

The Institution of Post Office Electrical Engineers.

**Some Notes on Exchange Equipment,
Factory Costing and the
Economics of Production**

By

S. J. HUSBAND, Assoc.I.E.E.

Read before the London Centre of the Institution
on the 14th November, 1933.

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Some Notes on Exchange Equipment, Factory Costing and the Economics of Production.

SYNOPSIS.

1. *Introduction.*

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Labour, its theoretical and actual proportion of total cost, mass repetition, the craftsman, direct and indirect wages, daywork, piecework, the rate-fixer, altered rates, special wage systems, Rowntree's wage system, profit sharing, responsibilities of employers, juvenile labour.

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6. *Distribution and Selling Expense.*

The case of Government contracts, sales depots, advertisement, proprietary articles, monopolies, freights, packing, selling policies at home and overseas, appropriation of selling expense.

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Independent of cost, profit the reward of capital, industrial risk, "cost plus", frequency of turnover.

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INTRODUCTION.

The objects of a costing system are threefold, namely :

1. To record detailed costs.
2. To discover and eliminate waste.
3. To study the behaviour of costs under varying conditions.

The primary objective is very simple—to present an accurate picture to the manufacturer of the real cost of the various articles that are being made in the factory. So simple does this appear that it may be difficult to believe that in most industries and certainly in the telephone industry, exact costing is quite impossible of achievement. A general example of this is afforded by the uses to which waste material may be put. Where material that is waste from one operation may be adapted for use on another operation, any division of the value of the material between the two operations in question must be an arbitrary one. An analogy is provided in the sheep-rearing industry in which the respective costs of producing hides, meat and wool can never be exactly identified. At the same time though exactitude may be unattainable, varying degrees of accuracy are possible.

Sub-division of Costs.

The key to the problem lies in sub-division of cost or departmentalization; that is to say, the greater the extent to which the detailed analysis of cost is carried, the closer to fact the results arrived at will be. The condition that accuracy is not possible need cause no alarm, and, were it otherwise, no advantage might result because attainment in all probability would be too costly. In a hard and practical world the manufacturer cannot afford to incur any expenditure which does not yield a practical return. He naturally wants to know his costs as accurately as may be, but he wants to acquire this knowledge at minimum expense, and there is a point at which he must call a halt.

We see, then, at the outset of our investigation :—

- (a) That exact costing is impracticable.
- (b) That a compromise may be effected between the degree of accuracy required and the expense to be incurred in its attainment.

The most elementary system will distinguish broadly between different classes of work done in the factory. Consider the case of a manufacturer producing two classes of electrical equipment such as small radio parts and domestic appliances and that

both classes of work pass through the same shops in the factory. The books show an overall 10% profit per annum on capital invested and there is no costing system in operation. On being taken to task this manufacturer's attitude would probably be one of surprise. "The factory is showing a profit," he would say, "Why waste money on a costing system that serves no purpose?"

Let us now suppose that envious eyes have been cast on the domestic appliances side of his business and that competitors appear. He loses a few contracts. To meet this competition and to recover his business he decides to cut his prices, but immediately he is in a dilemma. He does not know how far he dare cut. He knows that his factory pays a 10% profit, but whether the profit comes from radio parts or from the domestic equipment or in what proportions from each he cannot say. Any sort of reduction is a shot in the dark for he may cut too little and lose further contracts, or he may cut too much and place himself unknowingly below production cost. In the face of competition he realizes that it is not sufficient to know that his factory is showing a profit overall. He must know where the profit is being made and he thereupon institutes a system of costing which distinguishes his expenses between radio parts and domestic appliances.

It may be that the new found knowledge will enable this manufacturer to survive and, for a time, to keep his recovered trade. Competition, however, becomes more keen and in due course he finds that he has to fight not only for finished assemblies but for replacement piece-parts, repairs, etc. It is now necessary for the costing system to differentiate further—not merely between classes of output but between parts within the class. Thus he must know the cost of castings produced in the foundry, of elements made in the moulding shop, of work done in the wiring shop, of various small fittings produced in the machine shop, of vatwork in the plating shop, of assembly and testing of the completed item in the assembly shop, and so on. In order to keep his business the maker must know precisely what his costs amount to in each of these respects.

If he has profited from his previous experience he will pay the necessary price for the required detailed costings. He may learn that for years he has been turning away good business at prices which he had supposed would be unremunerative due to, say, the use of a general overall burden rate instead of a specific shop burden rate. Conversely, with equal probability he may have been selling parts below cost and have incurred losses through ignorance of the real facts of productive, administrative and distribution expense. An immediate adjustment of selling prices in the former instance means more business for the factory. In the latter instance he is faced with alternatives. He cannot continue to sell at a loss. He may abandon this particular line and close down the unproductive plant; but he must be careful in this for if the component concerned is used in finished assemblies he will still have to obtain such parts for his own sales and it may be dangerous to depend on

purchase by sub-contract, particularly from firms who are, or may become, rivals in his main market. Alternatively he may continue to manufacture for his finished assemblies and increase his price for the part. It is possible that the original price may not have been commercially practicable and that even after increasing the price within limits he would still be able to compete with his rivals. At the same time he would have to face the risk of losing the piece-part business whilst still making for his finished assemblies.

He may, and this brings us to the second part of the threefold benefit of an accurate costing system, explore probable and hitherto unknown sources of waste in his factory, and office organization which would stand revealed under the searching light of his detailed costings. These wastages may be found in many places. They may lie in the treatment of materials from the point of view of suitability of kind and quality for the purpose in hand; in methods of handling and cutting; in the grade of labour employed for the various operations; in the understanding of the real cost of overtime; in faulty distribution of standing charges and so on.

Thirdly, with an accurate and flexible costing system, the manufacturer is in a position to study and forecast the possible behaviour of his costs under a variety of problematical conditions which may arise in the future, or which he may cause to arise. Quantity, for example, is of vital importance and a policy of stimulating demand by various artifices in order to justify the installation of plant for mass production methods may be adopted. Again, design in the engineering office, drawing office, or works planning department may need re-consideration.

It will be found possible also to combine other functions with the costing system, one of the most important being the record and payment of wages. Many tabulations will be required and if the organization is of any magnitude, some sort of mechanical tabulating and sorting equipment employing punched cards (such as the Powers system) will be indispensable. A system consisting of punchers, sorter and tabulator, representing an annual charge of £200, would be equivalent to 30 to 35 assistants on this type of work.

L.M.S. Railway.

It is instructive to refer to the wide-spread economies that have resulted from the recent rationalization on the L.M.S. Railway. At a meeting of the shareholders in February, 1932, Sir Josiah Stamp stated that despite a heavy fall in gross receipts of over five million pounds, expenditure had been reduced by a still wider margin. Managers of factories with declining outputs will realize the extreme significance of this statement. Most of these economies had been made possible through the detailed system of costing which, in the face of some opposition, had been introduced. Detailed costings had revealed many flaws in the organization which the ordinary financial statements had failed to reveal. As a result of this and a system of progressing, they

had been able to reduce idle time in the repair shops of expensive rolling stock with a consequent reduction of emergency stock; to reduce enormously the numbers of similar piece-parts and overlapping operations; and to eliminate a multiplicity of divided controls in the engineering, research, drawing office accounting, purchasing, printing and clerical departments.

Following the amalgamation of the various interests now represented by the L.M.S. Railway the crying need was for standardization. It is worthy of note that the institution of a scientific costing system practically established also the principle of standardization without a battle being fought since accurate costings showed how simplification might be attained with profit.

Further information may be obtained by those interested from a pamphlet published by the Modern Transport Publishing Co., entitled "Modern Developments on L.M.S. Railway." This pamphlet contains extracts from papers by experts of the L.M.S. Coy. on (a) Rationalization, (b) Scientific Research and (c) Costing.

Various Costing Systems.

It may, I think, be agreed that the introduction of a costing system in sufficient detail to provide a reasonably close approximation to accuracy is essential in any well-ordered factory. Broadly speaking, we have so far touched on principles and considerations which are of general application. In particular industries, however, the treatment of details will differ, and several systems to meet various conditions have been evolved. Some of these are:—

The Multiple system, covering the manufacture and assembly of many piece-parts.

The Operating system for transport, gas, water, undertakings, etc.

The Process system for continuous process.

The Single system for units of quantity, the barrel of beer, ton of coal, etc.

The Terminal system for individual construction works.

The first of these methods, namely, the multiple system is clearly best suited to the production of telephone exchange equipment consisting, as this does, of a multiplicity of different piece-parts employing practically every process of manufacture in industrial use.

Cost in all systems is built on the basic elements of materials, labour and overhead burden, to which profit is added in order to give selling price. In the main, cost may be regarded as the reward of labour, and profit as the reward of capital. The constituent elements comprising selling price will now be considered.

MATERIALS.

Zero Cost of Material.

Fundamentally the cost of material is nil. That is to say all material is of the earth in mineral,

vegetable or animal form. No human effort has contributed to the fact of its primal existence, and, neglecting for the moment the fact of ownership by the individual it has no characteristic which may be said to represent production cost. Various considerations, however, render this conception of the zero cost of material one that is true in theory only. In few industries is the crude untouched material of the earth of immediate utility. The application of labour is required for its transformation or transmutation into other shapes or guises. Natural material is usually material in the wrong place and many services become necessary in order to facilitate its employment.

Ownership or Possession.

Let us now consider another phase, the fact of possession or ownership. "A" owns a piece of land in which is found a specific mineral commodity or in which a particular species of plant life grows in greater profusion than elsewhere. "B" enjoys neither of these advantages, but he feels that were he in "A's" position he could turn them to greater profit. "B" therefore approaches "A" and offers a consideration for the produce or use of this piece of land. When "A" accepts and the consideration is paid, something which already existed has acquired an extra value. No real worth has been added to the thing bartered. "B" has paid for it independently of whether "A" has or has not expended labour on it in order to make it attractive in the eyes of "B" and the nominal value is increased by an arbitrary amount merely because of the transfer from one to the other. Now, from the moment that the raw produce of the earth is deemed to possess some value for the purpose of disposal, the elementary conception of its primal cost as nil and its worth as one hundred per cent. labour ceases to obtain. The new factor is a mysterious one; it is neither material nor labour, but some unknown artificial condition dependent on the intensity of the purchaser's desire to obtain possession and on the reluctance or readiness of the possessor to sell. Moreover, a further peculiar condition has arisen. If we suppose that "A" had expended labour on the material before disposing of it to "B" then labour has become material for "B's" material is no longer the simple raw produce of the earth. It now includes "A's" labour, the artificial added value of transfer and the labour of transport. But it is still new material so far as "B's" purpose is concerned. It appears, then, that material is an elastic term and that what may be classed as material cost by one individual may be the total selling price of another.

The Relationship of Material to Labour.

The division of prime cost between material and labour is very liable to faulty treatment. In the past it has been common practice to express the labour necessary to the production or handling of a particular commodity or article in terms of a percentage

on the cost of material. The timber merchant buys so much timber at a price. Seasoning, storage, cutting and administering his business cost so much. Over a large number of transactions he discovers that his handling costs bear a fairly steady relationship to his purchasing costs and he enters, therefore, with some confidence into forward contracts, on the basis of a percentage addition to his material costs. If the timber merchant's business is of one class or character and he has no competitors he is able to rely on this working. In actual fact he has no knowledge whatever of the real nature of his costs. A board sold to a customer has to be cut with a saw which he has had to buy; it is cut in a yard which may be his own property or on which he may have to pay rent; it is prepared from a log which he may have squared and cut himself, but which is more probably obtained in that state from the sawmills. The proprietor of the sawmills in turn will have purchased from the owner of the concession or land on which the tree was produced. It is apparent that the point at which labour ceases to be labour and is designated as material is an arbitrary and widely fluctuating one. The retailer probably called his stock "material" at the board stage, the wholesale merchant at the log stage, and the owner of the land or concession at the tree stage.

The Relationship of Material to Oncosts.

So far timber has been considered as a simple commodity. It might now be considered in the form of finished articles. The small master carpenter or cabinet maker requires not only the wood on which to work, but a number of other things. These will include glue, fillers, pigments, gums, shellacs, nails, and screws of iron or brass and sundry metal fittings. He requires also a large variety of tools, fuel and a bench at which to work. In his case consuming a number of materials, some raw and some already manufactured, the point at which labour becomes material is more complex. He probably makes no reasoned effort to distinguish these at all. Too many factors are involved and his easiest way out is to count how much money he has spent in buying things whether these are consumable or not and how much in paying for labour including his own wages. The one he calls material and the other labour and proceeds to use this ratio for all of his estimates, hoping for the best.

One further aspect of this question of what constitutes material: Let it be supposed that the small cabinet maker is successful in selling all the work he can produce to a factor or other distributive organization. The distributor receives the finished goods and writes down the price he pays for them to material. His labour and other charges will represent the cost of re-selling at a higher value. Again it is seen that the element of material changes. The finished selling prices of one trade are the bare material costs of another, and this condition may run through several cycles before the raw produce of the earth eventually reaches the consumer at a price.

Stores Accounts.

It is clear from the foregoing that exact records of material costs are necessary. A brief survey of the methods employed in the control of Purchase and Stores departments may be desirable. All materials used on productive work are classed as direct stores and materials used on contributory services are classed as indirect stores. Four records will normally be kept.

- (a) Stores Purchases Account.
- (b) Stores Receipts Record.
- (c) Stores Issues Record.
- (d) Stores Control Account.

Stores Purchasing.

The purchase of the stores necessary for production and factory maintenance should be controlled by a Purchasing Department. New stores as they are purchased should be recorded day by day in the Purchasing Account which should show the date, quantity, supplier, cost, reference numbers, etc., as per the various invoices received. Buying is a very important function demanding exceptional qualities in the buyer if it is to be carried on to the best advantage. Whatever the class of material, time is vital, and the buyer must be on the watch for the most suitable moment at which to purchase, always having regard to the time schedule and the scheme of operation required by the Planning Department. If he buys too early, capital will lie idle and interest be lost; if he buys late the shop procedure may be disorganized or the factory may be hard pressed to meet a contract date. In addition he must watch the markets with an eye to the probable demands of other users; he will need also to consider qualities of material and his advice to the Engineering and Planning Departments may be invaluable in deciding on the precise grades of quality which it may be economical to use for the standard required. The co-operation of Drawing Office, Planning Department and Purchasing Department may be productive of much economy in regard to ensuring that the design of piece-parts makes use of standard commercial sizes of the various materials required whenever possible. On the other hand the buyer must not change his sources of supply for cheaper sources without being thoroughly conversant with all the requirements. For example, a manufacturer making telephone relays has to observe very close tolerances in order to secure interchangeability of parts. The springs of the various spring sets must be coordinated with spacers, insulators, etc., and adjusted to the position of steps on the buffer blocks with close accuracy.

Also spring tensions required to meet operating conditions have to be carefully considered. These requirements necessitate particular qualities and a tolerance limit of a single mil in the thickness of the sheet from which the springs are stamped. Sheet which failed to conform rigidly to this tolerance would be dear at any price if it resulted in wastage of parts or even possibly in the rejection on test of the finished goods.

Stores Receipts and Issues.

The bulk of the purchases required for normal production should pass into the custody of the storekeeper and be entered in the record of stores received. In exceptional circumstances of urgency or special individual work such as repair services it may be advantageous for stores to pass direct to the particular service or order concerned and it will not be necessary for such stores to figure in the storekeeper's record.

The main store should be roomy and all goods placed to facilitate access by the storemen in order to reduce to a minimum, idle time of men waiting with demands for material. It should be planned in the lay-out of the building in such a position as to be of easy approach from the roadway or siding from which incoming material is delivered and should offer equally easy access to the various shops and departments where the bulk of the goods will be used. It may be of advantage to arrange for two stores, one near the roadway handling rough material and a central store for piece-parts and purchased goods. Finished goods should be stored separately in a despatch store situated to facilitate easy transport.

Stores should be issued by the storekeeper to shop foremen on the authority of requisitions and all such issues recorded in the stock records of receipts and issues. Requisitions should bear reference numbers and codes identifying the particular class of work or shop concerned in order to facilitate the subsequent posting to the correct sub-head. It is desirable with a view to the prevention of fraud or petty theft that the storemen actually engaged in the issue of stores should have no access to, or participation in, the preparation of the stores records.

Stores in stock represent capital lying idle and it is of prime importance that normal stocks should be kept at the absolute minimum that will enable shop requisitions to be met without delay. Conflicting interests are at work here because though clearly it pays to keep stocks at a minimum it will not pay to order in quantities too small to be commercially economical. Both the purchase price and the expense of handling would be increased thereby. The head storekeeper should maintain a frequent and careful review of the records in his charge and advise the Purchasing Department of probable deficiencies. Similarly the Purchasing Department should consult the storekeeper and the Production Department as to the sufficiency of stocks immediately it becomes known that an important order has been secured.

An occasional source of trouble in the stores is the return of surplus issues from particular jobs. One way of meeting this is by means of a "transfer" order to another similar job if one such is passing through the factory at the same time. The trouble may be largely eliminated if the lay-out plans issued by the Production Department are accurate.

In the case of a telephone factory handling many thousands of very small parts, some of which are used in trifling quantities, it may be too costly and cumbersome to keep detailed records of receipts and

issues. As already stated, a good costing system seeks only such accuracy as can be profitably justified. It would be economical for small stores such as miscellaneous screws, nuts, washers, bolts, etc., to be issued to shops in bulk lots of fixed value to be drawn on as required. The cost of these small stores would then best be allocated to work on a percentage value basis.

Stores Control Account.

The last record of material is the "Stores Control Account." This should summarize all transactions of receipts and issues together with purchase prices and the type of work on which issued, *i.e.*, productive or indirect stores, repair work, plant maintenance, sales or distribution. It is designed further to show at any moment total value of stores in stock.

The prices paid for stores in constant use will vary from time to time due to fluctuating market conditions, the period available for execution and delivery, the supplier's commitments and the time of buying, etc. It is desirable, therefore, that stores values should be based on average prices of the stores in stock or spread over such periods as experience shows will give the most uniform results. In the event of any market upheaval resulting in sudden and extreme alteration in values it may be advisable to make special adjustments to the stock values. Such a step should only be taken in exceptional circumstances as an extensive change would upset the relative burden appropriations.

Stock-taking.

Before leaving the subject of material it may be well to make a few remarks on stock-taking.

Accurate stores records should in theory preclude the necessity for the periodic taking of stock. Practice shows, however, that errors creep into the records and their effect becomes cumulative. It is necessary, therefore, that the business of stock-taking should be continued as apart from audit requirements, it affords an opportunity of correcting errors, of identifying excess or unusable material and of writing down or disposing of obsolete stores. An accurate knowledge of the stock position is also essential to effective production control. The question of the relevant values at which stock should be priced occasionally presents problems. As an axiom it may be stated that in no circumstance should profit be anticipated. In this connection a contentious question is that of interest on capital. The expense of lost interest in plant and stock undoubtedly represents a legitimate component of cost. At the same time any sum allowed as interest is a form of profit which according to the axiom enunciated is not permissible. Commercial practice varies according to whether the conception of the profit or of the cost component is uppermost. A true distinction would be to charge any form of interest payment necessary to production such as bank overdrafts, debentures, etc., but to exclude interest in the form of profit distribution to ordinary shareholders. Unused new

material should normally be entered at bare cost although it is sometimes the practice to enter at a very low price the minimum amount of stock required to run a business. This practice is sound from the point of view of having value in hand. Finished goods should not be entered at normal selling prices, but at bare production costs. As regards shop plant the difficulties arise in the fact that equivalent market values may be unavailable or non-existent. Tools and jigs made for special orders possess a value only if further orders capable of making use of them are expected. In this case part of their cost should be reserved for these future orders, but if no such further orders are anticipated the entire cost should be allocated to goods already completed and the tools written off as valueless. This eventuality should, in the ordinary way, be foreseen and the selling price for the initial demand fixed accordingly.

LABOUR.

Earlier in the paper it has been stated that, fundamentally, labour represents 100% of total value; but if we consider the much more limited commercial aspect of labour a different picture is presented by the low ratio to total cost which it actually represents in the factory accounts. This is due in some measure to the high degree of mechanization of processes that exists in the modern factory, and even more perhaps it is due to the present day trend towards specialization. That is to say, in the long course which raw material must follow in its passage from the earth to the consumer, not one, but a dozen or more factories may be concerned each performing its own special function before passing the product on to the next for the succeeding operation and so on. Thus the selling price of one firm is ever becoming the bare material cost of the next with the result that the individual labour cost incurred in each factory is a correspondingly smaller proportion of selling price. It is obvious that this is merely a localized symptom due to sub-division and that, in the aggregate, labour does represent the greater part of gross cost.

The condition is interesting as illustrating the absolute necessity to correlate overhead cost with direct labour in the factory, rather than with the total of material and labour cost.

The Craftsman.

A regrettable consequence of this dual process of mechanization and specialization in industrial mass production is the partial elimination of the craftsman. It is with mixed feelings that one witnesses so many examples of the effacement of manual skill by the machine. Nevertheless it is wrong to suppose that the craftsman has been effaced. He still exists in industry to-day in fewer numbers, but with a higher standard of individual technical skill than ever before. The machine has removed the necessity for individual mechanical ability in repetition work, but in the tool shop, in machine service and in the model shop the craftsman continues to reign. It may be that in this

respect the telephone equipment industry is more fortunately placed than others. The production of telephone equipment requires the co-ordinated output of many thousands of different parts, many of which are in such small quantities that machine production is not economical.

Wages.

The payment of wages depends on the quantity and class of work performed. In many trades and industries, Trade Boards, etc., have established minimum weekly time rates, which must be paid to any adult worker. Over and above this, many methods are in common use in the factory for assessing a reasonable wage for a week's work. Broadly speaking, all labour is expended on:—

(a) Production (direct labour).

(b) Service (indirect labour).

Direct labour is used in the production of goods for sale and indirect labour is used in the production of goods and parts not for sale, *i.e.*, tools, frames, jigs, for consumption in the factory and on various services contributory to production. These services include gatekeeper, shop foremen, stores clerks, portage and conveyance, plant maintenance, repairs and renovations to buildings, power, heat, light, water, testing and inspection, training, canteen, sick service and welfare, cleaning, night watchmen, and so on. In addition to the foregoing there are salaried charges such as the drawing office, engineering, planning, production and costing departments, experimental and research laboratories, general clerical, accounting, secretarial, sales and administrative services.

Hours Worked.

The record of hours worked in the factory is normally collected from individual attendance cards, stamped by clock time recorders. Hours are totalled for a period, usually the wage week, and checked against the totals shown by the various job cards for the same period. Attendance cards, either for day or week periods, and job cards should be issued to each worker and should bear special codes, numbers or colours, to identify the particular shop and class of work concerned in order to facilitate the cost allocation. Idle time cards should also be supplied to each worker in cases of breaks between jobs.

Wages for work done may be assessed on the basis of the number of hours worked—day work—or on the rate of doing work—piece-work.

Day Work.

The principle of day work has many disadvantages and is only employed in present day practice where the alternative is impracticable such as general maintenance and service duties, or where special objections exist. Its defects are that it places all workers, good and bad alike, on a common footing; it offers no inducement to the good worker to increase his output or bring to notice better methods and thus to reduce costs; it gives no reward to the man who wants to earn more money and is willing and

able to offer value in return. In the telephone industry day work is disliked by the operatives and is avoided if possible. If, however, a time job is handed out by the foreman, the operative will do it quickly in order to be rid of it and so be available for piece-work as soon as possible.

Piece-work.

To overcome the objections particularly as regards repetition piece-part production, the system of piece-work and the many refinements of the piece-work system have been devised and they are more satisfactory than the hour method to worker and employer alike. Approximately 80% of the work done in the telephone equipment factory is piece-work. Under the piece-work system a reasonable time rate for doing a job is fixed by a Rate-fixer after he has made a careful study and practical test of the time necessary for the operation in question. In suitable cases time-motion studies may be undertaken. The Rate-fixer is usually an old hand, capable of demonstrating his own times to unbelievers and is mostly held in some respect by the operatives who are required to work to his times. As may be supposed the Rate-fixer's task is not always an easy one. He has to act squarely by his employers, and he has also a duty to the workers since he must not set a standard which cannot be attained by the average good worker. In practice it is found that a good worker on piece-work can earn an average of 30% to 40% over and above the equivalent day rate. There are also exceptional individuals who will make any piece-rate system appear unbalanced by an excessively high output. These are freaks though exceedingly adept operators, and their performances should be—and usually are—ignored, so far as rate-fixing is concerned.

Altered Piece-rates.

Much controversy has raged for many years round the difficult question of altered rates. The worker quickly gets to know up to what rate he is expected to work and he is naturally suspicious that if he exceeds this level he may invite a revision of the rate. When an impression of this sort becomes prevalent through the factory a very vicious circle is set up. Managements as a rule are well alive to the risk and, therefore, attach the utmost importance to the exact assessment of the original rate. Once satisfied with this rate they are able to issue an assurance that no matter what output is achieved the rate will not be amended. In spite of the care taken, however, errors in rate fixing have, on occasion, crept in with the result that abnormal and possibly unearned wages have been paid. This is a further source of trouble since those workers who have not been fortunate enough to be employed on the item in question are quick to see the advantage of their fellows and to envy their temporary good fortune. If the case be abnormal the solution lies in the cancellation of the operation and its substitution by some re-constituted form. In any case of genuine error it should be possible to effect an adjustment by mutual consent.

Special Methods of Assessing Wages.

A great deal of thought has been given in the industrial world to this question of securing and preserving the mutual trust and co-operation of employer and employed. It does not need stating that both management and worker in the ideal state are out to get the best and most profitable return for their combined endeavour and it is of prime importance that no sense of suspicion or injury should be engendered in the worker's mind. Suspicion breeds slow work and consequent loss of profit; still worse, the loss of orders may result. Many refinements of the piece-work principle have been devised in order to allay any possibility of distrust. A method which has met with success is the combination of a guaranteed minimum weekly wage with the urge of a piece rate or bonus addition. This is an ideal system because it offers an assured wage to the poor worker together with the necessary incentive to rapid work. It does not follow, of course, that the guaranteed minimum is to be abused. It should be set at such a level that all ordinary workers can meet the requirements and the consistent failure of any individual to earn bonus therefore calls for attention. An investigation will normally be made by the rate-fixer whose recommendation would be subject to the approval of the "Welfare" office. Either the individual is wilfully working slow or he is unfitted to the particular operation. In the former case some grievance obviously exists and requires airing. In the latter case, the operative should be changed to another class of work or discharged if suitable employment cannot be found.

A good example of these methods outside the telephone industry is found at Messrs. Rowntree's Cocoa Works, York. Here piece rates are in vogue, covering 90% of the female workers and 82% of the male employees. All piece rates in this factory are set so that the worker of average ability can earn at least 25% above time rates, but in many instances, even on these carefully set standards, as much as 50% above time rates is earned. All such rates are guaranteed against change, unless it is agreed with representatives of the workers concerned that changes affecting the rate of output attainable for the same effort have occurred in respect of machine or other equipment, the material used or the process or method of manufacture.

Further, the workers are guaranteed against some of the inequities of the wage system. A piece worker who on any occasion does not earn the minimum time wage is nevertheless paid the minimum for the week in question, though consistent failure in this regard is a proof of inefficiency and is followed by dismissal. If the unsatisfactory working of machines or a deficiency or failure in the supply of materials should stop or restrict the output of piece workers, payment is made for any time so lost at the average rate of piece earnings.

Another and perhaps less satisfactory form of guaranteed wage is the combination of a definite hour-rate, say 48/- per week of 48 hours, plus any

extras arising out of equivalent piece-rate profits. If the individual fails to earn the minimum of piece-work he gets into debt with the wage account and these debts must be discharged out of subsequent surplus earnings before he can collect extra wages.

A scheme of payment known as the "Premium Scheme" allows, say, one hour at 1/-, for a particular job. If the operative does the job in half the time he is allowed half the saving, *i.e.*, half an hour at 1/- = 6d. plus half the saving of 6d. = 3d., giving a total of 9d. Both management and worker are pleased because the management gets a 1/- job done for 9d. and the worker gets 9d. for half an hour's work instead of 6d.

General telephone factory practice guarantees a minimum day work wage at twenty-one which is approached by juveniles on a sliding scale basis. Thereafter payment is by merit in the form of extra piece-work earnings as shown by each individual's job cards. This merit money is usually in the neighbourhood of 40% of the day work wage.

Grouped Piece-work Earnings.

Quite recently a form of bonus payment known as the "Grouped" or "Shop" piece-work bonus system has come into more general usage. This is the collective, or co-operative effort as against the individual or competitive effort and several arguments for and against have been made by supporters and opponents of the scheme. It is claimed in defence of the grouped scheme that once the workers in the shop concerned appreciate that their rate of bonus depends on the collective output of all members of the group, a spirit of co-operation will be engendered. The adept operator will seek to instruct his less adept neighbour; lazy workers will be forced by their associates to put a jerk into their output; wastages will be fewer; better methods will more readily emerge and be more freely shared. It will also be possible for foremen to keep individuals without demur on specialized jobs which may not, perhaps, be so remunerative as other jobs; troublesome inequalities between good and bad time-rates will be flattened out, and finally, records and clerical service will be much reduced.

Some of the disadvantages are other viewpoints of the above advantages. Skilful workers will be reluctant to give part of the benefits of their greater skill to their less effective fellows and incurably lazy workers will be prone to lean on good workers. Perhaps the most serious objection lies in the control. The shop foreman, who is not a producer, will be paid on the measure of the shop's output. He will thus have an incentive to drive his operatives to the utmost effort while the operatives will see themselves paying for their own driving. The workman hates to be driven and the realization that his own efforts furnish a reward to the individual applying the spur may sometimes prove too much.

Bedaux.

A scheme popular in America and already working in this country, known as BEDAUX, is based on the

well-known time-motion studies of operations under predetermined ideal conditions combined with periods of rest dependent on the degree of fatigue produced and the result is expressed in common units which bring all operations including rest time to a common footing. Undoubtedly this produces economy and profit. It is a moot point whether the scheme is suited to the British temperament especially as the worker knows that, other things being equal, dismissals are inevitable.

Profit Sharing.

Before leaving this section it should be remarked that any scheme of profit sharing as partial remuneration is unsatisfactory, because all the workers—good and bad alike—receive the agreed proportionate amount dependent on the magnitude of the firm's profits, and the staff also share irrespectively of the extent by which factory efficiency or the office commercial policy has contributed to the making of the profit. Further, the workers must normally take on trust the management's statement as to the amount available for distribution as it would be undesirable to allow the factory hands any access to the firm's books for purpose of checking accounts, etc. Another disadvantage is that distribution is too long deferred, since it is only possible at wide intervals such as the end of the firm's accounting year.

It should not be lost sight of that the payment of the agreed amount of wages is not the last word to be said in regard to the relations between employer and employed. Admittedly wages received is of prime importance to the worker and the good employer in his own interests and in the interests of his work-people will endeavour to pay the maximum rates that the financial state of the firm will permit. He will also consider other questions of social importance. To take for example the further employment of juveniles; it is the practice of some employers selling at cut prices to employ juveniles until they reach full insurable age and then to throw them on to the market. Such practice is bad from individual and national standpoints alike and recent legislation has largely remedied this condition. The good employer in specialized industries, such as the telephone industry, will train and employ labour having due regard to the future development of the industry. This involves the employment of operatives and staff of varying grades of experience and is not by any means economical from the point of view of cost only, but it is beneficial to the art as a whole. There are also such matters as the continued employment of disabled men, the sympathetic treatment of lost time incurred during slack periods, arrangements for sickness and staff welfare, and the provision of facilities for various sports, all of which are the concern of the good employer.

OVERHEAD CHARGES.

So far we have dealt broadly with principles and practices which are in fairly general observance, but we come now to a contentious subject in regard to

which much diversity of thought exists—the evaluation and distribution of overhead charges, known also as oncost, burden, or establishment charges. Overheads comprise all those costs incidental to production and sale which are not covered by direct factory labour and material charges and as already stated the good costing system aims at appropriating these charges as accurately as possible in the cheapest possible way.

The task is of some complexity because of the number and variety of the charges which have to be spread and the possible methods of appropriation. It demands in the fullest sense the close co-operation of the cost accountant and the technical staff. It is of interest in this connection to quote the following from Ridgway's "Cost Accounts in Principle and Practice":—

"Costs Accounts must be prepared by a man having inside knowledge of the particular trade, the many technicalities of the subject making it quite impossible for the costs to serve any useful purpose unless the practical side of the business is thoroughly understood."

In general, overhead charges may be regarded as falling in the three main categories of factory overhead, administration overhead, and sales and distribution overhead. It is convenient for special Standing Orders to be earmarked to particular services and to collect the charges recorded thereon and express them in the form of a number of main expense accounts such as:—

- Buildings expense account.
- Stores expense account.
- Power expense account.
- Plant maintenance expense account.
- Research and Development expense account.
- Tools expense account.
- Management expense account, and so on.

Each of these main accounts includes a number of subsidiary charges, some of which may figure in more than one of the main expense accounts. The building expense account will include such items as rent, rates, water, heat, light, fuel, depreciation, insurance, cleaning, repairs, etc. The power expense account similarly will include, in addition to the main charges for fuel and maintenance, a large number of subsidiary headings figuring in the buildings expense account. Appendix No. I shows a typical collection of overhead headings of expense together with their allocation to main expense accounts. The one object is to ensure that, so far as possible, all the expenses incurred shall be identified with the particular operation concerned. It is an elementary principle of costing to charge the expenses of any job to that job where it is reasonably possible to do so. It is only in cases of uncertainty that an arbitrary allocation must be resorted to and then the basis of division may be labour or machine occupancy or floor space or capital plant value, whichever seems most fitted to the individual requirement.

In the light of modern industrial development with conditions of high productive capacity and fierce competition the need of an additional form of general

classification has been felt. The following division of expense:—

- (a) The overhead cost of providing productive capacity
 - (b) The overhead cost of using this capacity
 - (c) The overhead cost of distribution and sales
- tells the manufacturer not only the fixed cost of the resources at his command, but the additional cost of that part of those resources which are in production at a given time and also the losses due to the idleness of unemployed capacity. This aspect will be examined in detail later in the paper.

Overhead as a Percentage on Material and Labour.

It has been a practice in the past, common among many manufacturers, to express overhead costs as a percentage on material and labour cost. This procedure is entirely fallacious because overhead is almost entirely incurred in providing accommodation and working facilities for, and control of, the labour employed, and is very little related to the cost of materials. Suppose, for the sake of argument, that the costs in a certain factory are £25,000 for materials, £100,000 for direct labour and £250,000 for overhead charges (Fig. 1). The ratio of over-

OVERHEAD AS PERCENTAGE ON MATERIAL AND LABOUR COST.

	£
MATERIALS ...	25,000
LABOUR ...	100,000
OVERHEAD ...	250,000
	£375,000

$$\frac{\text{OVERHEAD}}{\text{MATERIALS} + \text{LABOUR}} = 200\%$$

THE FINAL COST OF AN ITEM COSTING £10 FOR MATERIAL AND LABOUR WOULD BE £10 PLUS 200% OVERHEAD = £30

FIG. 1.

head to material plus direct labour is 200%, and the ratio of overhead to direct labour only is 250%. If now an enquiry is received for an item for which the material and labour cost is £10, the overhead at 200% overall will be £20, giving a total cost of £30, and upon this cost the firm's quotation would be based.

Overhead as a Percentage on Direct Labour Value.

But it has been said that by far the greater proportion of the charges comprised in overhead are independent of the cost of material and it is desirable therefore to divide the above cost of £10 between labour and material. The division may be £1 for

material and £9 for labour or £9 for material and £1 for labour (Fig. 2). In the former case the overhead

OVERHEAD CORRECTLY EXPRESSED AS PERCENTAGE ON LABOUR VALUE.			
£10 MAY INCLUDE LABOUR AND MATERIAL IN VARYING PROPORTIONS.			
		£	£
MATERIAL	1	9
LABOUR	9	1
OVERHEAD AT 250% ON LABOUR	22½	2½
		£32½	£12½

EITHER OF THESE MAY BE THE REAL
COST OF THE ITEM PREVIOUSLY COSTED
AT £30.

FIG. 2.

at 250% on a labour cost of £9 would be £22 10s. 0d., giving a total cost of £32 10s. 0d. In the latter case it would be 250% on £1 equals £2 10s. 0d., giving a total cost of only £12 10s. 0d. These figures of £32 10s. 0d. and £12 10s. 0d. would be the real costs of the two hypothetical cases taken, whereas under the inaccurate overall system £30 for each would have been quoted in all good faith. It is clear, therefore, that though a manufacturer may with reasonable accuracy express the overall ratio of his overhead to material and labour cost over a period in the form of a general percentage, this percentage is quite useless for itemized costing.

Overhead as a Percentage on Direct Manhours.

Taking labour as the basis of appropriation it will be necessary to distinguish clearly between direct factory labour used in actual production and indirect labour which is contributory to production and in itself forms part of factory overhead.

Direct labour may be expressed in terms of the money value of wages paid or in terms of the number of manhours worked. In the former case a disadvantage from the costing point of view is that in a mixed shop one hour of work may be performed by juvenile, female or male labour. The actual cost in wages paid for an hour of work would, of course, vary widely, say from 4d. to 1/6d. according to type and class, and if overhead be regarded in the main as representing the cost of accommodating and controlling persons at work independently of what is paid them for doing work, then the wage value basis would consequently result in the expensive labour being loaded too heavily and the cheaper labour too lightly.

Many costing authorities, however, take the view that the higher priced labour actually does incur more expense in the way of service, tools, equipment, training, etc., and the wage basis is, therefore, more accurate. This claim can, I think, be offset by the greater degree of supervision required by the cheaper

labour. On the balance it is thought that the man-hour basis of apportionment is better than the wage basis except in the special case of a factory where one class and scale of labour is predominant. As against this, however, it is of interest to note that a year or so ago the Automatic Electric Company, Ltd., of Liverpool, after a short trial of the manhour system reverted to their former wages value basis for the general distribution of manufacturing overhead for the foregoing reasons.

In using the manhour basis of distribution care should be taken to see that suitable deductions are made for lost time in respect of holidays, breakdowns, and time losses between jobs and during repairs to machinery.

Machine Rates.

In the modern factory, machine production has introduced a further problem in the allocation of overhead. In many shops the machine has largely supplanted labour, which has been reduced to the trifling expense represented by the machine minder or feeder. The capital and running costs of the machine may, however, be very high and to express its charges on the basis of an inconsiderable total of cheap labour would be unsound. In such a case it is advantageous to evolve separate machine rates for each particular machine. The hour rate for the machine would include the whole of its individual costs such as capital outlay and cost of repairs and maintenance, while the various services of heat, light, rent, rates, etc., might be allocated between various types of machines in the shop on a basis of floor space occupied. Power cost should be charged on the number of units consumed. Each machine for a specified period of occupancy would have its own hour-rate of cost while working and in a highly developed machine shop it is unquestionable that this method will give a more accurate record of real cost than the manhour or wages method. Each machine in these circumstances will bear its own individual rate.

In dealing with machine rates it is immediately apparent that the time occupancy is a vital factor. When the Planning Department, studying the normal demand for a particular part, decides that the time is ripe for the introduction of a machine, its first consideration is the minimum annual quantity of the part that will balance the estimated annual cost of the machine. The machine may be able to produce this quantity in a few days and be idle for the remainder of the year. It may not be capable of adaptation to any other purpose and in this event the management will endeavour to stimulate a demand because a selling rate which has to support a long period of dead time in respect of the machine will be easy prey to the competitor and will introduce a risk which the firm cannot allow to continue indefinitely. Alternatively the designer may have arranged that the machine in question shall be adaptable to the production of some other parts of the firm's standard lines or the management may go all out to create new demands by offering attractive terms. But whatever steps are taken the probability remains that the

demand and, therefore, the output of the machine will vary while the annual charge remains more or less steady, with the result that the time rate will be constantly changing depending on the period of occupancy. The only solution possible is to forecast the volume of business anticipated during a period based on the results of the previous period, if any, and to adjust the rate where necessary at the periodic review. The condition described is a common enough one in most factories and it leads to some interesting problems in price fixing. First in importance is the rather anomalous condition that the firm is able to sell to a second customer at cheaper rates than to its first stand-by customer. This difficult position will be examined in the section dealing with differential costs.

Model Shop.

At the other extreme of the factory lay-out is the model shop. This is a shop where individual bench work and the expert hand work of the craftsman predominates and one that is indispensable in a factory which aims at producing the varied equipment required for a telephone exchange. The making of machines and precision tools is an expensive process, the simplest running easily into £20 or £30, and it may require an order for many hundreds of unit parts before the making of tools for press punchings can be justified. In telephone equipment there is a very great variety of items required in comparatively small quantities and on which expensive tool making is, therefore, not justified. Such work must be given to the individual craftsman to make in units, employing the existing shop machinery where convenient. These items are costly in labour and consequently the amount of oncost for the shop applied to a large volume of expensive labour will be expressed by a comparatively low percentage—a good example of the condition that a low percentage of overhead cost does not necessarily imply economical production.

Supply of Items by the Department.

It may be thought that in these circumstances so far as the Post Office Engineering Department is concerned, it would be better to obtain such items in bulk and supply to all contractors for equipment works. By this means the Department would be able to order in larger quantities and thus enable cheaper methods of manufacture to be employed. As a matter of fact this procedure is actually followed for a number of items where it is convenient to do so, but for many others it would introduce difficulties and would frequently result merely in the transfer of expense from the factory to the Department. Under the existing arrangements the equipment contractors supplying exchange equipment to the Post Office Engineering Department undertake full responsibility for the efficient working of an exchange by a specified date and are liable in liquidated damages if they fail in any respect. The supply of small items which might prove faulty on test, or any delay in supply, might have unfortunate results for which the contractor would have to charge if he were called on to shoulder the added risks entailed thereby.

Waste Materials.

The allocation of expense arising out of various forms of wasted material occasionally presents difficulties. Wastage due to the ordinary process of manufacture such as scrap copper wire, brass turnings, press blanks, and so on, should be credited where possible to the particular jobs concerned. This is not often convenient and if the value is trifling compared with the expense of detailed allocation a general scrap metal account should be kept and the net return arising out of sales or re-use spread as a credit percentage for the period. Some waste, especially as regards timber, is valueless for selling purposes and would normally be taken to the boiler house as fuel. Great care is therefore necessary in cutting timber economically. Much ingenuity has been expended in the direction of reducing wastage or of extracting the utmost value from unavoidable waste.

Practice of Ericsson Telephones, Ltd.

Some practices observed in operation at the factory of Messrs. Ericsson Telephones Ltd., at Nottingham, may be of interest. This firm is justly proud of its wood shop and it may be taken that little wasteful cutting is in evidence, but the matter is by no means left at the stage of careful cutting. The firm have installed what might be described as a timber recreator. This ingenious machine is fed by a miscellaneous assortment of fragments of wood which are applied edge to edge and joined by means of invisible fine longitudinal glued dovetails. Jointed pieces are discharged in a continuous stream. The process may be extended without regard to the size of board required and it is a boast that no break will occur at a joint. Wood chippings and sawdust are collected by a pneumatic suction plant and are carried direct to the boiler house to serve for fuel.

Oil from the lathes and automatics in the machine shop is reclaimed by means of high speed whirling extractors which effectively drain the last drop of oil from the mass of turnings and filings produced in the machines.

Apart from scrap wastage, the cutting of material may be arranged so that other parts may be made from the unwanted pieces. Examples are the exterior parts of steel ingots when only the centre is required, blanks from stampings are occasionally usable in their original form and more frequently may be re-usable for smaller stampings. The correct assessment of the value of the material used in each part in cases where material which would otherwise be waste, is capable of use, is a nice point for decision.

Economic Design.

As an example of economical planning by which both waste of material and unnecessary labour were eliminated, the following is interesting:—A certain order required the production of large quantities of soft iron former plates in the shape of a broad letter "T" and the problem was very neatly solved by stamping the plates from strip in sets of four as

Obsolescent Stock.

Obsolescent stock represents an instance where the losses involved should be met from profit. It is a prime duty of the management to see that the finished goods stock is kept at the lowest level that will ensure the meeting of normal trade demands without delay. Unfortunately orders are not received at evenly spaced intervals and it is a common experience that periods of slack business are followed by a rapid succession of orders. If this interrupted condition were interpreted exactly by the planning and production departments, the disorganizing effect on the shops would be such as to render economical production very difficult. In lean times, therefore, it will pay to maintain a small output which is passed to store in readiness for the boom and herein lies the risk of obsolescence. In the meantime the stand-by customers may have changed their specifications or public demand may have altered. Goods sent on approval to the various sales distributing offices may have failed to catch on and are duly returned to store. All this spells loss and urgent disposal is necessary which is usually effected by heavy price reductions. In the case of domestic lines it may be possible to induce large-scale retailers to stage "special sacrifice" weeks and so stimulate consumption by the general public.

The converse of this condition sometimes happens when the customer requires replacement or extension of an obsolete type of equipment and he is informed that the factory is not now in production, that tools are broken up and drawings and shop specifications destroyed, and that the order can only be met by skilled bench labour at a greatly enhanced cost. But when the dust is wiped from the ancient contents of some corner of the store-room the manufacturer may perhaps be excused for a little pardonable satisfaction!

Depreciation of Plant.

An appropriation from gross profits of over six million pounds figure annually in the Post Office Commercial Accounts in respect of depreciation of telephone and telegraph plant. In the factory, the matter of depreciation is of similar importance and a few remarks on factory practice may serve some purpose. First, as to what depreciation is; this may be expressed simply as the loss in value of any asset through deterioration or wastage. General practice demands also that obsolescence shall be covered in the definition. It is usual to assume a period of years during which this wastage occurs and to describe such period as the "life" of the asset. At the end of the assumed life there is a recovery value against which must be set the expense of recovery. In the case of structural assets it may well be that this expense is greater than the recovery value, and, if practicable, it would pay to abandon such plant. This is seldom possible in the factory, and recovery in the normal course must be effected. The difference between the recovered net, or residual, value and the original cost of provision represents an expense incidental to ordinary factory production and should

be charged to factory cost precisely as any other production expense is charged. This is effected through the depreciation fund, to which sums are debited periodically in order to ensure the original expense being fully recovered at the end of the assumed life. Various methods are in common use such as a yearly revaluation, the sinking fund method, the straight line method, etc. The yearly revaluation method is self explanatory and somewhat arbitrary. The sinking fund method provides for a regular annual sum to be set aside each year which, if allowed to accumulate at compound interest will, at the end of the life of the plant provide the sum required. The straight line method provides for a regular sum to be set aside each year sufficient in itself to cover the required sum at the end of the life period. Under this method the earned interest is not required for depreciation purposes and can, therefore, be applied if required to meet the additional cost of maintenance which would naturally be highest towards the end of the life period. The simplicity of the method of writing off equal annual sums has much to commend it and, so far as productive plant is concerned, is closely in accord with fact since the output value of new machines would be very level for the greater part of their life and would then fall steeply as wear and tear began to exact their toll.

The practice is still prevalent in some undertakings of varying the appropriation to depreciation according to whether the firm has had a profitable or a lean year. This erroneous treatment probably arises from the fallacy of regarding depreciation as a lump sum charge to be met from gross profits instead of an essential component of factory production cost requiring exact and careful allocation to each particular expense sub-head. Here again the financial and the costing viewpoint may be in conflict.

Finally, the risk of obsolescence must be visualized as a factor vitally affecting the provision to be made. The progress of invention and the fickleness of public fancy are a perpetual menace to the lives of assets and this is particularly evident in regard to the most expensive part of the factory equipment, namely, tools and machines. The sudden cessation of demand may render thousands of pounds worth of plant completely valueless and it is never safe to allow more than a few years' life to equipment of this nature. My own feeling is that the depreciation account is not the place in which to care for obsolescence at all. Invention and the incidental retirement of plant are factors which should be considered separately and on their own merits from the point of view of their effect on revenue.

Control Accounts.

We have reviewed the three main components of production cost and may now observe briefly the control and co-ordination of these components by the Costing Office. This is effected by means of three main accounts which summarize respectively all debits and credits in respect of stores, wages and overhead month by month, these accounts being supplemented by other subsidiary accounts, namely,

shown in Fig. 3. As will be observed the wastage in this process is nil. The stamping out of vertical

STAMPING OUT OF SOFT IRON FORMER PLATES (NO WASTE).

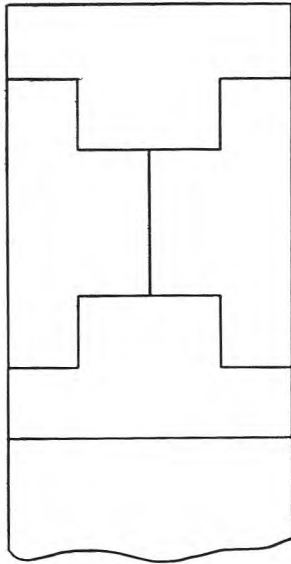


FIG. 3.

magnet armatures provides another interesting example of a three-cornered cost comparison to economize metal. Fig. 4 shows part of a 6' iron

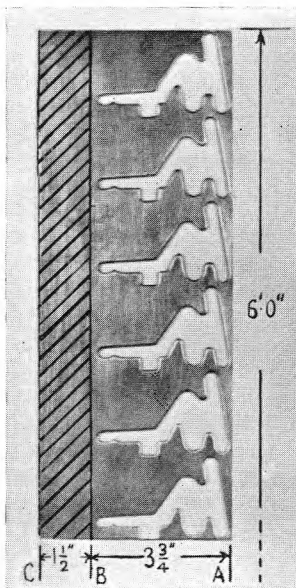


FIG. 4.—2-MOTION SWITCH VERTICAL MAGNET ARMATURE (PART OF 6 FT. STRIP).

strip from which the armatures are punched. A blank $3\frac{3}{4}$ " wide is sufficient for one row of stampings

and a certain amount of waste metal is left between each stamping. It will be seen that by adding $1\frac{1}{2}$ " to the width of the strip, it is possible to utilize this metal and obtain a double series of stampings from the strip (Fig. 5). Additional labour and other

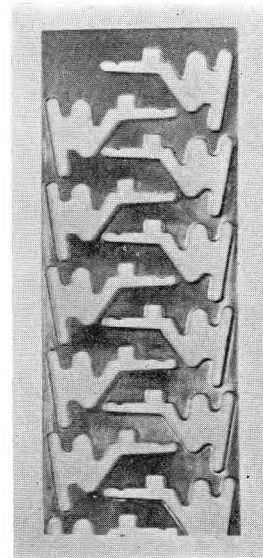


FIG. 5.—2-MOTION SWITCH VERTICAL MAGNET ARMATURE (PART OF 6 FT. STRIP).

charges are involved and the operation may be performed either by duplicating the punch and block for double stamping or by running the blank through the press twice. For simple stampings the first method would be used, but for heavy stampings of the type indicated, tooling costs would be excessive, and it would be preferable to run the blank through the press twice. The press in this instance is 45 tons and difficulties due to distortion of the blank and edge burrs caused in the first run through have still to be overcome. The value of the material saved, however, in regard to the quantities produced, justifies the expenses involved.

Spoilt Work.

Every effort should be made to keep spoilt work or work rejected on test at an absolute minimum and weakness in this respect should be rigorously guarded against because not only wastage of material is involved but labour has been put into the work and a proportionate amount of overhead cost has been incurred. If the spoilage is due to bad workmanship the operator normally makes good the bare value of the lost time at his own expense, but if he can show that it is due to defective material the entire expense is borne by the firm. The charge should be passed to general overhead because although the exact job on which the spoilage occurred may be known such waste is not a legitimate normal cost of the part and it would be misleading to base future quotations on costings which included particular wastages.

the Work in Progress Account, the Finished Product Account, the Additions to Plant Account, and the Repairs to Plant Account. The control accounts afford the Management what is in effect a continuous Profit and Loss account and the monthly summary focuses attention on any adverse movement before it has time to develop.

It may be mentioned that work which needs to pass through several shops for the various operations to be performed should be charged in and out of each shop on a separate account or held on suspense account until all the departments concerned can be credited in the finished work account. Otherwise the shops, by duplicating the progressive value of the work in question, would show an inflated volume and value of work in and out, a result which might be very misleading to the management. Where numerous repetitions are going on together on different Order numbers it may be difficult to identify exact costings to each Order. In this event "Process costing" rather than the costing of particular quantities might be employed and applied as a general average.

From the control accounts, final cost schedules are prepared summarizing all headings of cost in respect of stores, wages and overhead absorbed for each department during a specified period. Reconciliation is effected between the totals thus obtained and the individual wage sheets, stores issues sheets, factory overhead accounts and general office expenses. The Finished Goods account will show total production cost exclusive of selling and distributing costs.

Standard Costs.

In undertakings which are producing a large variety of piece-parts for making up into various assemblies and sub-assemblies a system of tabulated costs known as standard costs is in being. Such a system is of particular utility in the telephone industry where the variety of piece-parts runs into tens of thousands. A standard cost is the ideal cost arrived at by supposing that all the component charges for material, wages, oncosts and profit are correctly represented without any disturbing factor and that conditions of quantity and production methods are suited to the particular operation in relation to its demand. The standards will, of course, be modified as improved methods are evolved. An important function served by standard costs is the provision of a check on actual costs and any tendency towards increases or decreases is immediately brought to light and opportunity afforded for investigation. Further, the costing of assemblies is facilitated by using standard costs instead of having to await the actual costs of all the individual parts and, therefore, estimates can be supplied much more readily and at short notice. At the end of the costing period there will be a debit or credit to the standard cost variation account according to whether the actual cost exceeds, or is less than, standard cost.

Progress of Assembly Order.

I should like, before leaving this section, to run briefly through the various movements of a simple

assembly order on the factory. The item demonstrated is the single horizontal type relay armature (Fig. 6) and the progress of an order for the

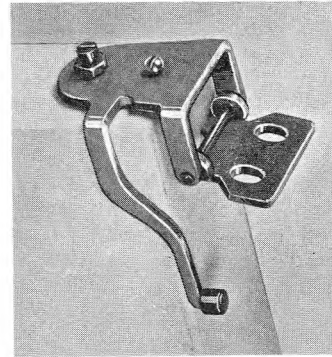


FIG. 6.

"assembly only" of a quantity of 1000 is shown in Appendix No. 3. The appendix describes the various cards employed and gives notes on the uses of each (Figs. 9 to 29). It should be mentioned that the values and times appearing on the forms have been inserted merely to indicate the sequence of movements and do not necessarily represent actual values.

OUTPUT.

"Output" has been used to introduce a section of this paper, because it is the storm centre round which rage all the complex and sometimes contradictory forces which influence modern industrial production. Quantity is the life of the factory and the present day world-wide tragedy that besets industry is that of reduced output. Following the unprecedented opportunities of the after-war boom years factory after factory was lured by bright promise, and in a great many cases, by large and easy profits, into development and expansion and still more development and expansion. Mass production methods were brought to a degree of perfection never before equalled so that when the crisis of 1930 fell upon the world it found a condition of maximum productive capacity to which it was able to offer an almost negligible demand. There followed feverish scrambling for the meagre amount of available business and the inevitable result of hundreds of factories endeavouring to keep going on a fraction of their productive capacity. The law of supply and demand decrees that with a falling demand prices must fall also. They must fall for the reason that the public has to be induced by lower prices to increase its consumption and so in a period of reduced spending power, prices and demand fluctuate until they find a temporary level. The paradox of the position is that a factory in which the output is below productive capacity finds that its unit costs become higher instead of lower, since a great proportion of its standing burden is constant and it is therefore faced with the triple problem of less business, higher

costs, and lower selling prices. The problem appears at first sight to be insoluble and indeed for many concerns it has proved too great; others, faced with extinction, have found salvation by stimulating a demand for new lines; all have been driven to retrenchment and this introduces a further paradox—the clash of interest between the manufacturer as a unit and the community as a whole. Viewed broadly, the prosperity of the producer depends on the purchasing power of the buyer and this is impaired when the general level of wages is lowered. Moreover, the cost of maintaining workers thrown out of employment is a charge on the community and in the long run is eventually borne by industry. On the other hand each individual employer feels the necessity to reduce costs in his own particular line of goods and does so, hoping against hope, that consumption will not decrease as a result.

Adjustment of Productive Capacity to Demand.

It has to be admitted that productive capacity in many fields during the boom years was inflated to a degree quite unjustified by normal every-day consumption and some contraction had therefore to be accepted. It is a principle of economic production that the capacity of the factory to produce should be in excess of actual output only by the smallest sufficient margin that still leaves an opportunity for further effort. Few men would willingly recommend to their Board a policy of contraction and the cutting of losses and the problem becomes instead, one of absorbing as much of the unproductive capacity of the factory as possible.

Differential Costs.

A reduction in prices is one way of attracting new customers, but this does not mean that the manufacturer is ready or able to extend reduced prices to his existing customers. To do this would be to court disaster. Overhead in the unit is a very elusive and uncertain factor and it is varying continuously with the variation in the volume of work in the factory and the point which the manufacturer has ever before him is the minimum combination of rate and quantity which will spell safety.

For a certain given output of an article "A" he may find that he must charge say £10 in order to cover his expenses. The £10 may comprise £5 in factory cost and that part of his overhead which is variable, and the balance may represent the net burden of overhead which he will incur whether he is in production or not. (Fig. 7). It is at once apparent that if he could add to his output by obtaining a further order at a cut price of say £8 or £7 or even £6 he will earn £3, or £2 or £1 respectively over and above what is necessary to meet his burden account. He, therefore, accepts as many orders as he can get at any price in excess of his basic £5 production cost in order to employ his otherwise idle capacity. It is a dangerous policy on which he embarks, but the forces which impel him are irresistible and the risks must be incurred. In February of 1933, Sir Clarendon Hyde, speaking at the

annual general meeting of the Metropolitan Railway Company said that cheap fares were dangerous things to play with and, in his opinion, it was doubtful whether they were worth having. So far as the manufacturer is concerned the risks are twofold. In the first place a price reduction sometimes has precisely the opposite effect to the one desired. If, for example, the commodity concerned is in general production, at the first sign of a price break buyers cease buying and wait for the lowest point of the fall to be reached. In the second place, customers who may be styled stand-by customers will soon get to know of the specially advantageous terms being accorded to occasional customers and will naturally want to know the reason why. It will be of little avail to tell these customers who are paying £10 that the customer who is paying only £6 is nevertheless contributing £1 towards the burden of overhead and that he can, therefore, reduce the cost per unit of the initial orders to, let us say, £9 10s. 0d. They will say, with force, that if differential costing is to be employed at all it should be in favour of the firm's old customers rather than in favour of casual chance customers. They are certain to insist, at least, on the repricing of the total output at a common rate for all. In either alternative there is little comfort for the producer because he is likely to lose his casual trade as soon as he withdraws favourable treatment and in all probability he will lose his old

FIXED AND VARIABLE OVERHEADS.

A FINAL COST OF £10 CONSISTS OF :—

	£	
MATERIALS AND LABOUR	3	
VARIABLE OVERHEAD	2	
FIXED " 	5	
	10	
	£10	

THEORY :—

“LONG RUN” BUSINESS MUST RECOVER £10 PER UNIT FOR BASIC QUANTITY. BUT

“SHORT RUN” BUSINESS IS ADMISSIBLE AT ANY PRICE IN EXCESS OF £5.

E.g.	PRODUCTION		
S.P.	—	COST	BALANCE
£6	—	£5	= £1
£7	—	£5	= £2
£8	—	£5	= £3
£9	—	£5	= £4

IF BASIC QUANTITY HAS NOT BEEN MET, THEN SHORT RUN BUSINESS STILL ASSISTS FIXED OVERHEAD BY £1 £2, £3 OR £4 PER UNIT.

IF BASIC QUANTITY HAS BEEN MET, THEN EXTRA SHORT RUN BUSINESS PROVIDES ACTUAL SURPLUS PROFITS OF £1 £2, £3 OR £4.—(FOR THE TIME BEING.)

FIG. 7.

customers as well when these find that the rate to them reverts necessarily to £10.

Post Office Buying.

The example of differential costing cited above has been quoted because it is indicative of a condition with which Departments of the Post Office are sometimes faced in their purchasing operations, and as regards firms concerned mainly with the production of telephone exchange equipment it illustrates the importance to the stand-by customer of extra overseas or other contracts which these firms may secure.

By-Products and Joint Products.

Sir Henry Bunbury in "Overhead Costs," published during 1932, has examined several aspects of this problem of idle productive capacity and differential costing. He cites the railway companies as among the first to employ differential costing by instituting the practice of cheap travel during certain specified periods. In the field of electrical engineering further examples are the different rates for power and light charged by power undertakings; and the reduced rates for the use of trunk telephone routes charged by the Post Office during the off-peak periods. Another common example is the half-penny post. In all these instances, however, the service offered at the differential rate is of slightly different character from that offered at the ordinary residual cost. Examples of differential cost for identical service which come very near home are our telephone and motor car. One telephone call per annum costs a year's rental plus one penny which for a London resident comes to £6 10s. 1d.; two calls per annum cost at the rate of only £3 5s. 1d., each and so on; the more calls made, the cheaper the rate becomes. Similarly before a motor car incurs a penny in running costs, heavy standing charges in the way of insurance, registration and accommodation have to be met, with the result that maximum use is economic use.

Reverting to our consideration of differential costs in the factory, Sir Henry Bunbury instances the case of the joint product. A manufacturer may be in production of two articles "A" and "B" at a joint price of £10. (Fig. 8). The cost of producing

DIFFERENTIAL COSTS.	
THE JOINT PRODUCT.	
"A" & "B" COST ...	£10
"A" ALONE COSTS ...	£7
"B" " " ...	£6
THE DIFFERENTIAL COST OF "A" IS £4	
" " " " "B" " "	£3
A MANUFACTURER MARKETING "A" & "B"	
IS ENTITLED TO £7 + £6 = £13	
(IF HE CAN GET IT)	
OR HE MAY SELL EITHER ONE OF "A" OR	
"B" AT ITS DIFFERENTIAL COST.	
BUT HE COULD NOT SELL "A" AND "B"	
TOGETHER AT DIFFERENTIAL COSTS.	

FIG. 8.

"A" alone may be £7 in which case the differential cost of "B" will be £3. The cost of producing "B" alone may be £6, in which case the differential cost of "A" will be £4. Under such conditions the manufacturer is entitled to quote anything from £10 to £13 (if he can get it) for "A" and "B" together, but he obviously could not sell both "A" and "B" at their differential costs of £3 plus £4 equals £7. Telephone expansion furnishes an interesting example of yet another form of differential cost—a form in which the differential cost may be either lower or higher than the residual cost. A telephone exchange must necessarily be built at the outset with a considerable volume of idle capacity in order to allow for growth of the system and the cost per working line curve falls steadily as each line is taken up. There comes a time, however, when all the spare accommodation is absorbed and it becomes necessary to provide an extension of plant. This demands the expenditure of a large amount of new capital and the differential cost for the first subscribers to be joined to the new extension would be very much higher than the residual costs for the existing lines. Similarly in the case of cables, at first sight it might appear reasonable to offer inducements in order to employ spare wires in the cables, but when the spares are all taken up and a new cable has to be laid, the position is very much the reverse.

The Long and the Short Run.

All this has an extremely interesting bearing on the question of the employment of the unproductive capacity of the factory. If filling the factory to capacity means that more plant must then be laid down in order to be ready to cope with future additional business one is driven to question whether this practice of differential costing is really a sound one. One view is that the factory should be large enough for its stand-by business, but no larger. With expansion the responsible heads get out of touch with detail and either sources of wastage and leakage begin to creep in or new executive posts have to be created to watch the position; either alternative means added expense. In support of this view the theory of the optimum quantity may be advanced. It does not follow by any means even in factory mass production that the cost per unit will always vary inversely with quantity. For example, in the production of an item demanding the co-ordinated effort of several teams each of whose processes has been carefully designed on a time-quantity basis, it may prove that the most economical arrangement of inter-working results in an output of (say) 5,000 units per week. An order for 6,000 units per week would disorganize the time schedule and the extra odd 1,000 would have to be produced on a less efficient basis. An order for 10,000 units weekly would, of course, employ two complete crews and would be profitable if the factory were large enough. We come back, therefore, to the original problem of whether to expand or to remain satisfied with small things. I am afraid that a conservative manager, turning away the above order for 10,000 units, would

soon be displaced. Sir Henry Bunbury has again, I think, provided answers to these considerations by examining them from the point of view of the long and the short run. He points out that when changes take place in the conditions of production in the factory, they may be due to outside influence affecting quantities or they may come from within in the form of more efficient planning, but whatever the cause it is necessary to distinguish clearly between the immediate and the ultimate effects. It may pay to employ the idle capacity of the factory with cut-throat business for a time, but if we look ahead for a few years after expansion has been undertaken, in all probability it will be found that the margin of slack is back again. We come then to the conclusion that output must lag behind capacity and that in no event should short-run trade be permitted to influence general policy.

Overtime.

There is one further aspect of this question of the occasional stop-gap order and this is the extent to which the performance of overtime influences the position. The idea is prevalent that because overtime is paid at higher than normal rates, and the work performed by tired workers, it is undesirable and uneconomical. Obviously one manhour of overtime represents a greater direct cost than one manhour of ordinary time, and undesirable it may be for many reasons of a political or social nature, but it does not follow necessarily that it is uneconomical. On the contrary, if the factory is in the fortunate position of having a full normal load, then additional labour in the form of extra time worked is profitable since productive capacity whose cost is already borne by the full load of normal manhours is being employed further at no extra expense beyond that of the mere working and service costs. In the very highly developed shop where overhead may reach a figure of 800% or even 1,000% on direct labour, the maximum employment of such expensive equipment is good policy. It is on this basis that the shift system is justified. Where blast furnaces have to be maintained continuously, continuous labour is an economic necessity. A good example close home is the foundry of the Ford Motor Works at Dagenham, where three shifts are working continuously night and day. On the other hand, in the factory working below capacity, the case against overtime is strong because there is ready and available a supply of the cheaper and more effective ordinary labour.

The most potent argument against the performance of overtime is the psychological one of personal interest. There is a tendency to slow up on day work and experience has shown that the extensive use of overtime does not increase gross output.

DISTRIBUTING AND SELLING EXPENSE.

In any industry it is essential to distinguish clearly between the cost of production and the cost of distribution and selling. This is particularly necessary in the manufacture of telephone exchange equipment

since much of the output of these factories is absorbed by Government Departments, frequently in the form of non-competitive controlled contracts. Distributing and selling expenses do not enter to any appreciable extent into the negotiating of Government contracts and these should naturally be relieved of any such costs where they are not incurred. This does not mean that the Government has no interest in the outside advertising and selling activities of its suppliers. On the contrary, since telephonic inter-communication in this country is a Government monopoly, it follows that these firms exist primarily to satisfy Government requirements and the Government is therefore in the position of the stand-by customer. It has been shown that the stand-by customer is sometimes in an unenviable position in relation to casual chance customers and when this stand-by customer takes the bulk of the factory output he is, and must be, vitally interested in the amount of other business secured by his suppliers. So important is this that the stand-by customer may, as an exceptional measure, conceivably be ready to contribute to selling expenses with which he admittedly has no direct connection if thereby business is likely to result and thus absorb part of the general overhead burden.

Selling expenses are varied and numerous and it must be emphasized again that so far as the marketing of a predetermined quantity is concerned they have no relationship with or bearing on the cost of production. The overhead cost of production is definitely related to the number of manhours or machine hours of work performed in the factory, but the overhead of selling is concerned solely with the machinery of persuading customers to buy. A firm catering for home and foreign demands requires an extensive system of sales offices, travellers and distributing centres for the home market and must maintain agencies for overseas markets. Advertisement is a powerful weapon in this persuasive campaign and the amount of money to be spent on advertising is limited only by the results which it is expected will be obtained. It may be that the management is endeavouring to create a new demand and will spend lavishly and even incur heavy losses if it has sufficient confidence that the policy will eventually prove remunerative. That there are plums in this field is evident from the profits being reaped by firms which have established monopolistic conditions in regard to proprietary articles. This is just to a point because much specific laboratory research or purchase of expensive patent rights may have preceded the establishment of the monopoly.

Freights, packing and packing cases, delivery, storage and returns are all charges to be met on the distribution and selling expense account. Also, the maintenance of stocks represents a heavy balance of locked-up capital on which no interest is being earned. The degree to which these charges should be borne by different customers in the first instance depends on the relative extent by which they are incurred. A circuit of small customers scattered in a wide country district which has to be carefully

nursed by travellers involves considerable expense; there is also the additional expense of handling a large number of small orders, many of which may be on terms of extended credits. At the other extreme is the case of large wholesale consignments to shippers acting as exporters. The shipper should obviously receive better terms by way of discount both in respect of his larger orders and in the greater ease of handling and also by reason of the fact that his payments are prompt. A further example of the need for itemized costing is presented where a firm is producing two dissimilar lines such as domestic electrical appliances and telephone equipment, one of which is for public consumption and the other for a form of guaranteed non-competitive demand of a governmental or municipal character. The advertising and selling costs in respect of the domestic appliances are clearly right outside the field of telephone equipment. Most of the large manufacturers of telephone equipment in this country have other lines in addition to their telephone interests. The Automatic Electric Coy. are large producers of domestic electrical appliances, totalisators, mining and traffic signalling equipment; Ericsson Telephones Ltd. have large newly-developed interests in totalisators and in paints and varnishes; The General Electric Company have varied interests in the fields of radio equipment and electric light and power; Siemens Brothers and the Standard Telephones and Cables Company are large makers of all classes of cables, batteries, radio equipment and so on. The cost of marketing these goods must be segregated from the sale expense of telephone equipment since, although the former business may contribute largely to the prosperity and financial stability of all the firms, it is, in no sense, necessary to the actual production of telephone exchange equipment.

In all the foregoing broad distinctions, the expense of distribution and selling may be accurately charged to the particular class of work. The allocation of expense to items within a class may be made on the basis of production cost since the amounts concerned are small and it would not be economical to spend more money in obtaining a more exact apportionment even if this were possible.

PROFIT.

Closely associated with marketing costs is the all-important question of profit. Profit recognizes no law though it is sometimes guided and sometimes driven. If the cost of production may be said in the main to represent the reward of labour then profit is the reward of capital. Not only should profit cover the use of capital, but it should be of such magnitude as to compensate for the greater risks incurred in industrial employment and, for this reason, it will fluctuate widely since the risks are many and the apparently solid and well-founded business is ever at the mercy of invention and public fancy.

During the war period when commodity values were varying daily, supplies were rationed or were sometimes unobtainable, and labour could command

almost any price, it became very difficult for manufacturers to tender for contracts save on terms which included a wide margin for unforeseeable contingencies. The Government, as the only real buyer, obviously could not commit itself to prices which were known to include these wide margins and this led to the fairly general adoption of a system of payment based on production cost plus an agreed percentage thereon for profit.

This was perhaps inevitable during a period of rapidly changing values such as the war period and the years immediately following, but it is a thoroughly iniquitous and unsatisfactory practice for normal business. Its defect is an entire absence of incentive to efficient production methods. On the contrary it sets a premium on high costs since the greater the prime cost the greater the profit. Exorbitant salaries to working directors could figure in the administration expense and the rate of profit collected thereon, the customer paying an inflated figure twice over. For effective operation of the "cost plus" system, complete control of the works organization and of the commercial and foreign policy equivalent to the function of management would be essential and this is not practical politics to-day.

In the normal course of industrial production, open competition, moved by the differences between supply and demand will exercise control over the amount of profit that can safely be demanded. Competition, however, is not always so free as it appears. Holding companies, mergers, rings, cartels, artificial restriction and all sorts of trade and financial entanglements complicate the situation. The proprietary market, of course, recognizes no law of profit. Its price is what it can get. For normal industrial production ten per cent. is generally recognized as an equitable and reasonable rate of profit in view of the daily risks that are incurred under competitive conditions. The figure, of course, means nothing until the basis has been defined. If profit be the reward of capital, it is apparent that the amount of capital in service in the business is the real criterion and that profit is not necessarily related to the cost of production at all. Many considerations serve to differentiate between the two bases of comparison, the most important of which is frequency of turnover. For example, the capital invested in a business may be £50,000 and the annual turnover £500,000. With this volume of business a profit of the very low order of 1% would be sufficient to pay 10% on the whole of the above capital. Moreover, it is improbable that the full amount of capital mentioned would be of a nature qualifying for full ordinary dividend. Capital includes debentures, preference shares, reserve re-invested in the business, and—for the purpose of assessing the amount of profit—bank loans. All these classes of capital will receive dividend interest at rates varying from 3½% to 5% or 6% according to type and, reverting to the example mentioned above, a charge for profit of 1% on cost may enable a dividend of 20% or more to be paid on ordinary capital. It is clear, therefore, that

the *amount* of profit required depends on the amount of capital invested for which interest has to be found. Having decided on this sum, the frequency of turnover is the deciding factor governing its application to the factory output. The distribution is most convenient in a form which results in a round percentage on selling price, *e.g.*, if the selling price is to be £100 showing a profit of 10%, the cost price of £90 will need to bear a profit of 11.1%.

Where finished goods are purchased from a subcontractor and are merely "merchanted" by the main contractor in the execution of the main contract, the amount of profit added should be merely nominal.

PRICE CONTROL.

In cases of contract work, where competition is not obtainable or is ineffective, it is better to seek tenders on a non-competitive basis with a form of price control by agreement. Indeed, if this method can be worked in a spirit of mutual co-operation it offers very definite advantage over the method of straight competition since it permits of many economies not otherwise obtainable. Under competitive conditions detailed estimates which may occupy an engineer for three or four weeks have to be prepared by each of the firms competing and for all but the successful tenderer this effort is necessarily a total loss. This waste is a load on the burden account and is eventually met by the customer.

Again, under the agreement control method, it is possible to assure a guaranteed volume of business to the firm or firms tendering and to arrange for an even flow of orders so far as circumstances permit. This enables the works engineering and planning officers to go ahead with a firm production policy for a forward period on the most economical basis and without the disturbing effects of fluctuating demands. The Post Office has recognized the advantages to both sides arising from this method of purchase and, in instituting the Bulk Supplies Agreements for the provision of telephone exchange equipment at controlled prices during a specified number of years, the Department has been able to secure substantial reductions in capital cost, at the same time giving to its suppliers a guaranteed demand.

The satisfactory operation of the first Bulk Supplies Agreement for telephone exchange equipment, which expired in March, 1933, after covering a period of five and a quarter years, has resulted in the present Agreement for a further five year period with further material benefits in the form of still lower prices and greater economies in production costs, and has given a strong impetus towards the ideal of standardization.

Rationalization.

The success of these two Agreements is a striking vindication of the effectiveness of the price control method because, in this business of telephonic communication, the general conditions are adverse to economic production. Rationalization visualizes standardization and simplicity of design and con-

struction, whereas, in actual fact, invention and development, the enemies of standardization, are never still. In no field is this more evident than in the complex field of the telephone art and the trend of rationalization can only be towards the free exchange and pooling of ideas and research; in the avoidance of overlapping and, so far as the factories are concerned, in the specialized manufacture of particular classes of equipment.

If one could go further and reconstruct some of the older buildings in any industry benefits must result. Too many manufacturing plants have been designed to fit into existing buildings instead of buildings being built to house the plants. Messrs. Boots Chemists have set themselves this new ideal in constructing their factory at Nottingham. This structure is the most advanced of the glass and concrete type in the country. It is not possible in the time available to go into this, but Appendix No. 4, with Figs. 30 to 33, indicate how the problem has been faced.

THE FUTURE.

What is the outlook for the future? Many industrial economists of the present day have a somewhat pessimistic outlook. It has been hinted that all labour saving machines and methods are inimical to the welfare of mankind. It has been said that the machines should be broken up and that production should revert to the hand labour of the craftsman in order to solve the problem of unemployment, and to give back to the worker his self esteem.

This view is fallacious. The wealth of the world and the means of subsistence are in the earth, requiring human effort for their extraction and enjoyment. Under the old regime man worked a full day in order to fulfil this function and to sustain life. But the possibilities of to-day are changed. Man, by taking thought, has evolved ways and means of lengthening his effective life. With his machines he can do in a day the work of many days and he would be foolish indeed to reject his new found power and to insist on a continuance of toil. The fault is not with the power of inventive genius or with the machines, but with, it would seem, the system of Control Accounts.

Many firms during the past year have adopted the principle of a shorter working week without reductions in pay. It is obvious, however, that, for real success to be achieved, world-wide, industrial co-operation is essential. The World Economic and Monetary Conference in July, 1933, experienced some of the difficulties of effecting relief in this respect. America has been making a bold and interesting experiment with the National Industrial Recovery Act and, whatever the result, the effort deserves admiration.

At the beginning of the year, Mr. Henry Ford confronted with serious strikes at his Briggs and Detroit Works declared that the age of machine production was, even then, only at the "ox-cart" stage. The art of modern telephonic communication is beyond the ox-cart stage, but the telephone

engineer has enough to think about. His task is, while aiming at an ever higher level of service and facilities, to standardize, to simplify and to cheapen, without stifling creative effort.

Plastic moulding may be mentioned as a typical example affecting the workshop as much as the laboratory. The telephone industry has yet barely touched the fringe of the possibilities of plastic moulding. It may be that the telephone exchange of the future will know nothing of wood and iron construction. We may see automatic switching equipment mounted on moulded shelves and racks; operators sitting at moulded boards on moulded chairs; the whole housed in a plastic moulded building. The problem must present itself as soon as standardization has prepared the way.

APPENDIX No. I.

Components of Overhead Cost comprised in Main Expense Accounts.

Typical main expense accounts are :—

- No. 1. Building Expense Account.
- „ 2. Power Expense Account.
- „ 3. Stores Expense Account.
- „ 4. Plant Maintenance Account.
- „ 5. Research and Development Expense Account.
- „ 6. Tool Expense Account.
- „ 7. Factory Management Expense Account.
- „ 8. Office Management Expense Account.
- „ 9. Sales and Distribution Expense Account.

Some of the components comprised in the above main accounts are as follows :—

The building expense includes land, rent, rates, insurance, interest on capital, heat, light, water, power, cleaning and depreciation.

The power expense includes most of the foregoing in so far as the provision of power is concerned in addition to the particular items of fuel and maintenance for prime movers.

The stores expense, apart from expenses covered in building expense account, includes special items

Conclusion.

In conclusion, it should be said that no attempt has been made in these notes to elaborate the various considerations in review. To do so would be impossible within the limits of a paper of this character, but sufficient may have been said to arouse interest.

I feel that the subject of planning and progress chasing in the factory well deserves detailed examination in a separate paper.

My thanks for valued advice and for the provision of various forms are due to Messrs. James and Nixon of the Automatic Electric Company, also to Messrs. Boots Cash Chemists for permission to show slides of their plant at Nottingham and to Messrs. Rowntree, of York, for information regarding their wages practice.

such as purchasing costs, storage, portorage, stores clerks, etc.

Factory charges apportioned to particular works, plant maintenance, etc., include such indirect costs as gatekeeper, night watchmen, liftmen, porters, shop foremen, lost time, overtime, local storemen, indirect stores, waste material, various services, testing and inspection.

General management expense covers the drawing office, engineering, planning progress and production departments, the pay-roll, costing and general clerical departments, provision for pensions, unemployment, holidays, first aid, sickness, sports, staff welfare, stationery, postage, telephone, printing, advertising, receptionist, chauffeurs, pilfering losses, accidental damage and depreciation.

Administration includes the secretarial, legal and accounting offices, directors fees, profit bonus schemes, interest on capital, depreciation and miscellaneous charities.

The sales and distribution expense includes travelling and transport, sales depots, showrooms, agencies, advertising, packing, packing cases, delivery, storage, salesmen, credits, discounts, bad debts, losses on obsolescent stock, insurance and depreciation.

All of the above main and component costs should be examined from the point of view of whether they are concerned with providing the capacity to produce or with subsequent actual production.

APPENDIX No. 2.

Overhead Expenses incurred in Designing and Engineering Exchange Equipments not incurred in the production of Apparatus and Piece-parts.

- (1) Apparatus design and development.
- (2) Research and experimental work including extensive circuit laboratory operations.
- (3) Development of new systems and methods.
- (4) Stocks put in hand in advance of requirements have sometimes to be carried for considerable periods, and are subject to the risks of deterioration and obsolescence. Items not in stock have often to be manufactured in very small quantities, at greatly increased cost; if necessary they have to be made up specially in the " model " shops by high priced labour.
- (5) The production of all the items required in an exchange equipment has to be co-ordinated and brought together on the premises.

Approximately 90% of manufacture is completed before installation commences. Valuable factory space is necessary for lining up switchboards, test frames, racks, cabling, etc.
- (6) Heavy financing cost due to long deferred payments. Capital is turned over only once in one or two years instead of at frequent intervals as is the case with simple apparatus sales. Consequently it is not possible to work to so low a margin of profit.
- (7) Workshop planning for the production of a wide range of different items is much more costly than for simple repetition orders. Many thousands of piece-part drawings are required

and have to be maintained. Tooling costs are very heavy when new designs are being carried through the experimental stages.

- (8) Equipment Engineering. This is a costly item involving the preparation of workshop specifications, heavy drawing office costs; visits to the exchange site; calculations of cable lengths and engineering consultations with Department's engineers. 50 new individual drawings and 100 re-issues are the average requirements for a manual exchange; for an automatic exchange such as Mayfair approximately 800 drawings would be necessary.
- (9) Freights to the site and allowances for increased risk of damage and increased cost of replacing rejections spread over long periods.
- (10) Insurance is necessary over a much longer period than in the case of simple apparatus sales.
- (11) Testing and inspection conditions are more rigorous and costly in exchange contracts, as the functioning of circuits under traffic loads must be tested.
- (12) Estimating costs are at a higher rate than those applying to bulk repetition orders for particular items.
- (13) Responsibility on completion for efficient operation of the exchange plant is assumed by the Contractor.
- (14) Skilled staff for exchange equipment work has to be kept together even when this is unremunerative on account of the fluctuation of demands.

APPENDIX No. 3.

Progress of an Assembly Order through the Factory of the Automatic Electric Coy. at Liverpool.

The following brief summary of cards and forms illustrates the progress through the factory of an "assembly only" order for 1,000 horizontal type relay armatures:—

SHOP ORDER & RECORD CARD.

ROUTE 15-35/15 22/15 ORDER No. 339358
 DATE 1/9/33 CODE L.71179.A.
 MEMO QTY. 1000
 EXCH. Stock
 DESCRIPTION

Armature Assembly L.H.

Dept's									
Operation Nos.									

FIG. 9.

FOR QUANTITIES OVER.		DRG.	
DESCRIPTION Armature Assembly, L.H.		L. 71179.A.	
MATERIAL		SPEC	NETT QTY PER 1000
As per Stock List			LBS FEET
SIZE			
ROUTE :- 15 - 35/15			
OPERATION	DEPT	OPERATION	TOOLS
		SUPPLY STOCK	
22/15			
14	15	Assemble	Fixture 54412
35/15		Inspect	
22/15		Stock	
		ISSUE 1/34	
DRG ISSUES... 15 - 35/15.....		DATE 17/3/30.	

MANUFACTURING LAYOUT

FIG. 10.

Fig. 9 is the initial shop order authorizing the commencement of work in the shops. The back of the card (Fig. 21) is utilized to record quantities made, rejected, scrap and salvage.

Fig. 10 shows the manufacturing lay-out. The card specifies the operation numbers, the tools or fixtures to be used and routes the job through the various departments concerned.

Fig. 11 is the piece-work rate card. This describes

OPER'N No. 14	P.W. RATE CARD		DRG.
DEPT. 15	FOREMAN'S COPY		L 71179.A.
DATE 11/8/30 SIG.	STD	RATES UP TO	PER 1000 COST £ 989
	28	4.1d	TIME HRS.
DESCRIPTION OF OPERATION Ass'le carrier to armature. with pin and swell over end of pivot pen (using block Tl. No. 54412 & hammer) Place ass'ly in vice & adjust carrier to be free from any bind or play. Ass'le nut to residual screw & screw to armature. Warm buffer on hot plate. Fit No. 15005 and ass'le to armature with pliers. NOTE; Cupped end of hinge pin to be adjacent to armature. eg. as per drawing.			

FIG. 11.

in detail the exact nature of the work to be performed by the operator and the time rate allowed. These cards are held in the custody of the shop clerks and are available for inspection by the workers.

Figs. 12 and 13 show both sides of the operator's job card. They record all details of the work in hand—operator's clock number, order number, operator's number, code number, department, standard rate and time, etc. The operator clocks on and off for the job.

CLOCK NUMBER	DEPARTMENT
14215	15
ORDER NUMBER	STANDARD QTY PER HOUR
339358	28.
OPERATION NUMBER	STANDARD RATES
14	4.1 ^d
CODE OR CT. NUMBER	GANG WITH
L 71179 A	

DELIVERY OPERATION
 TO DEPT 22/15
 VIA 35/15

QUANTITY MADE (Continued)					
DATE	COUNT	COUNTER	DATE	COUNT	COUNTER
	BROUGHT FWD				

FIG. 12.

to the pay-clerk in return for the wage envelopes, thus serving as receipts for wages.

Figs. 16 and 17 are equivalent " Powers " machine cards punched out from the attendance cards. The holes in the various columns represent details of the work performed and wages earned and enable very rapid mechanical sortings and tabulations to be made.

operators to draw material. A third copy of the requisition is used to serve as an identity ticket on the relative material as it lies in the shops.

Fig. 19 is a delivery card issued by the shop clerk when a supply of finished parts is sent out from his department. These circulate on trays with the finished goods through the shops and act as identity tickets.

JOB CARD											
DEPT.	ORDER NO.	OPN.	CODE OR CT NO.	CLOCK	QUANTITY	ACTUAL HOURS	STANDARD HOURS	D.W.L.W.B.	P.W. BONUS	EFFY.	W M Y
1	2	3	4	5	6	7	8	9	10	11	12
0	0	0	0	0	0	0	0	0	0	0	0
1	1	1	1	1	1	1	1	1	1	1	1
2	2	2	2	2	2	2	2	2	2	2	2
3	3	3	3	3	3	3	3	3	3	3	3
4	4	4	4	4	4	4	4	4	4	4	4
5	5	5	5	5	5	5	5	5	5	5	5
6	6	6	6	6	6	6	6	6	6	6	6
7	7	7	7	7	7	7	7	7	7	7	7
8	8	8	8	8	8	8	8	8	8	8	8

FIG. 16.

FACTORY PAY ROLL														
CLOCK	DEPT.	COY'S INS.	RATE	S.A.M.A.	S H	EMPS. INS.	HOURS	D.W.J.W.B.	P.W.B.	NETT	GROSS	T.D.	W/E	M Y
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
2	2	2	2	2	2	2	2	2	2	2	2	2	2	2
3	3	3	3	3	3	3	3	3	3	3	3	3	3	3
4	4	4	4	4	4	4	4	4	4	4	4	4	4	4
5	5	5	5	5	5	5	5	5	5	5	5	5	5	5
6	6	6	6	6	6	6	6	6	6	6	6	6	6	6
7	7	7	7	7	7	7	7	7	7	7	7	7	7	7
8	8	8	8	8	8	8	8	8	8	8	8	8	8	8

FIG. 17.

A paper slip is produced by the " Powers " tabulator from Card No. 16, showing the quantity, standard hours, time and piece-rate wages and is associated with the cost summary card for the job.

The factory pay-roll also is produced by " Powers " machines from Card No. 17. Wages are automatically totalled for each department as the department code number changes.

Fig. 18 is the master requisition. The order in question is an assembly order only. The requisition, therefore, draws from stock the necessary quantities of completed piece-parts. It is issued by the Production Office and sent to Stores where it is used for recording issues to jobs. A duplicate of this form is used as a shop copy and is presented at Stores by

Fig. 20 is issued in triplicate by the shop clerk when delivery of goods is made and all copies pass with the goods to inspection. After inspection this copy is returned to the shop clerk, who completes the card shown in Fig. 21, which is the back of the card shown in Fig. 9.

A second copy of the delivery ticket (Fig. 20) is sent by the Inspection department to the Production Planning department, which records particulars on the Progress card shown in Fig. 22.

A third copy of the delivery ticket is sent by the Inspection department to the Stock Record section which records the receipt of stocks on the stock record cards.

Figs. 23 and 24 show the two sides of the stock

record card with particulars of receipts, issues and balances of stores.

TO STOCK ROOM 22/15 Sheet No. 1 DEPT. 15
 N° of Sheets 1
 ORDER REQUIRED FOR 5744 APPROVED SHOP ORDER 339358
 Armature Assem. CODE L. 71179 A
 L.H. QTY. 1000

QTY	CODE	PR OR SO.	STOCK ROOM	TOTAL ISSUED	PRICE	PER	VALUE
1	L. 71185. A	1000 339364		1000	16 216	49	
1.	- 73574	1000 338067		1000	5 028	20	
1.	- 77076	1000 337580		1000	1 335	20	
1.	- 76031	1000 338054		1000	940	20	
1.	- 19510	1000 338104		1000	2 654	29	
1.	- 37503	1000 337579		1000	1 520	20	
1.	- 76693	1000 335054		1000	1 82	20	

STOCK ISSUED BY: -
 Sig. Date Received
 STOCK CARDS
 Sig. Date

FIG. 18.

DELIVERY TRAFFIC CARD. SHOP CLERK'S STAMP.

TO BE PRODUCED WHEN BOOKING ON THIS JOB.
 ORDER No. 339358
 CODE L. 71179 A
 OPER No. 14
 COUNT 1000 COUNTER 7
 NUMBER OF TRUCKS 1
 CLOCK No. 1 BOXES 1 TO DEPT. 22/15
 WEEK ENDING 35/15 TRAYS 1 VIA 35/15

FIG. 19.

PLEASE WRITE CLEARLY

W.D. 26. ROUTINE PER W.M.J. NO 409

FROM	VIA	TO	DATE	ORDER NO
15	35	SHOP	8/9/33	339358
		STOCK RML	22/15	

SHOP CLERK TALLY NO 14215 OPERATION NO 14 CODE L. 71179 A

MADE	PASSED	REJECTED
1000	1000	
SCRAP	SALVAGE	REPAIR ORD NO

INSPECTOR: Armatu DATE 8/9/33

This copy returned to Shop Clerk.

FIG. 20.

Figs. 25 and 26 are the two sides of the final delivery notification. The card passes from shop to shop as each operation is finished. It acts as a "chaser" for closing orders that have been completed and is associated with the cost summary card as it gives the costing quantity.

Fig. 27 is a combined standard cost record and pricing card. It is used for the purpose of pricing requisitions, for building up prices of other assemblies and for estimating.

DELIVERIES TO 22/15

DATE	MADE	DATE	PASSED	DATE	REJECTED	DATE	SCRAP	DATE	SALVAGE
8/9	1000	9/9	1000						

FIG. 21.

RECEIPTS FROM

DEPT.	QTY.	DEPT.	QTY.	DEPT.	QTY.	DEPT.	QTY.
DATE	PASSED	DATE	PASSED	DATE	PASSED	DATE	PASSED

PROGRESS.

ROUTE	15-35/15	22/15	ORDER No.	339358
DATE	1/9/33		CODE	L.71179.A.
MEMO			QTY.	1000
EXCH.	Stock			
DESCRIPTION				

Armature Assembly.L.H.

DATE	MADE	TOTAL MADE	PASSED	TOTAL PASSED	REJ.	SCRAP	REPAIR ORDER
8/9/33	1000		1000				

FIG. 22.

Fig. 28 is a schedule of the overhead cost distribution. It shows the sources of the various charges and also the basis of distribution to the various departments in order to arrive at percentage values. The percentages are applied to the labour costs shown on the slips prepared by the "Powers" Tabulation from card No. 16 and associated with the cost summary cards.

Fig. 29 shows the final cost summary of the completed shop order and the unit cost of the component manufactured.

P. L. 71179.A.
 DRG **STOCK RECORD.**
 STK. RM. 22/15.....
 RACK No. 2 BIN No. 8.....
 DESCRIPTION..... Armature Assembly. L.H.....
 FOR Horizontal Relays.....
 WORKS WITH..... CARD NO. 1

STORES ISSUES.

APPROPRIATIONS		ISSUED			BALANCE IN STOCK
ORDER	QTY	DATE	ORDER	QTY.	
		1/9/33			1000

FIG. 23.

APPROPRIATIONS		ISSUED			BALANCE IN STOCK
ORDER	QTY	DATE	ORDER	QTY	
B/road					

STORES RECEIPTS.

ORDERS PLACED			RECEIPTS			BALANCE ON ORDER
DATE.	ORDER	QTY	DATE	ORDER	QTY	
1/9/33	339358	1000	1/9/33	339358	1000	NIL

FIG. 24.

The difference, if any, between the total actual cost and the total standard cost is brought to account through the standard cost variation account on the basis of theoretical inventory being maintained at

FINAL DELIVERY NOTIFICATION.

ROUTE 22/15 15-35/15 ORDER No. 539358
 DATE 1/9/33 CODE L.71179.A.
 MEMO QTY. 1000
 EXCH. Stock
 DESCRIPTION

Armature Assembly. L.H.

THIS NOTIFICATION TO BE FORWARDED BY THE DEPT. CLOSING THEIR ORDER TO THE NEXT DEPT. ON THE ROUTE. LAST DEPT. TO FORWARD TO ORDER CLOSURE CLERK.

DELIVER TO SHOP CLERK DEPT.

LAST DEPT ON THE ROUTE WILL BE RESPONSIBLE THAT THIS NOTIFICATION HAS BEEN COMPLETED BY ALL DEPTS BEFORE SENDING TO ORDER CLOSURE CLERK.

FIG. 25.

THIS SHOP ORDER HAS BEEN CLOSED IN THE DEPTS INDICATED BELOW.

Total Quantity Delivered	By Dept.	To Dept	Scrap and Salvage	Insp Date on Last Pink Ticket Recd	Date Order closed by Shop Clerk	Shop Clerk's Signature	Date F D N Recd by Order Closure Clerk
1000	15	22/15		8/9/33	10/9/33		10/9/33

FIG. 26.

ACTUAL OVERHEAD EXPENSE DISTRIBUTION.

TOTAL DIRECT WAGES £

Item of Expense.	Total Expense. £	Basis of apportionment.	Manufacturing } 02 Press. 03H Screw. 03A Autos. 04 Drill. 05 Mill. Departments. } Departmental } £ £ £ £ £ Direct Wages } Direct Wages % % % % %				
			£	£	£	£	£
Accounts Dept. & Secretary	} Direct Wages %	(* And various other Departments not scheduled.)				
Advertising						
Bank & Legal Charges and Audit Fees						
Insurances, W.C.A. and N.H. & U. Management						
Pension Fund						
Plans & Estimating Dept.						
Stationery						
Telephones, Telegrams & Cablegrams	...						
Travelling Expenses						
Total Administration Charges ...	£						
Burden % on Direct Wages ...	%	%	%	%	%		
Depreciation	} Floor Space and Plant Values. Direct Wages % Floor Space					
Insurances, Fire, etc.						
Rates & Taxes	£	£	£	£	£	
Total ...	£	%	%	%	%		
Burden % on Direct Wages ...	%	%	%	%	%		
Coal & Coke	} Consumption					
Electricity						
Gas						
Water						
Total ...	£	£	£	£	£		
Burden % on Direct Wages ...	%	%	%	%	%		
Buying Dept.	Direct Wages %					
Freight, inwards	Direct Wages %					
General work	Actual					
Post Dept.	Direct Wages %					
Experimental work	Actual					
Idle time and Allowances	Actual					
Inspection	Actual					
Labouring	Direct Wages %					
Layouts, Rates, Tool Design	Actual					
Loose Tools	Actual					
Machine setting	Actual					
Overtime extra	Direct Wages %					
Packing & packages	Direct Wages %					
Production Dept.	Direct Wages %					
Rejections, Renovations, Modifications	...	Direct Wages %					
Repairs to Buildings & Plant	Floor Space and Plant Values.					
Supplies	Actual					
Scrap and Excess material	Actual					
Shop Administration	Actual					
Stores	Actual					
Wardry materials	Actual					
Testing apparatus	Inspection %					
Traffic	Direct Wages %					
Training	Actual					
Total ...	£	£	£	£	£		
Burden % on Direct Wages ...	%	%	%	%	%		
Drafting Dept.						
Drawing Materials						
Engineering Dept.	£	£	£	£	£	
Total Engineering ...	£	%	%	%	%		
Burden % on Direct Wages ...	%	%	%	%	%		
Total Burden ...	£	£	£	£	£		
Burden % on Direct Wages ...	%	%	%	%	%		

FIG. 28.

DESCRIPTION Armature Assem.

1000 CARD No. 1.

Dept.	Operation No.	Std. Qty. Per Hour	Rate DWIWB	Comps Etc	Standard Labour Cost	Per	Revised Standard Cost Per	£
15	14	28	0274		0.989	A.		
							Mat'l	
							Lab'ur	
							Burd'n	
							Total	
							Revised Standard Cost per	
							Mat'l	
							Lab'ur	
							Burd'n	
							Total	
							Sched Lab'ur	£ 1
							Assem.	£
							Lab'ur	989
							Assem.	£
							Burd'n	2 964
							Standard Cost Summary	
							Per A.	
							£	
							28 805	Mat'l
							Vat. ind.	989
							Lab	
							2 964	Bur.
							Total	32 161
							Code	L 71179A

Code or Material	Quantity or Weight	Per	Material £	Labour £
L 71185A	1	A	16 216	
73544	1	A	5 028	
74046	1	A	1 335	
76031	1	A	940	
19510	1	A	2 654	
37503	1	A	1 520	
76693	1	A	812	

FIG. 27.

standard cost values. Continued discrepancies would, of course, result in the production of revised standard costs.

It should be noted that this order is for the work of assembly only and, therefore, the value of overhead shown on Figs. 27 and 29 is in respect of the labour of assembly only. A large amount of overhead is also included in material which represent the final cost of the various finished piece-parts drawn from stock.

INCOMPLETE SIGNWRITING REQUESTS (Record purposes)

Date	Sheet No.	Number of Characters	Accumulated Total	Date	Sheet No.	Number of Characters	Accumulated Total

Group 20

COST SUMMARY.

15-35/15 22/15 339358
 1/9/35 L.71179.A.
 1000

Stock

Armature Assembly. L.H.

NON-STD PER										SCHEDULE OPERATIONS									
£	dec	Vat Indic	Dept	Material Weight PER	Labour PER	£	dec	Labour Value	Burden Value	£	s	d	£	s	d	£	s	d	
STANDARD COST PER					ACTUAL COST PER					DEPARTMENTAL SCRAP CHARGES									
										Department									
										Value									
MATERIAL	28	505		28	505														
LABOUR				989				863											
BURDEN	2	964		2	589														
VATWORK																			
TOTAL	32	161		31	954														
QUANTITY PASSED BY LAST DEPT					TOTAL STANDARD COST OF ORDER					TOTAL ACTUAL COST OF ORDER					CLOSED STAMP				
1000					32 9 3					31 19 2					CLOSED 9-SEP-1933				
SCRAP															PUNCHED STAMP				
MATERIAL CHECK					PRICED					PASSED					PUNCHED				

FIG. 29.

APPENDIX No. 4.

*Messrs. Boots (Chemists) Factory at Beeston.
Factory Lay-out and Conveyor Plant.*

Messrs. Boots new factory at Beeston, Nottingham, is the most advanced and largest of the glass and concrete type in the country. The conception behind the design is that the building should fit the plant rather than the plant being made to fit the building. As an essential towards economy in standing charges this seems elementary, but it is an ideal seldom attained.

Fig. 30. The main structure is still incomplete.

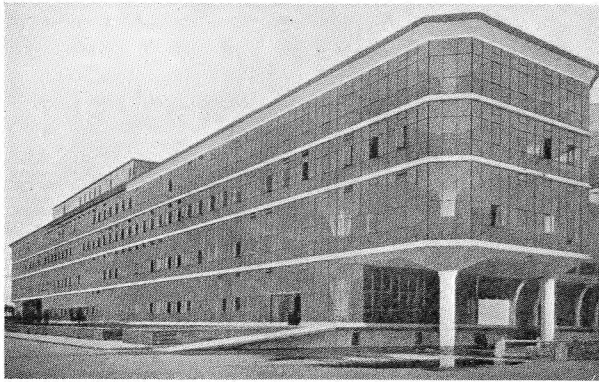


FIG. 30.

The photograph gives a general impression of the huge expanse of glass that meets the eye. When the lighted building is viewed at night from a distance the effect is very striking.

Fig. 31. This picture shows the cantilevered glass roof over the unloading dock. It is 550 feet long and projects 30 feet throughout its length, without supporting columns. Travelling cranes under the roof

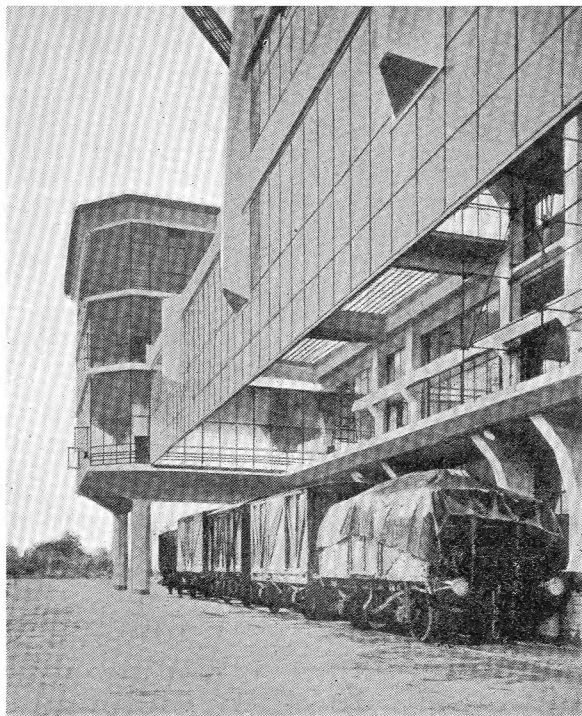


FIG. 31.

serve trucks and lorries at any point along the dock, and feed either ground or first floor levels.

Fig. 32. This gives a very fine view of the interior

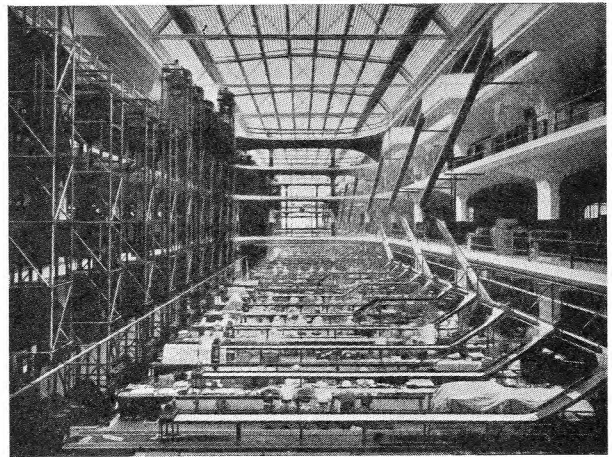


FIG. 32.

of the main hall. The floor area is three quarters of a million square feet at present. The roof consists of closely perforated concrete slabs, each having 160 holes approximately 10" in diameter in which are fitted clear glass circular lights. There are 9 slabs to a section and 20 sections completed, giving a total of nearly 30,000 lights. Free joints allow for expansion and contraction of various members without harm.

The working counters run in parallel lines across the floor of this hall. At the incoming ends of the counters, empty card boxes are received from gravity chutes fed by girl operators working in the steel enclosures on the third floor. Coincident with the delivery of the boxes, bulk materials are fed to the counters on band conveyors and the necessary bottling, testing and packing proceeds as required. At the far ends of the counters the packed boxes pass on to "pater-noster" elevators and are conveyed to the despatch departments on the upper floors where they are automatically discharged. Here the various boxes are packed in crates by hand and eventually delivered by roller conveyors and lifts to the despatch siding.

Fig. 33. This is looking across part of the main hall.

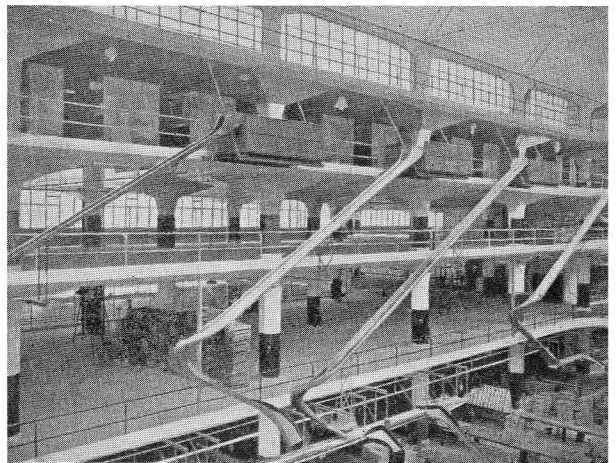


FIG. 33.

DISCUSSION.

SIR HENRY BUNBURY :

The subject chosen by Mr. Husband is a very wide one indeed and I have rarely seen so much material of the kind compressed into a single paper.

I should like to begin by congratulating the Institution on having taken the subject of Costing and the economics of production into its consideration, and especially to congratulate Mr. Husband on the very valuable and enlightening paper he has produced. It has been said that cost accounts are costly accounts, and are therefore bad and not to be encouraged. I think Mr. Husband's paper is an effective answer to that rather superficial criticism. A number of business men uphold it and the reason, I think, is this : that the term " Cost Accounts " is itself a misnomer. Costs or costing is essentially a method of analysis. It is true that the cost account so-called was evolved from the financial accounts, but, as those of you know who are interested in this subject, cost accounting is more and more divorcing itself from the processes and the technique of financial accounting. It is trying to gain that freedom of investigation, analysis and method which are essential if the figures are to give the answers to the questions you ask; so I dislike the term " Cost Accounts." I want to talk about costs and costing.

At this point I am going to pass a mild criticism on something Mr. Husband says. He begins on page 3 by saying that the objects of a costing system are threefold, viz., to report detailed costs, to discover and eliminate waste, and to study the behaviour of costs under varying conditions. One is inclined to ask as regards the first and third of these purposes, why? I think the answer to the question is that the purposes are better expressed rather differently. I should express them in this way—that the purpose of a costing system is to determine policies, to fix prices and to facilitate control. By determining policies I mean deciding between one or more possible alternatives. When some action has to be taken and some decision made there are usually alternatives before you, and you have to decide which of them you are going to adopt. And in any question of production or service—technical method, operating method, rate of charge, whatever it may be—I think the whole trend of modern opinion is that cost analysis is an essential to making the right decision. Secondly, as to fixing prices; on that subject Mr. Husband is exceedingly interesting. It is a very big subject and a very difficult one, and one which we have to-day very much with us in the Post Office; but clear thinking on costs and the interaction of costs on prices and *vice versa* is essential if you are going to make the right decision. And then, thirdly, the use of costs (with which probably the present audience is more familiar than with any other), for increasing managerial control. You will observe that when the uses of cost analysis are regarded in that way a certain very important distinction emerges. For the last purpose—the purpose of managerial control—

you want to know what costs have been; you are referring to the past. In the first and second you want to know what costs are going to be under the conditions and in the circumstances you have in front of you. That distinction, which really is very important, I feel that Mr. Townshend is more competent to talk about than I am, so I won't say much more; but it does bring out the limitation in the use of costs which is rather common. We are apt to assume that when we have ascertained the cost of some particular process or equipment for a current or past period, that that is going to be the cost for the same service in the future. It is just an assumption, which may or may not be true, and there again, Mr. Husband has alluded to and brought out the aspects of the problem which are associated with that distinction between past and future costs. It is perfectly true that you are often compelled to take the costs of the past period as the costs of the future period. Unfortunately, that very often is the fact. One of the things, for instance, which come out rather clearly on the postal side of the Post Office business is that the analysis of the costs of particular types of postal operation seems to be pretty steady. You don't get the same variety, the same reduction of cost as business increases, as you do, for instance, if you take a single telephone exchange as the unit. Postal operations are conducted on such a wide scale that the law of averages seems to apply and those averages are pretty steady and constant. All the same, it is important to realise the limitations which are inherent in any cost calculations based on past experience and on the results of a past period. I mention these, you may think, rather subtle considerations because Mr. Husband has encouraged me to think along the lines he has laid out, and I can assure you I spend quite a lot of time in trying to think out these problems to their ultimate solutions.

I want now to deal with certain particular points in the paper.

On page 3 Mr. Husband says something which I should not be quite prepared to accept. He says that the key to the problem of finding out costs of particular operations lies in the subdivision of cost or departmentalisation. That is to say, the greater the extent to which the detailing of cost is carried, the closer the results arrived at to the facts. I think that is true up to a point and in certain circumstances, but it is not true universally. That is a rather comforting reflection because if we felt we could get at the truth about the behaviour of costs if we only analysed enough, I am afraid we should have to do a lot of analysis and spend a lot of money. The fact, as I see it, is that the ultimate problem in any composite production, whether of goods or services, is to get back your costs as quickly as possible. Some of them, Mr. Husband points out, vary with the amount of work done, so that if the amount produced increases the unit cost goes up in proportion. But others do not behave in that way at all, and there I do not think departmentalisation of costs is going to help you very much.

Page 7. Here Mr. Husband speaks of marked

upheavals resulting in alterations in the values of stocks, and suggests that it is not desirable to adjust stock values in these circumstances except in exceptional conditions because it would upset the method by which overheads are distributed.

I think that is a rather dangerous doctrine. Personally I would rather face the disadvantage of having to alter the system of distributing the overhead in the course of the period than face the greater disadvantage of carrying and issuing your stock, and basing your prices, on stock values which no longer conform to market conditions. Then, on the same page, Mr. Husband says that accurate stock records should in theory preclude the necessity for the periodic taking of stock. I think he should spend a few months in the Accountant-General's Department and there he would at once appreciate that stocktaking is just the same as the taking of a cash balance, and that its primary object is to make sure that the stock which ought to be there is there. That would be very necessary, irrespective of the accuracy or otherwise of the records.

Just a word about depreciation on p. 15, which of itself is a subject sufficient for the whole evening. Mr. Husband speaks with disrespect about the business practice of charging depreciation when you have profits—of making your depreciation depend on the amount of profit available for the purpose. I know all the accountants say that. It is a thoroughly unpopular practice, but I cannot help thinking that there is something in it. After all, is it not a pretty considerable assumption that the rate of exhaustion of the investment in any asset is proceeding at a uniform rate throughout the working life of that asset? Some large concerns I know of have already so far departed from the orthodox that they calculate depreciation not at a uniform rate p.a. but in terms of the output of the equipment from year to year, so that when it rises the depreciation is higher, and when output falls the depreciation is correspondingly lower. It seems to me that that is fundamentally more sound than the orthodox accounting practice, provided you set your standard high enough. I have sometimes thought you ought to distinguish—I think Mr. Husband makes the suggestion—more completely between depreciation on the one hand and obsolescence on the other than is done in the customary practice. The position as regards obsolescence should be reviewed, say, annually, and the appropriate revision made according to the prospect of plant becoming obsolete.

On page 17 I must quarrel with the Chairman of the Met. Railway Co., who said that cheap fares were a doubtful proposition. Mr. Husband quotes him in relation to this difficult question of basing prices on differential costs. I would say in regard to this, that the railway managements now seem to be particularly pleased at the result of their latest experiment in cheap fares. I think therefore that there is more to be said for differential charges, for cheap fares, on railways as a means of making a greater net revenue than Sir Clarendon Hyde admitted.

I should like to add one word of entire agreement

with Mr. Husband. On page 22 he gives admirable advice with regard to expense. At the foot of Appendix I he divides expense into the cost of providing productive capacity and the cost of using it. After setting out a specification for various overhead expenses he says "All of the above main and component costs should be classified from the point of view of whether they are concerned with providing the capacity to produce or with subsequent actual production." Well, that is the keynote of that part of the paper, the greater part of which relates to overhead costs and economic production. I believe the subject is one of the greatest importance to us and to all engaged in production. To get the optimum results from equipment and resources in use we have not necessarily to reject the old-fashioned, conventional ways of regarding these things, but we have to regard them with a critical eye and ask ourselves constantly: does this particular method of arriving at certain figures, the basis of our decisions, stand analysis? Does it really do what we suppose it does? Very often we shall find it does; sometimes it doesn't.

One other thing: I don't believe in pursuing these cost studies in isolation from each other. Neither the accountant nor the technician can dispense with each other. It is essentially a co-operative matter. The former is lost unless he has that intimate acquaintance with the subject matter which the latter alone possesses. On the other hand, the basic materials are materials which the accountant holds and produces and of which he knows the accuracy, the characteristics and the limitations. I think if we want to get the answer to our conundrums right it can only be done by a combination of the efforts of those two people.

MR. A. B. HART :

The author has drawn a distinction between costs and prices, and I would like to make this point: that we engineers represent the customer in the matters dealt with in the paper and what we are primarily concerned with is prices. On the other hand, we represent the producer in so far as we play our part in production. I should like you to bear in mind the distinction between costs and prices. I am not at all sure that in our duty as production engineers of telephones, we should pay too much attention to costs, which are the primary concern of the other fellow, being the producer supplying us as a customer. On the other hand, this paper deals with the subject as a science and, in so far as it is an outline of the science of costs, it deals with a very important subject to us in our function as the producers of telephone service. But I think we must be very careful in studying the question of costs of production of the items we buy, and to remember that, after all, our costs in the production of telephone service are going to depend on several other factors and that the cost of equipment or anything we buy is going to depend very largely on our work as designers. If we design a system that requires very expensive parts we must not then waste our time in

quarrelling with the people trying to produce the parts by saying the charge is too high. We should be careful in our design to see that we use the most economical methods, circuits, installation, etc., and I admit that in the science as outlined here, it is important for us to know many of the factors that make up cost.

In one part of the paper the author refers to something which touches a very responsive chord, but I am not sure whether I agree with everything he has said. I think he deplors the fact (on page 8) of the regrettable consequence of this mechanisation that has partially eliminated craftsmen. Let us go back a little further in the history of engineering. The point I want to make is that for a given time in engineering progress this statement is going to be true only in regard to that particular time. At the beginning of things, when men had to till the ground, the spade was a machine. When spades gave place to the plough the plough was a machine, and so on. I am not sure that the author is correct in thinking that the machine has entirely eliminated the necessity for individual mechanical ability. I think that to-day there are more skilled craftsmen than there were, say, 50 years ago, but I think that if the author means that the proportion of skilled craftsmen has diminished sadly, he is right. Anybody with any knowledge would say that the skilled labour to-day is simply marvellous. If you take old clocks to pieces and examine the works with a measuring instrument you will find those old things, beautiful as they look, have not anything like the precision in make compared with the equivalent instruments of to-day. I think there still exists in industry a pride of craft, and I have seen nothing that would incline me to believe that that pride of craft will diminish with mechanisation. I must say that when I have been in factories and seen mass production on monotonous jobs I have wondered how the operatives could go on, and yet, to talk to them, you would find they are quite happy. They will tell you they are not thinking of their job, and you may think it is a pity.

Elsewhere the author gives a hint of processes whereby mechanical parts may be moulded so that machining is avoided: processes of which the telephone industry has barely touched the fringe as yet. I wonder whether he is aware that machine tools, in which the basic material is iron, have been made by the moulding process.

My last word is in reference to the author's remark on the future. I am very glad indeed he has put in a few words on this subject—page 21. I am going to speak from my own experience. I say that I have had an increasing concern as to what part I may personally have played in the work I have done in putting other men out of employment, and I know others of my generation who have experienced the same concern. I do not think the engineer to-day should deflect one step in his path towards maximum efficiency in his design by any fear that what he is doing will put others out of work. If he does, he is not doing his duty as an engineer. But while his

duty as an engineer is to engineering, he has his duties as a citizen to tackle the problems his work has raised. It is a social problem and he must be prepared to take his part in it. The average man to-day could not enjoy the leisure and his many facilities if the engineers who were largely responsible for working out the plans that have made that leisure and those facilities possible had deflected from their path in wondering how it was going to affect somebody else.

MR. A. JAMES :

I do not profess to be an expert on the subject of costing, although my calling is that of a cost accountant.

The need for costing has I think, already been ably put forward by the paper read this evening, and also by the preceding speakers, therefore it is unnecessary for me to add anything, but before going any further I would like to commend Mr. Husband for the able manner in which he has handled this subject. I can also assure him that the paper has been well read by our people at Liverpool, and has drawn forth much admiration, and it would appear that the manufacturers are gratified to have a customer who displays such a sympathetic consideration for scientific costing. I am not really prepared to go deeply into the present discussion as most of my points have been treated by the speakers before me. As regards the subjects of material and labour most of you know that these are definite factors, and that it is comparatively easy to allocate these expenses to jobs, but dealing with the more elusive element of burden is not so easy, and here is where disagreement occurs. Here also is where inaccuracy is likely to enter, and I think I am right in saying that most authorities on the subject are agreed that it is practically impossible to allocate overhead or burden charges with absolute accuracy. It is in the allocation of burden that most of us have yet something to learn, and I am of the opinion that every method used to-day contains some weakness.

Again, as Sir Henry Bunbury pointed out, it is in this matter of overhead allocation that the co-operation of the engineer is needed by the accountant, particularly in such questions as the estimating of depreciation, etc. I am on the accounting side, and I am prepared to say we cannot make really good estimates concerning depreciation without the assistance of the engineer, and it is in this way that we get valuable assistance from our engineers at Liverpool; in fact I feel that only with the co-operation of the engineer is scientific costing possible.

MR. H. TOWNSHEND :

Mr. Husband has given an interesting paper covering an enormous range—so much so that if I were a member of your Institution I should like to suggest the immediate formation of an economic section!

Mr. Husband has brought out clearly what differential cost is. In determining policy, as Sir Henry Bunbury has said, the main question one

honestly wants to ask oneself is whether what one is going to do will pay or not. People who have not studied the subject are apt to think this can be determined by asking what the proposal will *cost*. That is never true. You have to say—What will our expenses be if we do it, *and* what will they be if we do not do it? The difference is a differential cost. In fixing rates or prices, the same thing occurs, with the further complication that the revenue has to be estimated. If you lower your prices you will have to produce more and that will alter your cost. You have also to allow for the change in your receipts caused by the prices. I was pleased to see that Mr. Husband raised that point. Cost accounting is absolutely necessary, but is not the whole story, and that underlies the fundamental distinction between prices and costs.

My next point is on the long and short run economics. Even an overhead cost is the cost of plant which is used and wears out in the long run. I do not altogether agree that the short run ought not to influence prices. But you must keep the long run in view.

MR. N. KIPPING :

I remember having heard national budgets as being classed in three groups—those which pleased the Treasury, those which pleased the City and those which pleased the constituents. It occurs to me that costing systems can be similarly classified as those which please the Cost Accountant, those which please the Directors and those which please the Works Manager. As a representative of the latter category, you will not expect me to adopt a very purist attitude.

One must, of course, agree with those speakers who have emphasised that the labour and material elements in cost accounting are the least controversial and in this sense the least important. In most factories labour costs are pre-determined because piece-work rates are set, and as a general thing it would be a waste of time to inform engineers that the labour costs were in fact equivalent to the piece-work rates which the engineers themselves had determined. I think emphasis should be placed on the fact that cost estimates, as distinct from so-called actual costs, must be the basis on which most business is transacted. You will realise that actual costs, when they do arrive, tend to be historical; that is to say the business they define and the price have already been determined on the basis of the estimated cost. The true function of the costing system is therefore to provide guidance which will form the basis of the estimator's procedure.

Agreement as between different firms and authorities on the subject of overhead is seldom reached. There are so many different ways of defining the boundary lines between the three elements of cost—labour, material and overhead. Even direct labour, for example, may be interpreted by some to include inspection, machine setting and the like, whereas others will even exclude from direct labour the cost of those operators who are engaged in the course of a day's work on so great a variety of different opera-

tions that it would become a farce for them to attempt to write out the time tickets necessary for the Cost Accountant to allocate their labour to each part handled. There is not even any general agreement of what are the legitimate components of cost at all.

I think Mr. Husband, if I may suggest it to him, should draw attention as a cost factor to the importance of the training of operators. This is a subject whose magnitude is seldom appreciated. If a new operator is engaged, his or her output will probably be twice in the third month what it was in the first. Where is the difference in cost to be allocated? This factor is not, of course, important where the customer can contribute a steady load to a factory, but hitherto this most desirable thing has not proved to be within the realms of practical politics and the training of operators is consequently a very big factor in costs.

Speaking of piece-work, it might be well to draw attention to the increase of so-called gang piece-work which is tending to spread as a system of incentive payment. I am glad attention has been drawn to the vicious practice of certain employers regarding the use of juvenile labour, which is laid off again when the labour reaches the age which carries with it an increase of pay. This evil is, of course, usually brought about by price-cutting wars which sometimes leave manufacturers with no other solution to the task of ending the year with a profit.

Finally, I should like to refer to Mr. Husband's comments on the attitude of the stand-by customer. There is such a thing, I think, as a stand-by manufacturer. Is it realised that a single customer can force an industry into the practice of differential costing when he places part of his business with a stand-by manufacturer on a price control basis, and the remainder on the basis of that kind of competition which is associated with the juvenile labour evil? The customer gains nothing in the end, but merely re-distributes his costs as between the two classes of business—only neither the buyer nor the seller knows quite where he is.

MR. C. C. PUCKETTE :

Does the lecturer believe such a system as " Powers " to be genuinely useful in a Telephone factory, and is it not rather that such systems are more applicable to Shipping and Railway Companies, etc., where a great deal of statistical information is required? Does not the use of such a system produce masses of figures which in many cases only confuse the real issue and make it difficult for executives to arrive at the precise facts they are seeking?

In a Telephone factory is it not a general practice to classify a raw material as that which is purchased outside the factory's activities, regardless of the fact that the said material is in many instances a fabricated product which carries both labour and overhead charges from its place of origin?

The suggested system of transfer note in regard to the transfer of items from one factory department to another appears apt to lead to errors in the Stock Rooms. Is not there danger existing with the

transfer note system that the Stock Rooms would not be kept fully alive as to the movements of stock and may issue orders for a further supply of items without knowledge of the parts already available?

The lecturer suggests in his Paper that the allocation of administration charges might with advantage be done on hours. This in theory seems to be a better method than the productive wages basis, but it is a known fact, however, that most firms who have launched allocation of charges on the hourly basis have very soon changed back to the productive wages basis. While agreeing with the lecturer that unskilled labour requires more supervision than skilled labour, yet the cost of this extra supervision is of very small moment compared with the saving in labour charges in a large Department by the employment of the unskilled or cheaper labour.

The lecturer mentions the disposition of waste and scrap materials and the procedure as to the accounting for this item. I should like to know how it would be proposed to handle the cost where a considerable amount of expensive material is scrapped due to some manufacturing error or mistake, as it will be appreciated that there are many materials which are expensive, but have practically no scrap value.

In the majority of manufacturing shops an Estimated Cost Department and an Actual Cost Department are in existence and are closely allied. The lecturer's so-called "standard" costs seem to be in effect a reconciliation between these two departments. We find that our estimated costs do not always agree with our actual costs. This goes to prove that wherever there is an estimated cost on an untried material, the estimator is on very thin ice.

LT.-COL. F. REID :

I would like to add my congratulations to those of the other speakers, to Mr. Husband for his interesting paper. It has come at a very opportune moment when public attention is focussed so much on economic questions. The engineer of the past generation concerned himself mainly with physical efficiencies and had very accurate methods of measuring these efficiencies, but when we come to economic efficiencies we find it is by no means possible to make accurate measurements or to get accurate results. In the field of factory costing one of the main causes of inaccuracy is the incidence of overhead charges, which may amount in some cases to 250% of the direct labour charges. There is first of all the uncertainty whether to apply overheads as a percentage of direct labour only or of direct labour plus materials. Having agreed to express overheads in terms of direct labour only there is some doubt whether to apply them on a manhour basis or on a labour value basis, the two methods giving very different results. In view of this uncertainty as to what is the actual manufacturing cost of any article it is not surprising that the manufacturer in fixing the selling price takes into account not the factory

cost only but also what he thinks the purchaser is willing to pay.

Mr. Husband refers in his paper to the method of fixing prices by price control and prefers this method to fixing prices by competition. I think Mr. Husband has barely made out a case in favour of price control and I would like to say a word in favour of competition. It has become rather fashionable to talk about wasteful competition but all competition is not wasteful and properly controlled none would be so. In an early part of his paper Mr. Husband describes some remarkable improvements in the L.M.S. Railway. Would these improvements have been made in the absence of competition by Road Transport? The gas industry has made wonderful improvements in the last 30 years, but I think these have been mainly due to the competition of electric light. The Post Office is a buyer of apparatus and from the buyer's point of view, buying cheaply is an important consideration. I think it is the experience of the Post Office that competition results in a substantial reduction of price.

Mr. Kipping advocates the Post Office buying all its apparatus from the large firms who manufacture exchange equipments. I would point out that a large part of the Post Office expenditure is on apparatus of a simple kind which can be made by small firms with low overhead charges. An overhead charge of 200% is not at all necessary for making a large proportion of telephone apparatus. Mr. Kipping suggests that the Post Office would get its exchange equipments cheaper if it placed all its stores contracts with the exchange equipment contractors. Can you imagine Walls who sells both ice cream and sausages putting on his ice cream barrows "Buy my ice cream, it is very dear but you will get your sausages cheaper?" I fear we are not yet wise enough nor honest enough to depart entirely from a competitive system.

MR. J. N. HILL :

I have listened to the paper with great interest and I am sure we feel grateful to Mr. Husband for presenting such an interesting subject. Personally I think there is a great deal of work to be done to enable full economic use to be made of the results of modern scientific research. A wider knowledge of the laws governing the economics of production is essential to the study of these problems.

Mr. Husband points out that a new telephone exchange at the outset possesses a large margin of spare plant which diminishes as development proceeds. It must not be overlooked that this margin of spare plant, which includes buildings, equipment and line plant, has been provided because a comparison of costs over a period of years has shown this course to be more economical than planning for a shorter period. The resulting burden of costs on spare plant to be borne by subscribers in the early years will be large and the cost per subscriber will be high in order to achieve economies in later

years, but from a tariff point of view the cost can be averaged over the period of years proportional to the revenue.

An increase in development owing to the effect of shortened planning periods and re-actions on the economic size of exchanges tends, under automatic conditions, to reduce the average cost per line. It is therefore sound policy to seek means of stimulating development. The reduction in cost per line may, however, not in itself be sufficient to enable the rental to be reduced to a figure which would create the extra demand. In such a case the principle of differential costs may be applied and a cheaper type of service offered at a reduced tariff. It is important the alternative tariffs should represent a measure of the service given, as otherwise there is danger of the cheaper service proving attractive to subscribers who would otherwise have accepted a full service at normal tariff rates.

MR. J. INNES (*communicated*):

I regret that I will not be able to take part in the discussion on Mr. Husband's paper due to my absence in America, but I should like to offer certain comments in view of the very great importance of costing from a Departmental point of view.

Mr. Husband compares in some detail the methods of buying represented by "Open Competition" and by the "Bulk Supplies Agreement" and he demonstrates very clearly that while a casual customer may benefit on a particular job the stand-by customer who must have the manufacturer's product, is mulcted in the costs incurred in obtaining work which in itself is unremunerative. There is, however, another phase of this question which might be expressed as fostered competition. In this class of contract the customer arranges to supply sufficient details to enable the manufacturer to cut down overhead expenditure, but the charges have still to be met by the buyer in his own office expenses. In our case such fostered competition is confined to "repetition" items which might well be called "bread and butter" business. The fostered competitor does no development work and is of no value to us on specialised work. The placing of large contracts for simple repetition type of business with him results in an unfair overhead burden being loaded on such items as telephone exchange equipment. The latter has to carry not only its own share of the overhead burdens but the burdens which would otherwise have been met by a proper share of the bread and butter business.

It is not easy to reduce capital costs on exchange equipment unless a proper share of orders for the simple items goes to the equipment manufacturer. Reference has been made by Mr. Husband to rationalization and the foregoing is a necessary step in this direction. The industry cannot function as a rationalized unit without the very complete co-operation of the buyer just as the united co-operative efforts of the manufacturers are essential to progress. The experience of the Bulk Supplies Agreement has demonstrated that the Department has

nothing to fear from collective bargaining and has in fact everything to gain.

Mr. O'dell gave a most excellent paper on standardization before this Institution in May, 1932. I would like to make one reference only to this question. To obtain the maximum benefit from any scheme of standardization, the manufacturer should not be called on to continue supplying obsolete types when extending existing exchanges. It is perhaps difficult to introduce new items in such cases, but if you compel your manufacturer to maintain tools, etc., for the manufacture of obsolete types, you cannot at the same time expect economic production.

I would like to congratulate Mr. Husband on the courageous way in which he has tackled a most difficult and engrossing subject. He has opened up a new field of discussion in this Institution and one which I am sure will be heartily welcomed. I hope he will continue at some future date with a paper on "Factory methods and Production."

MAJOR H. BROWN:

Sir Henry Bunbury said that Mr. Husband had defined the objects of a costing system but he suggested also that they could be better expressed rather differently; namely, (a) to determine policies, (b) to fix prices and (c) to facilitate control. In the first and the second cases you want to know what prices are going to be; in the third, what they have been. I think, in the last ten years, there has been a completely new orientation as to what information cost accounts should give. They are now concerned not so much with what they have been, nor with what they are going to be, but with what they ought to be, and the whole system of standard costing, as we understand it to-day, is designed accordingly. That is a fundamental fact.

I am not particularly familiar with the practical processes of costing in the factory, but I do know the methods that have now become standard for ascertaining Departmental costs of labour. It is not quite as Mr. Husband has put it: the way to arrive at standard labour rates is to take not the output of the average man but to strike a mean rate between the output of the most skilled operator and that of the average operator. This gives you a standard rate. The object of this method is to obtain ultimately a better output from your average worker than would have been the case if there had been no encouragement to go ahead.

Mr. Hart was very concerned about unemployment in the future. That is a matter which troubles all of us. We are hoping by the development of the commodities we have to offer the public that, in better times, we shall be able to place a volume of orders equal to anything in the past, but as Mr. Hart said, it would be a disastrous state of affairs if the first move towards the production of a still more efficient system were paralysed by the fear that the consequences would be harmful to anyone.

Mr. Husband has boiled into a single paper the essence of about half a dozen. It represents a

series of debates and he has given us what indeed is a very useful publication. I wish I had an opportunity of dealing with more of it.

MR. S. J. HUSBAND (*in reply*) :

I have listened with pleasure, and, I must admit, at times with some dismay, to the variety of points of view and suggestions that have been presented. Though personally, I find the consideration of costing practices and production methods of absorbing interest, I had not thought that this interest was so widespread as has been shown. I have attended many lectures here and listened to the questions fired at the lecturer, but I am sure that none of these could have felt quite the sort of Aunt Sally I feel now. Nor, is this in any way surprising, because, as you all know, the speakers this evening are expert authorities on matters of economics, finance and factory production methods.

Some of the questions are answered in parts of the paper that have not been read. Major Brown has provided a response to Sir Henry Bunbury's comments on the objects of a costing system. The ultimate object is, of course, to find out, not what costs have been, not what they are, or what they will be, but to find out what they ought to be. Before we can arrive at this happy state we must :

- (a) collect some evidence ;
- (b) discover weaknesses ;
- (c) experiment with remedies.

These are the lines of approach I have set out in my introduction. In the process, much will be indicated to facilitate control and to aid in the determination of policies. We may even find that there is more than one answer to the question as to what prices ought to be. If changes in policy make us change the quantities we require, then our ideas as to what prices ought to be, for the new set of circumstances, must also change.

Sir Henry Bunbury does not favour my statement that the key to the problem of ascertaining costs lies in sub-division. I am bound to agree with him on the issue that some costs vary with quantity and some do not, and that these latter can only be allocated on an arbitrary basis. In such cases, analysis, so far from being the key, cannot be carried out at all. The main point I wished to bring out in this paragraph was that sub-division enables you to allocate within the limits of practicability in order to obtain correct unit rates. Exactitude, as I have said, is unattainable.

Sir Henry refers also, to the effect on stock values of sudden market changes. I do not think that we are really at variance on this issue. We agree as to the necessity for adjustment. I have suggested a periodic averaging out. Sir Henry would re-value his stock at once and he is probably right. Another point he mentions is in regard to the necessity for stock-taking. Sir Henry states very definitely that a periodic taking of stock is indispensable and I have a feeling that he finds it hard to forgive me for suggesting otherwise. My Paper is primarily about Costing and in arguing in support of accurate costs

records I have theorized to the extent of suggesting that in the face of accurate records, stock-taking should not be essential. Well, I must bring out the fact that my accounting sins stopped short at theory because in the next sentence, I have admitted that there are reasons—apart from Audit requirements—why stock-taking must be carried on.

As regards depreciation, my remarks, again are coloured more by the costing aspects of the matter than by any other. The object is to allocate costs, uninfluenced by considerations of a political or financial nature. Since plant depreciates during the passage of time, and also during production, then suitable allowances must be made in your factory production costs. I agree with Sir Henry on the point of charging depreciation on the basis of the rate of output, so long as the output is being maintained. But if the output falls away, then another factor presents itself. I mean the constitution of overhead. In the highly developed factory, the overhead cost of actual manufacturing is low in relation to the standing overhead required to provide the capacity to produce. In such case expensive plant continues to deteriorate almost as rapidly as though full production were being maintained and allowance on a period basis would have to be considered. I would not in any circumstance base depreciation on profit (in an analysis of cost) because profits do not necessarily move with output and a very active year in the factory may produce little or no profit in times when competition is keen or when particular policies are being launched. I am very glad that Sir Henry shares the opinion that obsolescence and depreciation are factors that should receive entirely separate treatment.

Turning to the matter of differential fares on railways, Sir Henry's comments are not easy to answer. He has, in fact, almost convinced me, except for the one objection as I see it, that once you introduce differential advantages, every one wants to benefit therefrom. If all users insisted on cheap fares, there would be no stand-by travellers left to pay full fares.

Mr. Hart touches on a vital point in picturing our organization in the dual role of buyer of plant and seller of service. He says that, as engineers, we must design cheaply to buy cheaply. I would like to present a factory viewpoint in this matter and prescribe four essentials preparatory to design.

- (a) To make sure that standard commercial sizes and grades of raw materials only are employed and that market lines of purchased items and parts may be utilized.
- (b) To consider the possibilities of all the various workshop methods and practices in construction for the quantities required in order to ensure rapid and easy output.
- (c) To allow widest possible tolerances compatible with interchangeability, so that tools and dies may have long effective lives and rejections be reduced to a minimum.
- (d) To be quite certain whether any of the thousands of piece-parts already in produc-

tion may be used in the new design before launching into the preparation of new specifications and drawings.

Mr. Hart's observations in regard to the elimination of the craftsman are very interesting. This elimination may be a matter of proportion rather than of number, in view of the enormous growth of industry, but there is no doubt whatever as to the superlative degree of skill and precision work of the present day.

I observe that Mr. James has refrained from criticism, but I must, in return, object to his remark that he himself is no expert on costing. I am indebted to Mr. James for the various cards and forms detailed in Appendix No. III and I think you will agree that it would need a very good amateur to produce the system demonstrated therein—the system, I may say, now under his control at the Automatic Electric Company's works at Liverpool.

Mr. Townshend emphasizes the wide-reaching effects of the differential cost. He has misquoted me in disagreeing that the short run ought not to influence prices. Short run prices are in the nature of a cat and dog fight and sometimes can't be helped. My conclusion was that short run trade should not influence policy.

I cannot altogether agree with Mr. Kipping that actual costs arrive so late in regard to a particular job that they "tend to be historical." If a monthly reconciliation can be undertaken so that, for example, July's actual costs are available in August, these are, in no sense, "historical." Nor can I agree that the only function of the costing system is to provide guidance which will form the basis of the estimator's procedure. On the contrary, the costing system tries to make the business sound and to keep it sound. Mr. Kipping's suggestion as to the training of operators is covered on page 10 of the paper. With regard to the "stand-by manufacturer," I appreciate—I think we all do—the good work which the stand-by manufacturer does for the art of telephone communication. Without the stand-by manufacturer, telephone development would be far behind its present day standard. But they should get together more.

I cannot share Mr. Puckette's apprehensions on the matter of the "Powers" accounting equipment. There is nothing sinister about "Powers" equipment and it will not give you any statistics except precisely those which you predetermine. The Management, therefore, would have only itself to blame for any confusion. To take the pay roll, for example, I consider that the "Powers" equipment will save a great deal of money and time in any organization employing large numbers of work people. I am in complete agreement with Mr. Puckette's definition of raw materials. As regards the transfer note system being likely to cause errors in the stock room there is a risk, of course, but surplus issues are usually small and good planning should still further reduce them. A note on the Production Order should protect the stores position. Mr. Puckette raises a point as to the treatment of large scrapings of

expensive materials due to manufacturing errors. I would charge such large and exceptional wastages to general overhead, or better still, allow from gross profit. In no case should the standard cost of the individual item be influenced by accidental expenses of this nature.

Colonel Reid doubts whether purchase by the method of price control is really better than by straight competition, his reasons being the apparent difficulties of exact costing and the natural wickedness of man. I have every faith in purchase by agreement. I am satisfied that good costing can show, if not the whole truth, then very close to it. It remains only to remove the distrust. An agreement which gives to the buyer low prices, and to the selling companies a sufficient profit to maintain them as healthy and contributory units in the community, should not be—and is not—beyond the capabilities of reasonable people. These advantages are obtainable from the savings resulting from the elimination of competition. I cannot agree with Colonel Reid when he says that "all competition is not wasteful and properly controlled, none would be so." I take this view because wherever competition exists, there is a deal of overlapping effort and this is a total loss to all but the successful tenderer. When the competition is for such a complex prize as automatic telephone communication systems, then the amount of overlapping and unremunerative effort is enormously increased. This waste can, and should be avoided.

There is another side to the picture of unrestricted competition. When business is scarce, somebody has got to suffer and a cycle of price cutting is started in which prices have no relationship whatever to production costs. All the participants are struggling to avoid being squeezed out of the market, and in trying to avert death, they are forced into heading for suicide. The survivors emerge weak and impoverished with depleted and poorly paid staffs, a drag on the National well-being instead of an asset thereto.

Colonel Reid points out also that some Post Office expenditure is on apparatus of a simple kind which does not need the extensive plant of the large factories. This aspect of the matter is, I think, very completely answered by Mr. Innes who has emphasized the disadvantages that flow from the withdrawal of "bread and butter" business from the equipment contractors in order to place it with specially fostered suppliers. I can add little to the comments made by Mr. Innes except to say that residual and differential costs cannot be compared on the same footing. The point to bear in mind is that if there were no differential prices, then the residual prices would all be correspondingly lower.

Mr. Hill advocates differential rentals in order to employ idle telephone plant, but he is only prepared to give a poorer grade of service for the lower rental and the case is not directly comparable.

Major Brown sums up the whole problem of costing as finding out what costs ought to be in a given set of circumstances.

I am grateful to Major Brown for the description of a method of arriving at a standard labour rate. Such a rate certainly provides a stimulus, but I do not think its adoption in precisely that form is general in the factory so far as piece-work earnings are concerned. Most piece-work time rates are arranged so that the experienced operator can earn about 30% above the amount prescribed by the piece-work rate. I would assume, therefore, that the standard referred to by Major Brown is the gross piece-work standard rather than the basic standard.

Unemployment is a sombre note on which to close. One of the greatest anomalies of our age of scientific progress is this fact that discoveries which in themselves are of inestimable value, result in unjustifiable distresses. That is a social problem which social administration must remedy. It would, as Major

Brown says, be unthinkable for science to hold back its gifts because it had outstripped political administration in the modern race. Further, it must not be forgotten that in many fields, science has created brand new industries and consequent employment.

One other word. I think it might safely be said that competition has had more to do with the development of the art of detailed costing than any other factor. Manufacturers were compelled to know their costs in order to meet competition. In the new field where price control is substituting competition, it will be instructive to observe effects. Without the spur of necessity, will slackness creep in? The temptation to revert to cheaper and less accurate methods will be persistent.

I thank you for the patience with which you have listened and for the kind, though undeserved remarks that have been made.

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