance Storekeeper for supplies in store, and should be assumed and discharged by precisely similar means. The only difference between them is, that the stores in current service are subject to alteration in name and condition from use, while those in store are only subject to change in condition from the effects of time.

The escape from the dilemma between the efficient working of the arsenal as a whole, and the personal responsibility of the Ordnance Storekeeper, is to be found in expanding the scope of the Current Service Return so as to make it include not only all transactions which can be performed by the Storekeeper, but also those over which, the Commanding Officer being himself a party to them, he, the Commanding Officer, has properly an exclusive jurisdiction.

These last are the *expenditures of material.*

It seems hardly necessary to repeat that the function of a Storekeeper is to keep stores. Hence the anomaly of his discharging himself of the responsibility for stores placed in his keeping by reporting them "expended," as he now does. Neither he nor any of his agents have the power to expend stores, or in any way

to alter their state, name or condition. This expenditure is the exclusive prerogative of the Commanding Officer.

Hence all that the Storekeeper can do is to obey the order of the Commanding Officer, expressed or implied, and turn over to him or his agents for use in the current service of the arsenal such stores as may be required. These the Commanding Officer may keep unchanged, or may alter by fabrication ("expend"), at his pleasure. It is his right and his duty, provided that he tells what has become of the material expended by showing into what fabrication has entered.

Now, since the whole is greater than any of its parts, the Commanding Officer may, besides expending material (altering its name), do whatever else is permitted to the Ordnance Storekeeper. Hence he may receive all materials purchased for current service directly on his own return, without requiring the Storekeeper to go through the motions of receiving and issuing property which neither he nor any of his agents may have ever seen.

So, if materials on his return are required at other posts, he need not go through the performance of first invoicing them to the Storekeeper, taking his receipts, ordering the Storekeeper to issue them, and having him make new invoices and take new receipts from the real consignee. He will simply do it all himself, once.

Should he fabricate a machine which he wishes to keep in the shop, he is not obliged to turn it over to the Storekeeper, and then, like the King of France, march down the hill again with the machine. He simply charges himself with the machine as having been received by fabrication.

His expenditures for fabrication are managed in the same way; and so with every transaction with material.

The volume of the Current Service Return will be somewhat augmented by this change, but that of the Store Return will be almost as much diminished, so that the amount of writing on the two returns will not be greatly increased from this cause. But the result will be, that each tub will stand on its own bottom, and that each return will explain itself so fully that, although it

is possible that more writing will be required (of the clerks only), this will be so distributed from day to day, and will be based on such plain and consistent data, that the total amount of labor performed will be much less than it is now, and its results be much more satisfactory.

Combining these advantages with those following the appointment of an Executive Officer, it seems reasonable to deduce the following propositions:

1. That the Executive Officer and the Ordnance Storekeeper shall be co-ordinate subordinates to the Commanding Officer, each acting independently in his own sphere in behalf of the Commanding Officer.

NOTE.—In the Executive Department there may be several officers, assistants to the Commanding Officer, each of whom in his own sphere represents the Executive Officer.

2. That the responsibility of each officer shall be confined to the property which, under the Commanding Officer, he himself controls or which actually passes through his hands.

3. That the Storekeeper shall be responsible for only the public property in store; and that the Executive Officer shall be responsible for only the public property of all kinds in current service.

4. That the Executive Officer shall account for the property in his charge on the Current Service Return; and the Storekeeper for that in his charge on the Store Return.

5. That the foremen shall be considered the agents of the Executive Officer, and the assistant storekeepers the agents of the Ordnance Storekeeper; and that the returns of these officers shall be compiled from the records of their agents' lawful actions.

6. That unless specially required, no account shall be had of property transactions between agents of the same principal; but that transfers between agents of different principals shall be always recorded.

7. That the Executive Officer shall, under the Commanding Officer, have sole power to expend materials, and to make and originally account for the fabrications resulting from such expenditures.

8. That to avoid circuitous methods, both officers be empowered to directly receive and issue material, under the general rules now governing the dealings of the Storekeeper with the outside world.

9. That the Stock Clerk shall complete both returns of the Executive Officer and the Storekeeper, and that the data from which the returns are compiled be preserved for future reference.

10. As indicated by the preceding propositions and the accompanying tables, the two returns would be made on strictly parallel lines, each one being supported by its own abstracts and vouchers, essentially as at present.

The circumstances suggest the following departures from the details of the present system:

I. Abstracts B and 5 would be dispensed with as part of the Store Return. The functions of a Storekeeper are only to receive, care for and issue stores. He has nothing whatever to do with fabricating them, nor is he empowered to expend them.

II. Abstract C should have nothing to do with the cash papers, but would be based on the fly bills invoicing the property actually received by the Storekeeper or his assistants. These bills would be numbered as received in a continuous yearly series, and, without obliterating the original entries the nomenclature of these bills would be plainly altered on the face of them in red ink, so as to correspond with the headings of the returns. The quantities would also be similarly altered to correspond with the numbers and units actually received.

These bills would be forwarded to Washington for comparison with the Paymaster's vouchers, so as to check the actual objects of his expenditures, as explained Chap. XIV.

III. Present Abstract 5 would be reserved for actual expenditures in fabrication by the foremen.

IV. Receipts and issues from either return to the other would be borne on Abstracts E and 6 respectively.

V. Receipts and issues by transfer between classes or conditions would be born on Abstracts D and 7 respectively.

VI. Abstract F would be reserved for articles taken up as found on the post in excess of the quantity called for by either return.

As to permitting the Executive Officer to make issues to the Army and Militia, and to make proper sales to private parties, directly, the Commanding Officer would decide. I am confident that experience would show the advantage of developing the possibilities of the system to the utmost.

Arsenal Return.

As to the disposition to be made of these returns when completed, much may be said. The natural course would be to forward them separately to the Chief of Ordnance for audit, as is now done. But the question arises whether, having made so many changes, one more radical still may not be thought advisable.

Considering that the essence of return building lies in its pyramidal structure, would it not be well to have the Commanding Officer audit both returns and transmit their aggregate results, with the value of the articles named, in the form of an Arsenal Return made yearly or oftener?

Considering his nearness to the scene of operations, his independence of both the accounting officers, and the incentive which this personal responsibility to an immediate superior would give his subordinates, the suggestion appears to have claims to attention. The saving in clerical labor throughout the Department would be very great.

If this view were adopted, the Commanding Officer, in compiling the Arsenal Return, would have a chance to examine so thoroughly the records on which the other Returns were based that their exactness would be assured; there would be no necessity for transcribing these records; and in the form to be hereafter described they would be so explicit that no rearrangement could make them plainer.

The Arsenal Return would take the place of the present two Annual Returns, and with the values added would also replace the Inventory. Being merely a transcript of the balances shown by the Store and Current Service Ledgers, Chap. XIV, it could be easily compiled in a very few days by two clerks, one to read off the balances and the other to enter them in the return.

Quarterly abstracts A, C, 1, 2, 3, with their vouchers would be sent to the Ordnance Office as now, for comparison with returns from other officers reciprocally accountable for the stores they enumerate; but the other abstracts, which are now based only upon the unsupported statements of the Commanding Officer, it would seem not inexpedient to entrust to his own auditing.

The saving in labor would probably easily permit the rendering of the return at least quarterly with the force now employed; and as it would be possible for the return and its substantive ledgers to exhibit the actual amount of each kind of material on hand at any time, the ledgers and the return could easily be checked by a random inventory.

This is only an indication of what may be done with a system, the elements of which are true and consistent; it by no means follows that it is necessary to develop it to the fullest extent in order to secure some of the benefits which follow the application of the principles on which it is based.

The following schedule, relating to transactions with material by foremen and Storekeepers, illustrates the nomenclature of abstracts proposed. For its fuller interpretation see Chap. XIII.

TABULATION of possible transactions with material, showing the designation of the corresponding abstracts and general instructions regarding the use of the material card.

I. FOREMEN.

					Abstracts.	Use of Card. (Chap. XIII.)
I. Cases affecting foremen relate to	1. Receipts	1. From without the arsenal	1. From agents of the U. S. (by invoice)		A.	Charge value of the material to the shop-order under which it is to be used in fabrication or under which it is to be held in charge. See also remarks to storekeepers.
			2. From private parties (by purchase)	1. By contract 2. In open market	C.	
		2. From within the arsenal	1. From without the shop	1. From store	E.	
				2. From other shops	not counted	
			2. From within the shop	1. From fabrication	B.	Leave price space blank
				2. From being found or taken up after having been reported expended	F.	
				3. From transfers between	1. Classes or conditions. D 2. Shop-orders (punch L. S. only) ... none	Transfers require double entry. In case 2 credit value of material to order under which it has been held or under which it has just been fabricated..
	2. Issues..	1. To without the arsenal.	1. To agents of the U. S. (by invoice)	1. To the army	1.	Credit value of the material to the shop-order under which it has just been fabricated or under which it has been held in charge. See also remarks for storekeepers.
				2. To the militia	2.	
			2. To private parties (by sale)		3.	
		2. To within the arsenal.	1. To without the shop	1. To store	6.	
				2. To other shops	not counted.	
			2. To within the shop	1. For fabrication	5.	
				2. Lost, worthless or destroyed	4.	
				3. For transfers between	1. Classes or conditions. 7. 2. Shop-orders (punch L. S. only) ... none	Transfers require double entry. In case 2 charge value of material to order under which it is to be held or under which it is to be used in fabrication.

TABULATION of possible transactions with material, showing the designation of the corresponding abstracts and general instructions regarding the use of the material card.

II. STOREKEEPERS.

						ABSTRACTS.	USE OF CARD. (Chap. XIII.)
II. Cases affecting storekeepers relate to	1. Receipts	1. From without the arsenal	1. From agents of the U. S. (by invoice)			A.	Commanding Officer's punch-mark required.
			2. From private parties (by purchase)	1. By contract		C.	
				2. In open market			
		2. From within the arsenal	1. From without the storehouse	1. From the shops		E.	
				2. From other storehouses	not counted.		
			2. From within the storehouse	1. From being found		F.	
				2. From transfers between classes or conditions		D.	Authority of Chief of Ordnance and Commanding Officer's punch-mark required.
	2. Issues	1. To without the arsenal	1. To agents of the U. S. (by invoice)	1. To the army		1.	Authority of Chief of Ordnance and Commanding Officer's punch-mark required.
				2. To the militia		2.	
			2. To private parties (by sale)			3.	
		2. To within the arsenal	1. To without the storehouse	1. To the shops		6.	(Par. 68, O. R., requires written order of C. O. modification proposed in text.)
				2. To another storehouse	not counted.		
			2. To within the storehouse	1. Lost, worthless or destroyed		4.	Action of Board of Survey... Commanding Officer's punch-mark required.
				2. To transfers between classes or conditions		7.	Authority of Chief of Ordnance.

CHAPTER XI.

PROPOSED SYSTEM.

B. *INTERNAL RELATIONS.*

1. METHOD OF GIVING ORDERS AND RECORDING THEM.

In the office is kept the Shop-Order Book (see page 150), in which all orders for work are entered and given successive numbers by which they are to be known. As these numbers are only symbols, they may run on indefinitely from one year to another, so that the same job may always be known by the same number. The signature of the Commanding Officer completes the act, which then receives the acknowledgment of the Officer in Charge of the shops and of his lieutenant, the Master Workman. The appropriation from which the work is to be paid should always be designated.

Standing Orders.

All jobs may be so entered; but as there are many small ones regarding only the maintenance of the arsenal, like the glazing of a window, repairs of machines, and routine work which cannot be deferred until special authority for every case is given, the following course is pursued:

A "standing order" is given for eacn of as many sources of general expense as it is desirable to know the cost of.

These may be analyzed more or less closely at pleasure; a distinction should, however, always be made between the maintenance of the military part of the post and of the civil establishment.

The cost of keeping up the public grounds; of heating, lighting and supplying with water both the shops and arsenal; of transportation and of motive power, are also useful secondary headings.

It is well to start with a thorough analysis, remembering that while charges can always be combined, it is always difficult and sometimes impossible to resolve them into their component parts. This remark is general.

The following examples of standing orders are taken from the practice at Frankford Arsenal:

No. of Shop-Order.	Maintenance and general repairs of—
213	Cartridge factory.
214	Factory in general, not above.
215	Arsenal and Military Post.
216	Motive power.
217	Heating factory.
218	" arsenal.
219	Lighting factory.
220	" arsenal.
221	Arsenal buildings.
222	Factory "
223	Arsenal grounds.
387	Proving ground (ballistic division).

The irregular sequence of these numbers shows their true symbolic nature. It was not until 212 special orders had been entered that the use of the omnibus orders occurred to me, so the first came as 213, and so on. After a while it became advisable to keep separate accounts with the ballistic division, so its number was taken as 387.

In future I should be inclined to reserve numbers up to 100 for the standing orders—grouping them, page 127, according to the appropriations from which payable. See Chap. XV. Private manufacturers, not dealing with appropriations, would probably group their standing orders according to some desired classification of their general expense accounts.

Starting afresh at Benicia Arsenal, the standing orders were first provided for as follows:

No. of Shop-Order.	Application.
1	Maintenance of Arsenal and Post.
2	" " workshops.
3	Repairs of public buildings.
4	Work on new shops, then building.
5	Maintenance of public grounds.
6	" " heating and lighting system.
7	" " water system (locally important).
8	Overhauling ordnance and ordnance stores in store and for issue.
9	Overhauling ordnance and ordnance stores in the hands of troops.
10	Packing ordnance and ordnance stores for issue.
11	Maintenance of transportation: horses, carts, wagons, harness, wharves, boats, etc.
12	Maintenance of motive power.
13	" " shop fixtures.
14	" " tools and machinery.
15	" " proving ground.
16	Private work, to be paid for.

At both arsenals the numbers soon became as familiar as the workmen's names.

Foremen are allowed, on their own authority, to issue small supplementary orders based on these standing orders, as it is considered that all necessary precautions have been observed when the Commanding Officer has an assured, though *ex post facto*, knowledge of their acts.

Order Tickets.

Going back to the Shop-Order Book, a definite number of copies of the order are made in brief upon order tickets.

Order Ticket in Duplicate.

Receipt.	M-A.	201.	205.	301.	401.	501.	601.	701.	801.
S-O. ; **C.** ; **O.** ; **N.** ; 188 .									

Authority, . Completed, 188 .									
Completion.	M-A.	201.	205.	301.	401.	501.	601.	701.	801.

Receipt.	**M-A.**	201.	205.	301.	401.	501.	601.	701.	801.
S-O. ; **C.** ; **O.** ; **N.** ; 188 .									

Authority, . Completed, 188 .									
Completion.	M-A.	201.	205.	301.	401.	501.	601.	701.	801.

These tickets are printed in duplicate, separated by a perforated line, and are of different colors. At Frankford Arsenal the following distinctions are made: *Yellow* is reserved for cartridge

work, the most important; *red* for other work for issue to the Army; *blue* is for the local work of the post; *white* is for sub-orders given by a subordinate in the execution of any of the above. The back is available for any sketches, etc.

The receipt is to be punched in its proper place on his superior's ticket by a foreman receiving an order ticket from him: this makes him accountable for the order. When his part of the job is done, he punches out his number on the completion line and returns the ticket to him from whom he received it. He keeps no other record.

(NOTE.—Foremen and others are known by certain numbers, according to a plan described page 91.)

The authority is abbreviated in the proper place, viz.: O. O. (Ordnance Office); O. S. (Order of Supplies); Req. (Requisition); C. O. (Commanding Officer), etc., on the originals, or by the proper punch mark on sub-orders.

Use of the Order Tickets.

Taking the simplest case first: supposing that there is no intermediary between the office and the shops, and that there is only one foreman; the duplicate tickets go with the order book to the foreman. He compares them with the book, signs the latter and immediately returns it to the office.

If he has some one whom he can put to work at once, say a blacksmith, he gives him one ticket and puts the other in the rack, see page 92, corresponding to the department where the man is employed.

If there is no labor available, he sticks both tickets, folded together, in a similar rack near by. Thus he has always standing before him an exact epitome (1) of what work is in progress, and (2) of what is awaiting attention.

Each workman should have a small rack over his bench in which to display such orders as he may have in charge; thus giving to all, from the foremen to the Commanding Officer, an opportunity of seeing at a glance what work is going on and who is doing it, whether the workman is present or not. See page 93.

When the blacksmith, having completed his task, returns the ticket, the foreman acts as follows, according to the case:

1. If the job has been finished to his satisfaction, he stamps both tickets with the date when completed, keeps one of them and returns the other to the office after identifying it by punching out his shop number in the "completion" line. He keeps no other record.

In the office, the date of completion is entered in the proper column of the Order Book. The tickets are then sorted according to the official classification, so as to serve as the basis for making out the monthly "Report of Work done." After this they are sorted in order of numbers, and placed in trays, page 94, with other tickets previously completed, for ready reference when required.

2. Should the job require further work by another man, say a carpenter, the foreman takes both duplicates and puts them in the carpenter's division of rack No. 2, awaiting the disengagement of the particular labor required; or else he simply transfers the smith's ticket to a carpenter. He picks out from rack No. 2 other work for the smith, divides the tickets, gives him one and transfers the other to the active list of rack No. 1. Should he wish to keep both men at work on the same job at once, he gives to one a similar white ticket, bearing the order number and such details as are necessary for his guidance, and substantiates the proceeding by punching the authority space. The duplicate of this ticket should be treated as the others were.

3. Should the foreman have to give an order based on one of the standing orders, he makes out a duplicate white card and treats it as before explained.

Whenever a duplicate ticket is turned in to him as complete, he sends it to the office, as an indication of the progress made in the work, and also as a check on his management. This permits him to act freely by requiring only a record of his acts.

In making out order tickets the foreman should be careful to indicate on them, as far as he may, the proper symbols to be used by the workman in reporting his resulting work. The manner of doing this is explained page 97 and Chap. XII, XIII.

Taking next a more complicated case, where there are several foremen united under a master workman, who, in turn, is under the orders of the Officer in Charge of the shops (Executive Officer), the following would be the course:

Following the principle of making clerks do clerks' work, as many copies of the order as may be required, not less than three, are made in the office and are sent with the book, as before, to the Officer in Charge. He signs the book and sends the tickets to the Master Workman, who punches one ticket and returns it, keeping the others, which he distributes to the foremen whose departments are to work on the job. The Master Workman takes their receipt by their punch marks on his own ticket, which, like the Officer in Charge, he places in the rack corresponding to the department in which the work is to begin, and so on.

The foremen, as well as himself, may issue subsidiary white tickets, giving in detail orders for such components of the work as are necessary.

The job being completed, each one passes his ticket to the one from whom he received it, so that finally the office is informed of its completion and the order is crossed off the book.

Remarks.

Thus it will be seen that there is but one book involved in the whole process; and that this book, serving both for original entry and for final record, is practically always at the office, where it is most required. The subsidiary operations, being within a subordinate jurisdiction, are carried on by order tickets based on the authority of the original entry, either directly or by derivation from it.

The tendency is always to give orders which are explicit, because in writing; and proper, because based upon authority. They are given in the loose memorandum form, which is the most natural and convenient; and they have besides the conspicuous advantages of portability and distribution combined with the possibility of formal delivery and receipt, thus giving them a force which no stray slip of paper, unsupported by the order book, could have.

The tickets follow the work in all its stages, both fortifying the workman by their assurance, and affording necessary information to the workman's superior. Finally, the work being done, they pass definitely away, leaving a clean score for other entries, to which an undivided attention may be applied.

The difference between the tickets and the "fabrication book" of the present system, see page 57, is now apparent: instead of the completed orders occupying the most room, they now disappear from view as soon as done; while the only real objects of interest, the incomplete orders, are most conspicuously displayed before those who have them in charge.

The standing orders give the system the flexibility without which it would fail; they permit it to be conducted as rigidly or as loosely as may be desired. Whether loosely or rigidly carried on, the result will certainly appear in the summing up of the year's work. The more specifically the orders are originally given, the better can the resulting charges be distributed to where their burden belongs; the more loosely they are given, the larger will be the account for indefinite miscellaneous expenses.

Between the fear of making his current work cost too much, and of being reproved for the undue size of his general expense accounts, the foreman will naturally incline to an accurate placing of every charge he controls, for he knows that all expenses appear somewhere in his accounts.

It must be remembered that an order ticket does not represent either labor, material or product. It is only a memorandum of the *authority* by which certain expenses are to be incurred. Attempts to combine this with the other ideas will result in confusion.

Sample leaf of Shop-Order Book in actual Use at Frankford Arsenal. (Each page 8 x 10½.)

CURRENT SHOP-ORDERS FOR MANUFACTURES AND OTHER WORK, FRANKFORD ARSENAL, 1881.

Date of Entry.	Source and date of Authority.	No. of Order.	NOMENCLATURE.	Appropriation to which chargeable.	PROMULGATION OF ORDER.		Acknowledgment of Master Armorer.	Cost per piece, etc.	Date of completion.	Remarks.
					Commanding Officer	Officer in charge of Shops.				
Jan. 18.	O. O. letter 5,309	49	Make folded-head rifle ball cartridges at the rate of about 15,000 per day until further orders	O. & O-S.	S. C. L.	H. M.	J. H. G.	$22.17 per M.	June 30.	
Feb. 3.	O. O. letter 7,896	107	Make 250,000 solid-head rifle ball cartridges, 500 gr. bullet, as per sample	O. & O-S.	S. C. L.	H. M.	J. H. G.			
Feb. 10.	C. O	617	Experiment with Dr. Woodbridge's friction primer	A. & E. M.	S. C. L.	H. M.	J. H. G.	.....	April 6.	Canceled.
March 1.	O. O. letter 9,169	784	Make two friction primer drilling machines	A. & E. M.	S. C. L.	H. M.	J. H. G.			
May 4.	C. O	896	Build new boat-house on wharf	R. A.	S. C. L.	H. M.	J. H. G.			

SAMPLE OF SERVICE CARD PROPOSED. FULL SIZE. A PRICK RULE IS SUPPOSED TO DIVIDE THE CARD FROM THE STUB.

DATE. | UNITS. { Time. / Pieces.

SERVICE CARD, Frankford Arsenal.

No. **Name.** **Price per Unit.**

Charge to-	Nature of service in detail.	No. of Units.	
S.O.-		Pieces.	Time.
C.-			
O.-		AMOUNT.	
N.-		Dolls.	Cents.

N. B. Make but one entry on each card.

1. Inside Services.

Each workman is supplied with a book of fifty pages, each page containing a coupon card $2\frac{3}{4}$ x $5\frac{1}{2}$ inches and a stub about $1\frac{1}{2}$ inches wide, in which, to save him writing, is stamped his shop number, his name, and his wages per time unit, unless he is working by the piece. Should he be steadily engaged at piece work at the same price, his wages per piece unit should be stamped in the proper place.

His employment begins from the time he receives the book: this prevents at the start many causes of misunderstanding as to when services began and as to the wages to be paid.

When the workman goes to work in the morning, he gets his book from the foreman, and when he leaves work he returns it to him, made out so as to indicate the distribution of his time during the day.

Day, or Time Work.

The workman makes but one entry on each leaf, so that, if the time unit in his shop be the quarter day, he may have, at the most, four pages to fill, representing four different jobs. If time is kept by the hour or by the half hour, he may have ten or twenty pages to fill, depending on the variety of his employment. If working steadily at the same job all day long, he will have but one page to fill, although the units recorded will be 4, 10 or 20, according to the time-reckoning adopted in the shop.

(Note.—This supposes the usual custom of reckoning 10 hours to a day's work, although, in government workshops, the number is now reduced to 8.)

He fills that portion of the card showing the employment by writing under "Charge to" the symbols explained in Chapter IX, adding such details as may be required to make the symbols explicit, in the middle space. In the "time unit" space he puts down the number of quarter days, hours, half hours, etc., he has worked on the job represented in the first column, and on the stub he makes such memoranda as he may wish to keep for his own information. He then returns the whole book to his foreman.

The book thus serves a double purpose: it affords the workman an opportunity of making a formal, definite charge for his labor,

and it gives him the *only* opportunity of doing so. Thus it takes the place of a roll call or time check when beginning or quitting work, and it makes the man who knows most about his work responsible *at the start* for the correctness of the charges. After the close of work the foreman looks over the books, verifies the charges, tears off the coupons, stamps them with the date and sends them to the office.

Absentees for a whole day are so marked on a leaf taken out of their own books. This prevents all future questions as to the workman's having been actually engaged or not on that day; the fact is settled at the time by the most competent authority. Those absent for a part of a day, if coming late, have the first page filled out to show the number of units absent, when they receive their books from the foreman; those leaving early have the last page similarly filled by the foreman at the time they leave the shop.

As a precaution against fraud, and for other purposes, the coupons of each book are serially numbered. A further precaution could be taken by requiring each coupon to be signed with the most characteristic of all signatures, viz., the impression of the ball of the writer's right thumb in such ink as is supplied with the ordinary rubber stamps. Except for a special purpose, Chapter XV, such a precaution is probably unnecessary, and, unless experience proves its wisdom, would probably cost more in time and trouble than would be lost by omitting it from the scheme.

It is not necessary to wait until the day is over to collect the books; they may be taken in as the men pass out to dinner, and returned to them as they come back to work. This would prevent them from coming to work in the morning, scaling the fence and returning in the afternoon in time to return their books. This practice is not unknown in places where men are much scattered out of doors.

The workman is not required to wait until the end of the day to record his employment; he may easily put down his time as each job he is working on is completed. Even should the job be taken up again, later in the day, no harm is done by having two cards for it.

The proper symbols are gotten from the order tickets, given

individually, or displayed on a rack or bulletin board in the workshop.

Every room of consequence should have a time piece, or, in extended works, time might be indicated as on board ship, by whistle blasts, bells or gongs marking the time units.

The 40th or 45th page of every book should be of a special color, or be distinguished by a special mark, so that, when the book becomes that far exhausted, another may be prepared in season. This saves keeping a large number of books stamped for each man, and avoids the loss resulting from sudden discharges, etc.

Piece Work.

A man working on piece work, who has completed a suitable batch of pieces, makes out a ticket to correspond, and gives it with the pieces made to the foreman or inspector. If the work receives the inspector's approval, he punches the service card and forwards it with the other cards. Whatever deductions are necessary, are indicated on the face of the card, so that it may tell its own story completely. The amount space may be filled, or not, at pleasure; it is for convenience in saving recomputation.

Besides making a charge for his labor, it is almost as necessary that the piece workman shall inform the office of how much time he has spent on his work, so as to guide the office in future adjustments of the tariff.

For this purpose the piece workman should give every day an account of the time units employed on his job; but to prevent his getting paid for them by day's wages, by accident, he should cross out the figures giving his "price per unit," so that the card will give simply a time record, at *no* price. This, for a man who usually works by the day and only occasionally by the piece. If he is generally employed by the piece, it would be better to have the "price per unit" blank, and let him fill it when required.

The foreman's dating mark is taken as his acknowledgment of the correctness of the charges, and also serves to sort all cards of the same date together, if they should become separated. By having him stamp them all with the same date, it becomes unnecessary to depend upon the workman's accuracy in reckoning

the calendar, and he is saved just so much writing. In effect he writes no more on each card than he would for each job, if all the entries were made on one "Time Card," as is now done at Frankford Arsenal.

We thus have all the operations of each member of each department for the same day narrated in the truest and fullest possible manner; it now remains to show how this information is utilized.

The cards go to the Cost Clerk and are shuffled, first, by names of workman; second, by shop-order numbers under each name. The time is then entered in the time book, Chapter XV, opposite to the shop-orders on which the man has been employed. This is to enable each workman's wages to be charged to the proper appropriation. In private shops all that would be necessary would be to put down his total time or wages for the day on form A, page 60. The cards corresponding to each order number are then placed in a pigeon hole bearing the number of the order on a detachable adhesive ticket (target paster). Those denoting absence are sorted by rates of wages and placed in a separate pigeon hole.

Each pigeon hole shows at a glance what labor has been done on the job it represents, when, and by whom. Every empty pigeon hole testifies to a job so far untouched, and so on.

When the order ticket comes back "completed," the cards corresponding to it are taken out, the summation of rates rapidly made, Chapter XV, the paster torn off, and the pigeon hole made ready for another number. The cards may then be filed away by order numbers, or may be shuffled according to **C., O., N.,** Chapter XV, and combined with others bearing the same symbols under other order numbers; so that at the end of the year, or earlier, a definite idea may be readily had of the cost of performing each operation on every one of the staple products of the shop.

General Remarks.

What has been said is predicated on the supposition that the employees are all able to write. Where this does not hold good, it will be necessary for the illiterate to find some one to make

out their cards; but if they should be employed in large numbers, the services of a time keeper will be necessary. He should get their cards at stated intervals and make them out, but the books should be in the men's own keeping. I have never known trouble of any kind to result in our workshops from the illiteracy of employees, although it is no new thing that they are required to write.

Cards for soldier workmen, whose wages are only nominally computed, should be on paper of a different color from that reserved for men whose names go on the pay roll. This helps to tell the story of the pigeon holes, and prevents mistakes elsewhere.

It would be well, especially in private jobbing shops, to turn in service cards for the principal machines employed. The "wages per unit" might be based upon their daily interest and depreciation, besides cost of taxes and insurance.

2. Outside Services.

Services rendered within the arsenal, and paid for on the pay roll, can be easily reckoned and distributed as before described; but for those performed without supervision, outside, and paid by separate voucher, no special provision was made until attention was called to them by Captain Michaelis.

Such services are express, messenger and telegraph service; freighting and the traveling expenses of workmen and others. For these he used a special service card, stating the service performed, and the shop-order to which it should be charged; and it was further ordered that no voucher would be approved for payment unless accompanied by the corresponding cards. This wise provision served to catch many charges which had previously escaped analysis, and made the resulting cost more accurate and consistent.

I have adapted to the reckoning of outside services this new form of the old "Time Card" (which name was only partly significant), and have thus made the new "Service Card" answer for both inside and outside services, as it well might, since they are, in their nature, precisely similar. The new card is also adapted to piece work, which was but little practiced at Frankford Arsenal.

EXAMPLES ILLUSTRATING THE PRACTICAL USE OF THE SERVICE CARDS.

NOTE.—The card is here reduced to fit the page. The references on cards 6–11 are to the examples in notation, page 131.

(1.)

SERVICE CARD, Frankford Arsenal. **APR 2 1885**

No.	Name.	Price per unit.
235,	Lannigan,	0,25.

Charge to—	Nature of service in detail.	No. of units.	
		Pieces.	Time.
S-O. 784	General work on job.		8
C. W.			
O.		AMOUNT.	
		Doll's.	Cents.
N. 991.	N. B. Make but one entry on each card.		

(2.)

SERVICE CARD, Frankford Arsenal. **APR 3 1885**

No.	Name.	Price per unit.
235,	Lannigan,	0,25.

Charge to-	Nature of service in detail.	No. of units.	
		Pieces.	Time.
S-O. 784	Setting up machines.		4
C. W.			
O.		AMOUNT.	
		Doll's.	Cents.
N. 911.	N. B. Make but one entry on each card.		

EXAMPLES ILLUSTRATING THE PRACTICAL USE OF THE SERVICE CARDS.

NOTE.—The card is here reduced to fit the page. The references on cards 6–11 are to the examples in notation, page 131.

(3.)

SERVICE CARD, Frankford Arsenal. **APR 3 1885**

No.	Name.	Price per unit.
235,	**Lannigan,**	**0,25.**

Charge to—	Nature of service in detail.	No. of units.	
		Pieces.	Time.
S-O. 617	*Getting ready for testing primer. Making fixtures.*		4
C. P.		**AMOUNT.**	
O.		Doll's.	Cents.
N.	N. B. Make but one entry on each card.		

(4.)

SERVICE CARD, Frankford Arsenal. **APR 4 1885**

No.	Name.	Price per unit.
235,	**Lannigan,**	**0,25.**

Charge to—	Nature of service in detail.	No. of units.	
		Pieces.	Time.
S-O. 617	*Testing primer until fixture broke.*		2
C. N.		**AMOUNT.**	
O.		Doll's.	Cents.
N.	N. B. Make but one entry on each card.		

EXAMPLES ILLUSTRATING THE PRACTICAL USE OF THE SERVICE CARDS.

NOTE.—The card is here reduced to fit the page. The references on cards 6–11 are to the examples in notation, page 131.

(5.)

SERVICE CARD, Frankford Arsenal. **APR 4 1885**

No.	Name.	Price per unit.
235,	Lannigan,	0,25.

Charge to—	Nature of service in detail.	No. of units.	
		Pieces.	Time.
S-O. 617	Repairs to primer-testing apparatus.		6
C. P.		AMOUNT.	
O.		Doll's.	Cents.
N.	N. B. Make but one entry on each card.		

(6.)

SERVICE CARD, Frankford Arsenal. **APR 6 1885**

No.	Name.	Price per unit.
235,	Lannigan,	0,25.

Charge to—	Nature of service in detail.	No. of units.	
		Pieces.	Time.
S-O. 107	Tempering cherry for bullet dies.		1
C. P.		AMOUNT.	
O. A. 31	(Example 2.)	Doll's.	Cents.
N. 313	N. B. Make but one entry on each card.		

EXAMPLES ILLUSTRATING THE PRACTICAL USE OF THE SERVICE CARDS.

NOTE.—The card is here reduced to fit the page. The references on cards 6–11 are to the examples in notation, page 131.

(7.)

SERVICE CARD, Frankford Arsenal. APR 6 1885

No.	Name.	Price per unit.
235,	Lannigan,	0,25.

Charge to—	Nature of service in detail.	No. of units.	
		Pieces.	Time.
S-O. 107	Making 3 pair of bullet dies. (Example 3.)		2
C. T.		AMOUNT.	
O. A. 31		Doll's.	Cents.
N. 313			

N. B. Make but one entry on each card.

(8.)

SERVICE CARD, Frankford Arsenal. APR 6 1885

No.	Name.	Price per unit.
235,	Lannigan,	0,25.

Charge to—	Nature of service in detail.	No. of units.	
		Pieces.	Time.
S-O. 107	Timing stroke of bullet machine, setting dies, gauging, etc. (Example 4.)		1
C. A.		AMOUNT.	
O. A. 31		Doll's.	Cents.
N. 313			

N. B. Make but one entry on each card.

EXAMPLES ILLUSTRATING THE PRACTICAL USE OF THE SERVICE CARDS.

NOTE.—The card is here reduced to fit the page. The references on cards 6–11 are to the examples in notation, page 131.

(9.)

SERVICE CARD, Frankford Arsenal. APR 6 1885

No.	Name.	Price per unit.
235,	Lannigan,	0,25.

Charge to—	Nature of service in detail.	No. of units.	
		Pieces.	Time.
S-O. 107	Running bullet ma-		1
C. W.	chine.		
O. A. 81	(Example 5.)	AMOUNT.	
		Doll's.	Cents.
N. 813	N. B. Make but one entry on each card.		

(10.)

SERVICE CARD, Frankford Arsenal. APR 6 1885

No.	Name.	Price per unit.
235,	Lannigan,	0,25.

Charge to—	Nature of service in detail.	No. of units.	
		Pieces.	Time.
S-O. 887	Mis. repairs to instru-		1
C. P.	ments in proof-house.		
O.	(Example 8.)	AMOUNT.	
		Doll's.	Cents.
N. 991	N. B. Make but one entry on each card.		

EXAMPLES ILLUSTRATING THE PRACTICAL USE OF THE SERVICE CARDS.

NOTE.—The card is here reduced to fit the page. The references on cards 6–11 are to the examples in notation, page 131.

(11.)

SERVICE CARD, Frankford Arsenal. **APR 6 1885**

No.	Name.	Price per unit.
235,	Lannigan,	0,25.

Charge to—	Nature of service in detail.	No. of units.	
		Pieces.	Time.
S-O. 214	Cleaning large planer. (Example 9.)		2
C. W.		AMOUNT.	
O.		Doll's.	Cents.
N. 122			

N. B. Make but one entry on each card.

(12.)

SERVICE CARD, Frankford Arsenal. **APR 7 1885**

No.	Name.	Price per unit.
235,	Lannigan,	~~0,25~~

Charge to—	Nature of service in detail.	No. of units.	
		Pieces.	Time.
S-O. 213	Making 10 drawing dies by the piece.		8
C. T.		AMOUNT.	
O. A. | 1		Doll's.	Cents.
N. 321			

N. B. Make but one entry on each card.

EXAMPLES ILLUSTRATING THE PRACTICAL USE OF THE SERVICE CARDS.

NOTE.—The card is here reduced to fit the page. The references on cards 6–11 are to the examples in notation, page 131.

(13.)

SERVICE CARD, Frankford Arsenal. APR 8 1885

No.	Name.	Price per unit.
235,	Lannigan,	~~0,25~~

Charge to-	Nature of service in detail.	No. of units.	
		Pieces.	Time.
S-O. 213	Piece work, drawing dies.		8
C. T.		AMOUNT.	
O. A. | 1		Doll's.	Cents.
N. 321	N. B. Make but one entry on each card.		

(14.)

SERVICE CARD, Frankford Arsenal. APR 9 1885

No.	Name.	Price per unit.
235,	Lannigan,	~~0,25~~

Charge to—	Nature of service in detail.	No. of units.	
		Pieces.	Time.
S-O. 213	Piece work, drawing dies.		4
C. T.		AMOUNT.	
O. A. | 1		Doll's.	Cents.
N. 321	N. B. Make but one entry on each card.		

EXAMPLES ILLUSTRATING THE PRACTICAL USE OF THE SERVICE CARDS.

NOTE.—The card is here reduced to fit the page. The references on cards 6–11 are to the examples in notation, page 131.

(15.)

SERVICE CARD, Frankford Arsenal. **APR 9 1885**

No.	Name.	Price per unit.
235,	Lannigan,	~~0,25~~ 0,75.

Charge to—	Nature of service in detail.	No. of units.	
		Pieces.	Time.
S-O. 213	10 drawing dies finished for stock.	10	×
C. T.		**AMOUNT.**	
O. A. | 1	(Card punched by foreman or inspector in time unit space.)	Doll's.	Cents.
N. 321		7	50
	N. B. Make but one entry on each card.		

(16.)

SERVICE CARD, Frankford Arsenal. **APR 9 1885**

No.	Name.	Price per unit.
235,	Lannigan,	0,25.

Charge to—	Nature of service in detail.	No. of units.	
		Pieces.	Time.
S-O. 49	Attending draw press.		4
C. A.		**AMOUNT.**	
O. A. | 1		Doll's.	Cents.
N. 321			
	N. B. Make but one entry on each card.		

EXAMPLES ILLUSTRATING THE PRACTICAL USE OF THE SERVICE CARDS.

NOTE.—The card is here reduced to fit the page. The references on cards 6–11 are to the examples in notation, page 131.

(17.)

SERVICE CARD, Frankford Arsenal. **APR 10 1885**

No.	Name.	Price per unit.
235,	Lannigan,	0,25.

Charge to—	Nature of service in detail.	No. of units.	
		Pieces.	Time.
S-O.	*Absent.*		8
C.			
O.		AMOUNT.	
N.		Doll's.	Cents.

N. B. Make but one entry on each card.

(18.)

SERVICE CARD, Frankford Arsenal. **APR 11 1885**

No.	Name.	Price per unit.
235,	Lannigan,	0,25.

Charge to—	Nature of service in detail.	No. of units.	
		Pieces.	Time.
S-O. 107	*Cutting brass stencil*		8
C. P.	*for packing boxes.*		
O. X 10		AMOUNT.	
N. 143		Doll's.	Cents.

N. B. Make but one entry on each card.

3. Shop Expenses.

The running expenses of a workshop are incurred only to organize its labor for profit. To this end buildings, power, machinery, etc., are supplied and maintained, and provision made for lighting, warming, and directing the labor employed. Without labor these expenses serve at the best only the negative good of maintaining unchanged material which the workshop has been organized for the express purpose of changing, see page 39. With labor, these expenses bear fruit, and the more labor they can profitably organize, the more will they return on their investment.

Hence, for the reasons stated pages 74, 97, the running expenses for any year are to be distributed among the special expenses by increasing on these the charge for labor; this is done as follows:

First we make all charges for labor as specific as possible, leaving as little as possible for the standing orders or general expense accounts, see page 142 and Chapter XV. Then, as we can never exactly tell what the general expenses for a year will be till that year is past, we assume that there will be no great variation from past experience, and divide the total general shop expenses for last year by the total number of hours' shop-work done in that year; we thus obtain a load by which to increase the charge for each hour's labor during the present year.

Correcting annually by inventory and specially for fluctuations as described Chapter XVI, we may apply the average charge of the first two years to the third year, and so on.

The load will vary in direct ratio to the general expenses, and inversely to the amount of labor in operation at any one time; it will be affected by many other circumstances and will depend much upon the management. From the experience of a private manufacturer I take it for his particular shop as 15 cents per hour. In the examples relating to cost it is arbitrarily assumed as 3 cents per hour.

In this discussion the additional charge for labor due to the application of this load is known as *shop expenses*. It relates ex-

clusively to the distribution of the running expenses of the workshops as distinguished from those pertaining to the military part of the establishment. Among such expenses are those authorized by the following Standing Orders, page 142: FrankfordArsenal, Nos. 213, 214, 216, 217, 219, 222; and Benicia Arsenal, Nos. 2, 12, 13, 14, and 3, 6, 7, 11 in part.

CHAPTER XIII.

PROPOSED SYSTEM.

B. *INTERNAL RELATIONS.*—Continued.

3. MATERIAL CARD.

DESCRIPTION.

The face of the card is divided by horizontal rules into five distinct sections, the names of which appear in the right-hand margin.

Title Section.

This has a place for the date and for indicating by the proper symbols the agents between whom the transaction reported has taken place. Thus "Receipts and issues from *Z* to *W* to *4* to *fabrication*" or "fab." would mean that the material had been originally received from the outside world (Z) by the keeper of warehouses (W), see page 91; had been issued by him to the foreman of the loading-room (4), and had by him been finally expended in manufacture (fab.); all these transactions being immediately consecutive.

On the next line is a place for the stock clerk to indicate the vouchers and abstracts to which each transaction belongs.

Material Section.

This indicates distinctly the name, etc., of the material involved. Full space is given for explanatory remarks as to dimensions, quality, purpose, etc.

The "class" space is for the use of the stock clerk. See page 44.

The "condition" space is to indicate the serviceability of the stores; when left blank they are supposed to be serviceable.

On the left is a space for writing the quantity of the material used. To mark the difference between quantities which are only estimated or assumed and those which are actually dealt with,

and also to allow for discrepancies between quantities invoiced and those received, a separate space is provided for each kind of entry under the general names "assumed" and "actual." And since units of measure differ so much, even for the same material, a separate space is provided for the unit in each case. For an illustration see case 2, *post.*

Beneath is a space for the "price per unit" of the material, and one for the amount or total value of the quantity of material at the price named.

Having thus fully described the agents using the material, and the material itself, the card proceeds to tell what is done with it.

Cost Section.

This is for the use of the cost clerk in connection with the symbols previously described. It shows in the smallest detail required, the purpose of each expenditure reported, whether as a charge or a credit to some shop-order, or both. See rule 3 and cases 7 and 16, *post.*

Stock Section.

This relates exclusively to the stock clerk. In the upper portion is space for a full description of the package in which the stores were received into the arsenal, or in which they were issued from it. This need only be filled in certain special cases hereafter described, viz., in receipts without invoice or bill, and in issues to the outside world, Z.

Next below comes the vital part of the card, showing the nature of the transaction with the material above described. This is done by the place of the attesting punch-mark, as follows:

All transactions with material may be reduced to two classes, receipts and issues. Whoever receives new material, or old material with a new name conferred by the process of fabrication, punches "received" in his own proper space. If he issues it to another person or disposes of it by transfer or fabrication, he punches "issued," marks the disposition in the title section, and, if the material is issued to another person, gets him to punch "received" at the time that the stores change hands. Thus he

may both receive a thing and issue it on the same card, by punching twice: once as received, and once as issued. Two agents may each do this, allowing the record of four transactions on the same card. See pages 178, 222. Two punch-marks on the same card express a simultaneous issue and receipt, and so on; each mark means exactly what it most evidently says, and can mean nothing else. Every possible transaction with material may thus be unmistakably represented and indelibly recorded with the least waste of energy and time.

L. S. Section.

This is used in authenticating entries which do not concern the stock clerk. It is a mere *locus sigilli*, meant to prevent the attesting punch-mark from appearing in the wrong place.

Remark.

The cost clerk concerns himself with the interpretation of the entries in the material section, by the indications of the cost section; and the stock clerk, with the interpretation of the same entries by the indications of the stock section. Thus they both, like others yet to be shown, act independently on the same original entry in a manner determined by their special functions. This saves writing and prevents mistakes in transcribing.

Back of the Card.

The requisition space is so placed that the punch-marks used as signatures to the requisition come through on the other side in the L. S. section. This is so arranged in consequence of the requirement, page 31, that all the communication with Z must be through the Commanding Officer, which applies to receipts as well as to issues. His sanction for issues is given directly by punching the L. S. section as from the front, before the issue can be made; his sanction for a receipt is found there indirectly in consequence of his approval of the requisition on the other side. See case 2.

Next comes a double column, like that on the correspondence card, which may be used in the same way for passing the card through the post-office. See pages 22, 90. It is not intended that all cards should be so marked. In practice they are sent in bundles, or are passed directly from hand to hand.

USE OF THE MATERIAL CARD.

PRELIMINARY REMARKS.

Use of the Price Space.

This is an important feature in the card, on account of the familiarity it affords those most directly engaged upon the expenditures with the cost of what they are consuming, and for the brevity of description which it permits. For example, suppose a certain quality of paper to have been used in fabrication; how much better to describe it at once as so many quires of paper at so much per quire, than to attempt to specify its characteristics so that another person may give it the proper price.

I know that it is often thought inexpedient to let prices paid for material be known in the workshop; but the disadvantages resulting from this course are so slight and indirect, compared with the benefits which follow the free promulgation of this knowledge, that I doubt whether any one would return to the secret system after having fairly tried the other.

Should I be mistaken in this view, it would be easy to have a standard price list for book-keeping purposes, variations between which and the true cost could be adjusted by those conversant with the key.

Prices are made known as follows: When the goods are received, the packages are marked with a rubber stamp or a tag, showing first to which class they belong, then the name by which they are to be known, the unit by which to be accounted for, and the price per unit at which they are to be charged; also when received, and from whom.

This course prevents the stock clerk from getting ahead, say, on "paper nails," and short on "finishing nails;" prevents nails from being taken up by the keg, and charged for by the pound, piece or thousand, etc. The rest of the information is often found valuable in ordering fresh supplies or in identifying old ones.

A certain discretion is of course to be observed in knowing what to mark and how to mark it, as well as in fixing names and prices. The prices should be taken from the bills or invoices accompanying the stores. This work should be easily done by the assistant

storekeepers in the spare time afforded by their proposed exemption from keeping account books.

Besides the prices so determined, tables are prepared and revised from time to time, giving the nearest estimated prices of component parts and component material. These tables are used in cases, such as, where from the product of a given order certain component parts are taken to fill another order, see case 6. Also in the fabrication of by-products, such as special tools; and even of such material as paints, scrap and component compounds like paste, fulminate, putty, etc.

The price should appear on every card, except when the material is a fabrication, the cost of which is yet to be determined. To show that this omission was not accidental, the price space in such a case should be crossed out.

Single Entries.

So great are the advantages of working with small units, which can be combined better than they can be divided, that but one entry is made on each card.

This permits the cards to be first sorted according to shop-orders by the cost clerk, and, his purpose having been served, they may be re-sorted by the stock clerk according to the name of the material entered on them; later they may serve the pay clerk to classify all purchases from the same parties, and finally they may go back to the cost clerk to be filed away either according to the orders on which used, or according to the operations involved. See Chapters XII. XIV, XV.

The number of cards will be slightly increased over that in use at Frankford Arsenal for the last three years (there each card has room for five entries), but the labor of consolidating their contents will be diminished.

Also, greater flexibility will follow. Suppose, for example, that the Commanding Officer should refuse, or suspend, one item out of a requisition of five; or that it should be impossible to issue one item out of an invoice of five; or that material to fill a requisition should be ordered from five different people, who would fill their orders at times a month a part. In the plan proposed

and herein adopted, it would be easy to act on each card, by and for itself alone, while in the other this would be impossible.

The labor of consolidating the contents of the cards will be diminished, while that of making out the cards will not be increased; for it is as easy to write one line on each of five cards, as it is to write five lines on one card, and paper costs less than account books, clerk hire and running about.

Distribution.

The cards are to be so freely distributed about the shops, that any workman having to make a memorandum, either as to his wants or his expenditures, makes it on one of these cards and has it authenticated by his foreman's punch-mark.

There is no scribbling on the back of old sandpaper or on shingles to be copied by the foreman, involving double work and double error; the thing is started right by the man who knows most about it.

Tabular Analysis of Abstracts, etc.

The tables accompanying Chapter X are designed to give one a general view of the subject, and, by establishing general evident rules, prevent the confusion likely to result when illustrations only, however abundant, are given of special cases. It will be seen that there is no question as to the mutual relations between foremen and storekeepers; each has only his own duty to perform. For each, the question is simply whether the transaction is a receipt or an issue, or whether it partakes of the nature of both a receipt and an issue. In any case he punches according to the facts as they concern himself, once for each act recorded.

The foreman, having the responsibilities of fabrication added to those of the storekeeper, has a greater number of possible cases to deal with, and has besides to account for the value of the material committed to his keeping for use on the fabrications with which he is entrusted. In spite of his greater range his duty is as easily learned as is the storekeeper's, and like him, he can promptly and finally decide each case which his practice may present.

REQUISITIONS.

Material is to be procured from store or from Z by first specifying on the face of the card its name and the purpose, and then by indicating on the back in the requisition space from which source it is expected and by whom it is required. The requisition is then to be authenticated by the foreman's punching near the edge of the card opposite, "required by."

The further course of the card depends upon the regulations of the post. The Commanding Officer may require all issues from store to foremen to first receive his approval; the embarrassing and expensive results of this requirement have already been dwelt upon, page 69. Suffice it to say, that while this course is not recommended, the form of card lends itself as freely to it as to the more direct method proposed; so that, if demanded, all requisitions, both from store and from Z, may need the previous approval of the Commanding Officer.

In the ordinary course they should pass from the foreman requiring, up through the Master Workman and Executive Officer; but should a more direct method be preferred, there is nothing in the working of the system to prevent the Commanding Officer from acting directly upon the request of any foreman.

Should the Commanding Officer wish to order supplies himself directly, he may also do it as freely as before; but he should have a proper card made out, when, or before, the stores arrive.

Requisitions from Store.

As a general thing it is proposed to have storekeepers honor all demands made upon them by foremen, receiving in exchange for the stores which they deliver the foreman's card punched "received." The storekeeper punches "issued" on the same card, and passes the card on to the stock clerk, to be disposed of as elsewhere described.

Requisitions from Z.

When materials are known not to be in store, the requisitions are made "from Z" and should always pass through the intermediate channels to the Commanding Officer. The reason for this is, that a requisition generally involves a purchase, which

should be avoided if possible. Material unnecessarily drawn from store may be returned to it, but a purchase is generally irrevocable. See page 28.

STORES IN CHARGE.

Could the material transferred to current service be locked up in some convenient portion of the shop, and only drawn as wanted for the particular purpose to which it is to be charged, this would be the end of the matter; but the advantage in exactness so gained would be more than offset by the inflexibility of such a method. We should be only one step beyond the plan of going to the Ordnance Storekeeper for everything in detail. See page 29.

In Chapter VIII, page 83, we have seen that the Executive Officer and his assistants, the foremen, are responsible both for units of property and for their values, and that these responsibilities are independently accounted for. From whatever source material may come, both responsibilities are simultaneously assumed when it is "received" on the card, but they may be separately discharged.

For example, since material in current service is subject to waste and to the omission of the records specifying its actual consumption, it is required that no material shall be transferred to current service, unless its value is charged to some shop-order, and this order is that on which the material will be most probably expended.

The charge in the cost section disposes of the responsibility for the value of the material, but leaves that for the units of property unimpaired.

As to this responsibility, two courses are open to the foreman: 1st, to immediately discharge it by punching "issued" on the same card on which the receipt of the material has been acknowledged; 2d, by only punching "received" to continue responsible for the units of property in question, which are then said to be held *in charge*.

The former alternative should be followed when the purpose of the issue is definitely known, as in prospective expendi-

tures. The latter alternative should be followed when the purpose is uncertain, as in the cases cited, page 30; or when material like machinery is to be held unaltered in name (page 39) indefinitely.

When the latter alternative is followed every subsequent issue of such material will require a double entry in the cost section: one, a charge to the order on which it is actually expended, and the other a credit to the order under which it has been held. (See cases 9 and 10, *post.*)

At the end of the fiscal year, when the inventory is taken, the value of the material actually remaining on hand is credited to the order under which it has been held during the past year. The order so stands charged with all omissions, and the undistributed burden falls naturally where it should most properly, because most *probably*, be borne.

Differences in units between the Inventory and the Return are to be explained by cards supporting entries on abstracts F and 4.

Rules for Use of Material Card.

Note. — By "foremen" are here meant both actual foremen and their superiors in the Executive Department, and by "storekeepers," both the Ordnance Storekeeper and his assistant in the different warehouses, according to the context.

1. Transactions between foreman and foreman, and between storekeeper and storekeeper, require no cards; but transactions between a foreman and a storekeeper always require cards, one card reporting all material of the same name dealt with in each transaction.

2. Storekeepers are to receive and issue materials required in current service on the presentation of cards properly punched by the foremen; conversely, no supplies are to be received or issued without cards.

3. All supplies issued from store to current service must be charged to some shop-order before the issue is made, and all received into store from current service must be credited to some shop-order before they can be received. See tables, Chapter X.

4. Cards accompanying material transferred should be kept by the agent relinquishing the stores, as his equivalent for the

property they represent. He punches "issued" and the other party punches "received."

5. Cards received by storekeepers should be sent first to the stock clerk, and those received by foremen to the cost clerk.

6. The final resting place of the cards is with the cost clerk, but, with a few evident exceptions, their course is not complete until they have been acted on by both cost clerk and stock clerk.

7. Hence the cost clerk and the stock clerk should expedite to each other all cards which do not bear the evidence of the other's action. This is indicated by the stamp-mark described page 274.

8. All transactions with Z require the Commanding Officer's punch-mark in the "authority" space.

9. All vouchers, whether for cash or property, should be accompanied by the corresponding material cards, when presented for the approval of the Commanding Officer or his assistants.

10. Previous entries must never be completely obliterated, but the alteration required must be distinctly marked in the place appointed.

11. For the information of the stock clerk, the title section should always indicate between what agencies the transaction occurs. Storekeepers are indicated by their title letters, and foremen by their shop numbers.

NOTE.—In case of dealings with Z, the rest of the card shows plainly enough their nature, but confusion might arise, possibly, in distinguishing between receipts by fabrication and by transfer, leading to articles which were merely transferred from one class to another being taken up as new fabrications, etc. To guard against this, in dealing with fabrications, the contraction "fab." or its equivalent should be used in the title section, whether the case represent a receipt from fabrication or an issue for fabrication.

Transfers being merely the dealings of an agent with himself, their character is shown by the consecutive appearance of two numbers or letters in the title section. These two numbers or letters need not be the same, since all foremen and all storekeepers are in their respective classes as one man. Transfers may also be identified by having two punch-marks and two entries in the name space. The word "transfer" or an abbreviation may be written in the title section, or a note to that effect may be put in the name section, when required.

When transfers of accountability only, involving no change in the status of material, are made between shop-orders; as when it is proposed to transfer the charge from one shop-order to another, to which it more justly belongs, the entry is authenticated by punching the authority space only. This shows that it is neither a receipt nor an issue, and so concerns the cost clerk only.

12. Whoever first punches the face of a card, should date it.

The abstract, voucher and class spaces are to be filled in by the stock clerk.

The amount space is to be filled in by the cost clerk, when required.

13. The price space should always be filled when the price is known; when not known, a query (?) should so indicate.

NOTE.—When fabrications, the product of a shop-order, the cost of which remains to be determined, are reported, the price space should be crossed out. The cost clerk credits such entries to the order on which made, as hereafter explained. When the job is done, they serve to show what it has accomplished.

14. The package and address spaces in the stock section need not be filled, except, 1st, when the material is received from some source other than that indicated in the requisition column on the back of the card; 2d, when the material is issued to Z; 3d, when, owing to the exigencies of the case, packages containing material have to be opened before the bill or invoice is received. The marks, size and weight of the package being at once recorded, no questions can afterwards arise.

15. But one entry may be made on each card.

16. Four, but not more than four, consecutive transactions can be represented on the same card. To be so represented they must be in immediate succession in point of time, the receipts and issues alternating.

What is said of any one of the illustrations following, is equally true of it, whether it represents an independent act, or is one of a successive series, as just described.

CASES IN PRACTICE.

The material card, shown full size in the illustrations of cases in practice, is supposed to be printed on manilla paper, weighing about 55 lbs. per ream, which is about stiff enough for sorting. The entries in script type are supposed to be made in pencil, and the dates shown in gothic type to have been impressed by the line dating stamp referred to, page 92. The sub-script letters f; s; s, c; c, c; 101, denote that the corresponding entries were made by a foreman, a storekeeper, the stock clerk, the cost clerk, or the chief clerk respectively.

The punch-marks are represented by the following symbols:

Any foreman, ✕;
Any storekeeper, ●;
The Master Armorer, ◆;
The Ordnance Storekeeper, ♣;
The Executive Officer, ✚;
The Commanding Officer, ↄ ().

The punch-marks are only represented on the significant side of the card, that is, they are not represented as coming through it. The lines showing the course of the card are omitted. See page 170.

The first seventeen cases relate principally to foremen, the remainder to storekeepers.

CASE 1.—*Drawing Material from Store to be held in charge.*

Supposing material to be required which is supposed to be in store. The individual making out the card—it need not be the foreman—fills in the "assumed" space with the estimated number in figures that are wanted of the units (lbs., feet, gallons, bbls., pieces, etc.), entered in the unit column next by. See page 169. The price space need not be filled by him, but under "name" must be given fully the kind and quantity of the material wanted, and in the cost section under "charge to" the number of the shop-order on which it is to be used, and also, if possible, the character of the expenditure, the object benefiting by it, and the special operation for which it is required.

The workman takes the card to the foreman, who after examining it turns it over, stamps the date and punches it near the edge opposite "required by;" he also fills in his part of the title section.*

If he sends the card through the post-office, he then marks it to the storekeeper whom he has reason to believe has the stores in charge, or else he may send the card by special messenger or simply take it himself to the storehouse.

Should the storekeeper have the twine which the workman is supposed to have asked for, he delivers it to the foreman, punching the card "issued;" the foreman punches "received" and exchanges the card so punched for the twine. The twine is now in the foreman's charge, subject to expenditure, but not yet expended. See page 175. If the twine is accounted for by the pound instead of by the ball, the storekeeper, before issuing it, changes the quantity and unit to correspond.

After having filled in his part of the title section the storekeeper sends the card to the stock clerk.

The latter indicates in the title section to what abstracts and vouchers each entry belongs and also designates the class and condition of the material when necessary. He then credits the

* Instead of punching out "required by" the foreman may simply punch "received" (in advance), and send the card for the stores. Many such short cuts are possible.

CASE I.

Drawing Material from Store to be held in Charge.

MATERIAL CARD.

FRANKFORD ARSENAL, MAR 24 1883 (f.)

Receipts and issues from, W (f.) to 4.(f.) to to

TITLE.

Per ABSTRACT,	6 (s.c.)	8 (s.c.)		
VOUCHER,				

QUANTITY.	CLASS. A.(s.c.)	NAME.	CONDITION.
No. Unit. Assumed. 10 (f.) balls		Twine (f.)	
Actual. 5 (s.) lbs.			
Price per unit. 15(s.)			
AMOUNT. 75 (c.c.)			

N. B. Make but one entry on each card.

MATERIAL.

CHARGE TO					CREDIT TO				
S-O.	C.	Object.		N.	S-O.	C.	Object.		N.
213 (f.)	W (f.)	K. (f.)		853 (f.)					

COST.

PACKAGE

KIND.	Received from, or sent to
NO.	
WEIGHT, Lbs.	
MEASURE, Ft.	

STOCK.

REC'D BY	Foremen punch here. ×	ISSUED BY	Foremen punch here.
	Storekeepers punch here.		Storekeepers punch here. ●

AUTHORITY,

{L.S.}

COURSE OF THIS CARD.

From.	To.	REMARKS:
COMMANDING OFFICER,	**C. O.**	
CHIEF CLERK,	101	
ORDNANCE STOREKEEPER.	**O. S-K.**	
WAREHOUSES,	W.	
MAGAZINE,	M.	
STOCK CLERK,	S. C.	
EXECUTIVE OFFICER,	**X. O.**	
COST CLERK,	C. C.	
MASTER ARMORER,	M. A.	
SHOP FOREMEN. MACHINE,	201	
CASE,	301	
LOADING,	401	
CARPENTER,	501	
PAINT,	601	
LABORERS,	701	
BALLISTICS,	801	
BALLISTIC OFFICER,	**B. O.**	
Outside World,	**Z.**	

REQUISITION FOR MATERIAL

From *W. (f.)* For *A (f.)*

DATE. **ACTION.**

MAR 24 1883 Required by, ✕

Approved by *M. A.*

" " *X. O.*

Ordered by, *C O*

from,

per order No.

To be received or issued by,

Date received or issued.

Appropriation.

PROPOSED SYSTEM.

store account and charges the current service account with the quantity issued, stamps the card "entered," and marks it to the cost clerk.

The latter charges the value of the material to 213, and files the card away as hereafter described.

CASE 2.—*Procuring Material from the Outside World to be held in Charge.*

If the material required from store cannot be supplied thence (see case 1), the storekeeper marks or sends the card back to the foreman with a proper explanation. The latter replaces W by Z in the requisition head line, marks the card to the Master Armorer and throws it into his own mail box. His responsibility is at an end; he has asked properly for what he wants; he has set in motion a ball which will continue to be in somebody's way until it is finally disposed of.

(The foreman would pursue the same course in requiring directly for material which he knew was not in store.)

The Master Armorer punches out "M. A.," dates the card and sends it marked to the Executive Officer, who sends it punched and dated to the Commanding Officer. Should the latter disapprove of the purchase, he either returns the card disapproved, or lays it by for future action, awaiting explanations, funds, etc. In any case, his deliberation on this subject does not lead to delay in other things concerning which prompt action may be desired.

The Commanding Officer, after indicating his approval to the purchasing clerk, has the cards brought to him accompanied by the purchasing order. After comparing he punches out "C. O." and indicates below who is to inspect and receive the material when it arrives.

(This need not be a storekeeper; it may, and in many cases hould be, the foreman who originally punched the card. The "C. O." also indicates from what appropriation the purchase is to be made.)

The card then goes to one clerk, preferably the stock clerk, to whom incoming invoices and teamsters with supplies are always directed. He holds it till the material arrives. When it has come he gets the bill or invoice from the teamster, unless it has preceded the stores by mail; gives it a serial number with the numbering stamp (page 92); changes the unit on the card to agree with the official nomenclature or with the bill; inserts the price per unit, and the abstract and class designations and the

CASE II.

Drawing Material from Outside the Arsenal to be held in Charge.

MATERIAL CARD.

FRANKFORD ARSENAL, MAY 24 1883 (*f.*)

Receipts and issues from, D. (*f.*) to 4 (*f.*) to to

Per ABSTRACT,		C. (*s.c.*)		
VOUCHER,		113 (*s.c.*)		

QUANTITY.	CLASS.	NAME.	CONDITION.
	C.		

No. Unit. Assumed.

10 (*f.*) pcs.

Actual.

40 (*f.*) lbs.

Price per unit.

35 (*s.c.*)

AMOUNT.

14 00. (*e.c.*)

N. B. Make but one entry on each card.

~~brass castings from patterns furnished~~

(*f.* corrected by *s.c.*)

brass cast (*s.c.*)

(2 pieces bad, blow holes) (*f.*)

CHARGE TO				CREDIT TO			
S-O.	C.	Object.	N.	S-O.	C.	Object.	N.
214 (*f.*)	W. (*f.*)						

PACKAGE

KIND.

NO.

WEIGHT, Lbs.

MEASURE, Ft.

Received from, or sent to

REC'D BY	Foremen punch here. ×	ISSUED BY	Foremen punch here.
	Storekeepers punch here.		Storekeepers punch here.

AUTHORITY, C 0

TITLE. MATERIAL. COST. STOCK

{ L.S. }

COURSE OF THIS CARD.

From	To.
COMMANDING OFFICER,	**C. O.**
CHIEF CLERK,	101
ORDNANCE STOREKEEPER.	**O. S-K.**
WAREHOUSES,	W.
MAGAZINE,	M.
STOCK CLERK,	S. C.
EXECUTIVE OFFICER,	**X. O.**
COST CLERK,	C. C.
MASTER ARMORER,	M. A.
SHOP FOREMEN. MACHINE,	201
SHOP FOREMEN. CASE,	301
SHOP FOREMEN. LOADING,	401
SHOP FOREMEN. CARPENTER,	501
SHOP FOREMEN. PAINT,	601
SHOP FOREMEN. LABORERS,	701
SHOP FOREMEN. BALLISTICS,	801
BALLISTIC OFFICER,	**B. O.**
Outside World,	**Z.**

REMARKS:

REQUISITION FOR MATERIAL

From *Z.(f.)* For *4 (f.)*

DATE.	ACTION
APR 21 1883	Required by, ✕
APR 22 1883	Approved by, ◆
APR 22 1883	" " ✖
APR 23 1883	Ordered by, CO

from,

J. & H. Jones Co., (101.)

per order No. *1183* (101.)

To be received or issued by,

401 (101.)

Date received or issued.

MAY 24 1883 (*f.*)

Appropriation. *A. & E. M.* (101.)

186

PROPOSED SYSTEM.

voucher number; keeps the bill, and sends the teamster with the card to the designated receiver, whose orders are specific to receive no goods without a corresponding card.

NOTE.—In case the bill is received by mail before the stores arrive, the stock clerk may readily make many of the changes beforehand. By changing the names and units to a uniform nomenclature, the stock clerk prevents the appearance on the return of such stores as oil by the gallon, case, pound, barrel, etc.; all requiring separate headings for essentially the same thing.

The receiver inspects the stores for quantity and quality, and enters under "actual" the quantity actually received in good order of the units indicated by the stock clerk. Thus the foreman has asked for "10 pieces of brass castings from patterns furnished." They may be billed by the seller and noted by the stock clerk as "50 lbs. cast brass." The receiver and inspector may find two of them bad, in which case he will receipt for, say, 40 lbs., explaining the difference on the face of the card if there is room for his remark.

It now remains for the foreman to authenticate the record; this he does by punching in the stock section "received."

He thereby charges himself with the quantity, and the order with the value of the material, until it is disposed of by actual expenditure. See case 3.

The illustration applies to the procuring of such bulky stores as lumber, coal, leather, etc., of which every foreman wants a supply for general purposes under his immediate control. Future expenditures from this supply must be credited to the order to which it is now charged.

To enable these charges to be made, the foreman marks the card to the cost clerk, who charges 214 with the material at the price named, $14.00, and forwards the card to the stock clerk, who takes up 40 lbs. of cast brass on the debit side of his current service journal as having been received by purchase (abstract C).

CASE 3.—*Procuring Material to be expended on Arrival.*

Should the foreman wish to expend the stores immediately on their arrival, he follows precisely the same course, but in addition punches "issued." The stock clerk then makes two entries in the current service column of the journal. One having a numbered and the other a lettered abstract title, they balance and record the transaction. See pages 45, 244.

As the card itself is the only voucher for abstract 5, no voucher number is given in the title section under the designation of this abstract; the serial number which the card receives from the stock clerk (page 248) is sufficient.

The foreman having asked for the lumber in lineal feet, his requisition is corrected by the stock clerk to agree with the established nomenclature and unit of measurement. This is only given as an illustration; it is not supposed that the stock clerk will have to correct every departure from the official nomenclature, nor to supply on every card the designation of the class.

CASE III.

Drawing Material from Outside the Arsenal to be Expended on Arrival.

MATERIAL CARD.

FRANKFORD ARSENAL, MAY 1 1883 (f.)

Receipts and issues from, *Z.* (f.) to *fab.*(f.) to to

TITLE.

Per ABSTRACT,	*C.*(s.c.)	5.		
VOUCHER,	*114.*(s.c.)			

QUANTITY.	CLASS. *E.*(s.c.)	NAME.	CONDITION.

MATERIAL.

No. Unit. Assumed.

1,100 *ft.*(f.)

Actual.

1,500 *ft*(f.)

Price per unit.

2(s.c.)

AMOUNT.

30 *00*(c.c.)

N. B. Make but one entry on each card.

lineal, yellow pine joists, 4 × 4.
(1. *f.*) (2. *s.c.*)

B. M. scantling, yellow pine.
(*s.c.*)

for new boat-house.
(*f.*)

COST.

CHARGE TO				CREDIT TO			
S-O.	C.	Object.	N.	S-O.	C.	Object.	N.
896 (f.)	*W.*						

STOCK.

PACKAGE

KIND.	Received from, or sent to
NO.	
WEIGHT, Lbs.	
MEASURE, Ft.	

REC'D BY	Foremen punch here. ×	ISSUED BY	Foremen punch here. ×
	Storekeepers punch here.		Storekeepers punch here.

AUTHORITY, C O

{ L.S. }

COURSE OF THIS CARD.

From	To.	REMARKS:
COMMANDING OFFICER,	**C. O.**	
CHIEF CLERK,	101	
ORDNANCE STOREKEEPER,	**O. S-K.**	
WAREHOUSES,	W.	
MAGAZINE,	M.	
STOCK CLERK,	S C.	
EXECUTIVE OFFICER,	**X. O.**	
COST CLERK,	C. C.	
MASTER ARMORER,	M. A.	
SHOP FOREMEN. MACHINE,	201	
CASE,	301	
LOADING,	401	
CARPENTER,	501	
PAINT,	601	
LABORERS,	701	
BALLISTICS,	801	
BALLISTIC OFFICER,	**B. O.**	
Outside World,	**Z.**	

REQUISITION FOR MATERIAL

From *Z.(f.)* For *5 (f.)*

DATE.	ACTION.
APR 21 1883	Required by, ✕
APR 22 1883	Approved by, ◆
APR 22 1883	" " ✖
APR 23 1883	Ordered by, C O

from,

Williamson & Co. (101.)

per order No. *1185* (101.)

To be received or issued by,

501 (101.)

Date received or issued.

MAY 1 1883 (*f.*)

Appropriation. *R. A.* (101.)

190

PROPOSED SYSTEM.

CASE 4.—*Reporting Fabrications which are kept in Charge.*

Should the foreman wish to keep the fabrication in charge, he punches "received" from "fabrication" and besides crediting the units to the order under which made, must charge them to the order under which held.

He fills in the price by the table furnished (page 172). If the case is not covered by the table, he leaves it to the cost clerk to determine, or estimates it as closely as possible.

This affords a very convenient means of keeping account of special tools made for consumption in regular work, otherwise a most difficult matter. Let us suppose that a tool maker completes 4 drawing punches, made under order No. 49. He has charged his labor from day to day to 49—T—A. 1—321, and his material has been likewise so charged. Now, when the tools are finished they are turned into the tool closet, where they are kept charged at the list price to 213—T—FA. 1—321, and credited at the same price to 49—T—A. 1—321, as indicated on the card made out at the time of their reception into the tool closet. Thus, if the tools have been made more cheaply than was to be expected, or at a profit, S-O. 49 gets the benefit of the difference, or the reverse if luck has been bad. The burden is automatically distributed.

Further expenditure of these tools must be reported as issues, punched accordingly, and charged to the special order on which employed. For the course to be followed when they are received back again into the tool closet, see case 12.

CASE IV.

Fabrication Reported and kept in Charge.

MATERIAL CARD.

FRANKFORD ARSENAL, MAY 24 1883 (f.)

Receipts and issues from, *fab.* (f.) to *A.*(f.) to to

TITLE.

Per ABSTRACT,	B.(s.c.)			
VOUCHER,				

QUANTITY.	CLASS. D.(s.c.)	NAME.	CONDITION.
No. Unit. Assumed. 4 pcs.(f.) Actual.	N. B. Make but one entry on each card. *Drawing punches.* (f.)		

Price per unit. 1 18.(f.)

AMOUNT. 4 72(c.c.)

MATERIAL.

CHARGE TO					CREDIT TO				
S-O.	C.	Object.		N.	S-O.	C.	Object.		N.
213 (f.)	T.	F. A.	1	321	49	T.	A.	1	321

COST.

PACKAGE

KIND.

NO.

WEIGHT, Lbs.

MEASURE, Ft.

Received from, or sent to

STOCK

REC'D BY	Foremen punch here. ✕	ISSUED BY	Foremen punch here.
	Storekeepers punch here.		Storekeepers punch here.

AUTHORITY,

{L.S.}

13

CASE 5.—*Reporting Fabrications which are turned into Store.*

Suppose that a foreman has completed an order in whole or in part, and wishes to turn the product into store to offset the labor and material which has been spent in its production.

He fills in the title section as shown in the example, writes the quantity and name of the fabrication, and under "credit to" puts the number of the order authorizing the expenditures incurred.

The price column is left blank, as the price cannot be determined until the order is complete and all charges against it known.

The foreman then punches "received," to account for the appearance of the material, and "issued" to account for its disappearance from his charge, and sends the cards with the stores to the proper storekeeper.

The storekeeper punches "received" and returns the card to the foreman, who sends it to the cost clerk.

The cost clerk credits the order with units made, only, and sends the card to the stock clerk.

The stock clerk makes three entries on the journal, each having a different abstract title; two of the entries being on the C. S. side and one on the other. The responsibility for the stores rests with the store return.

Turning Scrap into Store.

This follows the case just described, except that the list price of the scrap should be given. This case is more important than it may at first seem, as it permits balancing the amount of material received with that charged and expended and that remaining on hand.

In cartridge making, one-third of the sheet metal is turned into scrap, of which a definite account should be kept, both in pounds and in dollars and cents. Otherwise, if the scrap is returned to the manufacturers at a reduced price, and no other record of the transaction but the credit entry on the bill be preserved, we shall seem to have been using in pounds, one-half more copper than was actually consumed.

CASE V.

Fabrication Reported and Turned into Store.

MATERIAL CARD.

FRANKFORD ARSENAL, OCT 24 1883 (f.)

Receipts and issues from, *fab (f.)* to *A.(f.)* to *M.(f.)* to

Per ABSTRACT,	*B.(s.c.)*	*6.(s.c.)*	*E.(s.c.)*	
VOUCHER,				

QUANTITY.	CLASS. *8.(s.c.)*	NAME.	CONDITION.

No. Unit. Assumed.

10,000 | *pc.(f.)*

Actual.

Price per unit.

× | *(f.)*

AMOUNT.

30 | *00(c.c.)*

N. B. Make but one entry on each card.

Rifle cartridges.(f.)

CHARGE TO					CREDIT TO				
S-O.	C.	Object.		N.	S-O.	C.	Object.		N.
					49 (f.)	*W.*			

PACKAGE

KIND.

NO.

WEIGHT, Lbs.

MEASURE, Ft.

Received from, or sent to

REC'D BY	Foremen punch here. ×	ISSUED BY	Foremen punch here. ×
	Storekeepers punch here. ●		Storekeepers punch here.

AUTHORITY,

{L.S.}

TITLE. MATERIAL. COST STOCK.

CASE 6.—*Reporting Fabrication of Components taken from one Order to complete another.*

Suppose that we are making cartridges under No. 107, and an order, No. 767, comes to issue 1,000 bullets of the same kind that we are making. We have a supply on hand, made under No. 107, which is more than is required for immediate wants. So we do not go to making bullets specially for No. 767, but borrow from No. 107 the 1,000 wanted, crediting No. 107, and charging No. 767 with the nearest approximation to their actual value.

1,000 more bullets will be required for No. 107, but these being made with a flying start, will be more economically made than if the machinery of record, like that of manufacture, had been stopped and set to work again for their special benefit.

For the further treatment of this card, see case 5 or case 11.

CASE VI.

Reporting Fabrication of Components taken from one Order to fill another.

MATERIAL CARD.

FRANKFORD ARSENAL, OCT 24 1883 *(f.)*

Receipts and issues from, *fab. (f.)* to *A.(f.)* to to

TITLE

Per ABSTRACT,	*B.(s.c.)*			
VOUCHER,				

QUANTITY.	CLASS. *B.(s.c.)*	NAME.	CONDITION.
No. Unit. Assumed. *1,000* *pc.(f.)*	N. B. Make but one entry on each card.	*bullets, 500 gr. (f.)*	
Actual.			
Price per unit. *.006(f.)*			
AMOUNT. *6* *00.(c.c.)*			

MATERIAL.

CHARGE TO					CREDIT TO				
S-O.	C.	Object.		N.	S-O.	C.	Object.		N.
767 (f.)	*W.*	*A.*	*31*	*852*	*107 (f.)*	*W.*	*A.*	*31*	*852*

COST.

PACKAGE	KIND.	Received from, or sent to
	NO.	
	WEIGHT, Lbs.	
	MEASURE, Ft.	

STOCK

REC'D BY	Foremen punch here. ✕	ISSUED BY	Foremen punch here.
	Storekeepers punch here.		Storekeepers punch here.

AUTHORITY,

{L.S.}

CASE 7.—*Reporting Fabrication of Plant remaining on Hand after Completion of Order.*

In the execution of an order, it is of necessity that all expenditures shall be charged to the order by authority of which they were incurred. But, as stated page 99, there are many necessary charges for work which is not only useful in the preparation of the order, but which has a contingent value for future manufactures of the same kind. Such are charges for drawings, patterns, special tools, etc., known generally herein as plant.

When an order is completed, these remainders should be appraised, and cards made out, charging them at their contingent value to the most probable standing order, and crediting them on the same card to the order under which made. The facilities of the workshop are thereby charged with the fair cost of what increases their future usefulness, and the order is correspondingly relieved.

The card should be punched "received" as by "fabrication."

Many special orders would receive credit only for the scrap value of the patterns and tools; in some cases these would have no value. Too great values so charged would be corrected by re-appraisement on the inventory.

CASE VII.

Reporting Fabrication of Plant remaining on hand after completion of Order.

MATERIAL CARD.

FRANKFORD ARSENAL, OCT 24 1883 (f.)

Receipts and issues from, fab.(f.) to 2.(f.) to to

TITLE.

Per ABSTRACT,	B.(s.c.)			
VOUCHER,				

QUANTITY.	CLASS.	NAME.	CONDITION.
	D.(s.c.)		

No. Unit. Assumed.

1 set (f.)

Actual.

Price per unit.

50(f.)

AMOUNT.

50(c.c.)

N. B. Make but one entry on each card.

patterns for davit steps, 2 pieces.

Appraised valuation.(f.)

MATERIAL.

CHARGE TO					CREDIT TO				
S-O.	C.	Object.		N.	S-O.	C.	Object.		N.
214 (f.)	P.				896	P.			

COST.

PACKAGE

KIND.	Received from, or sent to
NO.	
WEIGHT, Lbs.	
MEASURE, Ft.	

STOCK.

REC'D BY	Foremen punch here. ✕	ISSUED BY	Foremen punch here.
	Storekeepers punch here.		Storekeepers punch here.

AUTHORITY,

L.S.

CASE 8.—*Turning Surplus Material into Store.*

The proposed system permits such free access to the store-houses by the foremen, that they will not be tempted to carry large stocks of material for their daily wants; particularly since by so doing they are compelled to keep track of the order under which the stores are held, and to which they are to be credited when consumed.

So the tendency will be, not only to avoid such accumulations, but to get rid of them when they occur, by turning the surplus into store for the general use of the post.

The card shows how this may be done.

CASE VIII.

Returning Surplus Material to Store.

MATERIAL CARD.

FRANKFORD ARSENAL, OCT 24 1883 (f.)

Receipts and issues from, 6.(f.) to W.(f.) to to

Per ABSTRACT,	6.(s.c.)	E.(s.c.)		
VOUCHER,				

QUANTITY.	CLASS. F.(s.c.)	NAME.	CONDITION.
No. Unit. Assumed. 10 lbs.(f.)		vermilion, Chinese. (f.)	
Actual.			
Price per unit. 1 50(f.)			
AMOUNT. 15 00(c.c.)			

N. B. Make but one entry on each card.

CHARGE TO					CREDIT TO				
S-O.	C.	Object.		N.	S-O.	C.	Object.		N.
					214 (f.)	W.			

PACKAGE	KIND.	Received from, or sent to
	NO.	
	WEIGHT, Lbs.	
	MEASURE, Ft.	

REC'D BY	Foremen punch here.	ISSUED BY	Foremen punch here. ✕
	Storekeepers punch here. ●		Storekeepers punch here.

AUTHORITY,

TITLE. MATERIAL. COST. STOCK. {L.S.}

CASES 9 and 10.—*Expending Material in Charge.*

When a foreman wishes to use some of the material in his charge, he makes out a card charging it to the order on which consumed, and crediting it to that under which held; punches "issued," and sends it to the cost clerk.

For example, in recording consumption of coal held, say, for power, and charged under order No. 216, daily reports should be made of the quantity consumed, as follows:

	DR.	CR.
Heating	217	216.
Lighting	219	216.
Melting	213 W; A. 31; 802	216.
Power*	216	216.

In case 9, the blacksmith has used among other items during the day, 2 lbs. of steel upon the job specified. He keeps an account on separate cards of each draft so made on his stock of iron, steel, etc., and hands the cards in to the foreman at the end of the day.

The foreman or the blacksmith knows that all the stock of metal in his charge was procured for the general purposes of the shops, and so is charged to shop-order No. 214. He therefore marks the issue to the credit of that order, and charges it to the job on which it was actually employed; punches "issued" and sends the card to the cost clerk. The latter makes the proper Dr. and Cr. entries and sends the card to the stock clerk, who credits the C. S. return with the 2 lbs. of steel issued.

* Being already once charged to power, the effect will be to charge the expenditure only once, though the entry will be treated as all others of the same kind.

CASE IX.

Expending Material in Charge.

MATERIAL CARD.

FRANKFORD ARSENAL, OCT 24 1883 (f.)

Receipts and issues from, 4 (f.) to fab.(f.) to to

TITLE.

Per ABSTRACT,		5.(s.c.)		
VOUCHER,				

QUANTITY.	CLASS. C.(s.c.)	NAME.	CONDITION.
No. Unit. Assumed. 2 lbs.(f.) Actual.	N. B. Make but one entry on each card.	Steel, Hobson's choice, bar 1¼ round, for drawing punch.(f.)	

MATERIAL.

Price per unit. 40(f.)

AMOUNT. 80(c.c.)

COST.

CHARGE TO					CREDIT TO				
S-O.	C.	Object.		N.	S-O.	C.	Object.		N.
49 (f.)	T.	A.	1	321	214 (f.)	W.			

STOCK.

PACKAGE

KIND.	Received from, or sent to
NO.	
WEIGHT, Lbs.	
MEASURE, Ft.	

REC'D BY	Foremen punch here.	ISSUED BY	Foremen punch here. ✕
	Storekeepers punch here.		Storekeepers punch here.

AUTHORITY,

{L.S.}

Expending Material in Charge—continued.

Case 10 represents the expenditure of cartridge tools from the stock required to be kept on hand in the tool closet, under the general cartridge order No. 213, for the special purpose required by order No. 107.

In the same way, after the completion of a machine, building or any other job, in taking a final view of it, before reporting it done, any little things which may have escaped record from having been picked up about the shop, from the scrap boxes, etc., should be reported in the same way. They may have to be bought for the next job of the kind, when the record will be useful, and they will relieve the proper standing order of just so much of its undistributed burden.

CASE X.

Expending Material in Charge.

MATERIAL CARD.

FRANKFORD ARSENAL, FEB 17 1883 *(f.)*

Receipts and issues from, *2.(f.)* to *fab.(f.)* to to

Per ABSTRACT,		*5.(s.c.)*		
VOUCHER,				

QUANTITY.	CLASS. *Z.(s.c.)*	NAME.	CONDITION.
No. Unit. Assumed. 5 *pc.(f.)* Actual. Price per unit. *50(f.)* AMOUNT. *2 50 (c.c.)*	N. B. Make but one entry on each card. *Drawing dies. (f.)*		

CHARGE TO					CREDIT TO				
S-O.	C.	Object.		N.	S-O.	C.	Object.		N.
107	*T.*	*A.*	*1*	*321*	*213 (f.)*	*T.*	*S. A.*	*1*	*321*

PACKAGE: KIND. NO. WEIGHT, Lbs. MEASURE, Ft.

Received from, or sent to

REC'D BY	Foremen punch here. / Storekeepers punch here.	ISSUED BY	Foremen punch here. ✕ / Storekeepers punch here.

AUTHORITY,

{L.S.}

TITLE. MATERIAL. COST. STOCK

CASE 11.—*Direct Issue to Z.*

It may suit the Commanding Officer to save time by directing the foreman making certain stores to issue them directly after completion: in fact as one would do in a small shop. When one thinks of how often stores take their departure from the carpenter shop, where they are packed, it will be seen how good a thing it may be to require the master carpenter to certify to the packing. When the box is ready for sealing, it is often very difficult to tell whether all the components of a machine, etc., are present, so much are they concealed by their separation and by the braces, etc., surrounding them.

In this case the Executive Officer should sign the invoices. The material comes from him, and there is no reason in the nature of things why they should have to pass through the storehouse and the O. S. K. Case 6 might properly be so treated.

This form should be used in returning scrap copper to the manufacturer directly from the shops, page 194. This enables such a transaction to be certainly done and definitely recorded.

CASE XI.

Issuing Material to Outer World by Foreman.

MATERIAL CARD.

FRANKFORD ARSENAL, FEB 17 1883 (f.)

Receipts and issues from, fab (f.) to Z.(f.) to to

TITLE.

Per ABSTRACT,	B.(s.c.)	1.(s.c.)		
VOUCHER,		73 (s.c.)		

QUANTITY.	CLASS. J (s.c.)	NAME.	CONDITION.

No. Unit. Assumed.

1 pc.(f.)

Actual.

Price per unit.

× (f.)

AMOUNT.

N. B. Make but one entry on each card.

Model of packing box.(f.)

MATERIAL.

CHARGE TO				CREDIT TO			
S-O.	C.	Object.	N.	S-O.	C.	Object.	N.
				704 (f.)	W.		

COST.

PACKAGE

KIND. Box.

NO. 1

WEIGHT, Lbs. 8

MEASURE, Ft. 1.8

Received from, or sent to

Commanding Officer,
Benicia Arsenal,
California.
(f.)

STOCK.

REC'D BY	Foremen punch here. ×	ISSUED BY	Foremen punch here. ×
	Storekeepers punch here.		Storekeepers punch here.

AUTHORITY, C O

{ L.S. }

CASE 12.—*Material found or taken up.*

For material actually found in excess of the quantity called for by the return no special explanation seems necessary; but the corresponding abstract, F, covers other cases which in a closely administered shop would be more frequently found.

Suppose that timber is cut on the military reservation; that stone is quarried on it; or that, in closing an order, tools which have once been issued and charged to it are returned to the tool closet. Thus, in the example, the dies were charged to No. 107 when they were first issued, and now, at the end of the job, as they are still serviceable, they are to be returned to the closet to be held under the standing shop-order No. 213, subject to such further service as may be required of them.

When the dies were originally issued for fabrication, the transaction being one between foremen, they were not receipted for by the foreman of the loading shop; he cannot therefore re-issue them to the keeper of the tool closet, 202; consequently only 202 punches the card, and he punches "received."

The stock clerk may ask, "How received? by transfer, by fabrication, or found on the post?"

They were not received by transfer, since that involves a double heading and a double punching. Not by fabrication, since that would be indicated in the title, as would be the case if they had come from Z. They were received by discovery; that is, that having been once issued to be consumed in manufacture and so accounted for, their present appearance is a sort of surprise, which abstract F is intended to include. They increase the stock of bullet dies by ten pair, so that future issues of them must follow the regular course.

They should be taken up at their full value, no discrimination being possible between new tools and old ones only partly worn, unless the list of names on the property papers be unduly increased.

CASE XII.

Taking up Material Found in Excess.

MATERIAL CARD.

FRANKFORD ARSENAL, FEB 17 1883 (f.)

Receipts and issues from, 3 (f.) to to to

TITLE.

Per ABSTRACT,	F.(s.c.)			
VOUCHER,				

QUANTITY.	CLASS. D.(s.c.)	NAME.	CONDITION.

No. Assumed. 10 | Unit. pr.(f.)

Actual.

Price per unit. 8 | 00(f.)

AMOUNT. 80 | 00.(c.c.)

N. B. Make but one entry on each card.

Bullet dies, returned to tool closet. (f.)

MATERIAL.

CHARGE TO					CREDIT TO				
S-O.	C.	Object.		N.	S-O.	C.	Object.		N.
213 (f.)	T.	A.	31	313	107	T.	A.	31	313

COST.

PACKAGE

KIND.	Received from, or sent to
NO.	
WEIGHT, Lbs.	
MEASURE, Ft.	

STOCK

REC'D BY	Foremen punch here. ✕	ISSUED BY	Foremen punch here.
	Storekeepers punch here.		Storekeepers punch here.

AUTHORITY,

{L.S.}

CASE 13.—*Dropping Material.*

The Commanding Officer of an arsenal is authorized to drop by his own act, subject to the approval of the Chief of Ordnance, such worn-out and unserviceable material as he does not wish to keep on his return of stores in current service. See abstract 4, page 45.

If the stores are absolutely without value, the accompanying case will serve; otherwise the form for transfers, case 14, should be used.

Such transactions may thus be made definitely as positive and distinct acts of the Commanding Officer's agents, the property dropped being actually in view at the time. It seems unnecessary to dwell on the difference between such a course and the common one of having the dropping done by memory alone, or in the judgment of a clerk who wishes to clear off his return.

The Commanding Officer may thus have the practical examination of the stores made by his agents, and merely ratify their acts in detail by his punch-mark. Cards so punched have only to be sorted into classes and copied to form abstract 4.

In the case shown, the couplings should in reality be taken up by transfer as scrap brass and credited to 215 at their scrap value.

CASE XIII.

Dropping Unserviceable Material.

MATERIAL CARD.

FRANKFORD ARSENAL, FEB 17 1883 (f.)

Receipts and issues from, 7 (f.) to 26 (f.) to to

TITLE.

Per ABSTRACT,	4 (s.c.)			
VOUCHER,				

QUANTITY.	CLASS.	NAME.	CONDITION.
	J (s.c.)		

MATERIAL.

No. Unit. Assumed.

10 Sect'ns (f.)

Actual.

500 ft. (s.c.)

Price per unit.

AMOUNT.

N. B. Make but one entry on each card.

3 in. fire hose, worn out, dropped as worthless. (f.)

COST.

CHARGE TO				CREDIT TO			
S-O.	C.	Object.	N.	S-O.	C.	Object.	N.

STOCK.

PACKAGE

KIND.

NO.

WEIGHT, Lbs.

MEASURE, Ft.

Received from, or sent to

REC'D BY	Foremen punch here.	ISSUED BY	Foremen punch here. ✕
	Storekeepers punch here.		Storekeepers punch here.

AUTHORITY, C O

{L.S.}

CASE 14.—*Transfers between Classes.*

It may happen that by mistake stores have been misnamed or misclassed, or their condition may have been so altered by use or repair as to make them belong to another class. A card might be made, embracing both items, with a note to show which was the class or condition passed out of, and which into. It would probably be better, though, to have a separate card for each entry.

Such cases will be more rare with material in current service than with that in store. The former condition implies a necessary deterioration from use, which does not require the explanation exacted in the latter case.

CASE XIV.

Transferring Material between Classes.

MATERIAL CARD.

FRANKFORD ARSENAL, FEB 17 1883 (f.)

Receipts and issues from, 8.(f.) to 8.(f.) to to

TITLE.

Per ABSTRACT,	4.(s.c.)	F.(s.c.)		
VOUCHER,				

QUANTITY.	CLASS. 1—C.(s.c.)	NAME.	CONDITION. serv. uns.
No. Assumed. 1 pc.(f.)		8-in. Columbiad.	
Actual. 6,000 lbs.		Soap iron. Burst in proof of powder. (f.)	
Price per unit. ¼(s.c.) AMOUNT. 150 (s.c.)		N. B. Make but one entry on each card.	

MATERIAL.

CHARGE TO					CREDIT TO				
S-O.	C.	Object.		N.	S-O.	C.	Object.		N.
214 (f.)	W.				387 (f.)	P.			

COST.

PACKAGE

KIND.

NO.

WEIGHT, Lbs.

MEASURE, Ft.

Received from, or sent to

Transfer.(f.

STOCK

REC'D BY	Foremen punch here. ×	ISSUED BY	Foremen punch here. ×
	Storekeepers punch here.		Storekeepers punch here.

AUTHORITY, 20

{L.S.}

CASE 15.—*Transferring Material between Shop-Orders.*

It may be desirable to transfer the responsibility for material held under one shop-order to another shop-order, as in correcting mistakes, in readjusting responsibilities under different shop-orders, or in settling up at the completion of an order for the material remaining on hand. In such cases we would only punch "authority," as the transaction is neither a receipt nor an issue.

The following tabular statement shows how such cases may arise, and also throws light on some of the preliminary processes.

We are supposed to be the master painter, whose stock of raw material is held under the general or standing shop-order No. 214, and 896 is a special order for which he thinks that he will require ten pounds of paint, which he accordingly fabricates. He actually finds that he only needs three pounds of it, however, and to avoid charging the job with the excess, he finally transfers the accountability for the balance not required to the standing order under which his stock of paints is held. By following the general rule to credit all issues to the order under which the material has been held, even when it is the same order on which it is to be used, we come out right, for we see that the account of No. 896 for mixed paints stands as follows. See also case 10:

DATE.	Entry to be made to be punched under the head of—			Charge to	Credit to	Remarks.
	Authority.	Received.	Issued.	Order No.	Order No.	
Jan. 1, '79.	.....	10 lbs. Vandyke brown	.....	214	....	Original purchase ....1, 2.
" "	.....	50 galls. B. oil	.....	214	....	
Aug. 4, '79.	.....	.....	2 lbs. V. brown	896	214	Used in mixing paint.....3, 4.
" "	.....	.....	1¼ galls. B. oil	896	214	
" "	.....	10 lbs. mixed paint...	.....	896	....	Fabricated, in charge.....5.
Au. 20, '79.	.....	.....	3 lbs. mixed paint	896	896	Used on boat-house .....6.
Au. 30, '79.	7 lbs. mixed paint	.....	.....	214	896	Balance not used. Case XV.....7.

CASE XV.

Transferring Material between Shop-Orders.

MATERIAL CARD.

FRANKFORD ARSENAL, AUG 30 1879 (f.)

Receipts and issues from, *to* *to* *to*

TITLE.

Per ABSTRACT,				
VOUCHER,				

QUANTITY.	CLASS.	NAME.	CONDITION.

MATERIAL.

No. Unit. Assumed.

7 lbs.(f.)

Actual.

Price per unit.

10(f.)

AMOUNT.

70(c.c.)

N. B. Make but one entry on each card.

Mixed paint left over from boat-house job. (f.)

COST.

CHARGE TO				CREDIT TO			
S-O.	C.	Object.	N.	S-O.	C.	Object.	N.
214 (f.)	W.			896 (f.)	W.		

STOCK.

PACKAGE

KIND.

NO.

WEIGHT, Lbs.

MEASURE, Ft.

Received from, or sent to

REC'D BY	Foremen punch here. / Storekeepers punch here.	ISSUED BY	Foremen punch here. / Storekeepers punch here.

AUTHORITY, ×

{ L.S. }

It is not to be supposed that every pot of paint will take so much book-keeping; this illustration is carried purposely to extremes, so as to show how perfect an opportunity is offered for thoroughly recording all such transactions, whatever may be the amounts concerned.

CASE 16.—*Making Inventory.*

Blank cards are distributed in sufficient numbers to those about to take the inventory.

They each take a floor, room or building, etc., and enter on the cards the separate items they find, consolidating entries of the same class as far as possible. Thus, all the scrap brass on one floor or room should go, if possible, on one card; all draw presses of the same value on another, etc.

The estimated value should be entered in the price space, and the order under which the stores have been held should receive both a Dr. and a Cr. entry as to the operation on which the machine is employed. Thus double-action presses would be *both* Dr. and Cr. to No. 213 P.; A. 1; 451.

As the transaction represents no change of status, only the authority space should be punched.

The cost clerk credits this year's shop-orders and debits next year's, with the aggregate value; while the stock clerk looks only after the units reported, as a means of checking his balance on the current service side of the ledger.

Taking in illustration shop-order No. 14, Benicia Arsenal schedule, page 144, this course would result as follows:

To the value given by the last inventory to the machinery on hand, we add all expenses since charged to No. 14 P. and deduct the estimated value of the machinery as determined by the present appraisal.

The remainder represents the deterioration. To this should be added the sum of the charges under No. 14 W., and the sum so determined will be the total running expenses on machinery since the last inventory.

The same being determined for the other standing orders separately, they may be either lumped in one general miscellaneous expense account, or better, distributed where they most probably belong.

Thus it would be manifestly wrong to make the same additional charge to cover the miscellaneous expenses of the saddler shop or of the paint shop, where material is used net, and where power is

scarcely required, as it would to cover those of the foundry, machine shop or cartridge factory, where the expenses for power, attendance and general waste are very great.

The selection of the standing orders thus becomes a matter in which judgment can be shown to great advantage.

NOTE.—I think it would be well to have, in addition to those before enumerated, one for each department of the arsenal. Its number might profitably be that of the shop; thus No. 1 would be that of the office; No. 7 of the outside department, and so on. See pages 91, 166.

In estimating the value of machinery, more attention should be paid to its future commercial or earning value during the coming year, than to its mere mechanical condition. Thus obsolete machines, which, though in running order, could only be run at a loss when in competition with more perfect processes used elsewhere, would properly suffer a more considerable deterioration than would at first sight seem possible.

In this way we would be distributing our deterioration among our expenses from year to year, instead of waking up, as many have done, to find their assets disappearing as their disabilities became pronounced.

CASE XVI.

Taking Inventory.

MATERIAL CARD.

FRANKFORD ARSENAL, JUN 30 1883 *(f.)*

Receipts and issues from, **Inventory.** *to* *to*

Per ABSTRACT,				
VOUCHER,				

QUANTITY.	CLASS.	NAME.	CONDITION.

No. Unit.
Assumed.
17 | *pc.(f.)*

Actual.

Price per unit.
350 | *(f.)*

AMOUNT.
5,950 | *(c.c.)*

N. B. Make but one entry on each card.

D. A. presses, complete.
(f.

CHARGE TO *and*					CREDIT TO				
S-O.	C.	Object.		N.	S-O.	C.	Object.		N.
213 (f.)	*P.*	*A.*	*1*	*454*					

PACKAGE

KIND.

NO.

WEIGHT, Lbs.

MEASURE, Ft.

Received from, or sent to

REC'D BY	Foremen punch here. / Storekeepers punch here.	ISSUED BY	Foremen punch here. / Storekeepers punch here.

AUTHORITY, ×

TITLE. MATERIAL. COST. STOCK {L-S.}

CASE 17.—*Transactions between Foremen.*

Although, as has been stated, the scheme proposed does not require transactions between foremen to be recorded, yet by taking some extra trouble this may readily be done.

It is supposed to be desirable to keep account of the valuable cartridge metal passing between different shops. According to the card, 301 credits the shop-order with the shells at the list price and punches "Issued;" 401 punches "Received."

An account should be opened with each foreman handling this metal, otherwise it were better to make no attempt at recording the transfer. Accounts which are not carried to the balance are a sheer waste of time.

It is open whether to account for the metal by the piece or by the pound; the latter course would probably be the more ready, but the former would serve to show the progress of the work. The difference between the weight of the metal originally drawn and that in the finished cartridges should be accounted for by the scrap and authorized waste. Whether these should be accounted for annually or oftener, would depend upon circumstances.

In order to avoid using the stock section, thus encumbering the return with entries which necessarily balance, it would perhaps be better to have the foremen punch in the L. S. space to the right and left respectively.

The same form would serve at the National Armory in accompanying work through the different departments.

CASE XVII.

Transferring Material between Foremen.

MATERIAL CARD.

FRANKFORD ARSENAL, FEB 17 1883 (f.)

Receipts and issues from, 3(f.) to 4(f.) to to

TITLE.

Per ABSTRACT,				
VOUCHER,				

QUANTITY.	CLASS.	NAME.	CONDITION.

No. Unit. Assumed.

4 M.(f.)

Actual.

Price per unit.

AMOUNT.

N. B. Make but one entry on each card.

Inspected shell, 49 A. 120.
(f.)

MATERIAL.

CHARGE TO				CREDIT TO			
S-O.	C.	Object.	N.	S-O.	C.	Object.	N.

COST.

PACKAGE

KIND.

NO.

WEIGHT, Lbs.

MEASURE, Ft.

Received from, or sent to

STOCK.

REC'D BY	Foremen punch here. × (401.)	ISSUED BY	Foremen punch here. × (301.)
	Storekeepers punch here.		Storekeepers punch here.

AUTHORITY,

L. S.

CASES 18, 19, 20.—*Storekeeper's Receipts from Z.*

With the material should come a card, made out by the stock clerk, so that all the storekeeper has to do is to verify the card and punch it "Received." Should no card have come and the emergency require the immediate delivery of the material, the storekeeper should make out the card himself. In such a case he should specify on each card the number of the package from which it was taken, and on one of the lot of cards representing the contents of each package, will give the weight, marks, etc., of the package as provided for in the stock section. In such a case he should have the Commanding Officer's punch-mark in the L. S. section before he punches the card himself; or it should certainly be submitted to the Commanding Officer before being acted on by the stock clerk. See page 174.

Should the storekeeper be so directed, he may immediately issue the material to a foreman by punching "Issued" and sending the card to him with the stores (case 19). If the foreman wishes to hold the material in charge he will simply punch "Received" and return the card to the storekeeper after indicating on it to what order the material is to be charged; but if he requires it for immediate consumption, he will also punch it "Issued."

Such involved cases, though always required under the existing system, would under that proposed be comparatively rare. The foreman in case 19 would simply receive the stores himself, and the storekeeper's return would not be burdened by the entries, since he would know nothing of them. Case 19 represents a direct purchase by the Commanding Officer, without previous requisition. See page 174.

Case 20 represents a requisition by a foreman for a special purpose. While the requisition is approved, the purpose is disapproved, and the material is bought for store. The storekeeper acts as in case 18, except that, as the material is not to be used on any shop-order, he crosses the number out at the time he punches the card. This is sufficiently explained by the order on the back, directing its receipt by W.

CASE XVIII.

Receiving Material from another Arsenal for Store.

MATERIAL CARD.

FRANKFORD ARSENAL, FEB 17 1883 (*s.*)

Receipts and issues from, *Z.*(*s.*) to *W.*(*s.*) to to

TITLE.

Per ABSTRACT,		*A.*(*s.c.*)		
VOUCHER,		*183*		

QUANTITY.	CLASS. *6*(*s.*)	NAME.	CONDITION. *uns. 1.*

MATERIAL.

No. Unit. Assumed.

20 *pcs.*(*s.*)

Actual.

Price per unit.

AMOUNT.

N. B. Make but one entry on each card.

Rifles, Springfield. No invoice. (*s.*)

COST.

CHARGE TO				CREDIT TO			
S-O.	C.	Object.	N.	S-O.	C.	Object.	N.

STOCK

PACKAGE

KIND. *Chest*(*s.*)

NO. *1*

WEIGHT, Lbs. *240*

MEASURE, Ft.

Received from, or sent to

C. O. Vancouver Barracks. (*s.*)

REC'D BY	Foremen punch here.	ISSUED BY	Foremen punch here.
	Storekeepers punch here. ●		Storekeepers punch here.

AUTHORITY, C C

{L.S.}

COURSE OF THIS CARD.

From.	To.
COMMANDING OFFICER,	**C. O.**
CHIEF CLERK,	101
ORDNANCE STOREKEEPER.	**O. S-K.**
WAREHOUSES,	W.
MAGAZINE,	M.
STOCK CLERK,	S. C.
EXECUTIVE OFFICER,	**X. O.**
COST CLERK,	C. C.
MASTER ARMORER,	M. A.
SHOP FOREMEN. MACHINE,	201
CASE,	301
LOADING,	401
CARPENTER,	501
PAINT,	601
LABORERS,	701
BALLISTICS,	801
BALLISTIC OFFICER,	**B. O.**
Outside World,	**Z.**

REMARKS:

REQUISITION FOR MATERIAL

From_____ For_____

DATE. **ACTION.**

_____ Required by,

_____ Approved by *M. A.*

_____ " " *X. O.*

_____ Ordered by, *C O*

from,

_____

_____

per order No_____

To be received or issued by,

_____

Date received or issued.

_____

Appropriation.

CASE XIX.

Receiving Purchases into Store for Issue to Current Service (to be held in ch'ge).

MATERIAL CARD.

FRANKFORD ARSENAL, FEB 17 1883 (s.)

Receipts and issues from, D (s.) to W (s.) to 2 (s.) to

TITLE.

Per ABSTRACT,	C. (s.c.)	6 (s.c.)	E. (s.c.)	
VOUCHER,	218 (s.c.)			

QUANTITY.	CLASS. C. (s.)	NAME.	CONDITION.
No. Unit. Assumed. 200 lbs. (s.) Actual.	N. B. Make but one entry on each card.	Hobson's choice steel, 1¼ × ⅞. (s.)	

MATERIAL.

Price per unit. 40 (s.)

AMOUNT. 80 00 (c.c.)

COST.

CHARGE TO					CREDIT TO				
S-O.	C.	Object.		N.	S-O.	C.	Object.		N.
213	T	A.	31	313					

STOCK.

PACKAGE

KIND.	Received from, or sent to
NO.	
WEIGHT, Lbs.	
MEASURE, Ft.	

REC'D BY	Foremen punch here. ×	ISSUED BY	Foremen punch here.
	Storekeepers punch here. ●		Storekeepers punch here. ●

AUTHORITY, 20

L.S.

COURSE OF THIS CARD.

From.	To.
COMMANDING OFFICER,	**C. O.**
CHIEF CLERK,	101
ORDNANCE STOREKEEPER.	**O. S-K.**
WAREHOUSES,	W.
MAGAZINE,	M.
STOCK CLERK,	S. C.
EXECUTIVE OFFICER,	**X. O.**
COST CLERK,	C. C.
MASTER ARMORER,	M. A.
SHOP FOREMEN. MACHINE,	201
SHOP FOREMEN. CASE,	301
SHOP FOREMEN. LOADING,	401
SHOP FOREMEN. CARPENTER,	501
SHOP FOREMEN. PAINT,	601
SHOP FOREMEN. LABORERS,	701
SHOP FOREMEN. BALLISTICS,	801
BALLISTIC OFFICER,	**B. O.**
Outside World,	**Z.**

REMARKS:

REQUISITION FOR MATERIAL

From_____ For_____

DATE. **ACTION.**

_____ Required by,

_____ Approved by *M. A.*

_____ " " *X. O.*

FEB 1 1883 (101) Ordered by, **C O**

from,

C. J. Field, (101.)

Philadelphia.

per order No. *1193* (101.)

To be received or issued by,

W. (101.)

Date received or issued.

FEB 17 1883 *(s.)*

Appropriation. *O. & O S,* (101.)

PROPOSED SYSTEM.

CASE XX.

Approval in Part of Requisition.

MATERIAL CARD.

FRANKFORD ARSENAL, MAR 17 1883 (s.)

Receipts and issues from, *D.(s.)* to *W.(s.)* to to

TITLE.

Per ABSTRACT,	*C.(s.c.)*			
VOUCHER,	*182*			

QUANTITY.	CLASS. *C (s.c.)*	NAME.	CONDITION.

No. Unit.

Assumed.

20 *dwt.(s.)*

Actual.

520 *gr.(s.)*

Price per unit.

5(s.c.)

AMOUNT.

26 *00(c.c.)*

N. B. Make but one entry on each card.

Pure plate gold for gilding sword handles.

(f.)

MATERIAL.

CHARGE TO				CREDIT TO			
S-O.	C.	Object.	N.	S-O.	C.	Object.	N.
973 1 *(f.)*	*W.* 2 (101)						

COST.

PACKAGE

KIND.

NO.

WEIGHT, Lbs.

MEASURE, Ft.

Received from, or sent to

STOCK

REC'D BY	Foremen punch here.	ISSUED BY	Foremen punch here.
	Storekeepers punch here. ●		Storekeepers punch here.

AUTHORITY, C 0

{ L-S. }

COURSE OF THIS CARD.

From	To.	REMARKS:
COMMANDING OFFICER,	- C. O.	
CHIEF CLERK, - - -	- 101	*Not to be issued except by special order of C. O* (c.o.)
ORDNANCE STOREKEEPER,	- O. S-K.	
WAREHOUSES, - - -	- W.	
MAGAZINE, - - - -	- M.	
STOCK CLERK, - - -	- S. C.	
EXECUTIVE OFFICER, -	- X. O.	
COST CLERK, - - -	- C. C.	
MASTER ARMORER, - -	- M. A.	
SHOP FOREMEN. MACHINE, - - - -	- 201	
SHOP FOREMEN. CASE, - - - -	- 301	
SHOP FOREMEN. LOADING, - - - -	- 401	
SHOP FOREMEN. CARPENTER, - - -	- 501	
SHOP FOREMEN. PAINT, - - - -	- 601	
SHOP FOREMEN. LABORERS, - - -	- 701	
SHOP FOREMEN. BALLISTICS, - - -	- 801	
BALLISTIC OFFICER, - -	- B. O.	
Outside World, - - -	- Z.	

REQUISITION FOR MATERIAL

From *Z.* For *2*

DATE. **ACTION.**

FEB 17 1883 Required by, ✕

FEB 18 1883 Approved by, ◆

FEB 18 1883 " " ✖

MAR 1 1883 Ordered by, C O

from,

Tiffany & Co. (101.)

New York.

per order No. *1817* (101.)

To be received or issued by,

W. (101.)

Date received or issued.

MAR 17 1883 (*w.*)

Appropriation. *A. & E. M.* (101.)

CASE 21.—*Storekeeper's Issue to Z.*

Suppose an order of supplies to arrive, directing the issue of certain stores. The Commanding Officer sends it to the Ordnance Storekeeper and from him it goes to the stock clerk. The latter makes out one card for every item on the order of supplies, as follows:

He fills the title space, except the date; also the spaces for abstract, voucher, class, quantity, name, address, and in "authority" gives the number and date of the order of supplies.

Inasmuch as all these entries, except those for the class, quantity, unit and name of the material, are alike for each invoice, if the number of entries on the invoice should justify it, they should be printed in by rubber stamps, the electric pen or cyclostylic stencil, or by some other permanent process.

The cards being returned to the Ordnance Storekeeper with the original order, the latter may either submit them to the Commanding Officer for the "authority" to be punched; or, preferably, relying on the authority implied in the transfer of the original order, the Ordnance Storekeeper may do this himself.

If the order should call for more items of one kind than one box will hold, the packer should make out blank cards for each box. Thus, suppose that 100 halters are ordered to be issued, and that it is found advisable to divide them among five boxes, containing other stores besides. Such a case is by no means improbable, in packing the large, irregularly shaped assortment of the cavalry supply table, when sent over roads where freighting is expensive and room must be economized.

In such a case, the packer would make out five cards, each one giving the number of halters the box it represented contained. These cards would be punched by whoever inspected the boxes, and the original card, unpunched, would be returned to the stock clerk with the others. He would destroy this card after seeing that the 100 halters ordered issued were fully accounted for on the five punched cards. These last would form the basis of his accounts.

So, in receiving or issuing large quantities of miscellaneous

CASE XXI.

Issuing from Store to the Army.

MATERIAL CARD.

FRANKFORD ARSENAL, MAR 17 1883 (s.)

Receipts and issues from, M.(s.) to L.(s.) to to

Per ABSTRACT,	1.(s.c.)			
VOUCHER,	84(s.c.)			

QUANTITY.	CLASS. 8.(s.c.)	NAME.	CONDITION.
No. Unit. Assumed. 25 M.(s.)	N. B. Make but one entry on each card.	Rifle ball cartridges, model 1881. (s.)	
Actual. 25,000 pc.(s.c.)			
Price per unit.			
AMOUNT.			

CHARGE TO				CREDIT TO			
S-O.	C.	Object.	N.	S-O.	C.	Object.	N.

PACKAGE

KIND. Boxes.(s.)

NO. 18—43(s.)

WT., Lbs. 108 ea.(s.)

MEASURE, Ft.

Received from, or sent to

Col. J. C. Kellon, A. A. G.,
San Francisco,
Cal.

REC'D BY	Foremen punch here. / Storekeepers punch here.	ISSUED BY	Foremen punch here. / Storekeepers punch here.

AUTHORITY, 20 O. S. 1763; 1885.(s.c.)

{L.S.}

TITLE. MATERIAL. COST. STOCK.

stores, as when an ordnance establishment is broken up, the contents of each box or other package would be represented by the cards made out as the articles were put in, keeping as far as possible those of the same name together in the same box. Thus, box No. 11 might contain 23 halters, 18 stirrups, 2 carbines made out on three cards; if there should be found room in it for 2 more halters, a separate card for 2 halters would make all right; or the number on the first card might be altered from 23 to 25. So in case some of the halters are taken out, to make room for other stores.

The top card of the lot or pile representing the contents of each box is to be marked in the package space with the kind of package, its weight and its measure if the shipment requires it.

These cards, going to the stock clerk, may be sorted first by packages, so as to show the actual contents of each package for the quartermaster's invoice, and then by items, bringing all the halters, carbines, etc., together for entry on the invoices and the classified journal slips to be described.

The value of such a plan will be appreciated by any one who has had to break up arsenals or depots, or to receive their contents. I have in mind such a case, embracing 693 items, 1,677,486 articles in 2,052 packages, which required about four months for its settlement at the receiving end only. Had there been no list or book, with its entries scattered over it and constantly overrunning, altered or erased, to confine the work to one man, twenty men might have been set to counting, each having before him one package at a time, the contents of which he would enter as described on cards; a separate card for every separate name comprised in the contents of the package. The chief packer would have compared the cards with the contents of the boxes as the latter were repacked and would have punched them if correct. Making out correct invoices or receipts would then have been an easy matter.

In cases of issue the Commanding Officer's punch-mark should not precede the packing. If great particularity were required, the packer might punch the L. S. section to attest the packing of the stores and defer punching "Issued" until he had received

the Commanding Officer's warrant in the usual way; or the packer might punch only in the L. S. section, and the inspector or the Ordnance Storekeeper punch "Issued." A variety of such methods are possible.

It is not required that each box shall have one card; stores like ammunition, complete sets of harness, equipments, Gatling guns, reloading tools, etc., in original packages, may be lumped together on single cards. But when the set is broken, it would probably be better to make out a separate card for each item, so that the requirements of paragraph 13, Property Regulations, which demand that all such items be accounted for separately, be complied with. In such matters a certain amount of discretion will have to be exercised, though as a general rule it may be said that all attempts to "cut corners" by calling in gross for stores accounted for in detail, must result in increased clerical work based upon more or less fugitive and unsatisfactory memoranda.

CASES 22, 23, 24, 25.—*Issuing on Requisitions.*

The requisition space may be used by the Ordnance Storekeeper in getting material from Z to complete the issue. This would be particularly useful at a place like Benicia Arsenal, where, on a single requisition, supplies for the field have often to be procured from the following sources:

1. By direct issue from store;
2. By fabrication in the workshop;
3. By purchase;
4. By receipt from Eastern arsenals.

Having a stock ledger which correctly shows from day to day the amount of material of every kind on hand, the first two cases would be indicated by the stock clerk writing either "from store," or "fabrication" under the words "to be received or issued by."

The packer would then know that the first lot could be sent off immediately, while the second would have to wait till the stores were made. The third and fourth cases would be indicated on the upper spaces in the usual way for requisitions; the Ordnance Storekeeper punching instead of the officer in charge. The card thus matches into both parts of the administration of the post.

The packer would sort his cards according to the sources of supply, so that, like the order tickets described page 146, all cards in hand would represent unfinished business, and would carry their own explanation to any inquirer, however unfamiliar with the history of the requisition. When stores arrived after purchase, manufacture, or receipt from other arsenals, each lot would have its billet, showing for whom it was intended: as it now is, this is largely a matter of memory; why mistakes are so infrequent, can only be explained by the comparative smallness of the transactions and the long experience of the warehousemen, for delays of months often occur between the first and the last issues on a requisition.

In punching "Issued" on cards representing issues after fabrication, the storekeeper should be careful to punch only "received" on the separate card on which the foreman issues the fabrication to store. As in every other case, he has only to punch according to the facts to have his card right.

CASE XXII.

Issuing from Store on Requisition.—I. Material on Hand.

MATERIAL CARD.

FRANKFORD ARSENAL, MAR 17 1883 (s.)

Receipts and issues from, W.(s.c.) to D.(s.c.) to to

TITLE.

Per ABSTRACT,	2(s.c.)			
VOUCHER,	8(s.c.)			

QUANTITY.	CLASS. 6.(s.c.)	NAME.	CONDITION.
No. Unit. Assumed. 6 pc.(s.c.) Actual.	N. B. Make but one entry on each card. Colt's revolvers. (s.c.)		

Price per unit.

AMOUNT.

MATERIAL.

CHARGE TO				CREDIT TO			
S-O.	C.	Object.	N.	S-O.	C.	Object.	N.

COST.

PACKAGE

KIND. Box.(s.)

NO. 1

WEIGHT, Lbs. 28

MEASURE, Ft.

Received from, or sent to

Governor of Pennsylvania,
Harrisburgh, Pa.
(s.c.)

STOCK

REC'D BY	Foremen punch here. / Storekeepers punch here.	ISSUED BY	Foremen punch here. / Storekeepers punch here.

AUTHORITY, C O

L.S.

COURSE OF THIS CARD.

From.	To.	REMARKS:
COMMANDING OFFICER,	**C. O.**	
CHIEF CLERK,	101	
ORDNANCE STOREKEEPER.	**O. S-K.**	
WAREHOUSES,	W.	
MAGAZINE,	M.	
STOCK CLERK,	S. C.	
EXECUTIVE OFFICER,	**X. O.**	
COST CLERK,	C. C.	
MASTER ARMORER,	M. A.	
SHOP FOREMEN. MACHINE,	201	
CASE,	301	
LOADING,	401	
CARPENTER,	501	
PAINT,	601	
LABORERS,	701	
BALLISTICS,	801	
BALLISTIC OFFICER,	**B. O.**	
Outside World,	**Z.**	

REQUISITION FOR MATERIAL

From_____ For_____

DATE. **ACTION.**

_____ Required by,

_____ Approved by *M. A.*

_____ " " *X. O.*

_____ Ordered by, *C O*

from,

_____

_____

per order No._____

To be received or issued by,

_____

Date received or issued.

_____

Appropriation.

CASE XXIII.

Issuing from Store on Requisition.—2. After Fabrication.

MATERIAL CARD.

FRANKFORD ARSENAL, APR 5 1883 (s.)

Receipts and issues from, W.(s.c.) to Z.(s.c.) to to

TITLE.

Per ABSTRACT,	2.(s.c.)			
VOUCHER,	8(s.c.)			

QUANTITY.	CLASS. 3.(s.c.)	NAME.	CONDITION.
No. Unit. Assumed. 3 pc.(s.c.) Actual.	N. B. Make but one entry on each card.	*Sponges and rammers, light 12-pd. gun.* (s.c.)	

Price per unit.

AMOUNT.

MATERIAL.

CHARGE TO				CREDIT TO			
S-O.	C.	Object.	N.	S-O.	C.	Object.	N.

COST.

PACKAGE

KIND. Bale.(s.)

NO. 3(s.)

WEIGHT, Lbs. 44(s.)

MEASURE, Ft.

Received from, or sent to

The Governor of Pennsylvania,
Harrisburgh, Pa.
(s.c.)

STOCK

REC'D BY	Foremen punch here. / Storekeepers punch here.	ISSUED BY	Foremen punch here. / Storekeepers punch here.

AUTHORITY, 20

{ L.S. }

COURSE OF THIS CARD.

From	To.
COMMANDING OFFICER,	**C. O.**
CHIEF CLERK,	101
ORDNANCE STOREKEEPER,	**O. S-K.**
WAREHOUSES,	W.
MAGAZINE,	M.
STOCK CLERK,	S. C.
EXECUTIVE OFFICER,	**X. O.**
COST CLERK,	C. C.
MASTER ARMORER,	M. A.
SHOP FOREMEN. MACHINE,	201
SHOP FOREMEN. CASE,	301
SHOP FOREMEN. LOADING,	401
SHOP FOREMEN. CARPENTER,	501
SHOP FOREMEN. PAINT,	601
SHOP FOREMEN. LABORERS,	701
SHOP FOREMEN. BALLISTICS,	801
BALLISTIC OFFICER,	**B. O.**
Outside World,	**Z.**

REMARKS:

REQUISITION FOR MATERIAL

From *Shops.* (s.c.) For *Z.* (s.c.)

DATE. **ACTION.**

Required by,

Approved by, *M.A.*

" " ♣

MAR 17 1883 Ordered by, C O

from,

Shops. (101.)

per order No. *785* (101.)

To be received or issued by,

After fabrication. (s.c.)

Date received or issued.

MAR 22 1883

Appropriation.

PROPOSED SYSTEM.

CASE XXIV.

Issuing from Store on Requisition.—3. *After Purchase.*

MATERIAL CARD.

FRANKFORD ARSENAL, MAR 22 1883 (s.)

Receipts and issues from, L.(s.c.) to W.(s.c.) to L.(s.c.) to

TITLE.

Per ABSTRACT,		C.(s.c.)	2(s.c.)	
VOUCHER,		298(s.c.)	8(s.c.)	

QUANTITY.	CLASS. H.(s.c.)	NAME.	CONDITION.
No. Unit. Assumed. 5 lbs.(s.c.) Actual. Price per unit. AMOUNT.	N. B. Make but one entry on each card.	Beeswax. (s.c.)	

MATERIAL.

CHARGE TO				CREDIT TO			
S-O.	C.	Object.	N.	S-O.	C.	Object.	N.

COST.

PACKAGE

KIND. Box.(s.)

NO. 2(s.)

WEIGHT, Lbs. 5(s.)

MEASURE, Ft.

Received from, or sent to

The Governor of Pennsylvania,
Harrisburgh, Pa.
(s.c.)

STOCK

REC'D BY	Foremen punch here.	ISSUED BY	Foremen punch here.
	Storekeepers punch here. ●		Storekeepers punch here. ●

AUTHORITY, C O

{L.S.}

COURSE OF THIS CARD.

From.	To.
COMMANDING OFFICER,	C. O.
CHIEF CLERK,	101
ORDNANCE STOREKEEPER.	O. S-K.
WAREHOUSES,	W.
MAGAZINE,	M.
STOCK CLERK,	S. C.
EXECUTIVE OFFICER,	X. O.
COST CLERK,	C. C.
MASTER ARMORER,	M. A.
SHOP FOREMEN. MACHINE,	201
SHOP FOREMEN. CASE,	301
SHOP FOREMEN. LOADING,	401
SHOP FOREMEN. CARPENTER,	501
SHOP FOREMEN. PAINT,	601
SHOP FOREMEN. LABORERS,	701
SHOP FOREMEN. BALLISTICS,	801
BALLISTIC OFFICER,	B. O.
Outside World,	Z.

REMARKS:

REQUISITION FOR MATERIAL

From *L.(s.c.)* For *W.(s.c.)*

DATE.	ACTION.
	Required by,
	Approved by *M. A.*
MAR 17 1883	" " ♣
MAR 18 1883	Ordered by, C O

from,

J. Frobisher, (101.)

Philadelphia.

per order No. *18275* (101.)

To be received or issued by,

W. (101.)

Date received or issued.

MAR 21 1883 *(s.)*

Appropriation. *O. & O. S, 3*

CASE XXV.

Issuing from Store on Requisition.—4. After Receipt from another Arsenal.

MATERIAL CARD.

FRANKFORD ARSENAL, APR 5 1883 (s.)

Receipts and issues from, *L.*(s.c.) *to* *W.*(s.c.) *to* *L.* *to*

TITLE.

Per ABSTRACT,		*A.*(s.c.)	*2.*(s.c.)	
VOUCHER,		*318*(s.c.)	*8*(s.c.)	

QUANTITY.	CLASS.	NAME.	CONDITION.
	7		

MATERIAL.

No. Unit. Assumed.

10 *pc.*(s.c.)

Actual.

Price per unit.

AMOUNT.

N. B. Make but one entry on each card.

Cinchas, hals.

(s.c.)

COST.

CHARGE TO				CREDIT TO			
S-O.	C.	Object.	N.	S-O.	C.	Object.	N.

STOCK.

PACKAGE

KIND.

NO. *3*(s.)

WEIGHT, Lbs.

MEASURE, Ft.

Received from, or sent to

The Governor of Pennsylvania,
Harrisburgh, Pa.
(s.c.)

REC'D BY	Foremen punch here.	ISSUED BY	Foremen punch here.
	Storekeepers punch here. ●		Storekeepers punch here. ●

AUTHORITY, 20

{L.S.}

COURSE OF THIS CARD.

From	To.
COMMANDING OFFICER,	C. O.
CHIEF CLERK,	101
ORDNANCE STOREKEEPER,	O. S-K.
WAREHOUSES,	W.
MAGAZINE,	M.
STOCK CLERK,	S. C.
EXECUTIVE OFFICER,	X. O.
COST CLERK,	C. C.
MASTER ARMORER,	M. A.
SHOP FOREMEN. MACHINE,	201
SHOP FOREMEN. CASE,	301
SHOP FOREMEN. LOADING,	401
SHOP FOREMEN. CARPENTER,	501
SHOP FOREMEN. PAINT,	601
SHOP FOREMEN. LABORERS,	701
SHOP FOREMEN. BALLISTICS,	801
BALLISTIC OFFICER,	B. O.
Outside World,	Z.

REMARKS:

REQUISITION FOR MATERIAL

From_____ For_____

DATE. **ACTION.**

_____ Required by,

_____ Approved by, *M.A.*

MAR 17 1883 " " ♣

MAR 18 1883 Ordered by, C O

from,

Benicia Arsenal, (101.)

by O. O. letter No. 785.

per order No._____

To be received or issued by,

W. (101.)

Date received or issued.

APR 5 1883 (*s.*)

Appropriation.

PROPOSED SYSTEM.

CHAPTER XIV.

DUTIES OF THE STOCK CLERK AND OF THOSE RELATED TO HIM IN THE ACCOUNTABILITY OF PROPERTY.

Outfit.

The outfit of the stock clerk consists of the journal and ledger slips; a number of wire letter files; a set of pigeon holes; and two stamps, one giving automatically consecutive numbers, and the other an entry stamp, such as described page 92.

The slips above mentioned are devised to assist in following the official sequence of names in making out the returns before described; the idea is borrowed from the ledger form in use at Frankford Arsenal, devised, as I believe, by Mr. H. T. Fries, the stock clerk there. The essential feature of the form here proposed is to have for every heading a separate slip which can be interpolated among others in the very place where the sequence requires it.

To keep the slips together they are not bound, but are strung on a stout vertical wire provided with a sufficiently stable base, like an ordinary letter file, and with its upper end furnished with a stop nut to keep the slips from falling off.

As many slips as may be desired may be strung on each file; but it would probably be best to file the slips by classes, each wire containing only the slips belonging to one class.

In case a new heading is required, the stop nut is unscrewed, the cards above the proper place are lifted off and the new card slipped on; the cards being then replaced and the stop nut screwed on, the file is ready for service again.

To keep the slips even, the holes for filing are punched at a regular distance from the ends. If it were an object to save paper, both sides of the slip could be utilized by punching a hole

at each corner of one end, otherwise I would punch but one hole in the slip. When one slip is filled, another should be put on over it, and so on.

To make an entry, the upper slips are swung aside, the entry made on the slip exposed, preferably in pencil, to avoid blotting, and the slips swung back into place, being confined by a rubber band about the outer end if need be.

To make the slips lie flat while making entries on them it would be well to have a cavity in the top of the writing table just deep enough to receive the foot of the file.

Stock Journal and Ledger Slips.

These are essentially alike; in each form the column containing the quantities received or issued is double, one half of it being reserved for the Store return and the other half for the Current Service return.

The journal is designed to facilitate the entry of material cards, and as it forms the first step in their consolidation, it contains all the data necessary for their identification. The designation of the corresponding abstract by a letter or a number shows whether the transaction was a receipt or an issue, and the column in which the quantity is entered shows to which return the receipt or issue belongs.

In the ledger these two columns are subdivided, the receipts being separated from the issues for each return, and the entries presented conveniently for summation and comparison. In posting to the ledger the entries are consolidated as far as possible according to the abstracts to which they refer.

NOTE.—Since the object of the journal is to save filling the ledger unduly; when transactions with material are not frequent, the journal could be dispensed with by adding to the ledger the first two columns of the journal and omitting the date.

PROPOSED JOURNAL SLIP, (3½" x 10").

NAME. CLASS.

Cartridges (serv. ~~uns.~~)

Rifle Ball *8*

UNIT.

Mode, 1881 *pc.*

PRICE.

2½c.

CARD NO.	Shop-Order.	Abstract.	Voucher.	Quantities. Store.	Quantities. C. S.
Brought forward..	.....	.....	.....		
Case 1	213	6	.....	5	
" "	"	E.	.....	.....	
" 2	214	C.	113	.....	40
" 3	896	C.	114	.....	1,500
" "	"	5	.....	.....	1,500
" 4	213	B.	.....	.....	4
" 5	49	B.	.....	.....	10,000
" "	"	6	.....	.....	10,000
" "	"	E.	.....	10,000	
" 6	767	B.	.....	.....	1,000
" 7	214	B.	.....	.....	1
" 8	214	6	.....	.....	10
" "	"	E.	.....	10	
" 9	49	5	.....	.....	2
" 10	107	5	.....	.....	5
" 11	704	B.	.....	.....	1
" "	"	1	73	.....	1
" 12	213	F.	.....	.....	10
" 13	.....	4	.....	.....	500
" 14	214	4	.....	.....	1
" "	"	F.	.....	.....	6,000
Carried forward.....				10,015	30,580

PROPOSED JOURNAL SLIP.—Continued.

NAME.	CLASS.
Cartridges	(serv. / ~~uns.~~)
Rifle Ball	*8*
	UNIT.
Model, 1881	*pc.*
	PRICE.
	2½c.

CARD No.	Shop-Order.	Abstract.	Voucher.	Quantities. Store.	Quantities. C. S.
Brought forward	.....	.....	.....	10,015	30,580
Case 18	.....	A.	183	20	
" 19	213	C.	218	200	
" "	"	6	.....	200	
" "	"	E.	.....	.....	200
" 20	.....	C.	182	520	
" 21	.....	1	84	25,000	
" 22	.....	2	8	6	
" 23	.....	2	8	3	
" 24	.....	C.	298	5	
" "	.....	2	8	5	
" 25	.....	A.	318	10	
" "	.....	2	8	10	
Totals				35,994	30,780

Recapitulation, March 31, 1885.

			A.	30	
			B.	.....	11,006
			C.	725	1,540
			D.		
			E.	10,010	205
			F.	.....	6,010
			1	25,000	1
			2	24	
			3		
			4	.....	501
			5		1,507
			6	205	10,010
Totals				35,994	30,780
Carried forward					

PROPOSED LEDGER SLIP, (4″ x 10″).

NAME.

Cartridges

Rifle Ball

Model, 1881

CLASS. (serv. ~~unis.~~)

8

UNIT.

pc.

PRICE.

2½c.

DATE, 1885.	Abstract.	Voucher.	Store Return. Received.	Store Return. Issued.	C. S Return. Received.	C. S Return. Issued.
Brought forward..	.....	.....	18,000	.....	600	
March 31.....	A.	183	20			
	"	318	10			
	C.	218	200			
	"	298	5			
	"	182	520			
	E.	.....	10,010			
	1	84	.....	25,000		
	2	8	.....	24		
	B.	.....	.....	.....	11,006	
	C	113	.....	.....	40	
	"	114	.....	.....	1,500	
	E.	.....	.....	.....	205	
	F.	.....	.....	.....	6,010	
	1	.....	.....	.....	.....	1
	4	.....	.....	.....	.....	501
	5	.....	.....	.....	.....	1,507
	6	.....	.....	205	.....	10,010
Totals.....			28,765	25,229	19,361	12,019
Balances carried forward.....			3,536	.....	7,342	
Gross Balance, 10,878.						
Carried forward.....						

Manner of Entering Material Cards on Journal and Ledger Slips.

Owing to the fact that the final resting place of the greater part of the cards must be with the cost clerk, so that the cost of the elements of each completed order may always be conveniently analyzed, it is necessary for the stock clerk to take note of them as they pass through his hands in such a manner as to lead to their ready combination on the returns. And since the individual entries made from the cards thus have their identity merged in the general result, in order to verify the entries by the Stock Clerk, it is arranged that each card, before being entered on the journal, shall receive a consecutive number by which it may be found among the other cards having the same shop-order number in the hands of the cost clerk. To show in what group of cards it may be found, the journal slip has a column to contain the number of the shop-order to which the material is charged, or, if not charged to any order, to which it is credited. Cards with order numbers go to the cost clerk; those without them are kept by the stock clerk, arranged according to their serial numbers.

Therefore the stock clerk should stamp once, with its serial number, every card passing before him, whether it is complete or not.

When cards bearing punch-marks in the stock section come to him, he goes carefully over them, changing the names, when required, to conform to the official nomenclature and inserting in the title section the designation of the abstract to which the transaction belongs. When it is supported by a numbered voucher, as in abstracts A; C; 1; 2; 3, he writes the number of the voucher under the designation of the abstract in the place provided for it on the card.

He then sorts the cards according to the nomenclature and enters them on the journal slips, making one entry for each punch-mark on each card.

The column in which the quantity should be entered is indicated by the character in the line above the abstract line; when the designation of the abstract comes under that of a storehouse,

the entry belongs to the store return; when it is under that of a shop or of a fabrication, the entry belongs to the current service column; when it is under Z, the entry belongs to either return, according to the circumstances of the case.

The proper return being thus known, the designation of the abstract indicates whether it is a receipt or an issue on that return and also to what class of receipts or issues it belongs. The story is fully told and with the fewest words. The card should then be stamped "Entered by stock clerk," and, if bearing a shop-order number, should be sent to the cost clerk unless previously needed by the pay clerk, as described page 260.

Posting to the Ledger.

This is done by adding up the quantities belonging to each abstract on each return and entering the totals in red ink below those made in pencil from day to day. They are then ready to be carried to the ledger, in which, however, entries belonging to abstracts A; C; 1; 2; 3 should be entered in detail with the corresponding voucher numbers. This difference in treatment is made necessary by the requirement that these abstracts shall show the individual vouchers to which their entries pertain.

The journal and ledger should each be consolidated quarterly, or, if desired, at any intermediate time, by simply posting the ledger slip to date and making the necessary additions and subtractions. The exact amount of material of any kind remaining on hand may always be ascertained and be verified if required by tracing to the very beginning every transaction contributing to produce it.

This is illustrated in the accompanying examples which represent the posting in both journal and ledger slips of the cards used as examples in Chapter XIII. To avoid multiplying the number of slips these cards are here all supposed to refer to the same material.

Principal Papers Combining Cash and Property Accountability.

1. PRESENT SYSTEM.

We have seen in Chapter V the importance to the present system of the quarterly Abstract of purchases, and have noted some of its defects. It was seen that these arise principally from its having to combine in one paper such independent evidence as that of purchase and of receipt, assuming a simultaneity which never exists.

In order to compile a more satisfactory substitute for this abstract from the data given by the material cards, it is necessary to examine the principal papers in which material and money are both referred to, and also to note what special services are required of the cards.

These papers are:

1. The certificate of inspection.
2. The voucher.
3. The monthly abstract of purchases.
4. The quarterly abstract of purchases "C."
5. The monthly abstract of disbursements.

1. *The Certificates of Inspection.*

These are consolidations of various bills received from each person or firm since the last payment. They are designed to show the Chief of Ordnance that the material, the purchase of which he is asked to authorize, has actually been received and is of good quality. They are generally made out monthly or oftener. When returned to the Commanding Officer, approved, vouchers in duplicate are made out as follows:

2. *The Vouchers.*

The purchase voucher is a complete statement of a purchase, with the names of the articles purchased, classified according to the appropriations from which payable. Under each appropriation the names should be arranged according to the official nomenclature.

CERTIFICATE OF INSPECTION. PRESENT FORM (8½″ x 14″).

Certificate No. ....., on contract* of _____, 188 .

THE UNITED STATES ORDNANCE DEPARTMENT, DR.

To *John Doe.*

DATE.		DOLLARS.	CTS.
	TOTAL.....ᵀᵒᵒ, $		

I hereby certify that I have inspected and accepted the above-named property furnished by ....., under contract with _____ dated....., 188 .

And I further certify that the said property has been inspected according to the Regulations established by the ORDNANCE DEPARTMENT for the inspection of _____, before its reception for the SERVICE OF THE UNITED STATES; that it is of good quality, and is in all respects conformable to the requirements of the contract.

GIVEN under my hand at_____this.....day of....., 188 .

APPROVED:

E. S. J.,
Assistant Inspector.

O. E. M.,
Captain of Ordnance, Inspector.

RECEIVED at_____, this.....day of....., 188 , the above-named property.

D. J. Y.,
Ordnance Storekeeper.

I APPROVE the foregoing, and certify the above account in favor of _____ for _____ ᵀᵒᵒ dollars to be correct and just.

A. M.,
Major of Ordnance,
Commanding.

* A similar form is used for purchases not by contract.

VOUCHER. PRESENT FORM (10½" x 8").

THE UNITED STATES, To *John Doe & Co.*, DR.

DATE OF PURCHASE. 1884.	APPROPRIATION.	AMOUNT.	REMARKS. Showing the objects of the purchase or expenditure.
	Ordnance Service, 1884.		
August 22	6 *split brooms* @ 43¾*c. each*	$2 62	*Current use.* ($2.62—O. S.)
	Ord. and Ord. Stores, sub-head No. 3, 1885.		
	6 *brass padlocks, No.* 75, @ 64¾*c. each*	3 88	*Metal limber chests, 3.20" rifle.*
	12 *lbs. sheet spring steel No.* 20 @ 14*c. per lb.*	1 68	*Metal limber chests.* ($5.56—O. & O. S., 3.)
	$	8 18	

I CERTIFY that the above account is correct and just.

A. M.
Major of Ordnance, Commanding.

RECEIVED at *New York City*, this *11th* day of *August*, 1884,

from *Capt. D. J. Y., O. S-K.*, the sum of *eight*

dollars *eighteen* cents, in full of the above account.

(ORIGINAL).

John Doe & Co.

3. *The Monthly Abstract of Purchases.*

This is a single abstract containing a list of the articles purchased during the past month, consolidated by names and classified according to the nomenclature. The amounts paid are extended conveniently for summation.

This paper has apparently a two-fold object: first, to consolidate the amounts disbursed for purchases; and second, to enable the Chief of Ordnance to compare readily the price paid for the same articles at different arsenals.

The voucher numbers in the margin are only for casual reference to the vouchers from which the items are derived; they serve no connected purpose. The same remark is true as to the "purposes" for which room is made. The recapitulation of the amounts at the end of the paper logically belongs to the abstract of disbursements, and has nothing to do with the functions of this abstract. See page 255.

PRESENT FORM (10½" x 18").

Abstract of Purchases at *Watervliet Arsenal* in *September*, 1884.

No. of Voucher.	Articles.	Quantity.	Price.	Per.	Amount.	Where Purchased.	For what Purpose.
	Class 10.						
291	*Wheels, Archibald No...*	80	$11.63¾	*each.*	$931 00	*Lawrence, Mass...*	*Gatling carriages and limbers.*
	Part Second.						
	Cloth, rope, thread, etc.						
284	*Cotton waste, lbs.....*	50	9*c.*	*lb.*	4 50	*New York.....*	*Use in shops.*
292	*Duck, cotton, dyed, No. 9, 36½", — yds.....*	1,129	32*c.*	*yd.*	361 28	*Worcester, Mass.*	*Equipments for U. S. Navy.*
292	*Duck, cotton, dyed, No. 9, 36½", — yds.....*	437	35*c.*	*yd.*	152 95	*Worcester, Mass.*	*Equipments for U. S. Navy.*
	Carried forward..	.....	.....	.....	$1,449 73		

Recapitulation of Expenditures in the month of September, 1884: (In MS., following body of abstract.)

Articles purchased	$1,449 73
Services of hired men	376 32
Transportation	5 12
Mileage	18 85
Advertising	75
Miscellaneous	8 11
Total per Abstract of Expenditures	$1,858 88

I certify that the above abstract is correct.

A. M.,
L't-Col. of Ordnance, Commanding.

4. *The Quarterly Abstract of Purchases.*

This is a double abstract, see page 42, containing a serial list of vouchers on which purchases have been made, with the articles purchased on each voucher arranged under headings furnished by the official nomenclature.

This paper is not compiled, as might be imagined, from the corresponding monthly abstracts, but from the individual vouchers. It affords the means of accounting for the purchases as receipts on the property return.

5. *The Monthly Abstract of Disbursements.*

This is a purely cash paper, in the form of a double abstract, containing a list of all vouchers paid during the month, both for purchases and services, with the amounts paid on each voucher, distributed under the heads of the appropriations to which they belong. The agencies are the vouchers arranged serially and accompanied by a synoptical statement of their contents. This synopsis is only useful as a guide to the general correctness of the distribution of the charges; it can serve no connected purpose. See Chap. XV.

NOTE.—It will be observed that each of the last three abstracts requires the overhauling of every individual voucher relating to purchases during the period to which the abstract belongs. No means seem to have been provided for their progressive consolidation, but the whole work has to be done over anew for every one of the papers.

PRINCIPAL PAPERS COMBINING CASH AND PROPERTY ACCOUNTABILITY—*continued.*

II. PROPOSED SYSTEM.

1. *The Certificate of Inspection.*

   As now made.

2. *The Voucher.*

   As now made.

3. *The Monthly Abstract of Purchases.*

CRITICISM OF PRESENT FORM.

For what is called a cash paper, the classification of the property purchased is, except for the minor reason given, page 253, a waste of time. Difficult work of this kind should not be required, except as tending to further consolidation. This is not here the case, since the quarterly abstract (4) requires a return to the elementary vouchers from which the monthly paper was originally compiled.

The place of purchase given on the voucher needs repetition no more than does the name of the creditor, which is not repeated. The same remark applies to the "purpose," which cannot always be definitely expressed, and which, were it otherwise, would prevent consolidation, except of purchases for a common object.

For a cash paper, which this is said to be, it seems strange that it makes no reference to the principal common feature in the purchases which it consolidates; viz., the appropriation out of which they have been made.

Finally, the whole paper seems useless; it has nothing to do with the property accountability; and could be dropped from the cash accountability without being missed.

REMEDY PROPOSED.

(*a.*) Make the monthly abstract of purchases a double abstract precisely similar in form to the quarterly paper, except that on

the right should be a space for each appropriation under which purchases are made. Adding up the articles consolidates the property; adding up the amounts consolidates the cash. See form proposed, page 258.

4. *The Quarterly Abstract of Purchases.*

(*b.*) Replace the quarterly abstract of purchases now made by a new double abstract, C, which would become the "Abstract of articles received by purchase." The agencies would be a serial list of the fly bills received from public creditors; the articles received would be arranged under the headings given by the nomenclature, precisely as is now done with the quarterly abstract. The only difference would be in the agencies, which would depend upon actual *receipts* without regard to whether they had yet been paid for or not.

(*c.*) Consolidate quarterly or annually the footings of the monthly abstracts and compare their aggregate with that of the consolidated abstracts C. Differences would be explained by an abstract of articles received but not paid for. I should prefer this consolidation to be made annually, because, since purchases must always be received before they are paid for, abstract C would be always ahead throughout the year, until its expiration compelled a settlement of all accounts.

5. *The Abstract of Disbursements.*

Transfer to this abstract on one line the footings under each appropriation on the proposed monthly abstract of purchases, as is now done with the footings on the return of hired men.

This would be logical and labor-saving, and would tend to reduce the abstract to a two-line paper, one line for services and the other for material, to which two headings all expenditures can be definitely referred.

ADVANTAGES.

1. The consolidation would be progressive, and work need not be done twice and even three times over, as is now required.

2. Detailed information would be given by papers of the proper

PROPOSED MONTHLY ABSTRACT OF PURCHASES AT *Watervliet* ARSENAL

FOR *September*, 188 . (10½″ x ?.)

Number of voucher.	Quantities.												Amounts charged.									
	Class 10.		Class A.										Appropriations for								Total Amount.	
	Wheels, Archibald.		Cotton waste.	Duck, cotton, dyed, No. 9. 36″.									Ordnance Service.		Ordnance and Ordnance Stores, 3.				U. S. Navy.			
													$	c.	$	c	$	c.	$	c.	$	c.
284	....	..	50										4	50	....	..	....	..	....	..	4	50
291	80														931	00	....	..	....	..	931	00
292	....	..	....	1,566											152	95	....	..	361	28	514	23
294	....	..	100	10									9	00	....	..	....	..	3	20	12	20
Totals.	80	..	150	1,576									13	50	1,083	95	....	..	364	48	1,461	93

See present form, page 254.

lower grade, and would not embarrass the preparation or comprehension of more concentrated statements.

3. On the proposed monthly abstract of purchases would hinge the property and money accountability of the arsenal, without preventing the independent treatment of these two accountabilities; the former on abstract C, made up without regard to values, and the latter on the abstract of disbursements, made up without regard to quantities.

The credit taken by the paymaster for money spent in purchases would be balanced by the accountability required of the storekeeper for the articles purchased, and this would be traced down, as elsewhere provided, to the very shop-orders on which the material was expended, just as the analysis of the time book (Chap. XV) makes the credit to the paymaster a charge to the shop-order on which the labor was most probably employed. The circle would be complete.

It will appear that the quarterly abstract of purchases C will have lost its character as a combination tool, making the evidence of receipt depend upon that of purchase. We may now treat the two questions independently, since the essential point in one case is to charge the material to the storekeeper as soon as it is received, from whatever source and under whatever circumstances it may have come; and in the other case to credit the purchase money to the paymaster in consideration of the equivalent value the government has received through its other agent, the storekeeper.

What the storekeeper needs is evidence that he has charged himself with all that was sent him; what the paymaster needs is evidence that the storekeeper was charged with the articles with the money value of which he is credited.

What the government needs is evidence that the articles for which it pays have actually been received and will be accounted for. This it gets by seeing, 1st, that what it pays for is accounted for: this comes from annually comparing the monthly abstracts with abstract C; 2d, that what is accounted for is what was received: this comes from comparing the bills or invoices from outside consignors with what is taken up on abstract C. Thus its own necessities and those of its two agents are satisfied.

Proposed Method of Compiling Principal Cash and Property Papers from Material Cards.

PERSONS.

There are three clerks involved; named in the order in which the cards generally reach them for entry, they are:

1. The cost clerk;
2. The stock clerk;
3. The pay clerk.

(The pay clerk is generally the chief clerk, or the cash clerk; but as the latter title might be confused with that of the cost clerk, I prefer to use the title given in Chapter VIII.)

1. *The Cost Clerk.*

The cost clerk should receive daily all cards concerning him, and after entering their consolidated values on the cost sheet, should send those containing punch-marks in the stock section to the stock clerk, and file away all others as explained in Chapter XV.

2 and 3. *The Stock and Pay Clerks.*

The stock clerk should enter the cards as soon as possible on the journal slips and send to the pay clerk those belonging to abstract C, with the fly bills received from the creditors. Cards should be stamped "entered" after their contents have been transferred to the journal, and those containing a charge or credit to a shop-order should be returned to the cost clerk, unless they belong to abstract C, when they are sent to the pay clerk, as above provided. Those not sent to either of the two other clerks should be filed away by the stock clerk according to their serial numbers.

PROCESS OF COMPILING.

1. *Certificates of Inspection.*

Let the pay clerk sort the cards received from the stock clerk according to firm names, and sort the cards in each firm name according to the nomenclature. Then he can compile the certificate by simply copying off the cards, consolidating materials

of the same name. The prices would be given by the fly bills unless otherwise established.

It is a moot question as to who should be the assistant inspector and the inspector required by the form to certify as to the quantity and quality of the materials enumerated. Inasmuch as I can find in neither the Regulations nor in orders anything about inspectors for arsenal purposes, except for coal, I am led to hope that the signature of the principal receiving officer may be held conclusive. Under this supposition the certificates should be signed by the Ordnance Storekeeper or by the Executive Officer, depending upon the return on which the material was received. The cards, the registered acts of these officers or of their subordinates, would show precisely who was responsible for the material accepted.

The certificates, the fly bills and the cards would then go to the Commanding Officer, who would be able to see for himself, before signing the certificate, that the rights of both the creditor and the government had been protected.

To prevent the same card from being used twice in making out certificates, it might be well for the Commanding Officer to have the cards stamped after comparing them.

2. *Compiling Vouchers.*

The pay clerk should sort each batch bearing the name of the same creditor according to appropriations. The cards under each appropriation being then sorted according to the nomenclature, would give the voucher form, to be completed by adding the prices given by the certificate of inspection. When the voucher has been prepared the clerk should stamp the corresponding cards "Entered on voucher No. ____, (month), 188 ."

3. *Compiling the Monthly Abstracts of Purchases.*

After the cards have been entered on the vouchers, they should all be sorted according to nomenclature. This may be easily done by interpolating cards relating to the same material and bearing the same voucher number among the cards previously sorted. Copying the names gives the headings sought in their proper order, and the abstract may be compiled vertically. See

page 265. By comparing it afterwards with the vouchers the prices and amounts may be filled in, and the work be generally verified.

The cards should then be returned to the cost clerk for file. In the event of his having needed any of those in the hands of the pay clerk, he knows exactly where to look for them, for the name of the material gives the journal slip; this, the name of the voucher to abstract C (see next section); and this, the name of the creditor in whose file the card will be found.

4. *Compiling Abstract C.*

When a fly bill is received from a public creditor the stock clerk gives it a serial number and copies it into a register, see page 263. This number is the voucher number for the cards supporting the bill, and the register is the retained copy of the vouchers to abstract C.

Differences between names and quantities billed and those received are plainly shown on both original bill and register. By comparing these now and then with the cards a proper check on the necessary freedom of the stock clerk may be established.

The original fly bill goes with the cards supporting it to the pay clerk, who, after making out the monthly abstract of purchases, returns it to the stock clerk to be used as a voucher to abstract C. The preparation of this abstract is not delayed until the return of the fly bill, since the abstract can be more easily compiled from the data of the journal than from the fly bills themselves.

NOTES.—To pass from the individual cash vouchers to the individual property vouchers, the pay clerk should note on each the other's corresponding numbers. Then, vouchers to abstract C not referred to any cash voucher would be those of property received, but not paid for, and the resulting outstanding indebtedness would appear from a simple inspection of the register of fly bills.

Incidentally, it will appear that the material cards in the hands of the clerks act very much as has been said of the order tickets in the shops, and of the material cards in the storehouse. See pages 147, 234.

The total indebtedness can at any moment be readily determined; for the cards in the hands of the stock clerk awaiting arrival represent material ordered, but not received, and those in the hands of the pay clerk represent material received, divided into two categories, paid and unpaid. They should be kept in separate pigeon holes.

One great advantage following the use of the fly bills as vouchers to abstract C is the readiness with which their serial numbers are given, and the help which this feature affords to the progressive preparation of the abstract. Otherwise, one has to wait until

PROPOSED REGISTER OF FLY BILLS. (18″ x ?)

Number of voucher.	Number of purchasing order.	BILLED.					RECEIVED.					Amount.	Number of cash voucher on which purchased.	REMARKS.
		Quantity.		NAME.	Price per unit.	Amount.	Quantity.		NAME.	Price per unit.				
		No.	Unit.				No.	Unit.						
113	1183	50	lbs.	*pinchbeck metal*...	.35	$17 50	40	lbs.	**brass, cast*.....	.35	$14 00	73	10 *lbs. defective.*
"	"	10	"	*solder*.....	.30	3 00	..	..	*as billed*.....	..	....	73	

* See case II, material cards.

the voucher is paid before knowing what number to give it on the property papers; and even when the proper number is known, nothing can be done toward preparing the abstract until all the vouchers, giving the names upon the serial arrangement of which the abstract depends, have been completed.

5. *Compiling Abstract* 5 (*of Expenditures*).

This, which is the only double abstract unsupported by numbered vouchers, requires special, treatment depending on the form in which it may be rendered in future.

It will be remembered, page 53, that its present arrangement is faulty in that it is indeterminate and groups together several inconsistent agencies.

Three courses seem open:

First, to dispense with its double form and make it a simple classified list of stores expended, *i. e.*, material, the name of which has been changed.

NOTE.—According to the system proposed, stores issued to current service are no longer considered as necessarily expended.

Second, instead of the present arbitrary subdivision of the objects of expenditure, to make one depending on the standing shop-orders of the post as indicated on the material cards reporting the expenditure. These would suffice for a classification of all expenditures not chargeable to special fabrications, which last would be reported in bulk on this abstract beneath the standing shop-order list as "fabrications."

Third, if it should be thought worth while to keep the present system, to designate the line on abstract 5, to which the entry belongs, in the voucher column of the ledger slip; thus, miscellaneous expenditures for the manufacture of small arm ammunition would be designated in the voucher column of the ledger by the number 2. See page 46. But this course would depend for its exactness, as does the present one, upon the judgment of the stock clerk, who would then, no more than now, be able to judge of the correctness of the entry. The second course appears the most homogeneous and the best.

6. *Compiling the Abstracts from the Ledger.*

The ledger slips being already arranged in the order of the nomenclature, we seek among them in succession for the desig-

nation of the abstract to be compiled; the names under which this designation occurs being entered on the abstract in order, the most difficult part of the work is done. We have just the names required, and no more, arranged in their exact order.

Single abstracts are compiled from the ledger slips by entering on them in the sequence of names the total quantities appearing on the slips which contain the designation of the abstract compiled.

But, if it be an abstract with numbered vouchers, we take from each ledger slip in succession the quantities relating to each voucher, and enter them directly on the abstract on the horizontal line corresponding with the voucher number in the margin. It will be observed that we work in vertical columns, finishing one heading at a time, instead of having to go from page to page, blotting each line before turning the leaf, as is required when carrying the same horizontal line through several consecutive pages.

A vertical strip of paper with the numbers of the vouchers on the edge may be carried from column to column, so as to show the exact line reserved for each voucher.

The work may be checked by reading off the vouchers, following along the corresponding lines to see that the quantities on the abstract agree with them.

The footings of the columns in the double abstracts should also agree with the quarterly totals entered in red ink on the ledger as before described.

NOTE.—In compiling abstracts it is possible that it may be found better to use the ledger slips only to give the sequence of names for each abstract, and to fill in the abstract in the usual manner. Such a course would permit all entries on the journal belonging to the same abstract to be bulked before posting to the ledger, without regard to the exceptions as to abstracts A, C, 1, 2, 3, noted page 248. It is only a question as to which course would in the end be found easiest to practice.

7. Compiling the Returns.

The subsequent course of the abstracts remains to be determined. They may be combined, as now, into two independent returns; or, as has been already suggested, may be consolidated into an Arsenal Return resembling the present inventory.

Whatever course may be desired, means have been provided for carrying it out with economy and dispatch.

CHAPTER XV.

DUTIES OF THE COST CLERK AND OF THOSE RELATED TO HIM IN THE ACCOUNTABILITY FOR VALUES.

OUTFIT.

Stencils.

After the shop-order has been signed, page 142, the book is sent to the cost clerk, who makes out from it the requisite number of tickets, including one for himself. In doing this he will be assisted by using stencils pricked by the cyclostylic or electric pens, which will assure the exact similitude of the order tickets and permit their indefinite duplication.

Racks.

He has in his office a rack similar to that described page 92, in which he classifies the orders according to the appropriations from which payable.

Completed order tickets should be returned through him, that he may know when to close the account.

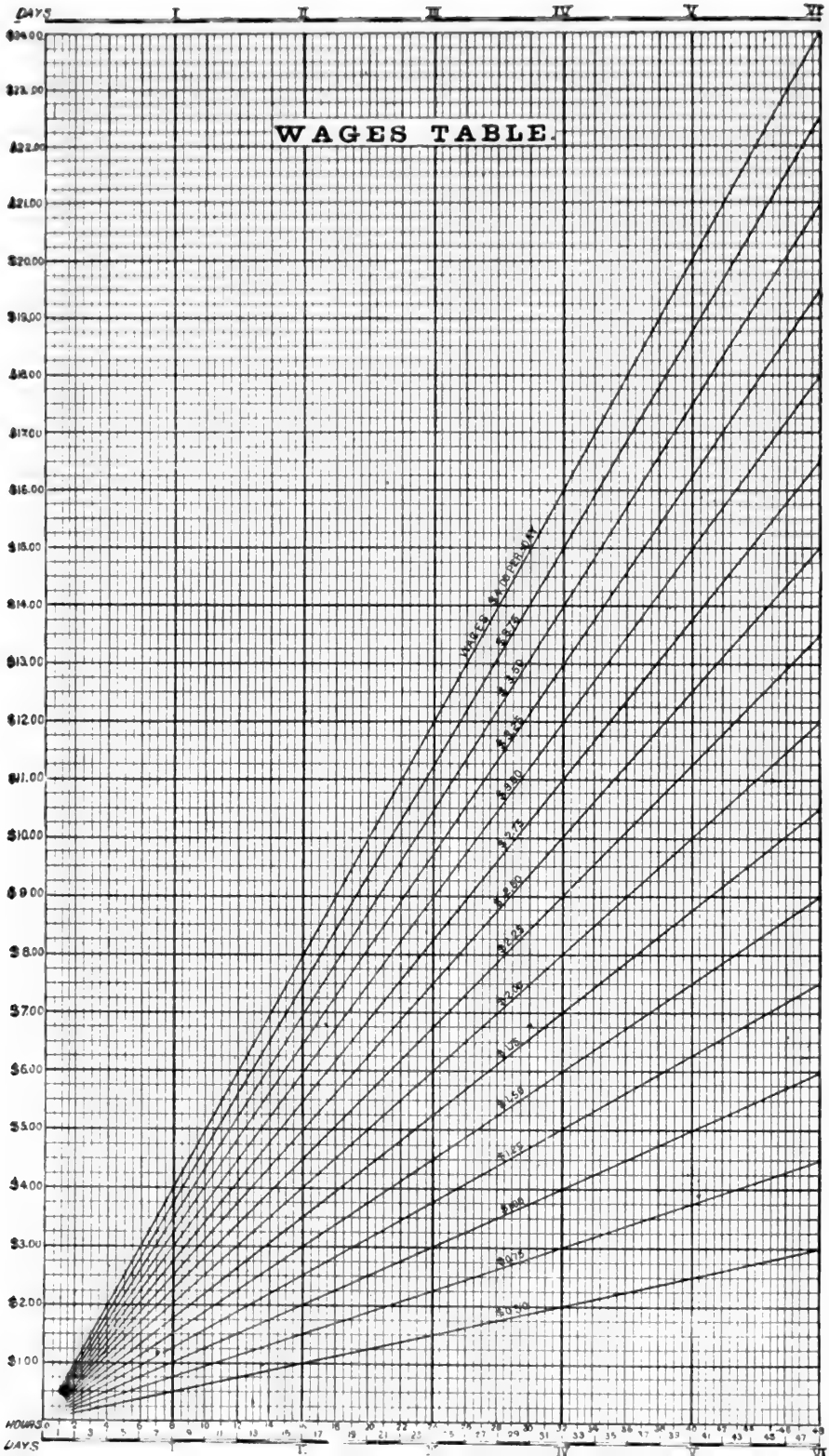
Sorting Trough.

Sorting the cards, of which the cost clerk has much to do, will be facilitated by using V-shaped troughs suited to the size of the cards sorted, in which they will stand with the characteristic side exposed. Movable triangular partitions serve to divide the cards into the assortment desired. Any number of assistants may be at work sorting the same cards at once; they need only be able to read intelligently.

The summation of quantities may be generally made from the cards themselves, particularly from the service cards. This carries out one of the main ideas of the present work: to avoid all work of computation not forming part of the records.

Wages Tables.

In computing the cost of labor, the wages tables shown herewith are very convenient. They are in the long run probably more accurate than separate computations for individual cases,


WAGES TABLE.
DAYS
I
II
III
IV
V
VI
$24.00
$23.00
$22.00
$21.00
$20.00
$19.00
$18.00
$17.00
$16.00
$15.00
$14.00
$13.00
$12.00
$11.00
$10.00
$9.00
$8.00
$7.00
$6.00
$5.00
$4.00
$3.00
$2.00
$1.00
HOURS
DAYS

and take much less time to prepare than any complete tables of figures. To find the value of labor, say at $2.75 per day of 8 hours, for 3 days 7½ hours, all that is necessary is to look out the given time in the lower line and follow up the corresponding vertical until it intersects the 2.75 line; the horizontal passing through the intersection gives the amount of wages with an error due only to mechanical inaccuracies in ruling.

The table shown is intended only as a general illustration of a principle to be applied for each case as circumstances may require. At Benicia Arsenal the following scales were found convenient: The paper was in each case about 18x23 inches, bought ruled in tenths of inches in pale blue. This ruling was overlaid by dark blue and red lines as indicated below. The general idea prompting the use of different scales was, that short jobs would generally be those requiring the most exact account.

Suggested Scales for Wages Tables.

No. of table, at Benicia Arsenal.	No. of spaces between dark blue lines.		No. of spaces between red lines.		Scales. Time (horizontal).			Scales. Money (vertical).
	vert.	hor.	vert.	hor.	Divisions.	Extent.	Max. rate per day for which table is complete.	One space equals
1	3	4	12	25	Hours, quarters and five-minute intervals.	14¾ hrs.	$2.50	2 cents.
2	4	5	32	..	Days, quarter days, hours and quarter hours.	5½ days.	$4.00	10 cents.
3	4	5	8	20	Days and hours.	22 days.	$5.00	50 cents.
Ex'ple in text.	16	4	4	..	Days, quarter days, hours and half hours.	6 days.	$4.00	25 cents.

It will be observed that the use of these tables enables time to be kept in very small fractions, as it scarcely gives the cost clerk more trouble than if it were kept in large units, say, quarter days or hours. This is often a great advantage, particularly when doing many small repair jobs, the cost of which, if the time on each seems too little to be counted, goes to swell unduly that of some other job.

I believe that this will go to meet the tendency to closer time reckoning, which I have reason to believe exists in workshops generally. Some shops get as low in the scale of reckoning as the half hour, though formerly nothing less than a day was counted.

The tables will favor such attempts at accuracy, but with the following slight disadvantages: Since the rulings of the table are of appreciable thickness and of only approximate accuracy, and since values intermediate between the given lines can often only be estimated, and may include fractional parts of a cent, it is evident that the aggregate cost of the labor charged to the several shop-orders for any one day, when the amounts have been computed by the tables, may differ from the total cost of labor for the same day charged on the pay roll. Though the errors due to these inaccuracies will tend to balance each other, there will probably always be more or less difference between the footings. The error should be corrected by altering the most probable items of reported cost, instead of altering the pay roll. It would be foolish to restrict one's self to a large time unit for the mere sake of accuracy in an immaterial detail; one too, which, like much of the fine-spun figuring of shop accounts, is often founded on unsubstantial data. For example, of what good can it be to balance with arithmetical exactness the cost of jobs on which no provision has been made for reporting anything less than an hour's work?

To make the tables as accurate as possible the oblique lines are drawn from hour to hour for each rate instead of joining the extreme points by a straight line, as one might naturally do.

The tables described have been tried at Benicia Arsenal with great success; many men return their time by the quarter hour and no trouble is found in reckoning it. When time costs, as it sometimes does here, a cent a minute, it seems only right to show how that time has been spent as accurately as other considerations of economy will permit.

TIME BOOK AND RETURN OF WORK DONE IN *Machine*

No. 235 NAME **Michael Lannigan*

S-O.	REMARKS.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
784	*Primer-drilling machine*	..	8	4	..	*S.*	..	..	..	..	*A.*	..	*S.*	..	..	..	..
617	*Woodbridge test*	..	..	4	8	..	..	..	..	..	..	..	..	..	..	..	..
107		..	..	..	..	..	5	..	..	..	..	8	..	..	..	..	..
387		..	..	..	..	..	1	..	..	..	..	..	..	..	..	..	..
214		..	..	..	..	..	2	..	..	..	..	..	..	..	..	..	..
213	*Piece work, time record*	..	..	..	..	..	..	8	8	4	..	..	..	..	..	..	..
213	*Drawing dies at 75c. each*	..	..	..	..	..	..	..	..	10	..	..	..	..	..	..	..
49		..	..	..	..	..	..	..	..	4	..	..	..	..	..	..	..
	Money value per day		$2 00	2 00	2 00	Sunday.	2 00	.....	.....	8 50	.....	2 00					
	Time value per day		1	1	1		1	1	1	1	A.	1					

* See pp. 157–166.

† To be inserted in MS. above wherever blank space permits.

Shop ....., FRANKFORD ARSENAL, *April* ....., 1885.

OCCUPATION ..... *Tool maker* .....

17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	No. of d'ys, &c.	Wages.	Amount.	Appropriat'n.	Statement expenditures.	
..	..	*S.*	..	..	..	..	..	..	*S.*	..	..	..	..	..	1½	$2 00	$3 00	A. & E. M.	D.	5
..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	1½	....	3 00	"	D.	5
..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	1⅝	....	3 25	O. O-S.	D.	3
..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	⅛	....	25	A. & E. M.	C.	3
..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	¼	....	50	Ord. Serv.	C.	1
..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	2½	p. w.				
..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	10 pcs.	75	7 50	A. & E. M.	D.	3
..	..	..	..	..	..	..	..	..	..	..	.	..	..	..	½	....	1 00	O. O-S.	D.	3
															8	....	$18 50			
															$18 50					
															8					

† *Recapitulation of—*

Appropriations.		*Statement of Expenditures.*	
Ordnance Service	$0 50	C1	$0 50
Ordnance and Ordnance Stores	4 25	C3	25
A. & E. M.	13 75	D2	11 75
		D5	6 00
	$18 50		$18 50

DUTIES RELATING TO SERVICE CARDS.

Time Book, pages 270, 271.

When the service cards, duly stamped by the foreman, are received by the cost clerk, he sorts them first by names if they require it, and then by shop-orders, and enters the gross results under each shop-order on the time book, form C, Chapter VI.

Except for piece workers, the time book carries the subdivision of the order no further; details of the employment must be looked for on the service cards.

For piece workers the left-hand margin may be ruled, so as to show by the symbols C., O., N. the specific operation for which a special price is paid. As a guide which may sometimes be useful, space is given for brief remark as to the nature of the order. These will be rarely used after the clerks become accustomed to the symbolic nomenclature.

Piece work is similarly reported except that piece units are reported for payment instead of time units.

On the right is space for reference to the appropriation from which the work done is to be paid, and also a column for indicating the proper subdivision of the statement of expenditures. See page 302.

A page of the time book should be reserved for entering service cards relating to services performed outside the arsenal, such as traveling expenses, express charges, telegrams, etc. See page 156.

Cost Sheet, pages 276, 277.

After entering the time the cost clerk sorts all the cards by shop-orders and enters the total value of the services under each shop-order opposite its number on the margin of the cost sheet. The shop-orders are grouped together according to appropriations from which payable, and the total for services under each appropriation entered separately. See page 278. The cards are then filed away in the corresponding pigeon holes until required for the analysis described page 292.

When this has been made, the cards should be tied up into numbered bundles and the numbers over the pigeon holes removed so as to leave them available for other orders.

The cost sheet is a valuable device which I have borrowed from Captain Michaelis. It is a sort of morning report of the cost of orders up to date. The difference between his plan and mine is due to my making but one charge on either the material or service cards. I am thus able to shuffle cards belonging to the same job together, and to enter their aggregate results directly on the cost sheet. By the other plan the charges for labor and material had to be consolidated on separate sheets and then combined on the value sheet.

Soldier Labor.

When soldiers are working in the shops of an arsenal they should be rated at the wages as citizens of the same ability similarly employed. This will avoid the perplexing differences arising in reporting the cost of work done sometimes by enlisted, and sometimes by civil labor, when no price is charged for the soldier's labor and full price is charged for the civilian's. But since the effect of so charging the soldier's time will be to increase the aggregate sum charged for labor beyond that actually paid, and so lead to discrepancies where strict equivalencies should be the rule, the following course is advised:

After charging the soldier's time to the job, credit the standing order for the maintenance of the arsenal and military post with the full amount so charged. (Benicia Arsenal, shop-order No. 1, and Frankford Arsenal, shop-order No. 215. See page 143.)

In this way the cost of the work will be kept uniform; the soldier's pride will not be hurt by evidence that his labor is thought of no account; and the one great object toward which the system tends, to make the cost of work equal the sum of all the expenditures upon it, will be approached. This idea I also owe to Captain Michaelis.

To assist in carrying it out it would be well to have service cards of a different color for enlisted workmen. The peculiar conditions of this case make it an exception to the rule elsewhere affirmed, that labor can never be a credit.

DUTIES RELATING TO MATERIAL CARDS.

Entering on Cost Sheet.

At the end of the day, or early the next morning, the cost clerk should sort the cards received, according to shop-orders to which charges are made, sum up their values and enter them on the cost sheet.

Forwarding Cards.

He should then stamp the cards "Entered by cost clerk," and forward all those bearing entries in the stock section to the stock clerk, except when they already bear his entry stamp.

Filing Cards.

The remaining cards go to the pigeon holes corresponding to the orders to which charges or single credits are made.

Duplicate Cards.

When a card contains a charge to one order and a credit to another, a duplicate card is filed in the pigeon hole to which the credit belongs. The duplicate may be printed or marked so as to be distinguished from those received in the ordinary course of business, and the original should be checked so as to prevent re-duplication. The duplicate need only contain the most essential parts of the original.

Reporting Product.

It has been explained how the product of an order is reported on the material card as the order is completed piecemeal, page 195. Such cards are to be known by being to the credit of the order under which the work is done, by having the price in blank, and also by referring to fabrication. They are to be filed by themselves at the bottom of the pile of cards in each pigeon hole. When the job is completed, and its cost is to be reported, they show just what it has accomplished.

It is far safer, and every way better to report in this way the product of an order, than to assume that the exact number of articles required by the order ticket has been made. It was once tried to report product on the order ticket, indicating departures from the letter of the order on the back of the ticket. But this

prevented piecemeal deliveries, and was also objectionable in that it confused the order simple, and the result of that order, the product

When products thus reported piecemeal, say parts of harness, are afterwards assembled into sets, material cards representing the transfer should be made out.

A note upon the card will call the stock clerk's attention to it, so that he will issue on his journal from the corresponding return "by transfer" the number of components required to complete the set. These he will ascertain from the standard lists, etc.

This course will permit an immediate record of all fabrications to be made without requiring the filling out of a separate card for each class of components assembled.

The contrary course in the present system frequently leads to confusion; as a rule, nothing is reported till all is done, so that the progress made in filling an order requires a special effort to determine it. Yet this knowledge is constantly required.

CASH ACCOUNTABILITY.

We come now to that portion of our trusteeship with which our accountability under different appropriations is concerned. See pages 34, 36. It is almost impossible to dwell too strongly on the idea that the only justification for any expenditure of money or material is the execution of the will of Congress as expressed by law. The law is generally in the form of an appropriation, the conformity with which of every expenditure it is the main object of our cash accounts to demonstrate. So that whatever forms minor accounts may assume, they are useless for accountability unless they tend to combine truly under each appropriation the expenses which it authorizes. There is probably no phase of the proposed system which illustrates better how such complex responsibilities as those imposed by the strict requirements of this trusteeship on the one hand, and the unrestricted employment of the resources of the arsenal on the other hand, may be easily and accurately met.

The Cost Sheet; Daily.

Columns A, B and C are filled by direct summation of the cards, sorted by shop-orders to which a charge is made. The

PROPOSED DAILY COST SHEET FOR *Watervliet*

Shop-order.	Appropriation.	Objects	Services.			Material.		Shop expenses a 3c. per hour.		Gross cost.	
			Time.	$	c.	$	c.	$	c.	$	c.
720	*O. & O-S.*	*R. b. cartridges &c*.....	113	118	10	200	00	3	39	321	49
838	.....	100,000 *rev. ball*.....	10	1	50	7	19		30	8	99
				119	60						
772	*A. & E. M.*	225,000 *friction primers*...	625	156	25	....	..	18	75	175	00
836	.....	400,000 *short primers*.....	....	....	..	500	00	....	..	500	00
837	.....	500 *copper discs*.....	8	4	00	....	..		24	4	24
845	.....	*Dynamo machine*.....	....	....	..	....	..	....	..	....	..
847	.....	2 *f. p. drilling machines*..	3	1	12	....	..	....	09	1	21
				161	37						
			A.	B.		C.		D.		E.	

ARSENAL, *March 3*, 1884, (14″ x ?″)

Total credits.		Net cost.		Per last report.				To-day.				Remarks.
				Total cost.		Balance available.		Total cost.		Balance available.		
$	c.	$	c.	$	c.	$	c.	$	c.	$	c.	
*116	82	204	67	1,079	46	18,920	54	1,284	13	18,715	87	
....	..	8	99	300	24	1,699	76	309	23	2,690	77	*Remittance* $1,000.
1	37	173	63	....	..	11,250	00	173	63	11,076	37	
....	..	500	00	....	..	1,600	00	500	00	1,100	00	
2	00	2	24	20	00	5	00	22	24	2	76	*Completed.*
...	..	....	..	...	..	.....	..	....	..	.....	..	*No work done.*
10	00	Cr. 8	79	595	35	4	65	586	56	13	44	*Completed, charges and balance transferred to S. O. 213.*
F.		G.		H.		I.		J.		K.		

* See page 279.

shop-orders should be grouped according to appropriations from which payable.

Service cards relating to large shop-orders should be re-sorted according to rates of wages; the product of each rate by the time gives the amount for that rate, and the sum of the times and amounts the data for A and B. The cost of services under each appropriation should be indicated separately, as in red ink.

Column D is determined by a fixed percentage of A. See page 166. E is equal to B plus C plus D; F is taken from the daily credit sheet, which see; G is equal to E minus F; H and I, the sum of which is equal to the allotment, were entered from the last report; J is equal to G plus H; K is equal to I minus G.

No charge for shop expenses is made to the standing orders, as they are the very source and cause of this expense.

Charges other than by regular expenditures reported on the cards should be explained by remarks.

When an order is completed, a remark to that effect should be made and the order dropped from future cost sheets. Incomplete orders should be continued so that those on which no work has been done may be determined by mere inspection of the cost sheet for the day.

In the column of remarks should be noted the transfer of the cost of a given order to another order. The occasion for this will arise when, for the sake of explicitness, a special order is given for work which might be done under a standing order, or when it becomes expedient to transfer the cost to another appropriation. In the first case suppose order No. 999 to require the erecting of certain machinery, say a gas works, the cost of which it is desired to know specifically. When completed, the cost is ordered pro-rated between orders 219 P and 220 P on the next day's report. A remark on each sheet should explain the transfer.

The cards belonging to the order transferred should be filed separately until needed for the analysis of the order receiving the transfer.

NOTE.—No attempt is made to analyze the gross cost reported on the cost sheet. Its object is only to determine daily balances and to give a bird's-eye view of the work.

The analysis is an entirely independent matter, and the methods are hereafter described which permit it to be done thoroughly.

PROPOSED DAILY CREDIT SHEET FOR *Watervliet* ARSENAL *March 3*, 1884. (10 x ?)

Shop-order.		Material.				Shop expenses.		Total credit to shop-order.		Appropriation.		Remarks.
Charged.	Credited.	Card No.	Name.	Amount.						Charged.	Credited.	
720	213	16,583	*Punches*	$7	50	....	..			*O-S.*	*A. & E. M.*	
896	"	.....	.....	....	..	$17	50	$25	00	*O. & O-S.*	"	
838	720	16,584	*Scrap lead*	$7	19	....	..			*O. & O-S.*	*O. & O-S.*	
836	"	16,855	*Powder*	100	00	....	..			*A. & E. M.*	"	
"	"	17,601	*Screws*	9	63	....	..			"	"	
								*116	82			* *See page* 277.
807	933	17,842	*Mixed paint*	$1	70	....	..	1	70	*O-S.*	"	
						$17	50	$143	52			

Recapitulation (in Manuscript).

				Totals.				Balances.					
				Dr.		Cr.		Dr.		Cr.			
			Ordnance service	$9	20	....	..	$9	20				
			Ord. & Ord. Stores	24	69	$118	52	....	..	$93	83		
			Arming & Eq. Militia	109	63	25	00	84	63				
				$143	52	$143	52	$93	83	$93	83		

The Credit Sheet; Daily.

a. Credits for material.

After the debit entries have been made on the cost sheet, the material cards on which credits appear are shuffled so as to bring together all those containing credits to the same shop-order, and these are further combined according to the orders to which charges were made. These are then entered as shown: the orders to which charged, the number of the card and the name of the material being given to assist in tracing the card if the entry should ever have to be verified.

b. Credits for shop expenses.

Shop expenses are credited only to certain designated standing orders determined by the character of the order bearing the charge. The appropriations to be charged or credited are determined by the numbers of the corresponding shop-orders as shown in the example.

The recapitulation of these amounts determines the balances to be entered on the monthly Recovery Record.

Proofs.

The sum of the shop expenses must agree with that given by the cost sheet for the same day.

In the recapitulation the sum of the total credits and those of the Dr. and Cr. entries under appropriations must all three be equal to each other.

The sum of the balances in each column of the recapitulation must agree.

The credits for material cannot be proved.

The Recovery Record page 285 (proposed).

The balances due to or from appropriations as shown by the recapitulation on the credit sheet are entered here daily, and the resulting monthly balances are distributed according to the manner explained page 286.

The "No., etc.," in the blank column refers to the employee on whose page of the time book the counter-charge will be found. This paper is kept in the cost clerk's office. It may be in book form.

The Appropriation Sheet (proposed).

We have seen that all expenditures of labor and material must be charged to some shop-order. By further requiring that all shop-orders be referred to some appropriation we make sure that all expenditures shall ultimately be directed to the most probable appropriation. See also page 284. The cost sheet prevents us from overstepping our estimates; the appropriation sheet performs the same office for our allotments of appropriations, and permits every penny appropriated to be spent deliberately, economically and legally. This is the climax of the system as regards cash accountability.

Remarks.

As explained page 289, there is a well-defined difference between material purchased and that expended; this sheet takes notice only of that just purchased. The expenditure of its value is reported on the cost sheet.

The miscellaneous debits and credits allow for the entry of remittances and for the transfer of balances shown by the recapitulation on the daily credit sheet.

The gross balance on the last day of the month should agree with that shown by the abstract of disbursements.

When services and material previously classed among liabilities are paid for, their previous estimated cost should be deducted from the next report of liabilities.

The gross balances and the corresponding totals are entered in red ink, so as to prevent their addition while computing the net balances given below.

The amount of services under each appropriation is obtained by grouping shop-orders under appropriations as explained page 272.

The miscellaneous balances are given, one way or the other, by the daily credit sheet.

This paper should be made out by the chief clerk and the pay clerk, jointly. The form given is for a daily report, but it may, like many of the other papers, be made weekly or monthly, as the Commanding Officer may require.

Watervliet ARSENAL.

PROPOSED APPROPRIATION SHEET

FOR *March 3*, 1884. (? x 8½".)

	Ordnance service.				O. & O. S.								Grand total.	
	Dr.		Cr.		Dr.		Cr		Dr.		Cr.			
	$	c.	$	c.	$	c.	$	c.	$	c.	$	c.	$	c.
By last gross balance	....	..	....	..	.....	..	26,987	25						
By remittance	....	..	....	..	.....	..	1,000	00						
To services from cost sheet	....	..	....	..	119	60								
To material paid for	....	..	....	..	4,000	00								
Miscellaneous balances	....	..	....	..	.....	..	93	83						
Gross balance (in red ink)	....	..	....	..	22,961	48								
Totals (in red ink)	....	..	....	..	27,081	08	27,081	08						
Liabilities, etc., estimated.														
For services (contracted for, etc.)	....	..	....	..	1,000	00								
For material (ordered, etc.)	....	..	....	..	6,000	00								
For remittances due	....	..	....	..	.....	..	500	00						
Net balance	....	..	....	..	16,461	48								
Totals	....	..	....	..	27,581	08	27,581	08						

System of Recoveries (proposed).

(a.) Recovery of Material.

We have seen the advantage of holding all material subject to expenditure under some shop-order; similar reasons require that all material in store shall be held under the appropriation by authority of which it was most probably procured.

Inasmuch as a due regard for economy and convenience will often require the expenditure on one order of material which has been bought cheaply, because in large quantities, for another purpose under a different appropriation, and since the appropriation thus borrowed from should have the means of being credited with the value of what has been so taken, the following course is recommended:

When material is received into store by purchase, let the storekeeper mark it with the designation of the appropriation from which it was bought; this he will find on the back of the card, placed there when the material was ordered. When future issues of this material are made to foremen, the storekeeper should mark the card to the credit of the appropriation from which the material was bought. This he will do in the cost section, where by using the initials of the appropriation no confusion with the shop-order symbols can arise.

Material which has come into store by fabrication, inventory, etc., or has been received by invoice from other posts, should, when taken out for current service, be credited to the most probable appropriation under disbursement at the arsenal in question. The number of such appropriations is generally limited, and little trouble will be found in determining the right one. Strictly military supplies might be credited to Ordnance Service, and materials from Part II to the principal appropriations disbursed in manufactures.

Note.—When material in current service is similarly taken, the shop-order under which it has been held will receive a similar credit. In due course this credit will be transferred to the proper appropriation, so that in the end the same result will be attained as when the material taken from store was directly credited to the appropriation from which it was bought. All depends upon keeping the orders under their corresponding appropriations.

Watervliet ARSENAL, RECOVERIES FOR MONTH OF *March*, 1884. (PROPOSED.) (8 x ?).

Day of month.	Ordnance service.				Ordnance & Ordnance Stores.				Arming and Equipping Militia.				Repairs of Arsenals.				Proof.			
	Dr.		Cr.		Dr.		Cr.		Dr.		Cr.		Dr.		Cr.		Dr.		Cr.	
	$	c.	$	c.	$	c.	$	c.	$	c.	$	c.	$	c.	$	c.	$	c.	$	c
1	....	..	90	80	6	17	....	..	84	63	....	..	....	..	....	..	90	80	90	80
2	17	12	....	..	....	..	10	00	....	..	....	..	....	..	7	12	17	12	17	12
3 (p. 280)	9	20	....	..	....	..	93	83	84	63	....	..	....	..	....	..	93	83	93	83
30	....	..	6	18	....	..	....	..	6	18	....	..	....	..	....	..	6	18	6	18
31	....	..	....	..	....	..	....	..	....	..	....	..	....	..	....	..	....	..	....	..
Total	26	32	96	98	6	17	103	83	175	44	....	..	....	..	7	12	....	..	....	..
Balance	70	66	....	..	97	66	....	..	....	..	175	44	7	12	....	..	....	..	....	..

Disposition of Recoveries on Time Book (in Manuscript).

Page.	$	c.	Page.	$	c.	$	c.	Page.	Page.	$	c.
301	50	00	201	60	00	60	00	201	401	7	12
403	20	66	301	25	32	50	00	301			
			401	12	34	25	32	301		7	12
	70	66				7	12	401			
				97	66	12	34	401			
						20	66	401			
						175	44	403			

NOTE.—The "Pages" refer to the shop number of the operatives on whose wages the charges are made.

These credits having been collated on the credit sheet for the day, are consolidated monthly on the Recovery Record, and an equivalent value of labor which would be normally charged to the appropriation receiving the credit is charged to the appropriation under which the special work is done. We thus repay, say Ordnance Service, for the material which it has contributed to the special job by transferring to the special job a portion of the charges for labor normally payable out of Ordnance Service. The account is squared by a counter-charge for labor rather than for material, because a more exact distribution of the amounts may thus be made.

The result of this course will be that the same work will, whenever repeated, be consistent in its cost, whether all of its material has to be bought for it, or whether it so happens that it may be supplied in whole or in part out of material on hand; and this cost, truly reported, will be that by which the appropriation authorizing the expenditure is diminished. The following example illustrates the idea:

We make an estimate for 100,000 friction primers based upon our knowledge of the true cost of previous work of the same kind. In setting about the work we find sufficient metal on hand of the proper thickness which has become obsolete from a change in the model of the cartridge for which it was originally bought. If we use this without charging it to the primers they become absurdly cheap and their reported cost becomes misleading. If we do charge it and do nothing more, the saving is not apparent; but if we apply the saving to relieve the cartridge appropriation, we shall have more money for making cartridges, which will be fair.

It must be remembered that the credit need not diminish the reported cost of the cartridges, since questions of cost are independent of appropriations and disbursements. See page 289. But we shall be able to make more cartridges at the same price for the same appropriation.

The only alternatives to the course recommended are: 1st, to buy specially for every job the material required for it, regardless of whether it is already on hand and can be spared for it or not;

2d, to count material on hand as costing nothing to the appropriation, making estimates only for supplementary funds for actual expenditure.

The first alternative is cumbersome and would often be extravagant, and the second is misleading and, when the material employed was bought under a different appropriation from that under which it is consumed, would be unfair, as it would rob one appropriation for the sake of helping another. Such a practice often repeated would increase unduly the apparent cost for material, say of cartridges, if this cost, instead of being finally determined by the indications of the cost sheet, as is here proposed, were arrived at from the ratio of product to appropriation, as was done at the National Armory in 1878.

When the material on hand is held under the appropriation under which it is to be consumed, there is no transfer between appropriations, and the adoption of the second alternative would do no wrong if the material said to be available were always actually used as intended in the estimate. But we can never be sure of anything in advance, and hence I believe that the safest general rule would be to make estimates for funds according to the full estimated cost of the work and to apply the saving due to the use of surplus material on hand towards continuing the accumulation of a similar surplus as a timely provision for future emergencies.

There are certain conditions in which this procedure would appear absurd, but notwithstanding, I believe that the general rule would give the best results. For example, let us say that to make certain repairs to quarters, $100 in funds will suffice, provided that material on hand be used, the material having been bought long ago, say for gun carriages. Wooden carriages have become obsolete, and the timber which it is proposed to use has been stored so long as to be in dire danger of dry rot; there is therefore every reason that the timber should be used on the quarters, *provided* the gun carriage account be indemnified. This I would do by estimating the repairs at their full cost, which the Chief of Ordnance should know before reducing thus the general resources of the department, and recovering from the appropriation for

Repair of Arsenals the value of the timber actually used with which to purchase, say steel plates suitable for modern carriage work, or to be simply held to the credit of the appropriation for such other disposition as may be required.

In this view material is a continuing form of the money originally appropriated, which happens to be on hand because it can be no longer returned to the treasury, as is done with unexpended balances of money proper at the end of the fiscal year. Advantage cannot be derived from this accident otherwise than by changing the form in which the money is held to one more suitable to the purpose for which it was appropriated, under the general discretionary authority by which it was first procured; otherwise we defeat the intentions of Congress, which, in appropriating for the purchase of material for gun carriages in one year, could never have intended it to be applied to the repairs of quarters in another year. The only escape from this position seems to be that the conclusion of the fiscal year bars all further responsibility under appropriations and leaves all unused material open to whatever application may be desired. If this be so, why wait till the 30th of June to put such doctrine into practice?

I owe this extension of the earlier principle of recovering shop expenses, see next article, to Captain Michaelis, who used both methods to advantage while applying the system at Frankford Arsenal.

(b.) Recovery of Shop Expenses.

The charge for current shop expenses made to any job is similarly a credit to the most probable appropriation. By the methods described page 149, these have been directly charged to the special job receiving them whenever it was possible to place them at the moment the charge was incurred. But there are many expenses in the nature of "fixed charges" which can only be determined annually by the methods shown pages 73, 166, 217. These are repaid to the proper appropriations by means similar to those just described for material. See illustration with example of credit sheet.

RECONCILING COSTS WITH DISBURSEMENTS.

I have vainly tried to find some simple current method of reconciling the cost sheet with the cash accounts, since this would establish the aggregate truth of the cost sheet before the highest court of audit known to military accountability. I am convinced, not only that this is impossible, unless either the papers are very much complicated or unless substantial truth is neglected for the sake of striking a balance; but I also believe that the same result is indirectly attainable by other means already described.

The trouble is: 1st, that we are always paying in one month for material which we expend in another; 2d, that we do not necessarily expend at once all that we pay for; 3d, that we cannot always tell whether what we are expending has been paid for or not, still less whether it has been paid for in the time covered jointly by the two sets of accounts or previously.

There would be no trouble in accomplishing the reconciliation if material were like labor, which is expended as soon as received, being therefore always a charge and never a credit, and which is paid for monthly in the period covered by the joint accounts. In such a case the monthly cost sheet would be a repetition of the Abstract of Disbursements, having its totals under each appropriation distributed according to a different list of agencies, the shop-orders serially arranged.

But in regard to expressing the relation between the payment for material and its expenditure, the following table shows how various its conditions may be:

MATERIAL.
- A. Paid for in period in which expended.
- B. Not paid for as above, but
  - 1. paid for previously.
  - 2. paid for afterward.
- C. Not expended in period in which paid for.

The variety of these conditions is increased by the fact that any one of them may be only true as to part of the material in ques-

tion, and that different lots of material of the same name may be in all of them at once.

In all such cases the old question between clerks and foremen will arise: How is the foreman to know whether the material he is using has been paid for or not? and how is the clerk to know to which of the classes named the material which the foreman has been expending belongs? Then, if the clerk could know, how is he to express the facts without greatly elaborating the accounts?

The attempt to distinguish these differences, if carried out conscientiously, would paralyze the manufacturer; and, if achieved, would only prove the *aggregate* truth of the cost sheet. The distribution of the charges within this aggregate will always, whatever precautions are adopted, be within the discretion of the immediate authority.

I discuss this at length because it has been from the first the goal at which I aimed, and because it has attracted the attention of others as well as myself.

I find the proof of the aggregate truth of the cost sheet in the following considerations:

A. As to services. This is proved by direct comparison with the aggregate disbursements for services on the abstract of disbursements.

B. As to material. This is proved by the two necessities: first, of accounting for all material received, whether paid for or not; and second, of charging to *some* shop-order all material expended or subject to expenditure, whether by accident or design.

It would of course be quite possible to strike a yearly balance sheet debiting all remittances and the aggregate value of the last inventory and crediting cash balances, special expenditures not for manufactures, and the aggregate of the present inventory. The balances, generally speaking, should be the aggregate cost of the fabrications at their reported prices, together with a correction to the account of shop expenses which should be dealt with as described page 217.

Having in view so comprehensive an auditing of the administration of the arsenal, the inventory would acquire an importance which the use now made of it does not justify.

ANALYSIS OF COST (PROPOSED).

The analysis need be carried no further than the circumstances of each case require; but the elements of Plant and Work should always be separated. The examples given show to what extent it is possible to carry the analysis. In the tables the full symbols described in Chap. IX are not given; viz., A; F, &c., represent *any* objects, and 1; 2; 3, &c., *any* operations.

We begin by treating separately the accounts for services and material as independent elements in the result shown by the consolidated analysis.

(a.) Services.

We sort the service cards first, according to P., A., T. and W.; or simply as shown, according to P. and W., omitting the distinction between A., T. and W., see page 102; then, each class according to objects, and each object according to operations. The cards belonging to each operation are then divided according as the services were paid for by the day, piece or job, and each resulting pile of cards is re-sorted according to rates of wages, *i. e.*, prices per unit.

NOTE.—*Job* is a term here used for outside services, *piece* and *day* relate to work within the arsenal.

We can then sum up the time of each grade of labor and enter it with its aggregate cost. Next after the day work comes the piece work on the same operations similarly arranged, but having also in brackets the time reported spent on the operation by the daily service cards. See page 154. Job work is like piece work, but no time is reported.

Having completed the entries under any one operation, we extend their amounts under N. This gives both the aggregate time spent on that operation and the cost of it, and serves to answer many important questions which would be more often asked if there were any ready way of answering them truthfully.

The total time and cost of the operations on one object being entered under O. gives the totals for that object, and so on. The remark about photographs is supposed to refer to the special

_____ ARSENAL, _____, 188 . (10½" x ?.)

PROPOSED ANALYSIS OF SERVICES PERFORMED ON COMPONENTS OF SHOP-ORDER NO. _____

Nature of services.	Charged to			Rate per unit.		No. of units.		Cost.		Total time units.			Amounts. N.		Amounts. O.		Amounts. C		Remarks.
	C.	O.	N.	$	c.	Pieces.	Time.	$	c.	N.	O.	C.	$	c.	$	c.	$	c.	
Day.	*P.*	*A.*	7	....	375	....	40	15	00										
Day.	..	..	..	....	125	....	10	1	25	50	..	....	16	25					
Day.	..	..	9	....	125	....	6		75	6	56								
Job..	..	..	..	....	50	4	....	2	00	..	..	....	2	75	19	00	....	..	*Taking photographic views.*
Job..	..	*F.*	6	1	00	8	....	8	00	..	..	56	8	00	8	00	27	00	*Repairing clocks.*
Day.	*W.*	*A.*	1	....	375	....	59	22	12	59	..	....	22	12					
Day.	..	..	2	....	3125	....	80	25	00										
Day.	..	..	..	....	125	....	456	57	00										
Piece.	..	..	..	....	10	125	....	12	50	580	..	....	94	50					
				....	....	....	44	....	..										
Piece.	..	..	4	....	5	247	....	12	35										
				....	....	....	91	....	..										
Job..	..	..	..	....	50	....	....	....	50	91	730	....	12	85	....	..	....	..	*Expressage.*
Job..	..	..	100	....	25	3	....	....	75	..	..	730	....	75	130	22	130	22	*Telegrams.*
												786	....	..	....	..	157	22	
										Days...		98¼							

employment of an outside expert who is paid for his services by the job. The illustration is not fortunate, as it implies a charge for material.

(b.) Material.

The analysis of material is conducted on the same general plan. The material cards are sorted down to operations and those of the same name and price are combined and entered as shown. When credit entries are shown, the quantity credited may be deducted without comment if at the same price as that charged; if at a different price, a separate entry should be made and the cost deducted before extension to the columns headed N., O., C. If the credit entry should exceed the debit entry, the excess should be noted in the remarks and be deducted from the total under C.

It will be remembered that charges for material herein refer only to material expressly procured for any one object or operation. There is no cumulative charge for material in transit through the different stages of manufacture. To determine the cost of material up to a certain point, we must include all charges upon the different components of the object in question by a process which is quite the reverse of the analysis of which we are treating. This applies to the charges for services as well.

(c.) Shop Expenses.

If these are uniform throughout the arsenal, see page 218, they can be determined in gross or for each operation from the time given in the analysis of services.

But if they vary for the different departments, in case a given operation on the same object has been performed in more than one department, which is very improbable, the service cards belonging to that operation should be further sorted according to departments, and the shop expenses for each department entered in the column of cost. The nature of the charge should be entered, by remark in the first column, as "shop expenses."

When a standing order is analyzed, the credits it has received for shop expenses charged to orders under different appropriations, should be deducted from the gross cost of services in order to

..... ARSENAL, ..., 188 . (10" x ?.)

PROPOSED ANALYSIS OF MATERIAL EXPENDED ON COMPONENTS OF SHOP-ORDER NO. .....

Charged to			NAME	Quantity.	Unit	Price per unit.		Cost.		N.		O.		C.		Remarks.
C.	O.	N.				$	c.	$	c	$	c.	$	c.	$	c.	
P.	*F.*	1	*?*	75	*?*		02	1	50	1	50					
		2		5		1	00	5	00							
				3		1	00	3	00							
				4			50	2	00	10	00					
		3		6			03		18		18					
		5		3			04		12		12	11	80			
	G.	6		2			02		04		04		04			
	H.	4		131			05	6	55							
				20			25	5	00	1	55	1	55	13	39	*Credit* $10.00 *charged to S-O.* 214, P.
W.	*F.*	1		43		1	00	43	00	43	00					
		2		1			50		50		50	43	50	43	50	
								66	89					56	89	

make it agree with the cost record. These credits were earned by no object or operation, being merely assigned as convenience required. See page 281.

Consolidated Analysis.

This gives one a general view of the entire subject, particularly with regard to the quantity and kind of labor required for future work of the same kind.

To compile this analysis we first sort the service cards according to shops, then according to nature of service, then according to P. and W. (A. and T. also, if desired), and then according to rates of wages, say per day. In each resulting category we add up the time, reduce it to days and enter it as shown. Shop expenses may be bulked as shown, or entered as described above. The same form may be used for comparing total day work and piece work; so also of the other forms, which will be found adapted to a variety of comparisons.

..... ARSENAL, ..., 188 . (10½" x 7.)

PROPOSED CONSOLIDATED ANALYSIS OF COST OF SHOP-ORDER NO. ..... FOR .....

Services.									Amounts for										Remarks.
Nature of.		Days worked.							Plant.		Attendance.		Tools.		Work.		Total.		
What.	Where.	Rate per day.		P.	A.	T.	W.	Total for shop.	$	c.	$	c.	$	c.	$	c.	$	c.	
Day.	200	3	00	5	..	..	7.1	....	15	00	....	..	....	..	21	37			
		2	50	..	..	..	10.	....	....	..	....	..	....	..	25	00			
		1	00	..	..	..	39.	61.1	....	..	....	..	....	..	39	00			
																	100	37	
Day.	400	3	00	..	..	..	0.2	....	....	..	....	..	....	..	....	75			
		1	00	2	..	..	18.	....	2	00	....	..	....	..	18	00			
Piece.		2	27	..	..	..	5.4	....	....	..	....	..	....	..	12	50			
		1	09	..	..	..	11.3	37.1	....	..	....	..	....	..	12	35			
																	45	60	
																50	....	..	*Expressage.*
Job..	Z.			..	..	..	....	....	....	..	....	..	....	..	....	75	....	..	*Telegrams.*
	"			..	..	..	....	....	8	00	....	..	....	..	....	..	....	..	*Clocks.*
	"			..	..	..	....	....	2	00	....	..	....	..	....	..	11	25	*Photographs.*
Total services				7	..	..	91.2	98.2	27	00	....	..	....	..	130	22	157	22	NOTE.—*The columns headed A., T. (Attendance, Tools) are to be filled when required as is shown for P. & W. in the example.*
Shop expenses @ 3c. per hour									1	68	....	..	....	..	21	90	23	58	
Material per report									13	39	....	..	....	..	43	50	56	89	
Totals									42	07	....	..	....	..	195	62	237	69	

MISCELLANEOUS PAPERS.

Pay Book (proposed).

(a.) For day workers: By adding vertically the time units reported each day on the time book the time value of the day's work may be determined for each man and its money value be posted into a book. Form A, page 60, ruled for values instead of for time, would serve this purpose.

(b.) For piece workers and for outside services a similar course may be followed, posting directly the money value of the units made in the pay book.

(c.) For men working partly by the piece and partly by the day: The money value of their earnings should be similarly entered.

Proof.

The sum of the daily earnings on the pay book should agree with that of services charged to shop-orders on the day's cost sheet, and with the difference between the total daily pay-roll and the aggregate value of the absent cards for the day. See page 153.

Use.

At the end of the month the daily earnings may be added up transversely and the denominations required to pay the corresponding workmen be extended as shown in the example.

This plan permits the money needed for the pay-roll to be conveniently and accurately determined without necessarily waiting for the computation of all the contributory items. These have been proved from day to day by the operation of sorting the service cards.

By adding a place for signatures the pay book may be used for the retained copy of the pay-roll. This idea I owe to Captain Michaelis.

Return of Hired Men (now required).

This is intended principally to classify the pay-roll according to appropriations from which payable. To compile it the cost clerk goes over the time book and indicates the appropriation

PRESENT FORM.

RETURN OF HIRED MEN EMPLOYED AT *Watervliet* ARSENAL FOR THE MONTH OF *September*, 1884. (17½" x 16¼".)

No.	Name.	Trade or occupation.	How employed. (State here the specific duties of each man.)	Days employed.	Wages.		Amount chargeable to appropriations for								Total amount	
							Ord. service, 1885.		Ord., Ord. Stores, etc. 1885.		Repairs of arsenals, 1885.		Arming and equipping militia, 1885			
					$	c.	$	c.	$	c.	$	c.	$	c.	$	c.
					Per year.											
1	*Chas. Walters* ..	*Chief clerk.*	*Office duties*	1 *mo.*	1,650	00	33	63	33	62	..	..	67	25	134	50
6	*Chas. Holman* ..	*Master harness maker.*	*Superintending work in harness shop*	25⅝	*Per day.* 4	00	..	..	25	00	..	..	77	50	102	50
10	*Andrew Hölz* ...	*Carriage maker*.....	*Repairing siege carriages, making band saw blades, parts for Gatling carriages & incidental repairs*...	26⅞	2	50	..	..	35	00	23	44	8	75	67	19
11	*James Peters* ...	*Carpenter* ..	*Making boxes for packing*.....	*Piece work.*			..	..	20	34	..	..	51	79	72	13
							33	63	113	96	23	44	205	29	376	32

from which each shop-order is payable. See pages 143, 272. The amounts under each appropriation being summed up, the proper credits given, see page 286, and the principal specific duties of the workman determined from the symbols, the result need only be transcribed to form the return required.

NOTE.—The time book may be divided among several helpers for the simultaneous computation of its data. When completed it may be kept as the retained copy of the hired return. (Captain Michaelis.)

It is worth while to notice the difference between this and the present method of making this return, particularly if the time is kept on form B, page 60. In such a case the Commanding Officer usually distributes the pay-roll among the appropriations rather according to the balances available than according to the purposes on which the time paid for has actually been expended. The reason for this lies in the nature of the time records, for these are so voluminous, scattered and incoherent, covering as many pages for each shop as there are working days in the month, and with the occupations of the men so confusedly stated in the cramped space allowed for them by the extended language required, that confining oneself to the book, it is quite impossible to take a comprehensive view of any one man's employment. The balance remaining under each appropriation is then the one thing most certain and tends most strongly to determine the distribution of the charge.

The Monthly Statement of Expenditures, Present Form (now required).

This is a cash paper, not belonging to the accountability, in the form of a single abstract serving to classify the expenditures solely with reference to their purposes, without reference to appropriations, objects or persons.

The list of agencies resembles in many of its features that of the standing and other shop-orders; but the classification is not exact, the pay of clerks being included with the purchase of animals, etc.

PRESENT FORM. (10½" x 16".)

STATEMENT OF EXPENDITURES for Permanent Improvements, Ordinary Repairs thereof, and for Miscellaneous Articles, including the Purchase, Manufacture and Repair of all kinds of Ordnance, Ordnance Stores, &c., at ..... during the month of ....., 187 .

A. PURCHASE OF LAND, including improvements thereon at the time of purchase		
B. PERMANENT IMPROVEMENTS, viz.:		
1. Erection of buildings	$	
2. New machinery		
3. *Shop fixtures		
4. Grading grounds, making roads and walks, planting trees, &c		
5. Mill-dams, canals, sewers, &c.		
6. Improving water power at Rock Island, Ill.		
Total for permanent improvements		$
C. ORDINARY REPAIRS OF–		
1. Buildings	$	
2. Machinery		
3. Shop fixtures		
4. Grounds, roads, walks, &c.		
5. Mill-dams, canals, sewers, &c.		
Total for ordinary repairs of buildings, machinery, grounds, &c.		$
D. MISCELLANEOUS, viz.:		
1. Purchase and manufacture of armament for fortifications	$	
2. Purchase, manufacture and alterations of small arms, spare parts and appendages		
3. Purchase and manufacture of field and siege carriages, caissons, equipments, accoutrements and all other ordnance stores not before mentioned ..		
4. Repairing, cleaning, overhauling and preserving ordnance and ordnance stores		
5. Purchase of animals, vehicles, &c., all expenses for repairs, &c., not chargeable to any of the foregoing		
Total for miscellaneous		$
GRAND TOTAL		$

I CERTIFY that the foregoing report is correct.

.....

Commanding.

NOTE.—The total expenditures reported on this sheet must agree with the amount reported on the Abstract of Disbursements for the corresponding month.

* Shop fixtures embrace shafting, hangers, pulleys, gearing and belting connected therewith.

Inasmuch as this paper is required to agree with the monthly abstract of disbursements, it can take no heed of the value of material bought in previous months and expended in this one, nor of the disposition made of material paid for in this month, but not expended.

NOTE.—The term "expenditure" in the title refers solely to money; it is a term rather loosely used in military accounts, having three separate meanings given to it.

Remarks.

The requirement that the total expenditures reported should agree with the total reported on the abstract of disbursements for the same month complicates the preparation of this paper and deprives it of some of its value. Otherwise, a simple statement of the cost to date of the standing orders and a corresponding classification of orders completed would give the information required, without regard to when the material expended happened to be paid or.

Preparation, Present and Proposed.

Under existing requirements we must re-analyze the time book according to the classification given in the statement in order to prepare a double abstract, the headings of which will be the classification adopted and the agencies the names or numbers of the individual operatives.

The right-hand column of the time book provides for entering opposite each expenditure for services of the same kind a reference to the proper heading of the statement. This may be an abbreviation; thus B—2 would mean new machinery; B—3 permanent improvements to shop fixtures; C—5 ordinary repairs to mill-dams, canals, etc. See forms, pages 271, 301.

Should the present form of this paper be continued, the standing shop-orders should be cast with reference to its requirements. Otherwise the time book would need contain both the S-O. and C. columns given on the service cards, to the great hindrance of the progressive consolidation of the arsenal accounts, which is so much to be desired.

To illustrate: take B—4 and C—4. At Frankford Arsenal these would correspond to S-O. 223 P. and S-O. 223 W. respectively,

and would require separate lines for P. and W. on the time book. Now, since all orders must be treated alike, every other order might be entered as P. or W., and many as A. or T. besides, thereby at least doubling all the headings of the time book and the labor of combining them and distributing them among the appropriations.

But if, on the other hand, permanent improvements and ordinary repairs of grounds have each a separate shop-order, there will be only *one* more order to be provided for; or if, still better, the statement attempted no distinction which could not be easily defined, the labor would not be at all increased.

A similar analysis of the material purchased during the month, whether expended in it or not, will complete the data needed for the preparation of this statement. This should be done by the pay clerk.

As a general thing it must be remembered that however extended our system of standing orders may be, it will always be much easier to combine them into any such groups as this statement requires than to analyze the showings of any that cover too much ground. Wine and water may be easily mixed, but once mixed, it takes the still to separate them.

Abstract of Disbursements (now required).

This paper logically should be a consolidation of all the disbursements for the month: first, for services, comprising the footings of the appropriation columns of the hired return and individual vouchers similarly distributed; and second, the footings of the appropriation columns from the monthly abstract of purchases. See page 257. If the return of hired men could be made to embrace external services as well as internal services, it would become a parallel paper to the abstract of purchases proposed, and the abstract of disbursements could then be made in two lines, one for services and the other for material.

PRESENT FORM

ABSTRACT OF DISBURSEMENTS AT _____

	Date of payment.	Number of voucher.	To whom paid.	Nature of the disbursement. State here *distinctly* KIND, QUANTITY, and PRICE PER UNIT of the principal articles in each voucher, on as many lines as may be necessary. Vouchers for miscellaneous stores—such as stationery, hardware, &c.—embracing many items, will be stated in general terms. Such phrases as "for the purchase of," &c., should be omitted.	Ordnance Service, 1885. For the ordnance service, required to defray the current expenses at the arsenals; of receiving stores and issuing arms and other ordnance supplies; of police and office duties; of fuel and lights; of stationery and office furniture; of tools and instruments for use; of public animals, forage and vehicles, incidental expenses of the ordnance service, and those attending practical trials and tests of ordnance, small-arms and other ordnance supplies. $100,000.		1. Manufacturing metallic ammunition for small-arms. $100,000.	
					$	c.	$	c.
1								
2								
3								
4								
5								
6								
7								
8								
9								
10								
11								
12								
13								
14								
15								
16								
17								
18								
19								
20								
21								
22								
23								
24								
25								
26								
27								
28								

IN PART. 29" x 19".

BY....., IN THE MONTH ENDING ....., 188 .

ORDNANCE, ORDNANCE STORES, &c., 1885.																	
2.		3.		4.		5.		6		7.							
Overhauling, preserving & cleaning new ordnance stores on hand at the arsenals.		Purchase & manufacture of ordnance stores to fill requisitions of troops.		For mounting and dismounting guns and removing the armament from forts being modified or repaired, including heavy carriages returned to arsenals for alterations and repairs, and other necessary expenses of the same character, and for repairing ordnance stores in the hands of troops and for issue at the arsenals and depots, and for extra-duty pay for enlisted men detailed for ordnance service.		Infantry, Cavalry, and Artillery equipments, consisting of clothing-bags, haversacks, canteens, and great-coat straps; and repairing horse equipments for cavalry troops.		Horse equipments for cavalry, harness for field and machine guns and for cavalry forge carts.		Ammunition, tools and material for target practice.		Total. O. & O.S.		**Arming and Equipping the Militia.**	
$20,000.		$115,000.		$25,000.		$75,000.		$40,000.		$25,000.		$400,000.		$200,000.			
$	c.	$	c.	$	c.	$	c.	$	c.	$	c.	$	c.	$	c.		

Monthly Work Report (now required).

1. Completed fabrications are compiled from the material cards, page 274, or from the ledger entries for the month under abstract B. The prices are to be obtained from the analysis of cost. See page 297.

2. Incomplete fabrications are reported by the cost clerk, who adds up the days' work done on them from the service cards found in the corresponding pigeon holes.

3. Work done under standing orders is reported in the same way; thus, "$127\frac{1}{2}$ days' work in the maintenance of the arsenal and military post." (S-O. 215 F. A. or, S-O. 1 B. A.)

4. Orders on which no work has been done are reported by simply enumerating the empty pigeon holes for service cards, and giving the purport of the corresponding orders.

PRESENT FORM. 14" x 10".

MANUFACTURES AND OTHER WORK DONE AT THE *Watervliet Arsenal* DURING THE MONTH ENDING *January 31*, 1885.

Men employed.			(Enter the class.) Class 2.				Class 3.				Class 7.			
Grades.	Hired.	Enlist'd.	Battery wagon and limber, experimental.				Fuze plug wrenches.				Bayonet scabbards, stee..			
Clerks and draughtsmen	5													
Master workmen	7													
Mechanics	81													
Helpers and shop tenders	16													
Laborers and stablemen	23													
Messenger and watchman	2													
Non-com. officers	....	8												
Privates	....	21												
Totals	134	29												
Fabricated and prepared for issue							4				300			
Estimated cost or value per piece, pound or M...							$1.20				88c.			
Unfinished stores on hand			1								1,800			
Date of order on which fabricated			Jan. 13 1882.				O. S. 2661. Dec. 22, 1884.				July 21 1884.			
Number remaining to be fabricated on order											2230			

OTHER WORK DONE.

Tin roof of officers' quarters repaired and painted. Partition put up in paint shop. Pumps and wells at barracks and stables repaired and cleaned. Gas pipes and fixtures extended over machines and work-benches. 1st floor machine shop, 1 shaping machine put up in machine shop.

PRIVATE WORK.

It may sometimes be permitted to have work done at the expense of private parties, the time of the workmen being dropped from the rolls. The ordinary manner of doing this has never been quite satisfactory to me; since, on the one hand, the officer or foreman ordering the work done has no absolute certainty that the person for whom the work is done will satisfy the workman's claim; nor, on the other hand, does the temporary employer always feel that his interests are guarded as they would be in the ordinary course of business. For example, the workman may drop half a day by going home, and yet may claim it as private work, etc.

To meet these objections, and also to satisfy the general rule, that all time must be accounted for on the cards, a standing order is established for private work, say shop-order No. 16.

Then any small jobs, say repairing an officer's saddle, which are not of sufficient importance to require an order to themselves, are charged to No. 16, and are treated like any other order as far as the supervision of the foremen is concerned.

At the end of the month the cost clerk should sort these according to the names of creditors and make out bills for payment. When paid, he or the Officer in Charge of the shop should require the workman to receipt each card, preferably by the mark of the ball of the right thumb. See page 153. This settles his claim forever, and disposes of the charge that might otherwise be made that private work is done at public expense. It also makes a positive record, showing what was done, and for whom; whereas dropping the time only gives but a negative indication, which, as far as the records are concerned, is of no value whatever.

CHAPTER XVI.

APPLICATION OF SYSTEM TO PRIVATE SHOPS.

I have applied the principles proposed in the preceding pages to the business with which I am most familiar in such a manner as to test their fitness to the utmost of my power; but have refrained from applying them specifically to other affairs, in which conditions would probably vary too much for rules made for one set to hold for them all. I shall be satisfied to have suggested from my own necessities the means by which others may work out their own accounts, knowing that if fairly done the result must be true, for its foundations will be true.

It is not to be expected that many private shops will find it to their advantage to carry out all the measures of accountability related herein. I have consequently excerpted the following portions of the book, so as to give a general idea of the principles underlying the system for the use of administrations whose responsibilities are self-contained. The references to arsenal work can be easily paralleled.

The only point upon which it seems necessary to dwell distinctively relates to the determination of the miscellaneous, or shop expenses. See pages 73, 142, 149, 166, 218. In addition to the sources of expense to which government establishments are subject, which might be called mechanical, there are others which may be called civil, such as interest, taxes, insurance, legal services, the cost of sale, etc., to which private shops have to contribute.

I can see no difficulty in apportioning these precisely as has been done with the mechanical expenses. For example, interest, taxes and insurance should be charged, as far as they can be discriminated, against those portions of the establishment to which they belong. Thus the load or extra rate charged for shop expenses (column D, page 276) would be less for work in a stone

yard than for work in a varnish room, say heated by steam, in the same establishment. Expenses which cannot be assigned must go into a miscellaneous account, to be distributed among other standing orders according to circumstances.

Having thus determined the estimated cost of the fixed charges in each department for the current year, should a sudden increase in work permit the employment of additional labor without increasing the plant, we may readily determine how far our charge for shop expenses may be reduced; for the divisor being increased while the dividend remains approximately the same, the quotient will be less. This will show how far work may be profitably "rushed."

Portions of this book especially relating to private workshops:

Chapters II; III; IV; VI, 57–65; 70–75; VII; VIII; IX; XI; XII; XIII, 168–179; XIV, 243–249, 260, 261; XV, 266–282, 289–299, 306–308.

APPENDIX.

THE SHOP-ORDER SYSTEM OF ACCOUNTS.

Extracts from a paper read before the American Society of Mechanical Engineers, Chicago, May 26, 1886.

I.

LET us imagine the art of music before its notation was devised. Think of the strains which might have been immortal, but which died, as voices die, and were lost. Imagine the energy wasted in repetition; the effort beginning afresh with each new learner of each new tune, enlarging his own experience merely and leaving no vestige to guide another's way.

Look forward, on the other hand, and imagine it possible to catch and fix the vibrations of an untrammeled voice seeking expression in speech or song. Is not this the ideal toward which stenography and phonography are but instinctive and feeble approaches?

Now, administration without records is like music without notes—by ear. Good as far as it goes, which is but a little way; it bequeathes nothing to the future. Except in the very rudest industries, carried on as if from hand to mouth, all recognize that the present must prepare for the demands of the future, and hence records, more or less elaborate, are kept. Their elaboration depends on what their results are worth.

I used to think that only government workshops suffered from circumlocution, and took it for granted that private establishments had simple and direct methods of procuring supplies, of keeping track of work in progress, and of determining its cost when done. I knew, of course, that no shop running to make money could afford to wait, as I have had to do, for the most necessary material, and assumed that, in other respects, their

management was generally on a par with their facility in procuring supplies.

But in seeking better methods where the permanent personal responsibility of profit tends to whittle off excrescences of administration which lead to wasteful delay, I found that much had been sacrificed to immediate advantage; that records were too often kept by memory, so that, as the manager of an establishment employing 1,400 men once told me, "The trouble is, not in foreseeing necessities, nor in starting the work to meet them, but in constantly running over the back track to see that nothing ordered had been overlooked, and in settling disputes as to whether such and such an order was or was not actually given and received. Superintendence," said he, "would be very different work if I were sure that an order once given would go of itself through the works, leaving a permanent trail by which I could follow it and decide positively where and by whom it was stopped. As it is, I spend so much of my time in 'shooing' along my orders like a flock of sheep, that I have but little left for the serious duties of my position."

These were familiar words, and when I went further down, and saw how much foremen's time and memories were taxed for means of attending at once and finally to their daily wants, I became convinced that the government methods, though bad enough, were not the only ones to be criticised.

In the matter of costs, too, I found great uncertainty. I found one business which had been exposed to expensive litigation, involving $6,000,000, to determine what was the true cost of machinery sold by its agents at a commission based upon its cost of production. I found another entire trade based upon costs determined, as one of its members writes me, by "thumb-sailing," large establishments suffering from the competition of ignorant free lances, who, in ruining themselves, also injured their neighbors.

II.

The proposed system of shop accounts is based on two compensating principles.

1. The radiating from a central source, let us say the office, of

all authority for expenditure of labor or material; these being, however they may be disguised, the elemental forms of all internal expenditure.

2. The converging toward the office, from all circumferential points, of independent records of work done and expenses made by virtue of that authority.

Upon the free play of the forces thus defined there is but one essential restriction, that every right to the means for executing an order shall be qualified by a responsibility, which shall be recorded in as great particularity of detail as the scheme of management adopted may require. This leads to a comparison of managements depending upon the automatic record of their results. The following discussion will show how easily and cheaply this end may be attained.

In a broad sense a manufactory may be considered as an engine for transforming material, and its efficiency, like the duty of a pump, may be measured by the ratio of the effort exerted to the effect produced.

It will not be disputed that this ratio is best expressed by the true costs of its products, and that managements may be compared by their costs.

The object of the proposed system of accounts is to provide automatic, and, therefore, impartial means for determining the most probable cost of manufactures in gross, or in such detail as the expense of its determination may permit. This is no new necessity. It enters into the imminent questions of what we can afford to make at market prices; of what is the lowest selling price; and also into estimates relating to the differences caused by the addition or removal of parts and the substitution of processes.

The difficulty of analyzing the usual gross account of expenditures, the uncertainty of this analysis when made by clerks unfamiliar with the processes analyzed, and the evident objections to so employing the time of foremen, have generally led to more or less exact accurate estimates of cost by those whose management was more or less in question. I do not exclude the self-deception of absolute proprietors. These objections are increased as the product of an establishment is diversified, so that the more

miscellaneous is the product, and hence the more necessary the knowledge of its difference in cost, the more difficult is this knowledge to obtain. A system which might serve a blast furnace would utterly fail in a repair shop, yet are not the accounts of repair shops often kept on blast-furnace principles?

It would seem that the practice of estimating costs would not be followed if a more positive method were available at a reasonable price.

The world has been working too long with existing methods for any one to hope to improve them; the change must be one of methods. I propose to replace the ordinary *ex post facto* analysis of expenses by a preliminary analysis of objects of expense, to be followed by a synthesis of items of expense, made mechanically by sorting cards, on which the objects of expense have been indicated at the time of expenditure, by the persons who most probably knew them best, in symbols significant to the least experienced compiler.

By thus defining every charge for labor and material, our accounts are, so to speak, balanced in advance, and it only remains to distinguish between specific and general expenses and properly to apportion the general expenses among the specific, in order to obtain the most probable cost of any specific object.

III.

A manufactory may be functionally divided into two main portions, the workshops and the office.

In the shops are performed the processes, with the records of which the office is principally concerned; on one side stands the foreman expending labor in transforming material; on the other sits the clerk recording the results of the other's acts. Taking these two as typical figures, I propose:

1. To require the highest local authority to define the objects on which its resources are to be expended. In other words, what accounts are to be opened.

2. To require the foreman to define the object most probably benefiting by the expenditure which he directs, as nearly as possible at the time that the expenditure is made.

3. To require a clerk, independent of the foreman, to compile the record of the foreman's acts.

4. To provide a simple symbolic language, common to both office and workshop, by which the same object of expenditure, whether it be a product, a component, or an operation of manufacture, shall always be called by the same name, and by which the foreman's symbols shall suffice the clerk, without requiring of either a knowledge of the other's work.

5. To make each act of record an independent unit by entering it on a separate card, certified by significant punch-marks.

6. To save clerk's work in combining similar entries by assorting mechanically cards containing similar symbols, only transcribing the summation of the charges they contain.

7. To provide that no claim for labor shall be allowed, nor any material put in the way of expenditure, unless charged to its most probable object; so that to every right there shall attach a responsibility of record.

8. To provide for the transfer between general and specific expenses, of charges more probably belonging to either.

9. While allowing free play to the foreman, to increase correspondingly his responsibility as measured by

a. The cost of specific work.

b. The ratio of his general expenses to the causes of such expenses.*

10. To eschew the use of books, except for final records, because of

x. Their inflexibility; they can be used by but one person at a time.

y. The labor of combining similar entries made in them at different times and places.

z. The certainty that when used for memoranda, the effete matter will soon obscure the important, so that the longer an entry has escaped attention, the more certainly will it be neglected.

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* It will be seen that relieving himself under one head increases his responsibility under the other, so that the line of least resistance will be the line of truth. The same result is reached by requiring daily records, the immediate bearing of which on ultimate costs can hardly be appreciated at the time.

11. To prefer natural methods to arbitrary, so that those who may use the system shall, of themselves, tend to conserve it.

IV.

THE SHOP-ORDER SYSTEM

The system has three principal objects in view:

1. The prompt performance of work by the prominence given to unfinished orders.

2. The determination of the most probable cost of work and of management.

3. The keeping of an account of stock, in units of material as distinguished from their values.

It attains these objects by using three forms of cards, viz.:

1. Shop-order tickets, or *warrants* of expense, and *records* of expense reported on.

2. Service cards.

3. Material cards.

V.

Taking the above objects in the order of their importance we have:

1. Orders for work—shop-orders.

These are of two kinds, viz.:

1. Special orders, requiring the performance of specific work.

2. Standing orders, requiring the maintenance of certain facilities for the execution of the special orders.

These facilities may be either in charge of certain foremen, the costs of whose management we wish to compare, or may be too general in their nature to be assigned to any one department.

The first are called departmental, and the second, general standing orders.

Designation.

The special orders are designated by serial numbers, beginning at 100, according to their sequence in the shop-order book.

Each department of the manufactory is known by a number,

preferably in the order of work, and the standing order relating to its maintenance has the same number as the department. The numbers below 100 may be reserved for these orders; *e.g.*, 1, for the pattern shop; 2, for the foundry, etc.

General standing orders may run from 50 to 100. In deciding how many and what they shall be, we must remember that our first analysis may safely be detailed, because details may always be combined by neglecting their differences, and it is easier so to combine them than to analyze results, too grossly stated, into their component parts. The more complete is our preliminary analysis, the more stable will be our synthesis. The history of chemistry and of mathematics teaches this. In another sense we say, "we divide that we may rule."

The following general standing orders are suggested:

51. Office expenses relating to factory.
52. Office expenses relating to sales.
53. Office, and other expenses which cannot be classified.
54. Power.
55. Heat.
56. Light.
57. Transportation, in and about factory.
58. Repairs of buildings, not departmental.
59. Superintendence, general.

For rent, insurance, taxes, and the subdivision of general expenses, see Cost of Work, page 329.

Authority to issue orders.

The authority for all orders is vested in the office; but, as is customary, is more or less extended to include transactions between foremen. With the free exercise of this right is combined the incidental responsibility of a written record, retained by the recipient, who is in turn restrained by the automatic record of the cost of his work. Both records coming finally to the office, one foreman is accountable for the necessity of the order and the other for the cost of executing it. This principle of liberty, qualified by responsibility, runs throughout the plan.

Form of order.

The shop-order book provides a place for the record of every order originating in the office. A special order here receives its serial number, and work of a general nature worth special entry takes the number of its proper standing order.

To distribute orders, and for other purposes, the order ticket is devised. See duplicate form separated by a perforated line, page 319. A punch-mark of special design in the "authority" space, indicates the giver.

Standing orders and their numbers are circulated in lists which are soon memorized.

Course of tickets.

I shall describe the simplest case first, as its principles apply in all others.

1. For short jobs, on which only one kind of work is done at a time, single tickets serve.

They are displayed in a rack in each foreman's office, while the work is in his shop. When the work is done he punches out his number* in the marginal line headed "Completion," and passes the work and the ticket with it to the next foreman in order. This is continued until the ticket reaches the office, where the date of its completion may be entered in the shop-order book.

2. When work is to begin or continue in more than one department at a time, separate tickets must be made out for each department. These issue directly from, and are returnable directly to, the office, as soon as each department's work on the job is done.

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* Men are known by the numbers of their shops or of the departments in which they work. In each department they are ranged by invariable numbers according to their importance, seniority, etc. Thus of shop, or department 3, the foreman is No. 301, the next man 302, and so on. This allows for 100 men in each department. If this number should be exceeded, many expedients of correction are possible. M. A. below signifies Master Armorer in arsenals; in private shops S. might be used for Superintendent.

Receipt.	M-A.	201.	205.	301.	401.	501.	601.	701.	801.

S-O. ; **C.** ; **O.** ; **N.** ; 188 .

Authority,	Completed	188 .

Completion.	M-A.	201.	205.	301.	401.	501.	601.	701.	801.

Receipt.	M-A.	201.	205.	301.	401.	501.	601.	701.	801.

S-O. ; **C.** ; **O.** ; **N.** ; 188 .

Authority,	Completed,	188 .

Completed.	M-A.	201.	205.	301.	401.	501.	601.	701.	801.

3. Subordinate orders.

Foremen requiring the co-operation of others may originate tickets specifying the work to be done, by indicating the number of the original order authorizing the work and punching the

authority space with their special punches. These tickets are returned to the office by the recipient. They may well be white to distinguish them from office tickets, which may be of two or three different colors to indicate the relative urgency of the work they authorize.

Thus S-O. 789. *Build* 6 *double axle lathes,*

might be on a yellow ticket, indicating a staple manufacture; and

S-O. 2, P. *Cut door north side pattern-shop,*

on a blue ticket, to indicate local work of an important nature. Such tickets emanating from the office would be in ink, and would refer to drawings, specifications, etc.; but a merely local order or foreman's request, such as

S-O. 55, W. *Stop leak in steam coil,*

sent, say, by the master carpenter to the master machinist, might be in pencil on a white ticket.

It is desirable, but not essential, that subordinate orders be in writing. The advantage in definiteness, in responsibility, in the certainty of execution, and in the accuracy of the record which follow from writing them are so great as to outweigh the slight loss of time taken to fill them up and punch them. A package of tickets, a lead pencil, and a ticket punch are all that a foreman needs for attending finally to any order which he is competent to give.

In complicated operations, where it is desirable to take heed of the receipt of orders on their delivery, duplicate tickets, such as shown in full, may be used to advantage. The duplicate ticket is also intended for a complete exhibit, say, in the racks of the superintendent's office of unfinished work ordered by him or by his superiors. As the completed tickets come in from the foremen, he takes down his retained copy from the proper rack, punches it, and returns it to the main office, keeping that which he has received on a file for future reference.

Advantages of order tickets.

Each foreman's unfinished work is always displayed before him, relieving his memory and permitting him to apply all his

energy to active work. This applies in even greater measure to the superintendent.

For the orders in question the ticket represents both the

SERVICE CARD, Frankford Arsenal.

No. Name. Price per Unit.

DATE.	UNITS. Time. Pieces.	Charge to-	Nature of Service in detail.	No. of Units. Pieces.	Time.	AMOUNT. Dolls.	Cents.
		S.O.-					
		C.-					
		O.-					
		N.-					

N. B.—Make but one entry on each card.

21

work and the authority for doing it; and as no foreman receives work without its warrant, each one checks the other and prevents the loss or neglect of either. The loss of a ticket, at the worst, would correspond only to an order forgotten under common methods; in practice they are never lost.

The tickets in the racks may be classified as work in hand, or as not in hand, by departments, and in many other convenient ways. When returned to the office after completion, they may be re-sorted according to objects worked on, forming an indefinitely expansible index to the order book.

VI.

RECORDS OF EXPENDITURE.

Having shown how an order, started from the heart of the administration or from one of its intermediate points, finds its way out to the circumference and along it; and how, its work accomplished, it is, by natural means, brought back to its source, it remains to show how the records of the expense it has involved are similarly directed in their centripetal course.

The expenses of a workshop may be classified under two heads:

1. Services. { Internal. / External.
2. Material.

I. SERVICES.

Labor may be performed either within the establishment or without it. To both kinds of labor the name service is given, and their record is kept on uniform service cards. For internal services these are roughly bound into little books like check books, each page containing one card detachable like a bank check, and having a memorandum stub for the workman's private use. All cards are printed on one side of brown manilla paper.

Employment of service cards.

One of these cards, designed for arsenal use, and such as, with the addition of a space for "machine time," is used by

one of our large locomotive factories, is reproduced full size on page 321.

R. G. & SON. APR 2 1886

No. Name. Rate.
235. Lannigan, 0.25.

ORDER NO.	PIECE.	WORK.	HOURS.
789	Spindles.	Planer.	10

The above is a full size cut of a similar card in simpler form, designed for day work in an establishment where no piece work is done. If greater simplicity were required, the two middle spaces might be omitted.

When a man is hired he receives a book in which, on each card, his name and rate of wages are stamped. This certifies his employment to his foreman. He gets his book from his foreman in the morning and returns it at night with one page filled for every order on which he has worked during the day.

If he has worked all day on but one order, his writing may consist of its number and the number of time units in a working day. Thus, if the hour is taken as the time unit, he might write:

S-O. 789 Time units, 10.

If time is kept by the half-hour it would read:

S-O. 789 Time units, 20, and so on.

The foreman looks over the books when handed in; if correct, stamps them with his dating stamp, tears out the leaves filled, and sends them to the office. The next morning he returns the books to the men.

The book serves a double purpose; it affords the workman an

opportunity for making a definite charge for his labor, and it gives him the only opportunity of doing so. This makes certain a record of his employment during the time for which he is paid, and also affords original evidence from an impartial source as to the object on which that labor has been spent.

It takes the place of a roll call or time check. Early comers get their books at once and can go to work. Late comers are so marked on their own books. Those who leave early have their books verified at the time.

If a man has worked on several orders during the day, he fills out a separate leaf for each order, the sum of the times equaling the total time, as before.

Piece work is similarly entered, the leaf being punched by the inspector. The time and piece records are independent of each other, so that if a batch of piece work should last a man for several days, he still makes his time record for those days at *no* price.

When the cards reach the office, daily, they are sorted, if need be, by names and the total time, pieces, or wages entered in the time book. They are then re-sorted by orders and distributed in pigeon holes corresponding to the orders.

2. External services.

Outside services embrace freight, insurance, rent, taxes, telegraphing, attorney fees, etc., pertaining to factory. These cards, when approved, are filed like those first described.

Payment for such service must be similarly distributed among the shop orders benefiting by the expense. It is optional whether this shall be done for each bill before payment, or whether such charges shall be consolidated from the books monthly or oftener.

2. MATERIAL.

Material card.

This card, which is freely distributed in blank to the foremen, permits every transaction with material to be recorded. The accompanying form is devised especially for private shops. If a foreman wants some steel he fills the card as shown, charging it to the order for which most probably needed. He makes a

direct charge to a special order if possible; if not, then preferably to his departmental standing order. The foreman makes his entry in pencil, entries of price and amount being added by clerks.

Punching out "required by," he throws the card into his

MATERIAL CARD.

APR 3 1886

QUANTITY.			NAME.
ASSUMED.	UNIT.		N. B. Make but one entry on each card.
6	*pcs.*		
ACTUAL			*Sanderson Steel* $\frac{3}{4} \times 1\frac{1}{4}$
164	*lbs.*		*about 8 ft. long.*
Price per Unit.	Dolls.	Cts.	

CHARGE TO				CREDIT TO				AMOUNT.	
S-O.	C.	O.	N.	S-O.	C.	O.	N.	DOLLARS.	CENTS.
820	*W*								

Ordered from Corning & Co.

REQUIRED BY ●

CERTIFIED BY ●

messenger box and concerns himself no more about it. Without awaiting a special time or opportunity for making known his wants, without awaiting the return from the office of his "requisition book," he has, at the very moment that the need of the steel presented itself, asked definitely and finally for what he wanted. He has set rolling a ball which will be in some-

body's way until it is finally disposed of. At the office it may be approved or sent back for explanation, or simply suspended, without interfering with immediate action on other articles asked for at the same time. A long list is like a large bank-note, easy to carry, but hard to change.

Suppose that the requisition is approved by the superintendent's also punching "required by," the card is sorted with other cards of the same kind, say for hardware, the name of the dealer from whom the material is to be ordered attached, or not, at pleasure, and the card sent with others to the foreman or storekeeper who is to receive it on arrival. If to the foreman, he knows what to expect.

When the steel has come, the quantity actually received is filled in, the receiver punches "certified by" or "received by," or whatever special form of acknowledgment may be required by the management, and sends the card to the bill clerk, who, after comparing it with the bill, and, maybe, adding prices or amount, sends it to the cost clerk for filing in the proper pigeonhole.

Let us suppose again that the foreman, having no immediate use for the steel, has charged his departmental standing order with it. By and by he finds that he wants ten pounds of it for a special job. He makes out another card, charging it to the special job and crediting himself accordingly on the same card, and punches "certified by" as before. The converse is possible if he finds that he has charged too much to the special order first mentioned.

If he lets another foreman have steel, he charges and credits appropriately between departmental orders, certifies the entry, and gets the other foreman to do so before he gives up the steel. The issuer keeps the punched card as his equivalent, and sends it to the office for entry.

The card may also be used for reporting each batch of work packed or shipped or sent to the storeroom or warehouse, as the custom of the place may require. Such cards contain a credit to the order under which the material has been made. They take the place of all memoranda recopied into lists for office use. Each card may start independently of the rest at the

very time that the batch is done or inspected, so that there may be any number coming into the office during the day. Like the other cards they are movable memoranda, written once and for all by those responsible for their accuracy.

These are the simplest of many possible cases; I have so far been unable to imagine one in which the card fails to tell its story in the easiest and plainest way.

VII.

THE COST OF WORK.

This second division of our subject involves two elements:

1. The work done.
2. The cost of doing it.

The second of these divided by the first gives the price.

1. *The Work Done.*

An order having been completed, we may simply wish to know what it has produced.

This may be determined in any customary manner, subject to this precaution, that it is not always safe to assume that the exact number of articles ordered by the tickets has been made. The means described, page 326, are probably as easy and expeditious as any that can be devised.

The gross product is, therefore, easily determined, but, except in the crudest industries, this will hardly satisfy those in charge. There is scarcely any work which does not require some preparatory expense in the way of drawings, patterns, tools, etc., which may be useful for future work of the same kind.

We shall generally, therefore, require separate information as to

1. What must be done again every time that such an order is repeated—what is made for sale.

2. What has been done in preparation, having, when the order is completed, a permanent value for future work of the same kind—what is made for the establishment.

In anticipation of such inquiries, we provide in advance that

all expenditures, besides being reported under the order authorizing them, shall be referred, under that order, either

1. To "Work," symbol W., or

2. To "Plant," symbol P.

"Work" has been sufficiently defined above.

"Plant" includes drawings, patterns, machinery, and special tools and fixtures not apt to be consumed during the execution of the order. Buildings, etc., are plant of standing orders; their extensive repairs and improvements are charged to P.; current repairs to W.

The simple analysis given suffices for miscellaneous products; but for the staple objects of manufacture for which a factory may be specially designed, such as guns, sewing or other machines, and appliances made on a large scale, we may also wish to be prepared to collect information relating to

3. Their component parts.

4. The operations of manufacture through which these parts have passed.

These comprise all possible questions involving cost, which, to be truly answered, must be prepared for before the work to be analyzed is begun.

Therefore, although it is essential that only the number of the shop order appear on every record of expense, yet, for a full development of the system, it is desirable that every such record have room for four symbols, viz.:

S-O. The number of the *shop order* authorizing the expense.

C. The *character* (P. or W.) of the expense.

O. The component part or *object*, profiting by the expense.

N. The symbolic *number* of the mechanical operation performed on the object in question.

Room is therefore made for the symbols S-O., C., O., and N. on the service and material cards already described. Only so many of these symbols need be used as the scheme of administration may require; some will be satisfied with gross costs, and will need only the first symbol; others will require plant to be separated from work; and others still, for staple manufactures, will want to know the cost of components and of the operations upon them. Such demands must be anticipated at a cost pro-

portional to the benefit expected; as we would reap, so must we sow.

2. *The Cost of Doing Work.*

The net cost consists of

1. The specific expenses for labor.
2. The specific expenses for material.

These are also called the direct expenses, or those which can be charged directly to any particular job. Added to

3. A proper proportion of the general annual, or indirect expenses, they make the gross cost.

It is comparatively easy to compute net costs by any of the usual methods. Their exactness depends upon the scale of trouble adopted, and, excepting errors of omission arising from unbalanced data, they may be assumed to be fairly accurate.

The main difficulty lies in apportioning these general or indirect expenses which cannot be referred to any special product. I therefore give special attention to this subject, as follows:

Apportioning the indirect expenses.

Factories are established for the profitable transformation of material by the organized employment of labor. How shall the indirect expenses be distributed? In ratio to the material, or the labor? By quantity, or by value?

I believe that the incidental expenses are incurred for the purpose of making labor more effective, and that the more material enters as their divisor, the more does it vitiate the probability of the result.

For, the more material costs, the more labor it has already had spent upon it; and the less, and not the more, does it need the facilities provided by the incidental expenses. On the other hand, the more men are employed, irrespective of their cost, the greater is the wear and tear, the waste, the cost for room, light, heat, and attendance, etc.

These and other similar considerations lead me to determine for each department a cost factor as follows:

1. To distribute such general expenses as rent, insurance, taxes, etc., among departments profiting by them according to the most probable hypothesis.

2. To distribute last year's general standing orders or the unclassifiable current expenses among departments in proportion to the total days' work done in each department.

3. To add this amount for each department to the sum of its own expenses for the past year, as given by the cost of its departmental standing order.

4. To divide the gross amount thus obtained by the number of direct days' work done in each department during the past year, and so obtain a cost factor, say of $0.95 per day, by which the cost of every day's direct work in the present year must be increased in order to make it bear its most probable share of the cost of facilities provided for it.

Thus a man at $2.00 a day would be really costing $2.95, and a bill as follows:

15 days at	$4.00	$60	00
6 "	2.50	15	00
27 "	1.25	33	75
48 days		$108	75

would be increased by $45.60, representing 48 days × cost factor of $0.95 per day.

The variation of the factor measures the foreman's management during the past year. Its amount is the cost of facilities for doing a day's work which is chargeable to a particular job.

VIII.

COMPUTATION OF COST.

Simple case—gross cost.

Our accounts may be on so simple a scale that we shall require no more than a simple statement of the gross cost of executing a given order. To obtain this, we add up the charges contained on the service and material cards found in the pigeon-hole corresponding to the order in question. This gives the net cost. This, increased by the sum of the products obtained by multiplying the number of direct days' work done on the order in question in each department by the cost factor for that department, and diminished by the sum of the credits, gives the gross

cost. In such a case the cards need only contain room for the symbol S-O.; the symbols C., O., and N. being omitted. I would recommend this simple method to beginners, although I believe that all will find it to their advantage as they become familiar with the system to analyze more closely. To such the following method commends itself.

Continued analysis of cost.

Sort the service and material cards belonging to a completed order according to Plant and Work, and add together their amounts under each head. Then correct the net cost so obtained for indirect expenses, as already described.

The appraised value for future uses of plant should then be charged to the most probable standing order and credited to the cost of work. The amount thus determined, when divided by the output, gives the factory cost per piece, pound, etc. The factory cost, increased by its proportion of the selling expenses, and profit added, gives the selling price.

For example, we find the total cost of S-O. 789 corrected for indirect expenses to be:

Plant	$ 50 00
Work	175 00
Gross cost	$225 00

Suppose that by inspection of the cards we discover that no credit has been given for the contingent value of the patterns, which, let us say, is $25.00, and that they are kept in department No. 2. The omission of the foreman of No. 2, known as 201, should be supplied by making out a card as follows:

One set patterns.

CHARGE TO...2. CREDIT TO...789. AMOUNT, $25.00.

This reduces the gross cost to $200.00, and increases correspondingly the liability of S-O. 2, subject to correction by inventory. (The annual inventory would correct the balance of 2, and hence affect distributively its charge for indirect expenses in future. This card should properly have been made out by 201 when the

order was completed, thus clearing his mind of it, and leaving to higher authority only the task of revision.)

Detailed cost of components and of operations thereon.

If, as in staple products, the cost is needed in greater detail, we sort the cards by the object symbols, and those having like object symbols by the operation symbols, and service cards having like operation symbols by departments in which working, and those in each department by rates of wages. This being done, and the charges added together, and labor increased by cost factor product, we may ascertain the most probable cost of every operation on every component. This is as far as any one would be apt to go.

Daily cost sheet.

By adding up daily the amounts in each pigeon-hole, and entering their net sum on the cost sheet, the office is kept informed how and where the money is going. The cards may then be sorted in continuous preparation for the analysis above described.

IX.

STOCK ACCOUNT.

By entering but one kind of material on each card we gain immensely in flexibility at a small cost of trouble, for it takes but very little longer to fill, say three cards with one line each, than to write three lines on one card, and when written the cards are independent of one other. (This applies to both service and material cards.)

This feature is particularly valuable in the accountability for Government property, which happens to be altogether by items, without regard to values. An instance of its immediate utility to private works will suffice. After the sorting, previously described, the material cards in each pigeon-hole may be re-sorted by the names of material upon them; this forms a convenient bill of material, the difference between which and even careful estimates will often prove surprising.

Space fails me to describe all the advantages following the inde-

pendence of these units of record, which, like that of the printer's type, adapts them to an immense variety of uses. I have tried them in every supposable case of the affairs of an arsenal, trammeled by all the precautions imposed by a most jealous audit, and have yet to find a case in which they fail.

X.

APPLICATION.

The data for an illustrative case are derived from the analysis of the expenses of an hypothetical stove foundry, which for the past two years has been the subject of discussion by the National Association of Stove Manufacturers.*

It had been estimated by one of the most experienced members of that association that the gross annual expenses of a foundry, capable of turning out about 3,000 tons of a fair assortment of stoves per annum, were about $321,000, divided as follows:

LABOR.

	Per ton	Per 3,000 tons.
Molding	$24 00	$72,000 00
Mounting	8 00	24,000 00
Pattern making	1 45	4,350 00
Pattern fitting and repairs	1 50	4,500 00
Pattern molding	25	750 00
Carpenters	1 25	3,750 00
Cupola-men, breaking iron, etc	75	2,250 00
Cleaning and piling	2 00	6,000 00
Engineer	30	900 00
Shipping	1 00	3,000 00
General labor	2 00	6,000 00
Watchman	25	750 00
Foreman, molding and melting	50	1,500 00
Clerks	50	1,500 00
Trucking	75	2,250 00
Miscellaneous and pilferings	50	1,500 00
	$45 00	$135,000 00

* It is fully analyzed in the *New York Metal Worker*, February 6, and in the *Chicago Artisan* of February 6 and 13, 1886.

MATERIAL.

Foundry Costs.	Per ton.	Per 3,000 tons.
Iron	$20 00	$60,000 00
Mounting materials, not including nickel panels and rails, etc.	8 00	24,000 00
Fuel for all purposes	2 75	8,250 00
Molding sand and clay	40	1,200 00
Facing	25	750 00
Patterns, flasks, and lumber material	75	2,250 00
Shipping material	10	300 00
Freight and expressage	1 25	3,750 co
Machinery and tools	1 75	5,250 00
Repairs	40	1,200 00
Gas and oil	20	600 00
Stationery and books	10	300 00
Rent	1 00	3,000 00
Insurance	40	1,200 00
Taxes	25	750 00
Miscellaneous and pilferings	40	1,200 00
Castings broken and discarded that have been paid for	1 00	3,000 00
	$39 00	$117,000 00

SELLING EXPENSES.

	Per ton.	Per 3,000 tons.
Allowances of various kinds	$ 1 25	$3,750 00
Attorneys' fees	25	750 00
Advertising, catalogues, etc	1 75	5,250 00
Bad debts	2 00	6,000 00
Clerks	1 60	4,800 00
Freight on stoves delivered	1 00	3,000 00
Gas and oil	10	300 00
Insurance	20	600 00
Interest	2 00	6,000 00
Discount for cash	2 50	7,500 00
Miscellaneous and pilferings	50	1,500 00
Postage, express, and telegrams	1 00	3,000 00
Rent	1 00	3,000 00
Stationery	15	450 00
Travelers' wages	2 75	8,250 00
Travelers' expenses and general traveling	3 25	9,750 00
Taxes	20	600 00
President and Secretary	1 50	4,500 00
	$23 00	$69,000 00

RECAPITULATION.

Total labor cost	$135,000 00
Total foundry cost material	117,000 00
Total selling expense	69,000 00
	$321,000 00

DISCUSSION OF THE ABOVE.

It must now appear that the essence of the system proposed is to afford means of making definite charges of expense in the following order of preference:

1. Special order, as plant or work.
2. Departmental standing order.
3. General standing order.

For the foundry let us call our departments and their standing orders as follows:

1. Pattern shop.
2. Molding.
3. Melting.
4. Mounting.
5. Foundry, unclassified.

These comprise the manufactory proper. Now, let all the other departments be consolidated under one head, viz.:

10. The selling department.

The number of departments is limited for simplicity's sake. The more they are divided the more exact will be the resulting costs, but the more trouble will it take to keep the accounts separate.

Each of the items of expense named (pages 333–335) was distributed among the departments named, and for each item of labor the number of days' work corresponding to the amount distributed, at an assumed average rate of wages, was also stated.

Labor, which, like molding, mounting, pattern and flask-making, is susceptible of being charged to special orders, was called direct work, and separated from that like engineers, cupola-men, and superintendence belonging to the standing orders, and a result obtained which represented, most probably, the actual results of one year's work under the system proposed.

TABLE I.

ANALYSIS OF LABOR CHARGES.

Department.	Direct. Chargeable to Special Shop-Orders.		Indirect. Chargeable to Departmental or General Shop-Orders. Standing.	
	Value.	No. of Days' Work.	Value.	No. of Days' Work.
1. Patterns	$10,500	4,500	$1,350	600
2. Molding	72,000	24,000	8,000	6,980
3. Melting *	....	....	4,050	2,270
4. Mounting	24,000	14,000	1,450	925
5. Foundry in general	....	....	6,400	3,615
Totals	$106,500	42,500	$21,250	14,390

Labor.	Value.	Days' Work.
Direct	$106,500	42,500
Indirect	21,250	14,390
	$127,750	56,890

TABLE II.

ANALYSIS OF CHARGES FOR MATERIAL.

Departments.	Direct.	Indirect.
1. Patterns	$1,500	$583
2. Molding	....	4,863
3. Melting *	....	72,483
4. Mounting	20,000	5,681
5. Foundry in general	....	12,915
Totals	$21,500	$96,345

* See page 339.

Combining Tables I. and II., we find the following total indirect charges:

TABLE III.

TOTAL INDIRECT CHARGES PER ANNUM PER DEPARTMENT.

Departments.	Labor.	Material.	Total.
1. Pattern	$1,350	$483	$1,833
2. Molding	8,000	4,863	12,863
3. Melting	4,050	72,403	76,453
4. Mounting	1,450	5,681	7,131
5. Foundry in general	6,400	12,915	19,315
Totals	$21,250	$96,345	$117.595

Expenses for shipping (labor and material), warehousemen, cartage, watchman, freight, and pilfering, transferred from the foundry data, increased the sales' account to $75,405, which is about 30 per cent. of the balance of $245,595 devoted to manufacturing.

For the present we set aside the direct expenses and seek how best to apportion the indirect expenses among them. This we do by distributing the most general charges among those less so, until the cost factor for each department is obtained, as follows:

We first take the total general foundry expenses, $19,315, from Table III., and divide them among 1, 2, 3, 4, according to the *total* days' work done in each department, as follows:

TABLE IV.

DISTRIBUTION OF GENERAL FOUNDRY EXPENSES AMONG DEPARTMENTS.

Departments.	Days' Work per Annum. From Table I.			Share per total d. w. of $19,315 in Table III.	Total Indirect Charges per Department from Table III.	Gross total, Indirect, per Department.
	Direct.	Indirect.	Total.			
	d. w.	d. w.	d. w.	$	$	$
1. Patterns	4,500	600	5,100	1,850	1,833	3,683
2. Molding	24,000	6,980	30,980	11,230	12,863	24,093
3. Melting	.....	2,270	2,270	823	76,453	77,276
4. Mounting	14,000	925	14,925	5,412	7,131	12,543
Totals	42,500	10,775	53,275	19,315	98,280	117,595

Next, except for melting, which will be treated later, we divide the gross total indirect expenses for each department by the number of days' *direct* work done in it during the past year, and get the cost factors per department as follows: *

1. Patterns	$0 82
2. Molding	1 00
4. Mounting	90

It is supposed that under the same management the cost factors will not vary greatly from year to year. In this respect they will resemble, to some extent, the phenomena of life insurance; so that such variations as may be found may be attributed to causes the effects of which, in future cases, may be closely approached. But in gaining this experience the following discussion may serve.

The indirect expenses may be divided into two classes: those like rent, insurance, salaries, etc., which are fixed charges; and those which, like attendance, wear, and waste, have a closer relation, say a direct ratio, to the number of men employed.

Calling the fixed charges for a given time F; the variable charges, V; the number of direct days' work in the same time, D; and the cost factor, either for the whole factory or for any one department, C, we have

$$C = \frac{F + V}{D}$$

If we change suddenly the number of men employed, then D will become D'; and V will become V', and

$$C' = \frac{F + V'}{D'}$$

For example, if $F = \$12{,}000$; $V = \$28{,}319$, and $D = 42{,}500$ d. w.

Then $C = \$0.95$.

* We may simply take the quotient of the aggregate indirect expenses of the three departments by their aggregate of days' direct work ($0.95) as a gross cost factor for them all. This course will be more simple than the other, but its simplicity will be purchased at too great a cost if we lose the opportunity for keeping the foremen up to the mark by comparing the expenses of their respective managements.

If we double the number of men employed, on direct work only, then

$$C' = \text{about } \$0.80.$$

If we discharge half the force,

$$C_1 = \text{about } \$1.23, \text{ etc.}$$

In the melting department, as the cost of iron in good castings depends so much more upon the output than upon the number of men employed, I disregard the men and divide the cost by the weight of good castings produced, say, 6,000,000 lbs.; this gives a cost per pound (not for melted iron, as it is often called, but for good castings) of 1.288 cents per pound; and this is taken as the cost factor of that department.

COST OF A STOVE.

Now, suppose that we have finished an order calling for 500 stoves of a special size and pattern, and that from overrunning or by direction 521 happen to be made with a lot of spare parts estimated to be worth, say, $200. Also suppose that the patterns are estimated to be worth half cost for future work. We may establish the cost per department as follows:

1. Patterns.

These have all been made by day labor, charged to the order from day to day. So has the material. We find that they have cost as follows:

Labor, direct, at average of $2.75	$1,500 00
Cost of facilities, 545 days' work at 82 cents	447 00
Value of material, estimated	513 00
Cost of patterns	$2,460 00

2. Molding.

If this is done by the day and an account be kept, as with the patterns, the same course is followed, except that no special charge is made for materials, all of which comes out of the cost factor. But since in stove foundries molders work almost altogether by the piece, and owing to the great number of different parts of different stoves which they are apt to mold at the

same time, it is almost impossible for them to keep their time on each order; the time may be approximated by dividing the total piece price per stove by the nearest average daily earnings. Thus, if the sum of the piece prices on the stove in question be $2.25, and the average earnings per day of molders employed on this class of work be $3.00, each stove will take on the average three-fourths of a day's work to mold, and the cost of molding may be expressed as follows:

Piece price	$2 25
Cost of facilities, viz., 0.75 day's work at $1 per day	75
Cost of molding each	$3 00
521 stoves at $3.00	$1,563 00

3. Melting.

Suppose that the stoves weigh 347 pounds each; 347 × 521 × 1.288 cents $2,328 00

4. Mounting.

Either of the plans described for the pattern shop or molding floor may be followed, according to circumstances; but a third case may present itself, where the mounting is done by a contractor who employs a number of men, the establishment furnishing power, tools, and room, and paying the contractor by the piece. This presents special difficulties, for while we pay the contractor by the piece, he probably pays his men by the day, and makes no attempt to distribute their time, contenting himself with securing a profit on their aggregate wages.

In such a case two methods are possible. The first and most accurate requires knowledge of the average profit made by the contractor and of the average number of men he employs per day. Then the men's share of the piece price paid for mounting any stove, divided by their average daily wages, is equal to the number of days' work in mounting that stove.

For example, suppose that owing to ignorance, on both sides, of the actual amount of labor required to mount any particular stove, and to the concessions which in long business intercourse of this kind supply the place of competition, the prices paid the contractor are so fixed as to allow him, in the long run, a profit of about ten per cent. on his expenses for labor.

This will give the men about ninety per cent. of the piece price, which, when divided among them, gives, say, an average per man of $1.50 per day. Supposing the firm pays for mounting our stove $1.25, then it takes

$$\frac{90}{1.50} \text{ of } \$1.25 = 0.75 \text{ day's work to mount that stove.}^*$$

The contractor's estimated profit should be charged to the general expense of mounting (S. O., No. 4), as he is virtually a foreman under a specially strong incentive to make his men work. It may seem rather inquisitorial to require the contractor to expose his pay roll; but this is justified by the circumstance that the foundry furnishes the facilities which are occupied, worn, and wasted more nearly in proportion to the number of men employed than to any other quantity.

Now, suppose the contractor keeps his profits to himself. We merge him with the men, and knowing, for police purposes if for no others, how many men are employed per day in a given time, the quotient of the contractor's gross receipts for that time, divided by the number of days' work done in his department during that time, gives the average cost of a day's work, which, divided into the piece price per stove, gives the day's work on that stove for mounting.

We can now sum up the cost of mounting per stove as follows:

Contract price	$1 25
$0.75 day's work × $0.90 (cost factor, p. 25)	67
Material, per material cards, or estimated from list of material as shown by drawings	1 10
Total per stove	$3 02
Total for 521 stoves	$1,574 00

Omitting ornaments, nickel work, tiles, crating, etc., all of which can be charged directly, we may sum up as follows:

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* (Proof. The contractor gets 521 × $1.25 = $651 25
Of which the men get 90 per cent., or 586 12
Which, at $1.50 per day = 390.75 days' work,
Or for 521 stoves 0.75 day's work per stove.)

COST OF SHOP-ORDER NO. 7,654, FOR 521 "O. K." STOVES.

Patterns		$2,460 00
Molding		1,563 00
Melting (iron in castings)		2,328 00
Mounting		1,574 00
Gross cost		$7,925 00
Deduct ½ patterns	$1,230 00	
Extra parts	200 00	
		$1,430 00
521 stoves at $12.46		$6,495 00
Foundry cost, each		$12 46
Selling expenses, at 30 per cent		3 74
Net cost		$16 20
Profit, say at 10 per cent		1 62
Selling price		$17 82

Let us suppose that another set of men are employed, who work so much faster that we can afford to increase their wages 50 per cent., the direct outlay for labor remaining unaltered.

The time on the job, and, consequently, its share of the indirect expenses, will be one-third less than before, and the cost factor determined with correspondingly slow labor remaining unaltered, we shall save $395 in the cost of the stoves, or about six per cent.*

Of course, if we continue with this grade of labor for the same yearly product, our cost factor may increase; but this tendency will probably be diminished either by an increase in product for the total number of days' work per annum, or by a diminution in interest charges on invested and working capital, or by both causes and other causes also.

The example is offered to show in dollars and cents that cheap labor is not always profitable, and how the rate of work enters into the rate of wages.

It will be observed that, as soon as the patterns are made and the piece prices for molding and mounting established, the

* The saving will depend somewhat upon the departments in which an increase of earnings is allowed. The illustration supposes the increase to be uniform.

selling price of the stove may be known almost as well before it is made as afterward. The advantage of this is apparent.

In a foundry such as has been described, the use of the service cards might be confined to pattern makers, and to a few other employees whose time is distributed among special orders.

General labor constantly engaged on standing orders might be cared for by the usual methods of time keeping, and piece workers by the means described.

Charges for material purchased might be made in bulk, on the principles set forth, from the bills received from dealers; and transfers of charges by foremen be also by values in bulk. Or charges for material entering into the cost factor might be made annually, as shown by item (e) in the following statement.

	Dr.	Cr.
On hand per last inventory	a	..
Procured since last inventory	b	..
On hand per present inventory		c
Accounted for by direct charges to fabrications since last inventory, made out from drawings or specifications, p. 28		d
Balance charged to proper departmental standing order		e

Experience only could tell how much detail it would pay to neglect.

EXTRACTS FROM DISCUSSION.

Mr. F. W. Taylor.—I have read with very great interest Mr. Metcalfe's paper, as we at the Midvale Steel Company have had the experience, during the past ten years, of organizing a system very similar to that of Mr. Metcalfe. The chief idea in our system, as in his, is, that the authority for doing all kinds of work should proceed from one central office to the various departments, and that there proper records should be kept of the work and reports made daily to the central office, so that the superintending department should be kept thoroughly informed as to what is taking place throughout the works, and at the same time no work could be done in the works without proper authority. The details of the system have been very largely

modified as time went on, and a consecutive plan, such as Mr. Metcalfe proposed, would have been of great assistance to us in carrying out our system. There are certain points, however, in Mr. Metcalfe's plan, which I think our experience shows to be somewhat objectionable. He issues to each of the men a book, something like a check-book, containing sheets which they tear out and return to the office after stating on them the work which they have done. We have found that any record which passes through the average workman's hands, and which he holds for any length of time, is apt either to be soiled or torn. We have, therefore, adopted the system of having our orders sent from the central office to the small offices in the various departments of the works, in each of which there is a clerk who takes charge of all orders received from, and records returned to, the central office, as well as of all records kept in the department.

The clerk or clerks in these department offices make, in all cases where it is practicable, under the direction of the foreman of the department, written orders stating what work is to be done, and how it is to be done; what order number to charge it to, and what drawings and tools are to be used, etc.

These orders are locked up in suitable bulletin-boards with glass doors in front, so that the men can see but not handle them. Each man in the shop receives from the shop clerk a note or a card for every job that he is to undertake, which refers him to the more elaborate order locked in the bulletin-board. The note which each workman receives gives him the proper authority for doing his work, and at the same time insures the concern, to a certain extent, against spoiled work which so frequently results from misunderstanding verbal directions. These notes are also the means of conveying all desired information about the work to which they refer, both from the foreman and from the man who is doing the work, for keeping the records in the small offices as well as in the main office. We find that there are a great many records which it is desirable to keep close to the department in which the work is going on, for which there is comparatively little need in the central office.

For instance, it may be very desirable for each foreman to be able to place his hands at a few minutes' notice on the record of the piece of work last done, similar to that which he is about to do. For those records, of course, he could not afford the delay of sending to the main office, and it would be a very difficult matter, if they were kept there, for him to obtain the information which he desired without going himself and saying just what he wanted. If he, however, has a series of card records kept in his own office, close to where he works, and if those records are arranged, not chronologically, but on loose cards, which can be filed in such a way that the record of each job, as it is finished, will be placed next to that of the job which most nearly resembles it; if the records are kept on cards instead of books, the foreman can, with great ease, obtain any information about former jobs similar to the one he is about to start on, either in the way of mistakes made, or suggestions as to the best method of accomplishing the work, the cost, the time, or the man who did the work, etc. In our system only such information is sent to the central office as is there needed to keep them posted as to the cost and progress of the work and the men's time; while in the department office is kept much fuller information about the work; in fact, everything which the foreman may find it useful to know.

Mr. W. F. Durfee.—I think this subject is one of the most important that has ever been brought to the notice of this Society, and while I fully concur in the opinion of Mr. Towne, that it is in the highest degree deserving of our consideration, I am somewhat in doubt as to the advisability of organizing a separate section for that purpose, being fully persuaded that every engineer here who is interested in the management of works, or ever expects to be, will be a member of that section, and we should simply resolve ourselves into a "committee of the whole" to consider that subject. I think it is perfectly proper to bring it before the Society as a body, and that this discussion will demonstrate that it will have an interest for all of us.

As an illustration of the importance of this subject, I will state some facts in my own experience. Some years ago I was

called to the supervision of a very large works, employing at times a thousand men, and I found an utter destitution of all system for determining the cost of work done. As an illustration of the state of the accounts, I would state that in the assets of the company, and on its books, there appeared a credit of six thousand tons of a certain kind of coal. As a matter of fact, there was no such coal on the premises. The coal, at that time, was worth six dollars a ton on the ground, and there was an asset that it would puzzle a book-keeper to account for. There was no system whatever for distributing stores at the works, and no proper storeroom account. One of the important items of supply was oil. The method of distributing that oil consisted in turning the barrels into an oil room in the charge of a man, and everybody who wanted oil came there and got it without reference to where it was to be used. There was no method of telling whether they carried it home, or into one department of the mill or another, or did anything with it. (*Description of improved method omitted.*)

One month's trial of the above described system demonstrated a saving sufficient (in the matter of oil alone) to pay all the clerical force necessary to the carrying out of a complete system of cost accounts for the whole works. One of the principal features of the system of cost accounts was this, viz.: All supplies which were consumed in the establishment were, when purchased, charged to storeroom account, and the storekeeper kept an account with each department of the works as rigidly as if he were a private merchant dealing with the same department. In this way waste, and what was far worse, petty thievery, was prevented, and a degree of responsibility fixed upon the heads of the several departments which resulted in increased efficiency to a marked degree.

In regard to Captain Metcalfe's paper, I am inclined to think, from what I have studied of his very valuable book and of the paper, that his system is an excellent one. Of course, it needs modification to suit particular cases. There is some question in my mind whether or not the plan of using a separate ticket for every little transaction is always the best. I have no doubt that it is, in cases where each man does a good deal of one kind of

work. But in a machine-shop where there is a production of a great variety of articles, especially in a small shop where each man works on from one to ten separate jobs each day, I do not know whether it is best. I had recently a little experience in this matter myself, and found that my associates were somewhat averse to carrying out the ticket system, because in our shop, employing seventy or eighty men, each man having from one to ten jobs a day (averaging perhaps five), if separate tickets were used for all the recording of time, it averaged five tickets to each man per day, or thirty per week, which made the total very large. If there were a hundred men in the shop, there would be three thousand tickets. I have not any question in my mind that it *does* pay to handle that number of tickets, for the ease with which they can be assorted, compared with posting and rewriting in separate books; but when it comes to the amount of paper and necessary printing, I do not know about it. Of course, in the card system we only use ten tickets where a man does ten jobs, and only one where a man does one job in a day, and we waste no paper so far as that part of the ticket is concerned where the writing goes; but each one must have a certain space for a printed heading, and there must be the waste of paper due to that heading and, also, the cost of the printing. If, however, you take one paper, or a larger card, for the recording of *one man's time* for a *week*, you have only one hundred such papers, instead of three thousand. A good deal of paper is, of course, wasted in cases where a man fills only one space out of ten provided. It is now a serious practical question in my mind which of the systems is best for my own particular case. I would like to ask Captain Metcalfe's opinion on this point—as to how great an evil is the necessary cost of extra paper and printing on the numerous tickets used where a small shop does a great variety of work, and where each of the men has a great variety of jobs.

Captain Metcalfe.—I have had to depend largely for experiments on what recognition my system might meet from private individuals and corporations. I got it up in the government works of which I had charge, but I have not had a full opportunity of trying it as I should like, and so cannot answer him explicitly. Of

the general truth of the principles on which it is based I have no possible question. I began the trial of it at Frankford Arsenal, where we had a hundred and fifty or two hundred people. I generally had about a hundred orders under way, of different kinds, some little jobs and some quite important ones. There, instead of the unit card proposed, we had a card with ten horizontal lines on it, allowing for the reporting of ten jobs, if necessary, one for every hour in the day. The saving of labor there was very great. I was to hire a time clerk. He had two little boys to assist him in posting the cards. This kind of card made a very great change and helped very much. But still I did not get my reports in at the end of the month as quickly as I expected. I went out West. The selfish element entered still more largely into my facilities, for I had to do almost all the work myself. I was allowed a soldier, however, and by the use of these single card tickets he did everything in about an hour a day. We did not have as many men, but I had about sixty or eighty, and this soldier did all of the sorting and all of the computing, and I had everything ready at the first day of the month, a full account of everything done the month before, the cost of every order analyzed and balanced with the pay-roll. I made a computation the other day at the Watervliet Arsenal, West Troy, where I am stationed now, but where I have had nothing whatever to do with the management of the system. I found that an average of a hundred and fifty men in a great many various capacities were making cotton duck equipments, harness, canteens, straps, steel and wooden gun carriages, and a great many other parts of military furnishing. I found that about $1\frac{2}{10}$ to $1\frac{3}{10}$ orders per day were worked on per man. Some of the men went up to four, or five, or six jobs a day—general utility men. Others work on the same jobs steadily day after day. I am very confident in saying that anybody who tries it will be very well satisfied with the great saving and the great readiness with which any desired result can be immediately attained. I think that answers Mr. Smith's question.

Mr. Smith.—Regarding the relative amount of paper and printing in the two systems I wanted to hear, if you please.

Captain Metcalfe.—Of course, in the independent card system

there would be more paper and printing. As to the statement of Mr. Taylor, who is connected, I believe, with Messrs. William Sellers & Co., to whom I am under many obligations, I think he somewhat confuses the order tickets and the time cards. The order tickets are substantially such as he represents as being used in his works, although most any convenient way of making the orders known to the workmen may be used. A bulletin-board will answer as well as anything, if nothing better can be found. Verbal transmission is the readiest, but, of course, it loses the character of a distinctive record. The order tickets are not torn; they are simply passed out and then returned and the transaction is cancelled. The only things which are torn are the labor cards, or service cards as I call them, which are torn off from the top of a book, so that, with the exception of the top one, they will always be reasonably clean. I have found no trouble with that. In my experience at the Benicia Arsenal the men kept them in little tin boxes outside their benches and filled them out as their work went on.

Then, as to Mr. Anderson's remarks about the sheets getting dilapidated and the difficulty of keeping track of them, I found no trouble of that kind. I never found one of these cards to be lost. You do not lose them any more than you lose money. They are used as if to buy things with, and go on from hand to hand until they get into the office, where they are all settled into their proper places. The receipt of the order ticket is indicated by each foreman's punch-marks on the duplicate retained by the superintendent, so that, having in his rack that ticket, the superintendent may see from a glance at the punch-marks upon it who has received this order, and in time that it has been completed by those whose numbers in the "completion" line he has punched out as their own cards come in completed.

All the record necessary is comprised on the original ticket.

Mr. W. H. Doane.—I merely rise to ask the captain to very kindly tell us how he arrived at the basis of cost; after he got the number of hours of labor, how he arrived at the cost of the product.

Mr. Taylor.—I think Mr. Metcalfe has misunderstood me if

he is of the opinion that I do not approve of the card system. I thoroughly approve of the card system. We have tried it practically in our works for nearly ten years. It is simply the working out of one part of the details of his system that I do not approve of.

His suggestion is, that each workman should have a book containing ten, or twenty, or a hundred or more cards, something like a check book, and that each day he shall return one of those cards to the office, punched by the foreman of the shop, and my objection was to that part of the system.

I think that the same card, the same check which he suggests as being useful for conveying the time and the work done, and the authority and so forth, to the central office, can be used to record a great variety of other facts which are exceedingly interesting and valuable. In point of fact, in our works we use a great variety of time cards, which proceed, in our case, first from the clerk to the workman, and then from the workman back to the clerk.

We have, at least, I should think, two hundred varieties of printed cards, differing according to the information desired to be conveyed from the workman to the office, all of them, however, containing, to a certain extent, the same information; that is, each card conveys the same information and other information besides, as is recorded on Mr. Metcalfe's blanks.

My criticism was that the information conveyed by his cards was not sufficient. I fail also to see the advantage of using a punch, as described by Mr. Metcalfe. The initial of the foreman, or the workman, or the clerk, is more rapidly made with a pen or pencil at the same time as the writing is done on the card than it can be with a punch, and it retains a certain amount of individuality.

Anyone who gets hold of a punch can punch the authority for doing work of any extent or variety that he chooses; but handwriting is much more difficult to counterfeit.

Mr. Oberlin Smith.—I thoroughly believe in Captain Metcalfe's theory of the subject, and in his system as a whole; but I believe with the other gentlemen here that some modifications may be

necessary for different shops. I confess I am a little alarmed at the two or three thousand tickets a week, which I might have to use if I carried it out strictly ; but I believe, in a great many shops, the system exactly as it stands is just the thing. There may be other shops where a modification making a card last a week instead of a day for one workman would be better. There may be cases where it would be better to put more than one job on the card, and there are cases, as I said, where the Metcalfe system could be used in its entirety. But all of this wants looking up, and in the happy future I hope that some committee or commission (perhaps of this Society) will have a chance to devise some systems of shop organization, not *one* system only, because we cannot apply one to all kinds of shops. The shops of this country want classifying into so many classes, and the best possible kind of organization for each will be ascertained only by careful study and by the collation of the experience of a great many persons.

In regard to the soiling of the shop cards, I do not think it amounts to anything. In the concern with which I am connected we have allowed workmen to write directly on cards for a long time. We have never had any trouble with their being lost or soiled, or too much torn for practical use.

Captain Metcalfe.—So many suggestions have been made, it is rather hard to take them all up in order, and I may omit some.

Mr. Hawkins made a point about men idling. That suggests to me one point which I had not dwelt upon, which is, that by making a workman start a record of what work he is doing, it gives him an interest in doing it rapidly from a feeling that it will be recorded somewhere in the office.

A gentleman asked me about the cost of production. The workman has to charge his time every day to some job so as to get paid for it. He is presumably disinterested in the cost of any particular job, so he tends to put it to the most probable one. We check his record by its verification by the foreman, and we make the probability greater by recording everything as nearly as possible at the time when it was done. I believe that the tendency will be to charge expenses—in fact, I have noticed

it myself—to charge expenses as nearly as possible at the time when they are incurred. Then the record is shoved away and passed on to another person.

The general scheme is this: You stand in the center of your works, give your orders, and echoes come back to you telling what is going on. Now, these being physical items having individual numbers, to which labor and material are charged, they may be assorted in pigeon-holes corresponding to the orders. They can be sorted from time to time during the progress of the work, so that, for example, the number of hours' work by operatives of the same class of wages being noted to get the cost of labor to date, you will merely have to add in those which have not been assorted. The differentiation can be carried still further, if necessary, so that, by providing in the beginning for a more complete analysis, the number of days' or hours' work by each class of men on each component in that job may also be ascertained.

Mr. W. H. Doane.—My query had reference to the bases on which Captain Metcalfe proposes to apportion the incidental expenses of an establishment.

Captain Metcalfe.—The cost of work is made up, I believe, of the cost of labor, the cost of material, and its fair share of the incidental expenses of the establishment. I believe that the incidental expenses of an establishment should be distributed on the basis of the quantity of labor which the establishment holds, by what I call a cost factor. I find it is used in several shops, Mr. Smith's among others. I divide the incidental expenses of each department, plus their fair share of the general expenses of the whole factory, by the number of days' labor done in that department during the past year. That gives us, say $1.25 per day. Rent, insurance, taxes, salaries, motive power, lighting, are all in the nature of facilities for the performance of labor. I once applied this method to the case of a stove factory, and with some satisfaction to those who heard me, I believe. If the price of iron goes up, your incidental expenses do not increase. If your change of material were to be very great, say from an iron stove to a brass stove, your cost for motive power, etc., would not be any greater, so I leave material entirely out of the

question and put these expenses with the cost of labor. But I distribute it according to the actual number of days' work irrespective of their cost. Poor labor costs more to watch it than dear labor. But if you attempted to divide your incidental expenses according to the cost of labor, the difference would be the other way. You would have to charge more for dear labor than for cheap labor.

As to Home Rule in the departments, that would be a question of locality. It is not necessary that everything should be run from the centralized power.

INDEX.

A. PAGE.

A. (Attendance)....100, 105
Abbreviations of title.... 91
Abstract of disbursements..255, 257, 303
Abstract of expenditures..11, 46, 137, 264
Abstract of fabrications....11, 13, 137
Abstract of purchases....13, 49, 253, 255 256, 257, 262
Abstract of receipts and issues.... 10
Abstract of sales....45, 53
Abstract space in material card filled by.... 178
Abstracts analyzed....140, 173
Abstracts, annual....11, 48
Abstracts B and 5, changes proposed in.... 137
Abstracts, compilation of....47, 264
Abstracts, designation of....41, 45, 249
Abstracts in detail not required.... 10
Abstracts furnished O. S-K. by C. O. 11
Abstracts, present method of preparing.... 47
Abstracts, proposed schedule of..140, 173
Abstracts, single, proposed method of compiling.... 265
Abstracts relating to C. S. return, criticism of.... 53
Abstracts, verification of.... 265
Accounts, arsenal, definition of terms, 34 41
Accounts for labor and material, requirements of.... 38
Accountability for public property..8, 12
Accountability for public funds....12, 256 260, 261, 275
Actual space, material card....168, 187
Address space filled, when.... 178
Administration, value of, measured by cost.... 17
Agencies defined.... 42

PAGE.

Agencies indicated in title section of material card.... 168
Altering nomenclature..177, 184, 248, 262
Ammunition, symbolic nomenclature in detail.... 123
Amount space, material card....169, 178
Analysis of abstracts.... 173
Analysis of cost.... 292
Analysis of expenditures of money as to objects.... 300
Analysis illustrated by tree....98, 102
Analysis limited by definiteness of first charges....98, 143, 303
Analysis of labor on time book..298, 302
Analysis of purchases as to appropriations.... 257
Analysis of services according to appropriations.... 298
Annual abstracts....11, 48, 55
Annual return....10, 48
Application to private shops....23, 309
Appraisal of plant.... 198
Appropriations....12, 34, 275, 282, 303
Appropriation sheet.... 282
Approval by C. O. of all requisitions, 174
Approval by C. O. of his own orders, 69
Approval by C. O. of transactions with Z.... 170
Approval in part of requisition...172, 222
Arsenal accounts, definition of terms used in....34, 41
Arsenal books required to be kept, 14, 23
Arsenal, breaking up.... 232
Arsenal compared to household.... 31
Arsenal departments, military post... 35
Arsenals, issues from....7, 9, 206, 230
Arsenals, organization of....27, 83
Arsenals, mechanical operations of, classified.... 127

PAGE.

Arsenal records 34
Arsenal responsibility to Chief of Ordnance and Treasury 36
Arsenal return 138, 265
Articles found on post 137, 208
Assistance, recognition of, 18, 27, 273, 300
Assistants to C. O. proposed 83
Assumed space, material card ... 169, 187
Attendance 100, 105
Authority space 217

B.

Balances available for expenditure determined 278, 282
Benicia Arsenal, shop-order No. 14 .. 217
Benicia Arsenal, standing orders at .. 144
Benicia Arsenal, system applied at ... 21
Bills, fly. (See Fly bills) 257
Books dispensed with 19, 21
Books, objections to 77
Books required to be kept at an arsenal 14
Books *versus* cards 7
Boxes, symbolic nomenclature of, 122, 124
Breaking up arsenals 232
Broken sets, issue of 233

C.

C. (Character of work) 99
Cannon primers, nomenclature of 124
Cards applied to book-keeping 22, 86
Cards, objections to 86
Cards required, list of 89
Cards summed up directly 266
Cards used for preparing catalogues .. 85
Cards *versus* books 77
Cartridge metal balanced 220
Cartridge scrap 194, 206, 220
Cartridges, &c., symbolic nomenclature in detail 123
Cartridge tools expended 204
Cases in practice with material card .. 179
Case 1, material from store to be held in charge 180
Case 2, material from Z. to be held in charge 184
Case 3, material from Z. expended on arrival 188

PAGE.

Case 4, fabrication kept in charge 192
Case 5, fabrication turned into store, 194
Case 6, fabrication transferred between shop-orders 196
Case 7, fabrication reported of plant remaining on hand 198
Case 8, returning surplus material to store 200
Cases 9 and 10, expending material in charge 202, 204, 214
Case 11, material issued to Z. by foreman 206
Case 12, material found or taken up .. 208
Case 13, material dropped 210
Case 14, material transferred between classes 212
Case 15, material transferred between shop-orders 214
Case 16, taking inventory 217
Case 17, material transactions between foremen 220
Cases 18 and 19, material received by storekeepers from Z. 222
Case 20, approval in part of requisition 222
Case 21, storekeeper's issue to Z. 230
Cases 22, 23, 24 and 25, storekeeper's issue on requisition 234
Cash accountability, present papers .. 250
Cash accountability, proposed papers, 256 260, 275
Certificates of inspection 250, 256, 260
Change of name by fabrication 39
Character of work, symbol of 99, 102
Charging labor of soldier workmen .. 273
Charging material issued from store, 175 202, 217
Chief of Ordnance, responsibility of arsenal to 36
Claims 19, 23
Classification and nomenclature of material 43
Classification of expenditures 46, 264
Class space, material card 168, 178
Classification of operations of a machine shop 128, 133
Class symbols 107, 119, 123
Clerks combined with foremen 77

PAGE.

Clerks determining cost of work, present method 74
Clerks' functions defined..... 78
Coal, expenditure of..... 202
Combination of foremen with clerks.. 76
Combination tools, objections to..... 76
Commanding Officer approves all requisitions 174
Commanding Officer, duties of..... 8
Commanding Officer ordering supplies directly.....174, 222
Commanding Officer and O. S-K., dual responsibility..... 28
Commanding Officer, proposed expansion of functions of..... 134
Commanding Officer, property accountability of.....13, 41
Commanding Officer, punch-mark... 170
174, 177, 184, 210, 230, 233
Commanding Officer's recurrent approvals criticized.....67, 69
Commanding Officer revises all communications with Z.....31, 170
Commercial value of machinery..... 218
Communication with Z. through C. O. 31
177
Comparison with household..... 31
Comparison with private shops....37, 78
Compilation of returns, present and proposed.....48, 265
Compilation of abstracts, present and proposed 47, 264
Completed fabrications reported..194, 198
204, 274, 306
Components 106, 107, 108
Component operations, labor for and cost of, determined..... 292
Component parts of sets enumerated, 233
Component parts, transfer of, between shop-orders..... 196
Condition changed by operations.... 127
Condition space, material card..... 168
Condition of business exhibited..146, 234
262
Consecutive transactions on material card 178, 222
Consolidated analysis of cost of work, 296

PAGE.

Consolidation of completed returns... 138
265
Correspondence marks, when not required.....170, 180
Correspondence space on material card.....170, 179
Correspondence between pay and property vouchers.....250, 262
Correspondence card..... 89
Cost clerk, duties of.....170, 177, 266
Cost, constituents of.....72, 97
Cost, determination of, by clerks and foremen, present method..... 72
Cost determined by proposed method, 292
Cost of administration determined... 17
Cost of labor determined by present methods..... 72
Cost of labor for component operations determined by proposed method... 292
Cost of material determined by present method..... 73
Cost of material determined by proposed method..... 294
Cost of product determined...37, 72, 278
296
Cost reconciled with disbursements.. 289
Cost of service determined..... 292
Cost transferred between shop-orders, 278
Cost of work, detailed knowledge of, 17
98, 102, 269, 296
Cost section, material card..... 169
Cost sheet described.....272, 275
Cost sheet proved..... 290
Cost sheet reconciled with pay-roll.. 269
Cost of work analyzed..... 292
Course of cards.....98, 170, 179
Credit entries.....176, 274, 281
Crediting material received into store, 176
Credit sheet 281
Criticism of abstracts relating to C. S. return 53
Criticism of abstract of sales..... 53
Criticism of C. O.'s recurrent approval, 67
69
Criticism of current service return... 54
Criticism of present methods, general.....23, 76

PAGE.

Criticism of present methods of compiling abstract C..... 49
Criticism of present methods of inspecting material..... 68
Criticism of present methods of procuring material..... 67
Criticism of property return and of inventory..... 54
Current service return.....9, 11, 13, 41 134, 244, 265
Current service return, proposed scope of..... 134
Cutting operations causing change of form..... 129
Cyclostylic pen.....230, 266

D.

Dating the material card..... 178
Dating service card..... 154
Day work, record of.....152, 272
Deliberation by C. O. on cards..... 184
Defenseless position of O. S-K..... 50
Definition of terms used in arsenal accounts..... 41
Definition of terms used in nomenclature..... 106
Denominations of money for pay-roll, 298
Departmental standing orders...218, 309
Deputies of officer in charge..... 32
Deputies of O. S-K..... 33
Descriptive symbols...107, 119, 123, 125
Designation of abstracts.....45, 139
Destination of cards.....177, 248
Details, correctness of, important, 37, 98
Deterioration..... 218
Determining balance available for expenditure..... 282
Determining cost of product.....170, 292
Determining material on hand....54, 249
Determining miscellaneous expenses, 67 74, 97, 166, 218
Determining price for piece work... 38
Difference between accountability for labor and material..... 38
Difference between quantities required and received..... 187
Difference between systems, present and proposed..... 149

PAGE.

Difficult interpretation of present time record..... 63
Difficulty of returning surplus to store, 70
Direct issues.....137, 206
Direct transactions..... 135
Disadvantages of wages tables. (See objections.)..... 269
Disbursements..... 12
Disbursements, abstract of..255, 257, 303
Disbursements reconciled with costs, 289
Disproportionate attention paid to material records..... 38
Distribution of material cards..... 173
Distribution of omitted charges..... 176
Double entries in cost section..... 176
Double entries, treatment of, by cost clerk.....274, 281
Drawing material from store.....30, 180
Dropping material.....13, 210
Dual responsibility of C. O. and O. S-K..... 28
Duplicate material card..... 274
Duties of Commanding Officer..... 8
Duties of cost clerk..... 266
Duties of Ordnance Officers.....8, 37
Duties of O. S-K..... 12
Duties of stock clerk.....243, 260
Duties of storekeepers.....33, 176, 222

E.

Electric pen.....230, 266
Emergencies.....206, 222
Entering material cards on journal and ledger..... 248
Entering service cards on cost sheet, 272
Equipments, issue of..... 233
Erasures on material card..... 177
Estimates, information for, derived from.....17, 63, 279, 286
Evidence of purchase not evidence of receipt..... 49
Examples in symbolic notation..... 131
Executive officer in proposed system, 83
Executive officer signs direct issues to Z..... 206
Exhibit of condition of business..146, 234 262
External relations, present..... 41

PAGE.

External relations, proposed..... 134
External services, cards for.....156, 272
Expenditures (of material), abstract of, 11, 46, 137
Expenditures of ammunition and other material.....14, 46
Expenditures at arsenals..... 11
Expenditure on arrival..... 188
Expenditures, classification of....46, 264
Expenditures of coal..... 202
Expenditures, determination of balance available for..... 282
Expenditures omitted..... 204
Expenditure of material in charge... 202
Expenditure of money, statement of, 300
Expenditure of tools..... 204
Expenditures, unconsumed, present treatment of..... 30
Experience and applied art relations, 17

F.

Fabrications, abstract of.....13, 137, 177
Fabrication changing name of material..... 39
Fabrication complete, reported...274, 306
Fabrication incomplete, price of..... 178
Fabrication incomplete, reported.... 274
Fabrication indicated on material card, 177, 188, 192, 194, 196
Fabrications issued immediately after receipt into store..... 234
Fabrications, monthly report of...10, 274, 306
Fabrication of paint, example..... 214
Fabrication kept in charge.....194, 198
Fabrication transferred.....196, 206
Fabrication turned into store..... 194
Fabrications untouched, reported.... 306
Fly bills evidence of purchase..... 49
Fly bills, importance of..... 137
Fly bills, register of..... 262
Foremen combined with clerks, 58, 65, 76
Foremen determining cost of work, present method..... 72
Foremen's functions defined..... 78
Foremen, issue to Z by..... 206
Foremen and storekeepers, transactions between.....174, 176

PAGE.

Foremen, transactions with each other, 176, 220
Form changed by operations..... 127
Forms prescribed.....11, 14
Frankford Arsenal, ledger form..... 243
Frankford Arsenal, relation to system proposed..... 18
Frankford Arsenal, standing orders at, 143
Frankford Arsenal, symbolic nomenclature of staple products in detail, 123
Fries, Mr. H. T.....20, 243
Functions, independence of..... 76
Functions of foremen and storekeepers..... 176
Fuzes, time, nomenclature..... 123

G.

Gatling guns, issue of..... 233
General remarks on material card.... 170
General remarks on present system and need of a better one..... 50
General remarks on service card..... 155
General remarks on symbols..... 102

H.

Harness, issue of, in detail..... 233
Hired return..... 300
History of operation of proposed system at arsenals.....18, 22
Household, comparison of arsenal with..... 31

I.

Importance of proper accountability for material..... 38
In charge, material..... 175
Incoming stores, receipt of..... 187
Incomplete fabrications reported, 275, 306
Indebtedness exhibited.....262, 282
Independence of functions..... 76
Independence of representative units of record.....87, 152, 172, 243
Inspector and assistant inspector..68, 261
Inspection certificates.....250, 256, 260
Inspection of materials.....68, 187
Instruments of the proposed system, 85, 97
Internal relations, present system... 57
Internal relations, proposed system.. 151

PAGE.

Inventory 9, 54, 176, 290
Inventory, proposed method of taking 217
Inventory and property return, criticism of 54
Invoices to O. S-K. by C. O. 11, 135
Involved cases in practice 214, 222
Issues from arsenals 19, 206, 230
Issues, duties of stock clerk regarding, 230
Issues of fabrications immediately after receipt into store 234
Issues other than by O. S-K. 137, 206
Issues on requisition for the army ... 234
Issues by storekeepers to Z 230
Issues by storekeepers to foremen ... 176

J.

Job work 156, 272, 292
Journal slips 243, 244, 248, 260

K.

Keeping fabrications in charge .. 135, 192

L.

Labor account, present form of 60
Labor account *versus* material account, 38
Labor analyzed 292
Labor charges proposed 85
Labor, cost of, determined by present method 72
Labor, cost of, determined for each operation 292
Labor by day 152
Labor of soldier workman 273
Labor on time book analyzed ... 300, 302
Laws and regulations, extracts from, 7
Ledger, posting 244, 249
Ledger slips 244, 248
Limitation of analysis 98, 143, 303
Limitation of books required at arsenals 14
Limitation of symbolic notation .. 109, 125
L. S. section 170
Lyford, Colonel S. C. 18

M.

Machinery, deterioration of 217
Machinery, inventory of 218
Machines, time-keeping of 156

PAGE

Machine shop, operations classified .. 133
Machinist, The American, extract ... 110
Manufactory one of arsenal departments 35
Marking material received 171
Material, accountability of, compared with that of labor 38
Material analyzed for cost 249
Material and ammunition expended .. 14
Material in charge of foremen ... 175, 180
184, 192, 202
Material in charge issued. Cases 9 and 10 202
Material charged, value recovered ... 284
Material classified 43, 47, 243
Material, cost of, determined by present methods 73
Material, credits for 176, 281
Material in C. S. and in store, proposed status of 133
Material dropped. Case 13 210
Material expended on arrival. Case 3, 188
Material and fabrications inspected, 68, 187
Material found or taken up. Case 12, 208
Material on hand, determination of, 54, 249
Material, importance of proper accountability for 38
Material, inspection of, present method criticized 68
Material issued always charged 175
Material on inventory. Case 16 217
Material issued by foremen. Case 11, 206
Material issued by storekeeper to Z. Case 21 230
Material kept in charge, 175, 180, 184, 192
Material named and classified 42
Material, procuring of, present method criticized 67
Material procured from store. Case 1, 180
Material procured from Z by C. O. directly 174, 222
Material procured from Z to be kept in charge. Case 2 184
Material purchased analyzed as to appropriation 257
Material received credited 176, 284
Material received, but not paid for ... 51
257, 262

PAGE.

Material records, requirements of..22, 38
Material received by storekeepers. Cases 18 and 19..... 222
Material remaining on hand. Case 7, 198
Material required for, approved in part, 172 222
Material returned to store. Case 8, 70, 200
Material section, material card..... 168
Material from store, present method of procuring..... 65
Material from store, card for, treatment of, by cost clerk..... 286
Material, how supplied for expenditures.....11, 174
Material in transactions between foremen. Case 17..... 220
Material transferred between classes. Case 14..... 212
Material transferred between shop-orders. Cases 6 and 15.....196, 214
Material, transactions with, analyzed, 173
Material turned into store. Case 5, 194, 200
Material card described..... 168
Material card, back of..... 170
Material card, double entries on, treatment of, by cost clerk.....274, 281
Material card accompanying vouchers, 177 261
Material card, duplicate..... 274
Material cards, entering on journal and ledger..... 248
Material card needed by cost clerk for, 260
Material card needed by stock clerk for..... 260
Material card, numbering..... 248
Material card, representing material from store, treatment of, by cost clerk..... 286
Material card, rules for using..... 176
Material cards sorted according to operations..... 294
Material card sorted according to source of supply.....234, 262
Material card stamped by clerks..177, 248 261, 274
Material card temporarily out, replaced by.....262, 274

PAGE.

Material card, use of.....171, 175
McAllister, Colonel J..... 21
Mechanical aids..... 92
Members combined..... 109
Member defined..... 106
Michaelis, Captain O. E.....20, 156, 273 288, 298, 300
Miscellaneous expenses, determination of...64, 74, 97, 166, 217, 278, 281 288, 294, 309
Miscellaneous operations..... 127
Miscellaneous work reported..... 306
Misclassed stores corrected by card.. 212
Money accounts, object of system of, 12
Money for pay-roll, denominations of, 298
Monthly abstract of purchases...253, 256 261
Monthly invoices to O. S-K...11, 55, 135
Monthly returns required..... 10
Monthly work report, preparation of, 306

N.

N. (number of operation).....97, 126
Names changed by fabrication..... 39
Names of staple objects..... 106
Names, sequence of.....11, 43, 47, 243 260, 264
National Armory, time-keeping...59, 61
Nomenclature.....86, 110, 187
Nomenclature altered..177, 184, 248, 262
Nomenclature and classification of material..... 42
Nomenclature of small arms, symbolic, in detail..... 119
Nomenclature of staple products of Frankford Arsenal in detail, symbolic..... 123
Nomenclature, definitions in..... 106
Nomenclature of obsolete objects.... 109
Nomenclature, remarks on..... 125
Notation for successive operations of same kind..... 128
Notation, symbolic, limited, 102, 109, 125
Number, symbolic, of operation..... 126
Numbering material card..... 248
Numbering stamp.....92, 243, 248
Numbering vouchers.....248, 249, 265

O.

PAGE.

O. (object worked on)..... 105
Objections to books..... 77
Objections to cards.....77, 86
Objections to present methods. (See Criticism.) 58, 61, 65, 76
Objections to wages tables..... 269
Observations, weight of..... 16
Obsolete objects, notation of..... 109
Officer in charge, deputies of..... 33
Officer in charge, status of....32, 83, 136
Officers and employees, relations of.. 27
Old tools found..... 208
Omissions distributed..... 175
Omissions, expenditure of..... 204
Operations causing changes in condition 127
Operations causing changes in form.. 127
Operations causing changes in shape, 127
Operations causing changes in situations 127
Operations causing change of objects by uniting them..... 128
Operations in machine shop classified, 128
Operations, successive, notation for.. 127
Operations, symbolic notation..... 126
Operations, sorting material cards by, 294
Operations, sorting service cards by, 292
Operations, table of..... 133
Operations unclassified..... 128
Orders of supply.....9, 230
Orders, present method of giving.... 57
Orders, proposed method of giving.. 142
Ordnance officers, duties of.....8, 37
O. and O. S. defined..... 8
Ordnance and ordnance stores classified 43
Ordnance regulations..... 8
Ordnance property regulations..... 12
Ordnance stores in the hands of troops, 11
O. S-K., deputies of..... 33
O. S-K. and C. O., dual responsibility of..... 28
O. S-K., defenseless position of..... 50
O. S-K., duties of..... 12
O. S-K., property accountability of.. 12
O. S-K., status of, present..... 27
O. S-K., status of, proposed.....83, 134
Originality of method..... 24

PAGE.

Outfit of cost clerk..... 266
Outfit of stock clerk..... 243
Outline of proposed system of bookkeeping 78
Outside services, time book.....156, 292

P.

P. (Plant).....99, 105
Package marks.....169, 222, 230
Package space filled, when..... 178
Packer sorting cards.....232, 234
Packing boxes, symbolic nomenclature.....122, 124
Packing stores for issue.....206, 232
Paint, fabrication of..... 214
Parts of return..... 44
Pattern symbols.....107, 119, 123
Pay book..... 298
Pay clerk.....83, 260
Paymaster 83
Pay-roll 60, 269, 298
Pay-roll reconciled with cost sheet... 269
Pay vouchers corresponding with property vouchers.....52, 259, 262, 289
Piece defined..... 107
Piece work, determination of price for, 57 73
Piece work on time book..... 272
Piece work, record of.....154, 272, 292
Pigeon holes.....92, 243, 272
Plant and Work..... 99
Plant remaining on hand, appraisal of, 198
Plant under standing orders.....100, 105
Plastic operations causing change of form 127
Posts, distant, supply of..... 52
Posting journal and ledger.....248, 249
Post, military, one of arsenal departments 35
Post-office 96
Preparation of abstracts, progressive, 255 257, 262
Preparation of property return, present method..... 48
Present method, compiling abstracts and property return.....47, 48
Present method, computing cost of work 37, 72

PAGE.

Present method, criticism of...23, 49, 57, 64, 67, 76, 256
Present method, determining cost of work by clerks and foremen....72, 74
Present method, external relations... 41
Present method, internal relations... 57
Present method, inspecting material, criticism of..... 68
Present method, keeping time..... 60
Present method, orders, compared with proposed plan..... 149
Present method, organization of arsenal..... 27
Present method of procuring material and its consequences in practice, 28 65
Present method of procuring material by purchase..... 65
Present method of procuring material from store..... 65
Present method, remarks on need of a better one.....55, 76
Present time record, forms of..... 60
Present time record, interpretation of, 63
Present and proposed theories of relations.....31, 41, 57, 134, 151
Present treatment of unconsumed expenditures 30
Price list, estimated..... 172
Price list, standard..... 171
Price for piece work determined..... 38
Price, space filled by..... 178
Price stated on material card, when.. 171
Primers, cannon, nomenclature..... 124
Private shops, application of system to.....23, 309
Private shops, comparison with public 37, 71, 78
Private work reported..... 308
Procuring material, criticism of present method 67
Procuring material to be kept in charge.....175, 180, 184, 192
Procuring material from outer world (Z).....65, 174
Procuring material from store....65, 180
Product reported piecemeal..... 274
Profit and loss..... 192

PAGE.

Progressive preparation of abstract C, 255 257, 262
Property accountability..7, 8, 10, 12, 28 36, 41, 250, 256, 250
Property regulations..... 13
Property return...9, 10, 13, 41, 138, 265
Property return and inventory criticized..... 53
Property return, proposed method of preparing..... 265
Proposed assistants to C. O..... 83
Proposed changes in present system, 136 256
Proposed internal relations..... 151
Proposed expansion of functions of C. O..... 134
Proposed external relations..... 134
Proposed method of compiling single abstracts..... 265
Proposed organization of arsenals.... 83
Proposed method of giving and recording shop-orders..... 142
Proposed scope of current service return..... 134
Proposed status of Executive Officer and O. S-K..... 83
Proposed system, essential features of, 22 86
Proposed system, instruments of..85, 97
Proposed system, objections to use of cards..... 86
Proposed system outlined..... 78
Proposed system, propositions advanced 136
Proposed time-keeping..... 152
Proposed treatment of abstract of purchases.....257, 259, 261, 262
Proposed wages tables, disadvantages of..... 269
Proving cost sheet..... 290
Public funds disbursed.....12, 36, 275
Punch-marks, material card.....22, 169
Punched signatures.....22, 91, 154, 164
Purchases, abstract of....13, 49, 253, 255 262
Purchases, card for, treatment by clerks 187, 260, 282

PAGE.
Purchases, direct, by C. O.....174, 222
Purchases, present method of..... 65
Purchases, requirements attending, 39, 250
Purchasing orders..... 184

Q.

Quantity space..... 169
Quartermaster's invoice..... 232
Quarterly returns required..... 9

R.

Racks 92, 146
Receipts and issues, abstract of..... 10
Receipt of stores on arrival..... 187
Receipt of material in emergency.... 222
Receipts before payment, 51, 257, 262, 289
Receipts from Z.....174, 184, 188, 222
Reconciling cost sheet with pay-roll, 269
Reconciling costs with disbursements, 289
Records of arsenals..... 34
Record of services outside arsenal.... 156, 272, 292
Recoveries of material..... 284
Recoveries of shop expenses..... 288
Recovery record..... 285
Register of fly bills..... 262
Regulations, ordnance..... 12
Relations of arsenal, external, present and proposed.....41, 134
Relations of arsenal, internal, present and proposed.....27, 83, 142
Reloading tools, etc., issue of..... 233
Repairs affecting name or class...13, 212
Replacing material cards temporarily out.....262, 274
Report of cost.....272, 296
Report of fabrications, complete and incomplete 9, 192, 194, 275, 306
Report of private work..... 308
Reporting product piecemeal....194, 275
Report of O. & O. S. received and issued 10
Reporting standing orders worked on, 306
Report of work.....9, 306
Requisition approved in part....172, 222
Requisition from army, issue on..... 234
Requisition by material card..... 174
Requisitions revised.....69, 174

PAGE.
Resting place of cards..... 177
Return, annual.....9, 13, 138, 265
Return, arsenal, consolidated....138, 265
Return corresponding to transaction, designation of, on material card... 248
Return, effect on, of changes proposed, 135
Return of hired men.....10, 298
Returns, monthly..... 10
Return, parts of..... 44
Return of property, present and proposed methods of preparing, 48, 136, 265
Return of stores in current service, 9, 11, 13, 134
Return of stores in current service, present form criticized..... 54
Return of scrap copper to manufacturer 206
Returning surplus to store.....70, 200
Returns, transfers between..... 137
Returns, weekly..... 10
Roll call..... 153
Rules for using material card..... 176
Running expenses of machinery, 144, 217
Russell, Lieut. A. H..... 24

S.

S-O. (shop-order number).....97, 99
Schedule of abstracts proposed..130, 141, 173
Science of administration..... 15
Scope of work..... 17
Scrap of cartridge metal.....194, 206
Selections for private shops..... 310
Sellers, Wm., & Co..... 24
Sequence of names...11, 43, 47, 243, 260, 264
Serviceable stores taken up...13, 137, 177
Serviceability of material....43, 168, 245
Service cards.....151, 272, 292
Service cards for machines..... 156
Service cards, sorted.....272, 278, 292
Services analyzed for cost...292, 300, 302
Services analyzed as to appropriations, 300
Services outside the arsenal, 156, 272, 292
Sets, broken, issue of..... 233
Shape changed by operations..... 127
Shop expenses.....65, 74, 97, 142, 149, 166, 218, 278, 281, 288, 294, 309

PAGE.
Shop expenses charged, value recovered 288
Shop expenses at varying rates 309
Shop-order book 142
Shop-order, completion of..194, 198, 204, 275, 306
Shop-order No. 14, Benicia Arsenal.. 144, 217
Shop-order numbers 99
Shop-order numbers on journal slips, 248
Shop-orders, procedure with 142
Shop-order tickets 145
Shop-orders, transfers between..177, 214
Signatures by punching 91
Single entries, advantage of..86, 172, 178, 303
Situation changed by operations 127
Slips, journal and ledger 243
Small-arms, nomenclature of, in detail, 119
Smith, Mr. Oberlin 106, 110
Soldier workmen, time of 156, 273
Sorting contents of pigeon holes, 272, 292
Sorting material cards representing issues 232, 234
Sorting material cards by operations, 294
Sorting material cards by pay clerk.. 262
Sorting service cards by cost clerk, 172, 292
Sorting trough 266
Stamps 92, 243, 248
Stamping material card 177, 248, 274
Standing orders 142, 149, 217
Standing orders, Benicia Arsenal.... 144
Standing orders, Frankford Arsenal.. 143
Standing orders, plant under....100, 105
Standing orders worked on reported.. 306
Staple objects of manufacture....105, 107
Staple objects, obsolete, notation of.. 109
Statement of expenditures 300
Statement of manufactures and other work done 10, 306
Statement of stores on hand...10, 17, 54, 249
Status of material in current service and in store 134
Status of officer in charge 32, 136
Status of O. S-K 27, 134
Stencils 230, 266
PAGE.
Stock clerk, duties of 179, 187, 230, 248, 260, 275
Stock section, material card 169
Stone quarried on post 208
Storekeepers, duties of 33, 176, 222
Storekeepers, proper functions of, 134, 176
Storekeepers receive and issue cards, when 176
Storekeepers, transactions between.. 176
Storekeeper's transactions with Z.... 222, 230, 234
Subsidiary orders 146, 147
Substitute for O. S-K 12, 13, 33
Summation from cards 266
Supply of distant posts 52
Supply, orders of 9, 230
Surplus to store, returning 70, 200
Symbolic nomenclature 97, 130
Symbols of class (object)...107, 119, 123
Symbols, descriptive (object), 107, 119, 123
Symbols for operations 126
Symbol of pattern (object)..107, 119, 123
Symbolic names of staple objects.... 106
Symbolic notation 86, 107, 110
Symbolic notation, examples in practice 131
Symbolic notation limited....98, 109, 125
Symbolic notation of mechanical operations of Arsenal 127
Symbolic notation of packing boxes.. 122, 125
Symbolic notation of small-arms in detail, examples 119
Symbolic notation of staple products at Frankford Arsenal in detail..... 123
System of money accounts, object of, 12
System, proposed, history of..... 18

T.

T. (Tools) 101, 105
Table showing analysis of abstracts.. 45, 140, 173
Table showing book-keeping of Arsenal 34
Table showing classification of material 43
Table showing fabrication of paint... 214

PAGE.
Table showing nomenclature..... 110
Table showing operations of a machine shop..... 133
Table showing organization of arsenals 27, 83
Table of wages..... 267
Taking up material..13, 14, 137, 177, 208
Target pasters, nomenclature..... 125
Thumb-mark, signature.....153, 308
Timber cut on post..... 208
Time book, proposed.....270, 298, 302
Time fuzes, nomenclature..... 125
Time-keeping, National Armory..59, 61
Time-keeping for machines..... 156
Time-keeping, present method..... 59
Time-keeping, proposed method, 151, 272
Time-keeping, requirements of....38, 64
Time-keeping for soldier workmen... 156
273
Time-keeping, small fractions of time, 269
Title section, material card..... 168
Tools (T.) 101, 105
Tool closet.....192, 208
Tools, combination, objections to.... 76
Tools made for consumption in regular work.....101, 105, 192
Tools found..... 208
Transfers between returns, classes and conditions.....13, 137, 177, 212
Transfers between shop-orders..177, 196
214, 278
Transfer of materials by invoice and receipt..... 11
Trays 96
Treasury department, responsibility of Arsenal to..... 36
Tree illustrating extent of analysis, 98, 102
Troughs for sorting..... 266
Trusteeship..... 36
Turning fabrication into store..... 194
Turning scrap into store..... 194

U.

Unconsumed expenditures, present treatment of..... 30
PAGE.
Union, causing changes in object.... 127
Units of record, independence of..86, 152
172, 173
Unserviceable stores transferred to serviceable 13, 137, 177, 212
Untouched fabrications reported..... 306
Unserviceable O. & O. S. dropped, 14, 210
Use of material card.....171, 176

V.

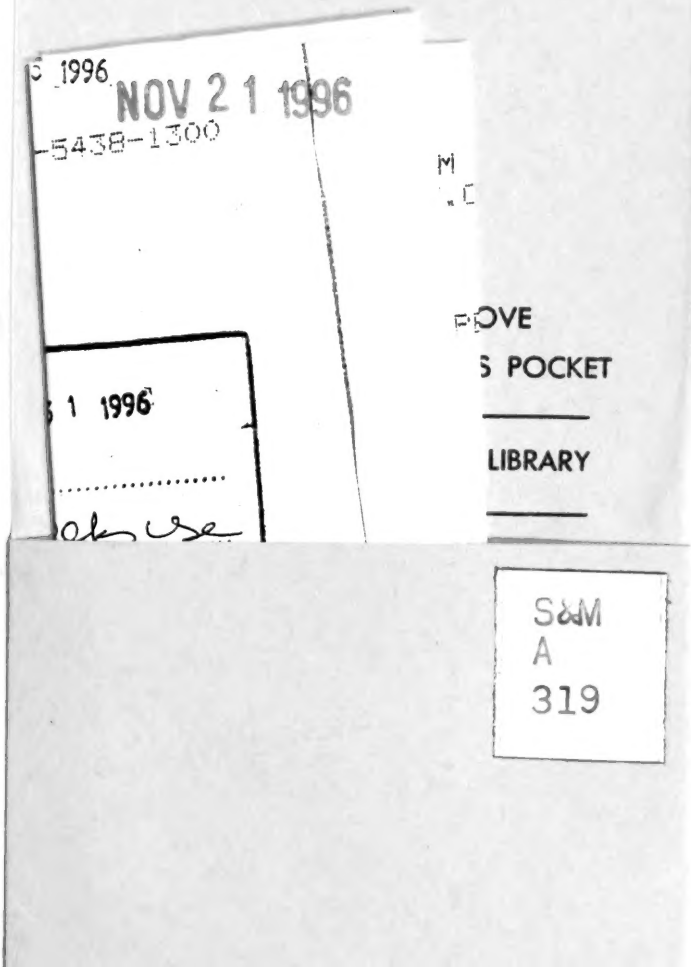
Value of machinery estimated..... 217
Value of detailed knowledge of cost of work.....17, 98, 269
Variable shop expenses..... 309
Variations in nomenclature.....187, 248
Verification of abstracts..... 265
Vouchers...12, 41, 46, 250, 253, 256, 261
Vouchers accompanied by material cards 177, 261
Vouchers, cross-reference between... 262
Vouchers numbered.....10, 248, 250
Vouchers, pay and property, correspondence between.....52, 259, 262
Voucher space filled by..... 175

W.

W. (Work).....100, 105
Wages tables..... 267
Weekly returns required..... 10
Work (W.).....100, 105
Work charges subdivided...100, 104, 292
Work by day, or time work..... 152
Work by job.....156, 272, 292
Work by piece.....37, 73, 154, 272
Work, private, reported..... 308
Work report.....10, 306
Work on standing orders reported... 278
306
Workmen's functions defined..... 78

Z.

Z, correspondence with.....31, 170, 177
Z, issues to.....206, 230, 234
Z, receipts from.....184, 188, 222



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