"Barrelfuls of broken drills might easily be saved if they were properly ground in the first place," said a factory superintendent. A drill grinder like that here shown will soon save its cost in a small or large shop (See chapter V)

OUTLINES OF FACTORY OPERATION

STUDENTS'
BUSINESS BOOK SERIES

A. W. SHAW COMPANY
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LONDON

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Part I

GETTING THE LARGEST RETURN FROM LABOR

Study Your Men

SOME men have that within them which always spurs them on; while some need artificial initiative, outside encouragement.

Some men extend themselves under stern discipline; some respond only to a gentle rein.

Some men need driving; some coaxing. Some need the spur; some the sugar lump.

Some men do their best with work piled shoulder high; some must have it given them a piece at a time.

Some men thrive on discouragement; some cannot work without cheerfulness.

Study men—the men over you, under you, around you. Study them and learn how to get from each the most that is in him.

CHAPTER I

Where to Look for Leaks

A FACTORY manager was on a trip through many plants, seeking ideas that save money. Not expecting to find all cost-reducing plans in factories where goods similar to his own were made, he visited a diversified lot of shops.

He was a shoe manufacturer. In a breakfast food plant he found cereal cartons being shipped in fiber containers—cheaper, lighter and easier to set up than the wooden crates he was shipping shoes in. When he adopted this idea in his own plant he figured his savings at $12.70 a day—$10.00 on the cases, $1.00 on labor of handling and $1.70 on freight charges.

This instance is typical of more than one hundred other ideas in this book, that have proved money savers for the managers in the shops where they have been installed. This book is an exchange of ideas—the selected fruit of many trips.

Each scheme has been used by some factory manager—has cut costs—has saved money. They will do the same for you—if you apply them. Because a certain method, short-cut or plan has been successfully adopted in a textile mill—that fact does not forbid its adoption in a wood or iron working plant. The shoe manufacturer found a good idea in a breakfast food "foundry;" the built-in shipping platform that saves coal for a machine tool maker, will be just as economical in a knitting mill.

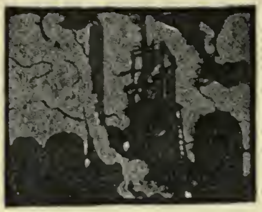
When you take a trip through a factory, there are in general four different headings you can post in your note-book:

I. Getting the Largest Return for Labor.
II. Economies in Production Methods.
III. Equipping the Plant.
IV. Building the Factory.

This book leads you through a hundred factories in the same order, and points out the money-saving ideas in each. Under the first head you will find methods of hiring, directing, paying and working labor—schemes of getting more output from men. Logical methods of tool arrangement, new ways of routing and grouping work, order and stock keeping systems—all tried out and found to be cost-reducing—are gathered under the second head. Methods that have lowered cost of power generation, distribution and utilization, methods of handling materials, lighting, heating and ventilating are grouped under the third head. The schemes for cost cutting in the location, arrangement and erection of your factory appear under the fourth head.

Each specific scheme and method and device—practical, tried-out, applicable—will cut cents from your production cost, and add dollars to your profit.

WATCH the little points. They spell success or failure; they are treacherous; they will knife your profits.



CHAPTER II

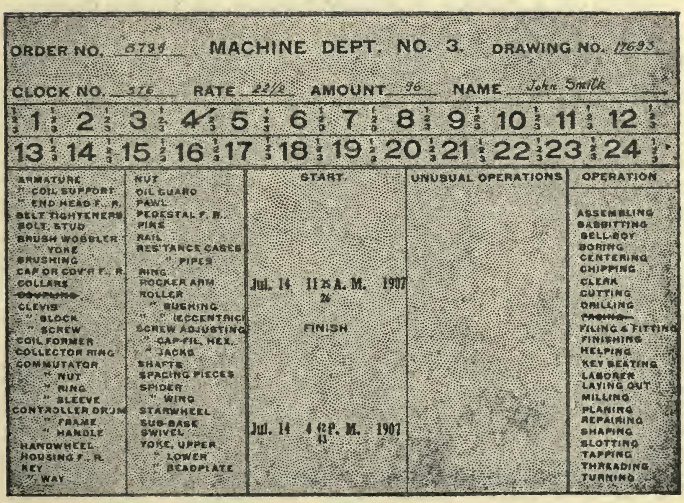
Time Keeping Methods

NOWHERE is the accurate figuring of time and costs more important than in the manufacturing plant—whether it be large or small. To keep correct account of the exact time spent on each piece of work during its entire progress through the factory is a difficult task for the cost department without a simple, uninvolved and quick method of arriving at the desired figures.

The following system for recording the exact amount of time expended on each job has been in use for some time in a large electrical manufacturing plant and has stood the test of practicability in every branch of the concern. It can be applied in almost any manufacturing business, with decided advantages in the way of simplicity and accuracy.

Under this method the entire record of time spent by each employee on any piece of work and the material used therefor is included on one small time ticket only 4x6 inches in size. On this ticket (Form I) is printed every bit of data required for all ordinary jobs, including the name of the employee and his department; the order number; a printed list of the materials and operations that the department takes care of, for checking the particular work at hand; spaces for registering the time of the start and finish, and a series of numbers to check off the total time used on the one piece of work. Space is also provided for notation in case of an unusual operation.

When an employee in any department starts on a job he is given one of these time tickets. He immediately goes to the time clock and stamps the slip with the time he starts the work. Then he simply draws a line through the piece worked on and its operation, and his duty so far as the record is concerned is practically done. This method is doubly valuable, as under old record systems, considerable time was spent in deciphering the illegible handwriting of some employees, which was an annoying item of expense. When the work is completed, the ticket is again stamped, to show the finish time, and after it is O. K.'d by the department foreman, is sent to the



ORDER NO. 8794 MACHINE DEPT. NO. 3. DRAWING NO. 17693

CLOCK NO. 576 RATE 22½ AMOUNT 96 NAME John Smith

1 2 3 4 5 6 7 8 9 10 11 12

13 14 15 16 17 18 19 20 21 22 23 24

		START	UNUSUAL OPERATIONS	OPERATION
ARMATURE " COIL SUPPORT " END HEAD F., R. BELT TIGHTENERS BOLT, STUD BRUSH WOBBLER " YOKE BRUSHING CAP OR COV'R F., R. COLLARS ~~COUPLING~~ CLEVIS " BLOCK " SCREW COIL FORMER COLLECTOR RING COMMUTATOR " NUT " RING " SLEEVE CONTROLLER DRUM " FRAME " HANDLE HANDWHEEL HOUSING F., R. KEY " WAY	NUT OIL GUARD PAWL PEDESTAL F., R. PINS RAIL RES'TANCE CASES " PIPES RING ROCKER ARM ROLLER " BUSHING " " ECCENTRIC SCREW ADJUSTING " CAP-FIL. HEX. " JACKS SHAFTS SPACING PIECES SPIDER " WING STARWHEEL SUB-BASE SWIVEL YOKE, UPPER " LOWER " BEADPLATE	Jul. 14 11 26 A. M. 1907 FINISH Jul. 14 4 43 P. M. 1907		ASSEMBLING BABBITTING BELL BOY BORING CENTERING CHIPPING CLERK CUTTING DRILLING ~~FACING~~ FILING & FITTING FINISHING HELPING KEY SEATING LABORER LAYING OUT MILLING PLANING REPAIRING SHAPING SLOTTING TAPPING THREADING TURNING

Form I: On this time card, the employee simply checks the work he is engaged at. This scheme has been found to facilitate accounting and minimize clerical errors cost department, where the time is figured up and entered merely by drawing a line through one of the 24 numbers on the slip to show the hours of time consumed. To indicate a quarter or half-hour, the line is extended through one of the smaller figures.

In the case of the record slip shown, the employee, whose clock number is 376, started to face a coupling according to drawing No. 17693, order No. 8794, at 11:25 o'clock, July 14, and finished the operation at 4:42 the same day, so that the cost department in a moment was able to register the total amount of time, which was four and one-fourth hours. At the rate of 22½ cents an hour the labor cost of this job was 96 cents. This amount is transferred to the regular order and added to the other cost items.

By this method of record both the labor cost and the exact progress or location of the job can always be learned at a glance, without wasting the time of foremen in answering questions.

Duplicate Check System That Proved Efficient

I HAVE seen the time-keeping puzzle solved in all sorts of styles, and have come to the point where I stand with the majority and favor a mechanical control worked with one or another of the clock methods. But my faith has had shocks, though I do not yet acknowledge a change of heart," said a factory superintendent.

"One of my old-time acquaintances has a check system. Two numbered checks are deposited daily by each employee. One check is deposited at the start in the morning, the other one is handed in at noon after lunch. The pair of checks can be put on a numbered board by the time-keeper or an assistant. The workmen take their checks home or not as they choose. The checks are conveniently located near the door and prominently in sight.

"Now, as every factory man appreciates, there is nothing new about this check system so far, but hear what the superintendent said when I hammered the idea: 'You see, this is a four-story building. Every minute counts. A man gets here on time. He could ring up if we had a clock, drop a check into a box or do anything else on the ground floor. Then he can walk upstairs or take the elevator. On any floor he may halt, loiter, if he pleases; but the clock or the old check system takes no account of it. Superficially the system is O. K., but it is weak when put to test. Most of our men are on piece work, but it is a pernicious plan that allows men to loaf unseen by us, even when they figure that it is on their own time. The example is bad. The factory is a workshop, first and last. Now take a look at these checks.

" 'These checks are made in as many sizes as we have floors. A tube runs up to each floor, and the inlets fit these checks. A man working on the top floor can not drop his checks on any other. He has to be in sight of his work, and is ready for business when he puts himself on record.

" 'The checks can all be alike for that matter. Have separate tubes and outlets to correspond with them. The outlets can lead to receptacles and the latter may be changed punctually at the starting time, thus affording a close check on the whereabouts of workmen at that moment—this can and should be done unobtrusively, and none but the clerk know of it.

" 'The fact that the clerk enters into the transaction in any way, is the weak point in all check systems in comparison with mechanical methods of keeping time records. The infallibility of a clerk, with the best intentions, can not be relied upon.' "

The Clock as a Straw Boss

I HAVE charge of a small machine shop where goods have to be pushed as much as possible in order to compete with larger firms," said a factory manager. "It is therefore necessary to see that the work is carried on at a good pace and that no time is lost on a job.

"Our work is of such a nature that quality has to be standard so that in urging the men to their best efforts, it is necessary very closely to inspect the output. Few men, even among those who rush their work, even watch to see how long it takes, but the habit is easily formed.

"Suppose a new man enters the shop, and he receives a bunch of fifty bearings to turn and bore; after he is fairly started, it is an easy matter to pass by his machine and ask him how long it takes to do one of the bearings. Ten chances to one he will not know, but a little later you may see him turning them out much faster.

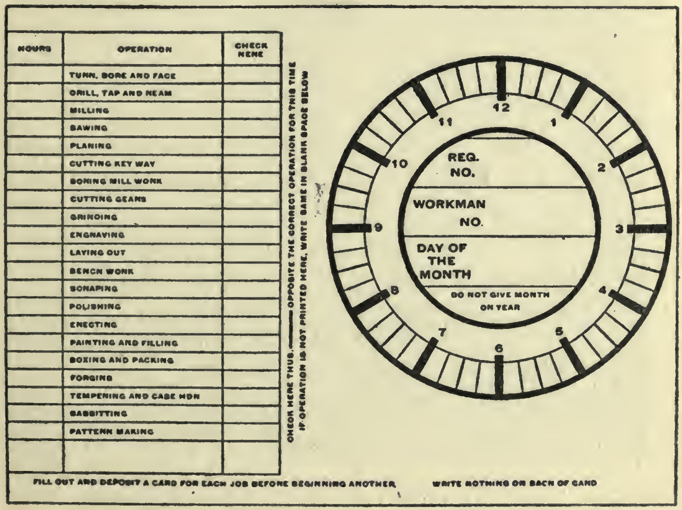
"If you call his attention to this, he will be sure to tell you that he gets one out every ten minutes, perhaps, but that if he had a little stiffer boring tool he could turn out the job considerably faster.

"In another instance, a workman will stop you when you are passing and ask whether certain bushings could be made a little shorter. If a quarter of an inch could come off of each one, they could be turned out considerably quicker. He knows this because he has been watching the clock. He knows it takes time to cut them, and he also remarks that the bushing is made of bronze, and that bronze costs money. His suggestions therefore not only save time but considerable metal, since the bushings are turned out in large quantities. He is a specialist—a consulting engineer—in his little department, and his words will often mean money to you."

Simple Time Card for Workmen

THE problem in most time cards made out by the individual workmen to keep check of the time spent on each job, is to minimize the amount of time necessary for making the record and to make the record itself so simple that any workman can handle it correctly. If a time card is complicated it will do more harm than good, for the workman may make many mistakes in entering up his record, and it is also very easy to make the time record so full that it swallows up precious time.

The time card shown in Form II is designed to meet these two problems. Its main feature is the clock face printed on it, by means of which the workman records his time.



Form II: A simple time card which materially diminishes clerical help in the factory

The workman makes out a new card for each job upon which he works. He fills in the requisite number or the quantity of pieces he is working on, enters his own number and date of month on the face of the clock in the "check here" column opposite the operation he performs upon the job.

Now suppose he begins work on this job at 7 o'clock in the morning and finishes it at 9:45; he simply draws a line with his pencil around the outside of the clock's face from the "7" mark to the "9:45" mark.

Eight years' use of time cards has proved that workmen are less liable to make mistakes if they simply have to mark their time out in this way than if they have to figure. Every one is familiar with the clock face. The workman when he begins his work glances at the face of his watch or the clock hanging in the shop, and need simply place a mark opposite the corresponding figure and space on the time card; he does the same thing when he finishes the job. It is almost mechanical; he need do no figuring, he need enter no figures—in a sprawling hand which the cost clerk may easily mistake; in fact, he need not even know how to write at all.

These cards are very quickly filled out; it takes less time to run a line around a circle than to enter two spaces of figures. Mistakes, too, are very rare.

The time cards for the preceding day's work come into the factory office every morning. Each job which is going through the office has an assembly card upon which is entered all the time put upon that job; every morning the number of hours spent upon each job the preceding day is entered upon that job's assembly card. As each operation, each job and each workman have separate cards, this posting is a very quick process,

Plate II: Life size drawings of machines bring out the niceties of design in the drafting room of the Newton Machine Tool Works. A blackboard drawing outfit does the trick (See Chapter V)

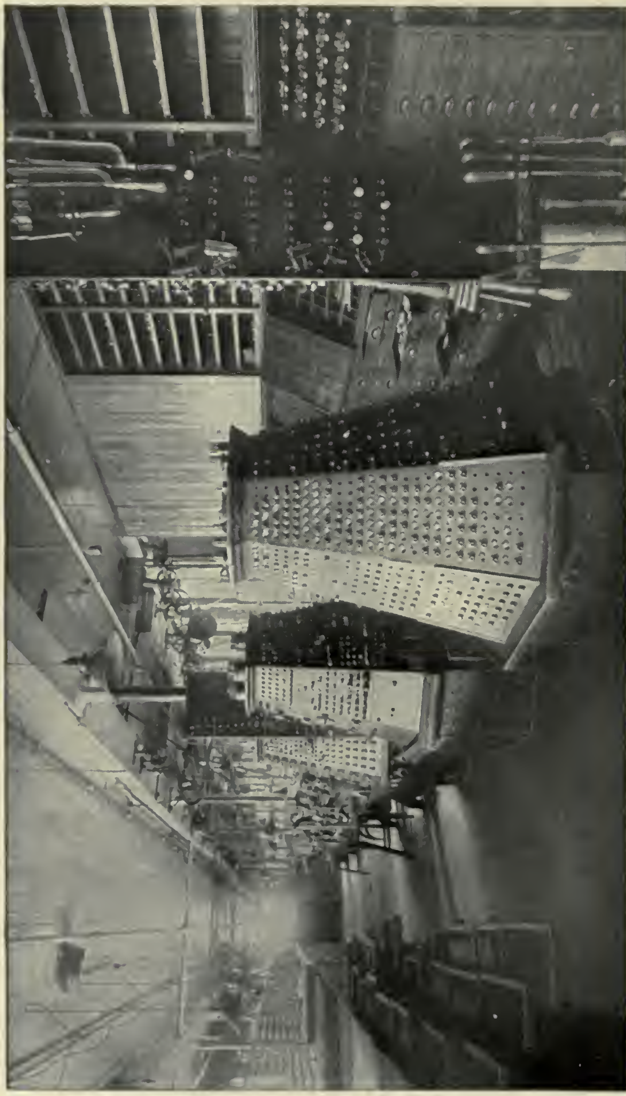


Plate III: A well ordered tool room is an index of a well managed shop. The tool room of the Waltham Watch Company, here shown is spacious without wasting space. Shelves, racks, cupboards and pigeonholes contain the various kinds of tools (See chapter V)

CHAPTER III

Wage Paying Systems

IN a big machine shop a certain piece of work had cost more than it should. The foreman was asked to explain.

"I was as economical as I could be," he said, "I put a two-dollar-a-day man on it." To which the superintendent replied, "Next time put a three-dollar man on it, just as an experiment, and let us see how it will come out then."

The results of the two jobs show the point. The first, the cheap man's work, figured as follows:

Forty-two hours machine work at 20 cents per hour	$ 8.40
Forty-two hours use of machine, rate 50 cents per hour	21.00
	$29.40

The second, the high-priced man, resulted as follows:

Twenty-seven and one-quarter hours work at 30 cents per hour.................	$ 8.17
Twenty-seven and one-quarter hours use of machine, rate 50 cents per hour.....	13.63
	$21.80

This shows a net gain of practically 33 per cent on the cost of the job. And that is not all. There was a saving of 14¾ hours in the use of the machine; in other words, the producing capacity of the machine was more than doubled. The fixed charges, or burden, remained the same, and does so whether machines are idle or producing useful work.

Machines are paid wages (in the form of interest on investment and depreciation) just as men. To get the highest efficiency out of machines is just as important as working men to their highest speed.

It is often, in fact nearly always, wise economy to employ labor of the necessary skill to permit every machine to turn out work to its fullest capacity, even if 50 per cent is added to the labor rate, as above. To have a ten thousand dollar machine "loafing" is as bad as to have the workmen taking things easy.

Wage Payment Plan That Brought Results

WE can't pay our workmen weekly without greatly increasing our clerical expense and shouldering an enlarged volume of detail."

"Yes we can. We can arrange a system which will allow us to handle the detail of weekly pay rolls just as easily, as carefully and as quickly as we now handle the rolls monthly. And the expense need be but very little more, it may even be less."

A conversation along this line took place some years ago between two officials in the scale manufacturing plant of E. and T. Fairbanks & Company at St. Johnsbury, Vermont, just before that corporation changed its manner of paying employees and adopted the rule of weekly payment of wages. This company was the first in that New England state to institute this plan.

The system which was evolved presents one distinct feature which may hold a suggestion for any manufacturing establishment or business house. In this plant, as is usual in any industry utilizing foundries in making its product, there are many men paid on the piecework basis and others by day wages. Those in the former class list the number of pieces they produce daily on sheets provided for the purpose, and these sheets, when checked and approved by the foreman, pass to the pay clerks. This system is found in many foundries and other plants.

However, the day-wage division holds a feature all its own. The brass check is the basis of time-keeping here. Each workman, as he enters the shops in the morning, secures at the time office the brass check bearing his factory number. He proceeds to his department, hangs his check on its proper hook in the glass-covered case fixed on the wall, and, at the blowing of the whistle, the foreman of that department locks the case. The worker gets his check at the noon hour, hangs it up again after lunch, secures it at closing time and leaves it in the time office as he goes to his home with the day's work ended. Thus, a constant tab is kept on each man. No employee, arriving late at any time, can get his check in the case and secure credit for his work without applying to the foreman, who holds the case key.

And here the time-saving feature enters. Recourse is had to a card system. Each card—a facsimile is shown in Form I—bears the workman's name and his factory number. The number of hours he works is punched in the card at the proper place at the close of each day. If there are fifteen, or twenty, or more men in his department who have worked nine hours, or full time, on that particular day, all the cards checking their time may be punched at once with a single pressure of the punching tool.

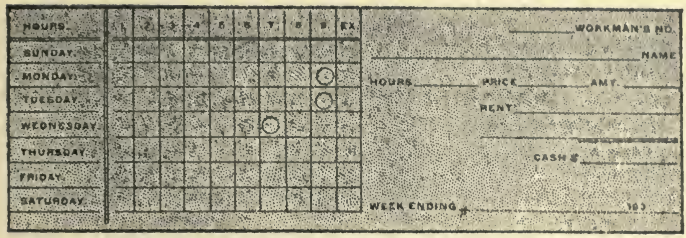
The punch marks are of varied shape, each department being designated by its own peculiar design. Thus cards listing workmen employed in one branch have crosses punched in the hour squares, another department has a star; another working division, a square; a fourth, a circle, and so on. If a workman is late he must wait until the clock marks the ensuing hour before he is allowed to go to his lathe or his bench. Thus, there are no fractions of hours to bother with or to create detail.

With these cards punched in the time office each day —foremen, too, reporting each man who failed to serve full time or who was absent from duty—the pay to which each workman is entitled at the week's end is quickly and accurately calculated. The total number of hours, as punched, is entered on the body of the card, together with the rate of wage per hour and the total wages due the workmen concerned for the week. Provided he lives in one of the houses which the company has constructed for his convenience, the rent item is entered on the card at the proper time for deduction from his total earnings. In this way a constant, accurate, lasting record is at hand every seven days of each man's hours of work and amount of pay. Detail, too, is reduced in great degree.

Determining Piece Prices Accurately

VERY often piece prices on a new article are named by the foreman of the department in which the operation is done. A workman runs through a lot of day work, and, from the time it takes, the prices to be paid are computed.

This price is not reduced every time a lot goes through, even though the men make more than they would at day



Form I: In this time card the foreman punches a hole to show the number of hours put in by each man each day

work. They expect to make more, they work harder in order to accomplish that end, and if the practice is to cut the price every time a man makes a good day's pay the men get discouraged and quit. In making the price, a figure is named which the firm can afford to pay, and then it is left alone, leaving something for the men to work for.

Slashing piece prices or reducing wages is a confession of weakness on the part of a foreman who indulges in these practices. Cutting out unnecessary operations or combining two or more which have been done singly is a proof of efficiency and can often be done with absolute gain to firm, workman and buyer.

To illustrate, a factory was putting out small bench vises, and the handles for these were made of five-sixteenths round cold-drawn steel. This was cut in an automatic screw machine, which knurled both ends of the piece. The balls were made in another screw machine, and were riveted onto the handle.

The machine shop foreman conceived the idea of buying the handles with one end formed, simply a bright round head or ball rivet. A die was made for the punch press, and, after the vise was finished, one blow rounded the other end of the handle and the job was done. Four operations gave a better appearing and no less service-able job when finished, and the cost was cut square in two.

"The fat mouse forgets he ever was thin," and men who have come up from the ranks to the position of foremen should think twice before beginning to build a reputation by reducing wages and cutting prices, as many of them are doing. Better results are possible by following more up-to-date methods.

Gearing Up the Working Force

IT does not take a big plant and a carefully worked out organization to make use of some of the economies that go under big names," said a small manufacturer.

"I have a small tailoring factory, employing on an average only a dozen people, and I am using with very good success, what the experts call the 'bonus system.' Only I don't think of it as a bonus system; I just call it 'pushing.'

"I figured out, by keeping private records over a period of several months, about what the average worker could do on each process. This was not what they did under forced pressure, but what the average output of the good workers was, under ordinary conditions. To this amount, I then added 10 per cent., thus fixing a standard of efficiency for the shop.

"Then one pay-day I gave each employee a note in which I stated his average day's work. I agreed that any worker who turned out at least this amount each day would receive a bonus of what amounted to 8 per cent of his week's pay.

"I was surprised at the results. Of course every worker will not try to work up to the maximum, but it geared up the force and increased the output tremendously.

Besides, the proposition had the effect of bringing the workers to the shop and keeping them steadily at their work, as they could not afford to waste any time if they wished to win their bonus. And the increased output from the same equipment reduced the fixed charges many times over the few dollars expended."

Reducing Non-productive Labor

A LARGE blacksmith shop has cleverly solved the problem of keeping the workmen supplied with jobs without loss of time to the pieceworker.

Near each shear or cut-off in the shop is a push button connected with an indicator in the department office. A few minutes before the shear man is through with a job, he pushes a button, which indicates to the storekeeper that shear No. 12, for example, will soon be ready for stock for another job.

The shop is run by schedule, and the department orders are on file in the office in their proper procedure. From this job file, the storekeeper takes from pigeonhole No. 12, the operation card which indicates the next job for machine No. 12. The stockkeeper makes from this operation card a memo order in duplicate on his iron house for the number of bars required to make the parts.

Then he puts the operation card back in the workman's job file so that it will be ready to go to him with the stock. The storekeeper then pushes a second button, which calls the man who has charge of the iron house. To him is given the original memo order, and he delivers the material to shear No. 12, in ample time to keep the workman busy, and prevent any loss of time on the shear. A great deal of time is saved in this manner. Usually the shear man handles many parts in a day, and, in a number of shops, by the use of push buttons one machine's time could probably be saved. The scheme avoids much confusion and greatly assists both the storekeeper and iron house man.

A Simple System for Finding Costs

TO find the cost of an article, it is necessary to know the amount of material that goes into it, the amount of productive labor that is put into it, and the percentage of all the general expense of running the business that should be charged to it.

Every article or job should be made out on order. An order blank may be made out, which tells the number of the article to be made and gives specifications and instructions regarding the making. Space is provided for entering the amount of material to be used. This should be entered by the foreman when he gets the material from the storeroom.

For the productive labor, a separate time slip may be kept by each workman, on which he enters the amount of time he puts on each job. When these time slips come into the factory office, they are entered on the reverse of the shop order.

When the job is completed the shop order is returned to the office, where the cost of the material is figured out. The time costs and the expense of material are then totalled.

Worse Than Wasted

BLACK smoke is unconsumed carbon—nascent heat—lost energy—wasted coal. A smoking chimney registers money lost.

CHAPTER IV

Efficiency Producers

A CERTAIN blacksmith's shop formerly required ten men at $1.50 per day to remove materials from machine to machine. The foreman in this plant thought the matter over, and now only four truckers are required, and these men are paid $2.00 a day.

No material is to be seen lying on the floor in this shop. Everything is kept in trucks so that it can be moved at once without unnecessary handling. It is this elimination of unnecessary handling which has enabled the non-productive labor in this case to be cut from $15.00 to $8.00 per day.

The method evolved for handling material at one machine, a punch press, will serve as an example. The sketch indicates the arrangement for all trucks at this machine. When the trucker brings a loaded truck it is placed in the position indicated at 1. The machine tender takes the pieces from truck 1, passes them through the press and throws them, not on the ground, but in truck 2. Truck 2 is then wheeled by the trucker to the next machine. (See Figure I.)

The other plant where the system of trucking has been studied is a textile mill. The manager noticed, as did the foreman in the blacksmith's shop, that much

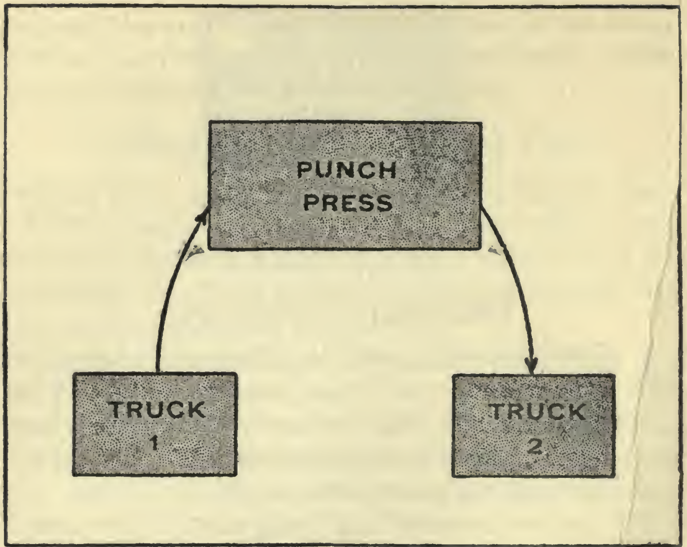


Figure I: One foreman saved six truckers by arranging the course of work and trucks as shown here

time was lost in transferring materials from the floor to the truck when the garments might just as well be placed in the truck in the first place. Several trucks were then built which would hold several gross of garments. The storeroom boy in carting the materials from the workroom to the storeroom simply exchanged a loaded for an empty truck.

Getting in Quick Touch with Executives

BRIDGE time—that is one of the two or three constants of the business world. Get messages, material, men, to the point of demand as quickly as modern inventions will carry them.

A great manufacturing plant in Northern Illinois covers 300 acres and employs 7,000 men. Its executives are all practical men. Therefore they are often wanted for advice or commands. A wire gearing becomes tangled in a mill. The chief electrician is wanted to repair it—and wanted quick; every minute idle means tens of dollars lost.

The plant is big; he may be in any of a hundred buildings or works of the three hundred acres. The foreman of the department where the break has occurred, telephones to the electric station, "Send the electrician here to mill No. 6, quick—break."

The engineer in the electric station pulls his whistle two shorts. It is the chief electrician's signal. And wherever he may be—in a mill overseeing construction, in the laboratory experimenting, in the superintendent's office consulting—he hears it.

Immediately he telephones from the nearest point.

"What's wanted?" he asks.

"Break in mill No. 6. Rush over."

In a moment he is there. The trouble is discovered and, under his able direction, soon fixed.

So the system operates throughout the plant. Every executive has his whistle signal distinguished by sound and action. Every general condition—fire, for instance—has its signal. In each mill there is a whistle code by which communication is had; every important workman has a whistle rope at his elbow.

Minutes and money are saved.

Time is bridged.

Supervision Basis of Cost Economy

SOME people seem to have the idea that if there is a system in a factory, the system will run itself. They do not realize that it takes just as good men to run the system, and discover the flaws which are continually pushing themselves into prominence, as it does to operate the factory itself. And, if it takes a capable man to keep a system going straight, it would seem as if it would require something better than the average ten-a-week man to handle the minor parts. Such a man may be, in fact is, satisfactory with close supervision of some much more capable person, but leave him alone and he will surely swamp himself.

Take, for instance, an ordinary cost-system in a factory producing small piece-work. Consider an ordinary time-keeper, who is obliged to weigh out all material leaving his department, and issue transfer slips giving the order number, condition, and number of pieces, this transfer ticket merely identifying the material for the people handling it in the next operation. If he makes out the time tickets for the man who has just finished a batch of goods in question, during the day (and more often he lets the man fill out his own time ticket) he usually takes the man's word for the number of pieces finished.

The result is, that if the workman is dishonest, he sees a good chance to boost his way, which he does by reporting a fictitious number of pieces completed.

The pieces then go through several departments where perhaps the same thing is repeated occasionally, and finally are assembled and shipped. As a check on the first time-keeper the time-tickets and transfers are checked by another cheap (?) man, who, the same as the average time-keeper, "does not see what's the use of all this weighing up and having so many tickets, etc.," and may report any discrepancy between transfers and time-tickets, but more often will not.

Now, what is the remedy? If you are operating a system, it does not at all matter whether for factory cost or a water-works, select a point from which you can watch and check the leaks, and at that point place a man of exceptional ability, one in whom you can trust.

How Electric Fans Increased Output

A STARTLING proof of the effect of working conditions on output was recently made in a certain factory.

The factory employs chiefly girls, who work on sewing machines. While the work rooms are large and light, necessarily there are many employees in each room, and the work holds them pretty strictly to their machines.

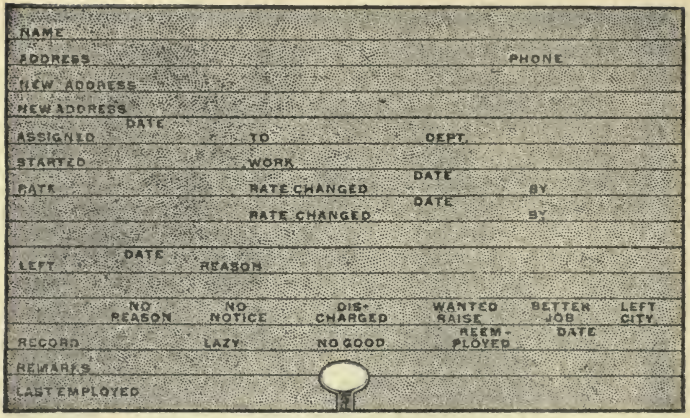
At the beginning of summer, when the hot weather came on, a proposition was made to install fans all through the factory. Some of the directors objected to the expense, which would necessarily be large. The manager of the factory contended that it would not be an expense, but a saving.

And he proved his contention. First, he kept track of the output of one room. Then the fans were installed in that room, and for the next ten days the output was again recorded. When the returns were in and the outputs of the two periods were reduced to exactly co-ordinate terms, it was found that the output was increased in the second period by sixteen per cent.

Even the manager was surprised. It has made him certain that good working surroundings are not charity, but good business. They pay.

A Card Record History of Employees

ANY firm with a large number of employees on its pay roll knows the desirability of having in some definite and concise form a brief personal record for each individual employed. Although few employers go to the extent of having a separate card for each person, this is


NAME
ADDRESS PHONE
NEW ADDRESS
NEW ADDRESS
DATE ASSIGNED TO DEPT.
STARTED WORK
RATE RATE CHANGED DATE BY
RATE CHANGED DATE BY
LEFT DATE REASON
NO REASON NO NOTICE DIS-CHARGED WANTED RAISE BETTER JOB LEFT CITY
RECORD LAZY NO GOOD REEM-PLOYED DATE
REMARKS
LAST EMPLOYED

Form I: How one factory keeps permanent record of employees, with least clerical labo

unquestionably the best system for handling the record. A 3x5 card with a printed outline, such as is shown in Form I, will answer every ordinary purpose, and when filed alphabetically under the name of the individual will be found very convenient for reference purposes. The form may be varied slightly to suit the particular requirements of the company, but usually it will be sufficient to show the name and residence address of the employee, his age, whether single or married, his habits, character and references. Following this should be an employment record, giving the date hired and wages paid. When wages are changed, note is made of this on the card together with date of change. If the person leaves the employ of the firm, the date and reason are noted on the card. Records of employees who leave the firm should not be destroyed, but should be placed in a separate file, where they will prove very valuable for reference in case the same person later applies for a position.

Part II

GEARING UP PRODUCTION

Make for the Making's Sake

QUALITY. The word oftenest on the lips of the man who sells things. The "open sesame" in the world of competition.

Study the successful factories. They are built on the idea that quality in goods is the fundamental of permanent business. Even dealers in makeshifts pay oblique homage to this basic virtue they cry quality until found out.

The passion to manufacture and sell the best has inspired every big figure in industry. These men reach giant's stature because for once creative impulse and hard commercial sense pointed the same goal.

For "make for the making's sake" is the industrial first commandment. To cut costs, to improve processes, to get an increasingly finer product from unchanging new materials; to give to customers the benefit of every automatic machine—this is good business as well as the only man's game left worth playing.

The prize is quality.

Quality begets success. More—it is success.

CHAPTER V

Reducing Costs by Studying Machines

ONE of the difficulties, often highly important, to be overcome in the designing of machine tools, is that of determining the suitability of proportions and outlines. Scale drawings are notoriously unsatisfactory in this respect; but full size drawings are, of course, out of the question for any but small—very small—machines and the like. Often a designer is quite misled into thinking a part well adapted to its use, as its proportions are shown in the scale drawing, only to find, after erection, that important or desirable changes could have been made, had he been able to see a full size plan.

In order to make this possible, there has been placed in the drafting rooms of the Newton Machine Tool Works, Philadelphia, a mammoth blackboard, covering most of one side of the room. On this, the designer lays out the principal lines and dimensions of his machine, using the floor as the base line. Minor details, of course, are omitted, except as it is desirable to show them for purposes of comparison, or to get an idea of their full size relations to the other parts.

Such a full size drawing makes it possible for the designer to work out to much greater advantage than usual the location of parts and operating levers so as

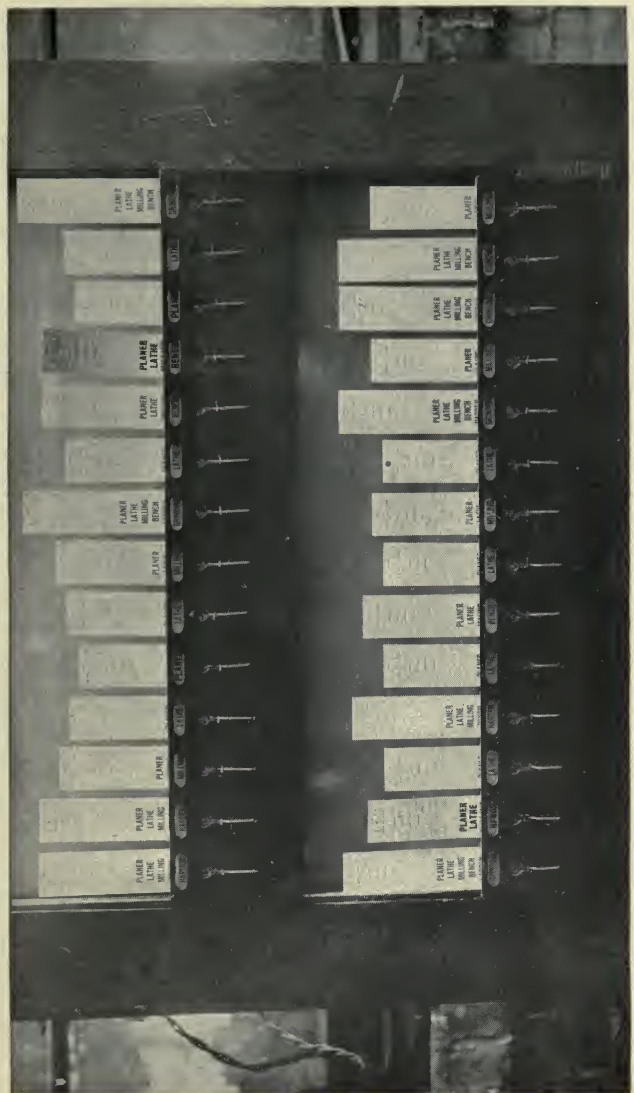


Plate IV: Orders for machines in progress are tabbed at the Gisholt Machine Company's plant by an ingenious card rack here shown. The cards slide vertically and register the location of each job in the shop graphically on both sides of the glass door (See chapter VIII)

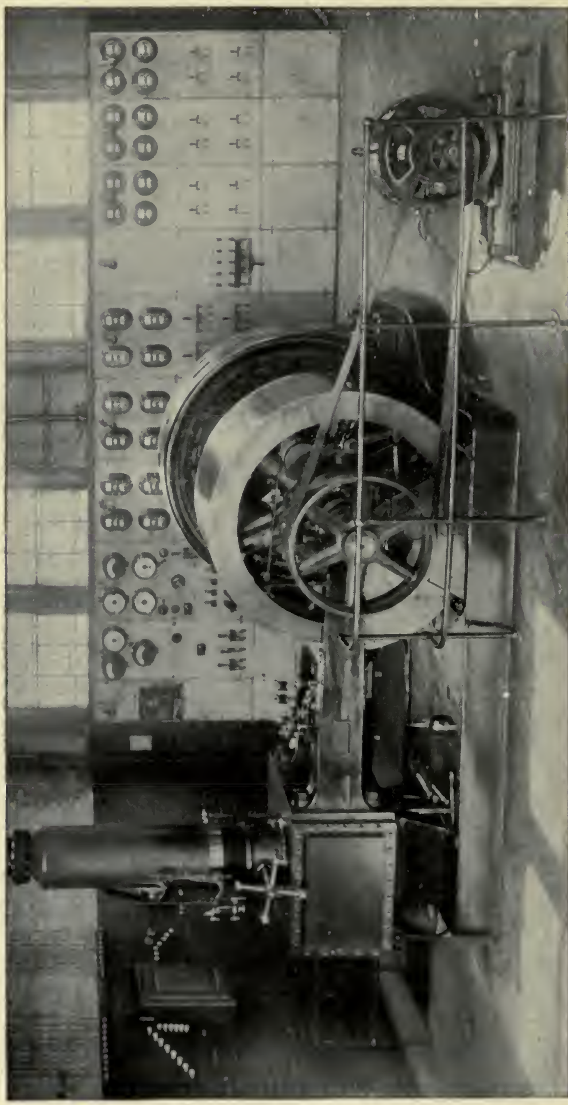


Plate V: Electric power in the factory permits department power consumption to be measured accurately. Meters on this switchboard at the H. H. Franklin Company's Syracuse plant enable departmental costs to be accurately apportioned (See chapter VIII) to make them most convenient for the operator. Standing beside such a drawing, the draftsman gets almost as good an idea of the machine as though standing by the completed tool. (See Plate II.)

The blackboard is sixteen feet high and thirty-two feet long, and is made of smooth boards so put together as to prevent it from warping or otherwise getting out of shape. The surface is covered with rubber blackboard cloth carefully and smoothly stretched. The board is provided with two horizontal straight edges, their ends attached to cords in such a way as to keep them always parallel. There are counterbalances to keep the straight edges in place. From the straight edges hang T squares. It is seen, therefore, that the board is provided with all the customary lining appliances ordinarily used with small drafting boards so that the same operations are readily performed.

This board is so large that it is necessary to use a ladder in drawing upon its upper portions. For this purpose a traveling step ladder is used, mounted on rollers at the floor end, and suspended from a track above. It runs so smoothly that the draftsman can push it along easily without dismounting.

A suggested improvement would be an adjustable seat for the ladder. Standing and balancing one's self in doing this work must be rather tedious and tiring; and a comfortable seat would apparently be a desirable addition to the equipment.

Saving Time in Grinding Tools

ONE of the greatest sources of loss of machinists' time and consequent idleness of expensive machines is the time spent in grinding tools. Machinists are apt to be finicky about the way they want their tools ground.

When a grinding department is established they complain that the tools are not adapted to the work.

Several shops have lessened their tool grinding troubles by having the grinding expert himself go from machine to machine; see that every machine has its full quota of proper tools, and that the men use them properly. This is much better than caging up the grinder far away from the machinists and arguing vociferously at long range. The frontispiece illustrates one way in which economy may easily be exercised both as to breakage and tool efficiency, with regard to drill grinding.

In machine shops where large pieces are handled, clamps and bolts are usually kept near the machines. Instead of allowing these to lie on the floor, it is best to provide large open-front boxes on the order of large pigeonholes for keeping these appliances in order and ready at hand.

The appliances themselves should be painted a bright color, such as red or blue. This catches the eye quickly and helps in locating the pieces and in keeping them where they belong.

Using the Trucking Force

A WELL arranged group of machines has other advantages than those gained by the saving of power. It is easier to handle raw and finished parts. Well defined aisles make it possible to organize the trucking force and cut out non-productive labor.

In one shop the manager has arranged the work so that the truckmen have a regular schedule on their respective floors. The elevator men form a part of the trucking force and handle all material between floors. This makes it possible to do the same amount of work with one-half the force formerly needed to handle the parts. The time lost when the truckmen rode on the elevator is saved.

Team System for Cleaning Machinery

THE old method of shutting down a factory or mill on Saturday to give workmen a chance to clean and overhaul the machinery means the loss of considerable valuable time that can scarcely be afforded in these days of close competition. Economy in this part of the factory work is as necessary as it is in any other, especially where the business requires that every machine possible be kept busy. Present day conditions must be met in every branch of industrial work, and this means that the cleaning of machinery must be accomplished expeditiously to help meet these conditions. The following system for keeping the machinery of a plant in good condition has been put into use with success in a big knitting factory, and it meets today's demands fully. If adopted, it will be found a money-saver in almost any kind of a factory.

This method of cleaning machinery allows the factory or mill to run without interruption. Only one or two machines in the whole works are stopped at a time. The cleaning is done by a specially designated team of helpers, generally consisting of two or three employees of the plant. These "cleaners," as they are called, spend the greater share of their time going from one department to another, overhauling one or two machines at a time. The man working on the machine in process of cleaning generally expedites the cleaning by lending his assistance on the job. Thus in a few moments an intricate piece of machinery may be put in shape and oiled for another week's work. In the case of a large plant, two or three teams might be employed at this cleaning work. On the other hand, if the mill is a small one, the team could be put on other jobs during light days, or they could be kept in readiness to substitute for other employees who might be taken ill. This matter could be easily regulated.

The men whose duty it is to keep the machinery clean and in good working order are able to do the work quicker than the other mill hands, under the old system doing it only once a week. For this reason, together with the fact that only one or two machines are stopped at a time, or in large mills at the most two or three, this plan of cleaning is found to be of great benefit to quality of product and life of machines. Worn out parts of machines, stuffed oil holes and other defects are sooner discovered and attended to.

Under old conditions the factory machine shop usually is rushed with work on Saturdays, and on other days work is likely to be slack. With the system here described, the work of repair is more evenly distributed over the whole week, reducing expenses throughout.

With more timely attention to cleaning, oiling and proper setting of machines, breakdowns happen less frequently, and if a machine is unexpectedly stopped for repairs, the team for cleaning tackles that machine first, instead of some other, and, unless the work on repair lasts long, there is actually no time lost on account of repairs.

Getting the Most Out of Machines

THE proportion of time that a machine is actually doing productive work is an item which it is very desirable to know. Absolute knowledge on this point enables one to know what the hourly rate is, which must be added to the man's rate; whether or not it is necessary to buy additional machines, and whether equipment and power are being wasted.

A device is now being used for recording by lines and blanks through electrical contact the actual record of the running of a machine, the recorder being placed at a central location, such as the superintendent's or manager's office. This system has shown a Cincinnati shop manufacturing lathes that many of their machines are running only 40 per cent of the time, and that they have been able to correct this to 80 per cent. This, too, in a shop which has already largely increased its productivity by the introduction some years ago of the premium wage system, and which is considered to be one of the finest shops in the country.

Saving Time in Handling Work

HOW much time will a workman save when he knows where to reach for his raw material and just where to put the finished product? How far does he have to go to get materials with which to work? And what is the saving in material in properly handling partly finished work? These are questions of importance to be considered in every manufacturing plant.

Although no factory manager can state definitely just how much time and material is saved, all know that it is considerable. Yet the majority of machine-tool workers have material piled up under foot or partly finished thrown carelessly together in a heap. There are several ways of caring for this detail—methods by which the shop will be made cleaner, the work better, and the cost of production less. Shelving the length of a room back of a row of machines is excellent. When parts come to the operator they are placed in the top tier of shelves—usually only one deep, so that they do not rest on each other. The operator places his finished parts in the lower tier in the same fashion.

This plan of handling small parts in process of construction is especially effective in shops where carriers are employed to distribute and gather up material and parts, since the operator and carrier can work without interference and no mistakes can be made. The shelves can be built any desired depth or height to fit different pieces and classes of work. When a workman is busied at a machine and has no bench, these shelves can be provided in the form of a cabinet or a portable table. Tools and work can then be kept neatly together. Another system of shelving, useful in storing small parts, works in well where the carrier system has been adopted.

This type of shelving has an advantage also in being fire-proof and practically indestructible. Metal only is used in its construction, and the complete affair can be built up from sheet iron and piping which has outlived its usefulness for carrying steam or water. The rack is made by slipping iron rings over the vertical pipes, passing iron rods through a hole in the ring, and when the spacing is right, one set screw clamps the whole. The sheet iron shelving is sprung into place. Because it is made half-round in cross-section, this sheet iron shelving is easily kept clean, and small parts can be removed without fumbling in corners. Plate III shows a neat and workman-like tool arrangement.

Saving Duplicate Machinery

ON a recent trip through one of the mills of a leading cement company, I saw a unique application of the motor-drive to rotary kilns, which, with modifications, can be adapted to a great variety of machinery. In making cement, after all the ingredients have been crushed and mixed they are calcined in long rotary kilns. The fuel is pulverized coal, which is lighted at the mouth of the kiln and carried through the mass by a blast furnished by a rotary fan. In this particular mill there is a battery of a dozen or more kilns in operation, each with an individual motor-driven blast fan.

All kilns, after having been put in operation have to be worked continuously, day and night. If a kiln stops, not only is all the material which it contains at that time lost, but it is necessary to wait thirty-six hours until the kiln becomes cool enough to remove the spoiled material and prepare it for another run.

The kiln itself revolves at a slow speed, so that there is very little wear, but the fans and motor which run at high speed are apt to require repairs at intervals.

Back of the row of blowers runs a truck carrying a small platform car, and this car is made an auxiliary to the fan and motor. When, at any time, it is found necessary to disconnect the regular equipment, this truck is run out opposite that particular kiln; its discharge pipe is coupled to the Y pipe in the main pipe and the auxiliary blower is started. In this way not only is that particular batch of cement saved, but there is no time lost in recharging the kiln. It is moreover unnecessary to supply a double motor equipment with each kiln, since the single motor run on trucks forms a flexible auxiliary equipment.

Reducing Pattern Shop Breakage

TELPHER systems are valuable adjuncts to a complete system of interfactory communication. This method of transferring material quickly is particularly applicable in the pattern and storage departments. Delicate patterns can be transported safely by this means, since the amount of handling is minimized and there is no liability of heavy parts being placed upon the patterns, as is the case when the transfer is made by trucks or cars.

In practical work, compressed air and electricity are the principal motive powers for cranes and hoists. Until recently direct current electric motors only were available for hoist purposes, and provision had to be made for a supply of direct current electricity.

On account of the saving in transmission, the adoption of alternating current for machine shop work is becoming more and more frequent.

With the increasing use of alternating current for other classes of power-service, however, an alternating current crane motor has been developed, so that cranes can now be operated on the alternating current circuit. This does away with the need for transforming from alternating to direct current and saves considerable initial investment in rotary converters and transformers when the main supply is delivered as alternating current.

A Labor Saving Pattern Bench

A GOOD mechanic never complains of his tools." Perhaps it is for that reason that many mechanics work under difficulties and, therefore, inefficiently. The best arrangement of good tools is conducive to the greatest economy of output.

A pattern bench designed primarily as part of the re-equipped pattern shops of the Worcester Polytechnic Institute is adaptable as well to commercial pattern making on a large scale. The bench was built at the Institute shops, and its design was settled upon only after practical tests of its adaptability had been made.

Two strong points in this bench are the vise and the lighting arrangement. Under ordinary conditions, a pattern maker works at a disadvantage with his vise. Either he has to sit down to work and can only get at one side of the job, easily, or he has to stand and stoop over the piece upon which he is busied.

Both these difficulties are overcome in this bench. The cast iron leg which supports the maple bench top has a grooved projection in which the fixed jaw of the vise is held by a bolt and hand-nut. This bolt slides vertically in a slot and can be secured where desired. For keeping the jaws parallel the crossed pivoted strips—the lazy-tongs parallel motion device—are fitted between the jaws. In this way the vise is nearly as quick acting as the trade scheme used for this purpose. Good light, where needed, is supplied by an ingenious electric fixture. The wiring is all placed on the ceiling of the room below, and the lamp is wired through a flexible pipe connection so that the light is available where wanted and the air is free from lamp cords and swinging shades, always in the way.

A Quick Method of Soldering

A MANUFACTURER of oil lanterns recently adopted electric soldering irons to do the work for which he had formerly used a gas-heated iron. By this means he reduced the leaky cans from five per cent to one-half per cent.

It was found that with a flame or coal-heated iron, the workman was constantly tempted to use the soldering point when it was too cool to do good work. With the electric iron, the soldering copper was held constantly at the proper temperature and good work assured. With the electric method, too, it was unnecessary for a workman to exchange irons, so that five per cent gain in output was possible.

In making use of electricity for any heating work—glue-pots, flat-irons or branding irons—certain points should be observed if good results are to be obtained. An electrically heated device has a certain amount of energy put into it at a certain rate. If the work required of the iron is too rapid for the rate of input, cold irons and poor soldering will result. If, on the other hand, an iron which is designed for heavy, continuous work is allowed to stand with the current flowing into it, the heat energy is not dissipated rapidly enough from the surface of the iron, and the solder is burned off.

These characteristics of electrically heated devices make necessary some engineering judgment in their selection. With proper investigation, however, many time-saving devices may be employed. A recent law in New Jersey demanded the stamping of butterine tubs with the name of their contents. One manufacturer started in by heating each letter in a coal fire and applying it in order to form the name. An electric butterine branding iron does the work in a fraction of the time.

Look Ahead

THE manager of every factory—whether he makes steam rollers or shoes—must run his plant by a plan. To figure costs closely, each future step between buying the raw material and selling the finished product must be definitely marked. *Robert Daily*

CHAPTER VI

Handling Material Economically

A SALESMAN was talking one day with the manager of a horse blanket factory. As they sat in his office, a man came in who was selling harness buckles at a very low price. The manager at once became interested and called in his foreman to find out what they paid for these buckles.

When the foreman saw the goods the man had to offer he pronounced them nearly as good as those which he was already using, and offered the man a little less than the wholesale price which he had been paying. The man agreed with alacrity and the sale was effected without more words.

When the foreman left the room, the manager of the plant asked the man where he got the buckles and his reply opened the manager's eyes to the waste which had been going on steadily in the factory without his knowledge.

"You know," said the bargainer, "that your foreman gives the sweepings of the factory to my brother, and I look them over and sort out anything of value which I find. I found those buckles scattered through the sweepings from time to time, and saved them up until I had a quantity worth selling."

Buying the same material twice is an apparent blunder; handling it twice may be as real an error.

Cheapening the Cost of Raw Material

IN many lines of manufacture, the source of raw materials each year grows farther from the factory. This is particularly true in wood-working plants of all kinds. Shops which formerly found a source of supply in forests at reasonable distances from their incoming platforms, are shipping unfinished stock from longer and longer distances. The wood near most manufacturing centers, particularly in the East, was long ago stripped from the hills, and the rivers which next served to float the logs down to the mills from wooded sections at more distant points, are each spring having a shorter "high-water" season, during which the output of the winter logging camps can be floated. Forestry is striving to remedy the results of the reckless use of natural resources which has led to these conditions; but reforestation is necessarily slow, and meanwhile raw material must be obtained from long distances by rail. Freight rates, as a consequence, form a most important item in the cost of the stuff that goes to make up the product.

To cheapen the cost of production several methods are in operation. Manufacturers band together in a common cause and seek some source of supply which can be developed economically. Different methods of construction, too, are being adopted more and more, in an attempt to reduce the amount of costly wood in a piece. In this connection built-up parts and veneers are being generally substituted for solid woods.

A third way of solving the problem is that of carrying the process of manufacture to a certain point in a separate plant located at the base of raw material supplies, and shipping the less bulky partly finished product to the old plant, where the material is worked up into form and from which distribution of the finished product is made. This method has been very satisfactorily worked out by a large basket manufacturer in the East. Among the products of his company is a line of cylindrical containing drums built up with veneers. Formerly the logs from which the veneer was peeled were delivered at the factory. As the distance from which the logs had to come grew greater, however, the freight charges on the raw material gradually assumed prohibitive proportions.

Consequently a large tract of timber land was purchased several hundred miles from the basket shops, and at this point a steam saw and veneer mill was established to work up the logs into veneer directly on the ground. In this form raw material is shipped to the mill. Since the thin, flat veneer will pack closer and is easier to handle than the logs, the freight charges have been reduced to such a point that the plant not only pays for itself, but makes the raw material considerably cheaper. Moreover, the material is of a better quality, since the selective process can be carried further in choosing the logs. The concern is also independent of outside raw material sources and can regulate supply and demand to meet conditions of trade as it fluctuates with the seasons.

Making Non-productive Time Productive

THE machine operator who is tooling heavy parts should have plenty of room, and should have his work arranged around him systematically. In a large western machine shop the lathes are ranged along the entire side of a room, but on both sides of the machines are broad aisles. The parts on which an operator is to work are always deposited on his right; he places the finished parts on his left.

These heavy pieces are brought on trucks. By this system the trucker runs down the right side, depositing his load; he comes back up the left side, taking on all the parts he finds. Confusion and mistakes are avoided.

A Supplies Patrol That Economized Time

A RAILROAD shop in the West has a very complete annunciator board in the tool room. A workman pushes a button and a boy goes out to get instruction. It may be a new file or any other needful tool that is required. Perhaps the lathe or planer tools or milling cutter needs sharpening.

This shop has established standards for the angle of lathe and planer tools. The room is equipped with a grinder that is far and away ahead of the old grindstone of funereal pace, remembered only as a good excuse for gossip and delays. The new grinder gospel backs up its doctrines with devices and diagrams ensuring the repetition of such forms to the cutting tools as the best available experience has there determined. No more waits. The machinery and the men have longer spells of combined action.

Another shop does not depend so much on the messenger system. Here there is a signal scheme. A strip of board attached to the nearest post arrests the attention of the patrol who takes a hand in tightening a belt, supplying oil or a bunch of waste or wipe cloth or whatever may be needed.

These strips of board projecting from the posts, can be seen at a considerable distance and, as many of the supplies are indicated by the particular signal, the double trip of the other system—the messenger and the push button—is cut to a single journey in most cases.

Facts as a Basis for Buying Cheaply

WHILE much depends on the business sense and personal equation of the buyer in the purchasing department, the basis of his judgment is dependent primarily on efficient stock keeping and proper testing. The buyer must keep his fingers, too, on the pulse of the market. Trade journals and periodicals should be systematically read to give the general tone of trade conditions, and much can be learned from the buyer's other half—the seller—who is a traveling directory of business conditions. A good buyer, with a keen knowledge of men, can profit materially from his daily interview with the salesmen he meets.

Handling Cotton Waste Economically

IN nearly all machine shops, factories and manufacturing plants, the cost of consumable supplies, such as waste and oil, becomes a matter of considerable importance, however economical may be the methods by which they may be purchased, stored, issued and accounted for.

The successful and economical handling of this matter depends on three factors: first, the purchase of the necessary supplies; second, the proper method of storing them; third, their economical distribution or issue.

The following system, where it is strictly adhered to, will save much time and expense in any large factory, and will, moreover, instil into the minds of employees the necessity of economy in using material.

The handling of cotton waste (or such other material) offers an illustration of the methods to be used, but there is hardly any substitute for cotton waste in cleaning high grade machinery, and a great many concerns who have experimented with substitutes have given them up after a short trial and gone back to the more expensive waste. The material used for the purpose of cleaning work and machines should have good absorbent qualities and be convenient to handle. If cotton waste, it should have sufficient adhesive qualities to prevent short fibres or masses of lint from becoming loosened from the mass; and it should have been disinfected.

There are various grades of white and colored waste, of long and short fibre, some of sufficiently long fibre to last through several washings or other cleaning processes, and others of such short and broken fibre as to be scarcely better than "shoddy." Quite naturally, the price varies as much as the quality; it runs all the way from three and three-quarters cents for the cheapest colored to six and three-quarters cents a pound for the best grade, and for white waste from eight to fifteen cents per pound. In practice it will not be found economical to purchase the cheaper qualities except for large and coarse work, where quantities of waste may be used. The best colored waste at six and three-quarter cents per pound is liable to contain small, sharp bits of metal or short pointed wires that find their way into it from the machinery used in its preparation. These are very exasperating to the employees, and there is always the danger of small punctures of the hands that may result in blood poisoning. Colored waste has usually much less of the absorbent qualities than white waste.

The supply of waste has been so reduced by utilization of short lengths of yarn for other purposes that various substitutes are on the market. These consist principally of washed pieces of white and colored cotton

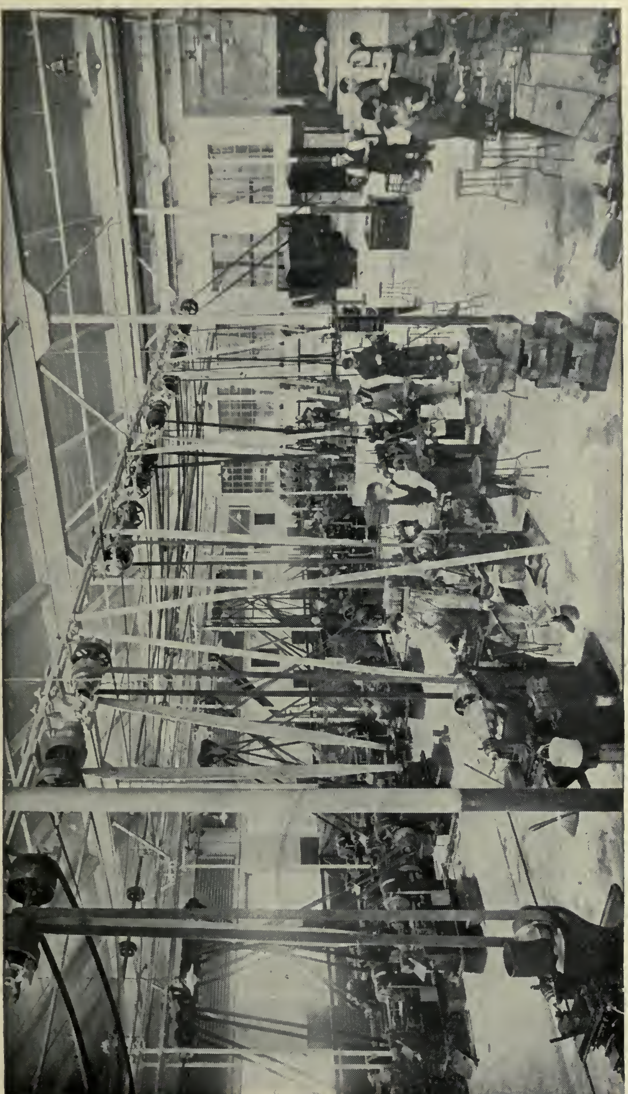


Plate VI: Shafting is placed on stilts in the shops of the Utica Drop Forge and Tool Company, so as to interfere less with the lighting from the saw-tooth roof and to be more easily transferable when machines are rearranged (See chapter VIII)

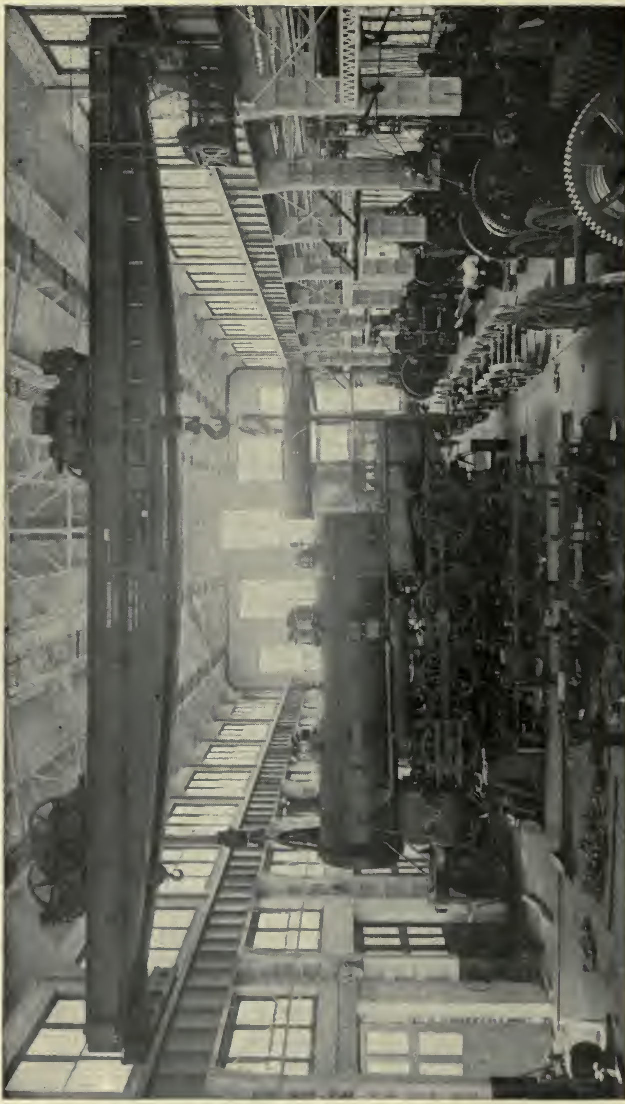


Plate VII: An electric crane in a locomotive plant will raise in ten minutes a locomotive which before took nearly as many hours to lift with jack screws. Much modern work would be practically impossible without the crane (See chapter IX) cloth cut from worn garments, and wiping towels manufactured of cotton or raw silk for this purpose.

In selecting the material, the use to which it is to be put should be considered. In a large majority of machine shops and factories a medium quality of white cotton waste will be the most economical.

Four to five ounces of white cotton waste of medium grade to each man per week, will be sufficient. Four ounces will usually be sufficient, and the amount will seldom go as high as five ounces. This will give twelve and three-quarters pounds of waste per man, per year, or to one hundred men, twelve hundred and seventy-five pounds. At nine cents per pound this will aggregate \$114.75, or \$1.14¾ per man.

Yet so loose and extravagant are many factories that many a factory manager or superintendent will find, if he will make up his annual account of waste purchased, that he used double this amount.

The waste should be stored in a dry place. Only one bale should be opened at a time, and then it should be kept properly covered from dust, dirt and grease.

In the economical issue of waste, several points should be borne in mind. It should be issued to employees once a week only, and in the properly determined quantity, say four ounces; these portions may be weighed on a cheap letter scale costing less than a dollar. No issue should be made except upon the written order of a foreman in each individual instance. To such men as the engineer, oiler and wipers, the superintendent should fix the amount of weekly issue as experience may dictate. This amount should not be exceeded except on the written order of the superintendent.

Where the entire issue of the week is made at a regularly announced time, it need require but a half-hour of the stockkeeper's time. He has a vertical case of pigeonholes, each four inches square and four inches deep, and numbered to correspond with the men's numbers. He places a four-ounce portion in each, ready for issue. Every man gives his check number as he comes to the window, and receives his portion. The empty pigeonholes show to whom the issues have been made. When this issue is complete the case is set aside until wanted the following week. Thus, with even an hour each week for the issue of waste to one hundred men, by a young man whose rate is fifteen cents per hour, the annual cost would be less than eight dollars, and the saving of fifty per cent, which can nearly always be made by this method, is over a hundred dollars to each hundred employees. And the moral effect of this systematic method is a considerable gain in itself.

The Speed Limit

MACHINE productivity is fixed by the weakest part of the mechanism. Up to a certain point machines may be speeded to a greater output; beyond this point the tool will fail. But between this point and the low limit is a field in which output can often be increased by a few simple changes in speed mechanism. A percentage of output which will change loss to profit may result from an hour's work—a dollar of expense.

Carl Bender

CHAPTER VII

Factory Systems That Have Cut Costs

WORK on machine shop orders is often contingent on the completion of special tools and jigs without which the customer's order cannot be filled. These special jobs in the shop are often lost sight of when regular work is being pushed through the plant, unless some system is used which keeps tab on special work more or less automatically," said the manager of the Gisholt Machine Company.

"We have adopted a system in our shop which has been found very useful by the foreman of the tool department, and which relieves him greatly of detail work in following up special orders. For each special tool or job a card is made out similar to that in the rack illustrated in Plate IV. On this ticket spaces are arranged for the order number, the shop order symbols, the date the job is to be started, the date completed, and remarks. At the bottom of the ticket, as indicated, the various operations through which the tool passes while being built, are printed. Two kinds of tickets are used, one blue and one white. Rush orders are scheduled on the blue cards, not on red color, for this purpose."

Probably the most novel feature of this scheme is the arrangement for filing these tickets. Between the tool designer's office and the tool department is a glass door. Across the glass panels, as shown in the illustration, two metal racks are screwed. Each card slides vertically into the pocket in this rack so that the height of the card can be easily adjusted. The clip holds the ticket in any given position. The general arrangement is made clear by the picture.

These racks are on the office side of the glass panel door, and the cards, which are printed on both sides, can be read on either side of the door. Peep holes in the middle of the rack enable the designer or any of the foremen on the machine shop side of the door to know the exact location of all orders in the shop.

Each day, reports are made to the office of the tool designer on the condition of the various orders, and the figures are adjusted so that the cards indicate each morning just where the work stands.

The tool designer in this way can tell at a glance how much it will take to complete a job. The time the rush orders were received and the general tool orders going through the shop is clearly apparent, and any hold up of any of the different jobs can be detected instantly. It is not necessary, therefore, for the foremen in the shop to bother the tool designer with questions as to the whereabouts of each job since they can get the information for themselves by reading through the glass panel of the door.

Safe Guarding Order Form

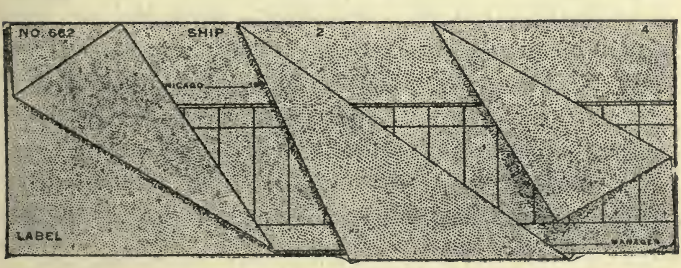
IT is often good business policy, in making carbons of an order sheet, to have the duplicates attached to the original order so as to prevent any possibility of an unauthorized order reaching the operating, bookkeeping or stockkeeping departments. This can be satisfactorily done by using a single sheet in place of the "original" sheet and the three separate duplicates ordinarily required. This single sheet, Form I, has three horizontal perforated lines dividing it into fourths. Parts 1 and 3 are printed as required on one side, parts 2 and 4 on the other.

When folded, all four sides are face up, folding being done by turning leaf 1 back over leaf 2, forming the first duplicate.

The second duplicate, or the third sheet of the series, is folded under sheet number 2. Finally, sheet number 4 is folded upward and under sheet number 3. In the illustration, the folded form is shown, with the corners turned back in order to display the different quarters of the sheet.

In inserting the carbons, one may be short or cut out over the "quantity" column, if it is wished to use "blind" checking.

The advantages of this little system—in addition to the fact that it prevents any chance for falsification of records—are that there is but one sheet to keep in stock, and as a consequence the number of supplies to keep track of or be wasted is cut down; and second, that when the printing is accurately done, it makes alignment per-



Form I: By folding the order sheet as here shown, four copies can be made at once fect, each figure lining accurately with the one above or below it.

This method is applicable to a great many forms which are used in sets, as those in the purchasing and shipping departments.

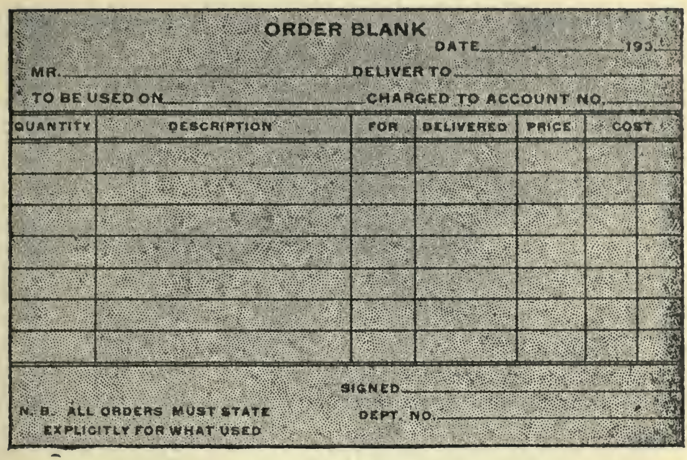
How a Foreman Pushed Orders

TIME was when a foreman could keep in his head all the orders he signed for repairs, parts and materials, but with the greater amount of detail work passing daily through the shop, it is impossible for any man to remember either the amount of material or the date on which it is due.

"The foreman of our factory uses this system," said a well-known implement maker.

"Our orders are made out on this blank (See Form II) and I am careful to keep a duplicate blank of every order that goes through my hands. I arrange all these copies according to the date of delivery in an ordinary index with tab cards corresponding to the days in the month.

"Each morning I take out the previous orders which are due on that day and check them off. If the order has already been delivered that fact has been brought to my attention and the order blank duplicate has been removed from the file and destroyed. But if there has been delay in getting out the order, I can immediately get in touch with the department involved and learn definitely whether the material will be delivered on that date. This fixes responsibility promptly for all orders in my department, and I have time to figure out new ways of doing work. Ordinarily the foreman has a hard time without a system. For instance a die might need repairing. He sends it to the tool room and states



ORDER BLANK

DATE.................193..

MR.................DELIVER TO.................

TO BE USED ON.................CHARGED TO ACCOUNT NO.................

QUANTITY	DESCRIPTION	FOR	DELIVERED	PRICE	COST	

SIGNED.................

N. B. ALL ORDERS MUST STATE EXPLICITLY FOR WHAT USED

DEPT. NO.................

Form II: This card enables a foreman to keep tab on his orders for tools and supplies

about when he wants it. Then, in the course of the day's work, he forgets all about the matter, and it is not called up until that particular die is needed to get out a certain piece of work in the shop. Then he immediately calls up the tool room, and very probably discovers that the die has been laid aside for some more novel work and is still untouched.

"Some time then has to be wasted in figuring out how to do that particular job without this particular die, and very likely the foreman has a certain number of the parts made by hand to meet the requirements of the order until the die is completed by the now well aroused tool room."

Labor and Progress Records to Increase Output

WHERE large contracts are paid for on a percentage basis as work progresses, the inspector often has a very intricate guess to make as to the progress made. His guess is almost sure to be far from the truth, and as liable to favor the contractor as his employer.

In order that the factor of uncertainty might be reduced to a minimum, the blank shown in Form III was devised for use in connection with the contract for a large rolling mill engine, the price of which was $54,000, to be paid for monthly as the work progressed, less a percentage held back for a given time after completion.

It will be noted that the work to be performed is divided on the blank into a number of sections, and the sections again subdivided for the various operations to be performed. A proportionate value is given to each section and subdivision, which can be taken from the contractor's estimate, and checked with known costs of similar work.

In the blank shown one thousand points represent $54,000, the total amount of the contract, and the number of points assigned to each section and subdivision are proportional to their value compared with $54,000.

The inspector marks in the proper space the number of points representing the progress of the work in each subdivision. These are totals in the column marked "Number of points completed," and the grand total of this latter column gives the progress of work in thousandths of the whole. This type of report blank is applicable to almost all contracts which are paid for on a percentage basis.

Cutting Costs in Raw Material

IN looking about the manufacturing plant for an opportunity to cut costs, the materials must not be overlooked. Cast iron, for instance, of which more is generally used than of any other material, offers a good opportunity for investigation.

ESTIMATE OF COMPLETED WORK.............1907 54X66 REVERSING ENGINE					
NAME OF PART	VALUE	MOLDING	CASTING	MACHINING	NO. OF POINTS COMPLETED
1 BED PLATE — DOUBLE	110 $5940	33	26	51	
1 BED PLATE — SINGLE	90 $4860	30	14	46	
BABBITT FOR BEARINGS	50 $2700		15	35	
3 TIE PIECES FOR BED	20 $1080	7	3		
3 BEARING CAPS, BOXES AND BOLTS	60 $3240		20	40	
2 CROSS HEAD PINS AND NUTS	5 $ 270		2	3	
2 CONNECTING RODS	75 $4050		30	45	
CRANK SHAFT AND PINS	60 $3240		30	30	
CRANK DISKS	40 $ 2160		20	20	
VALVE GEAR COMPLETE	200 $10800		50	150	
ERECTION, BOLTS ETC.	75 $4050			75	
.............INSPECTOR	1000 $54000	TOTAL....			

Form III: Keeping records on a big factory job by the "point" system insures accuracy

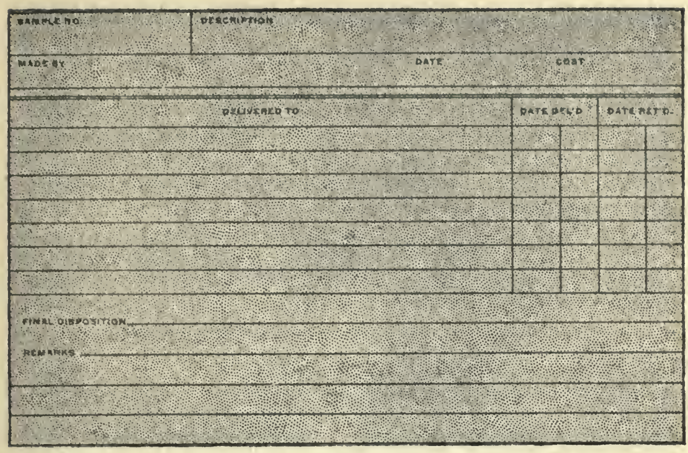
Castings are usually furnished by the pound. It is for the interest of the iron foundry that as much weight should be charged for as possible; hence, the pattern is wrapped more than necessary before it is drawn from the sand, and by this enlargement and the swelling of the casting, due to the loosely rammed sand, considerable weight is added. This extra weight will add from five to ten per cent to the foundry bill.

Further, in castings that are to be machined, the extra weight and the extra dimensions must be machined off. This work will add ten to twenty per cent to the labor bills.

What is the remedy? Have sample castings made that are as nearly true to pattern as possible. Let the weight of these samples be the standard weight for fixing the price per piece, not per pound. Then it will be well to the interest of the foundry to see that there is no unnecessary overweight, since every pound extra would result in loss to them.

Another point. The buyer should frequently investigate the quality of the castings, bearing in mind that the addition of cheap scrap iron tends to harden the castings, and while it is a saving to the foundry the extra cost of working up the castings in the machine shop more than overbalances that. This cost will run all the way from thirty to one hundred per cent for the labor of machining, not to mention the large extra expense of keeping tools in order and the not infrequent cost of new tools, particularly milling cutters that are ruined by the extra strain of use on the hard castings.

A close investigation of these matters will account for many of the increased costs that perhaps have not heretofore been possible of so clear and satisfactory an explanation as is desirable.


SAMPLE NO. | DESCRIPTION
MADE BY | DATE | COST
DELIVERED TO | DATE DEL'D | DATE RET'D
FINAL DISPOSITION
REMARKS

Form IV: Used for a perpetual inventory of incoming and outgoing wheat shipments

Keeping Stock in a Flour Mill

FOR this purpose a perpetual stock record should be kept. This can be handled very nicely with the card system. The form should, however, be made to fit the special requirements of the business.

A card should be used for each grade of wheat, showing at the top the grade and where stored. If the same grade of wheat is stored in two or more elevators, cards should be used for each elevator. As the wheat is received, enter on this card the date, car number and initial, and the weight. Shipments are also entered on the card, showing car number, initial and weight, while wheat sent to the mill is entered by weight only. At the extreme right the balance is extended. This shows the quantity by weight and also in bushels, with the price and total value. If wheat is shipped or used in the mill, the quantity is deducted from the quantity received, extending the quantity on hand in the balance column.

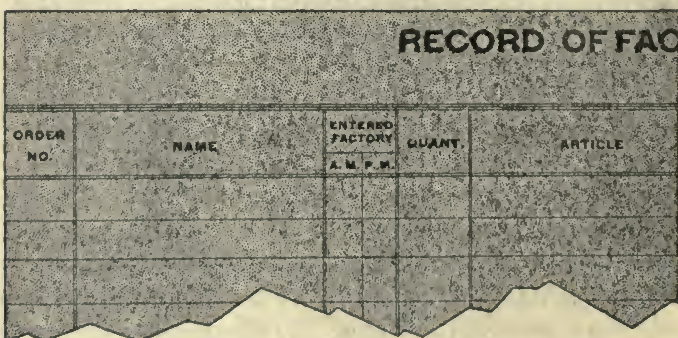
This gives a perpetual inventory. When a card is filled, the balance is simply carried forward to a new card, removing the first one from the active file. This keeps the records up to date, with no dead matter to handle over. These cards also furnish a record of the quantity of wheat handled and the quantity shipped or milled during a given period.

A record of this kind may be easily adapted to the business of storage whether of grain or other commodities.

Keeping Output at Maximum

ONE of the most important items to be considered in a manufacturing business is to get the very maximum output from the resources of the factory. Very often the difference between a comfortable output and a crowded output represents the entire profits of a manufacturer. A simple system is described below for following up and pushing out orders, that, if kept up, should increase the output of most factories at least 15 per cent.

Sheets are ruled and printed as shown in Form V. Each morning when orders are received they are entered



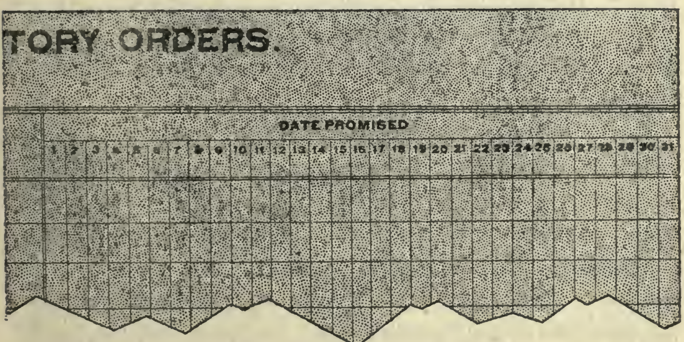
RECORD OF FAC

ORDER NO.	NAME	ENTERED FACTORY		QUANT.	ARTICLE
		A. M.	P. M.		

Form V: By the use of this blank for all the work in progress in the shop, definite on uniform order blanks showing all technical information necessary, and date job is promised for delivery. The factory copies of orders immediately go into the factory for execution and the office copies are passed to a clerk who enters each order on the "Follow-up Blank." Each blank has room for from fifteen to fifty jobs, depending upon the depth of sheet used, and covers a period of one month.

Each morning the clerk whose duty it is to keep up the record takes the shipping record of the day before and scratches out the check mark on the "Follow-up Blank" for all jobs that were shipped the day before. The "Follow-up Blank" is then given the manager to look over. The foreman is called in and must explain why each order promised for the day before was not shipped. He must state just what progress has been made with each job, why it was delayed and when it will be completed. The old check mark is then scratched out by the manager and another one entered in a column farther along, according to present condition of the job.

A glance at the sheet shows when each order is promised, when shipped and what percentage of orders are



dates of shipment usually can be made to office with a considerable degree of accuracy

shipped when promised. Any one who has ever had anything to do with a manufacturing business knows that it is impossible to ship all orders when promised; but when the foreman knows that the manager sees each morning a condensed report of all promises and all failures to ship when promised, and knows that he must explain why orders were not shipped, and tell exactly what state all delayed orders are in, he is going to exert himself briskly and not allow work to drag. The "ginger" infused by a system like this can be counted on to increase the output to a very profitable extent.

Distributing General Expense

THE troublesome feature to deal with in all establishments is the proper distribution and application of such items of shop and general expense as can not be apportioned directly to the various products.

As it is necessary to apply the indivisible expenditures as a percentage upon the output and while we may know that our shop and general expense is a certain percentage of labor, or of labor and material, it looks as if the goal had been reached when we apply this percentage uniformly throughout the product, but it is clear that in many establishments manufacturing different articles this policy must be modified according to the character of each class.

Even assuming that only one class of articles is manufactured, we realize that the arbitrary application of percentage is apt to lead to error unless checked at every step. We run but little risk in applying the general percentage to the completed machine, but when it is extended to detail parts we are led at once into error, as the purchased article upon which no manufacturing work is performed shares in this percentage to an amount that should really be added to the manufactured article, and such discrepancies will become all the more aggravated under uniform application of percentage, as conditions are apt to change.

We have in mind a hypothetical illustration which will perhaps clear our meaning on this particular feature. Assuming the cost of a machine to be as follows:

	Material.	Mfg. Labor.	Total.
Material manufactured	$40.00	$50.00	$90.00
Material purchased	10.00	......	10.00
Complete article, representing cost of material and labor...	$50.00	$50.00	$100.00
If our shop and general expense is 50 per cent of our "Material and Labor" it would add to the above...........			50.00
Making the total cost of the machine.................			$150.00

This is correct and safe as to the completed article. Now, see the effect of extending this general percentage to details:

	Material.	50 per cent Shop and Gen. Ex.	Total.
Material manufactured	$90.00	$45.00	$135.00
Material purchased on which no manufacturing has been done	10.00	5.00	15.00
Total			$150.00

This looks plausible, but let us analyze it. We have added 50 per cent to the purchased material upon which we have done no manufacturing, making it cost $15.00. This is wrong, as that material should bear only its fair proportion to cover handling, and certainly this would not reach 50 per cent. As we have applied too much to this item, manifestly the cost of all the other items are rated too low. To continue this mode of figuring on the detail items would soon affect the balance sheet.

Here are articles that we have purchased and that anyone else may purchase at something like the same figures, yet we rate them as costing us 50 per cent more by reason of handling.

The consideration of this subject involves proper cost of material, which should include invoice price, freight and handling from the receiving to the shipping door.

The purchased material upon which no manufacturing has been done should bear its proper proportion of shop and general expense; all other material should be subjected to a greater percentage, as more handling is required before reaching the manufacturing stage. These percentages will vary with every manufacturing establishment, but can be closely approximated by a careful investigation.

For ready example suppose we add, say 10 per cent to purchased material and 15 per cent to material that undergoes handling for manufacture.

The remainder of shop and general expense should then be applied as a percentage on the manufacturing labor involved on each item.

Applying this to the above would give the following results:

The completed article is to absorb $50.00 of shop and general expense.

Purchased material, add say 10 per cent on $10.00
for handling ....$ 1.00

Plate VIII: To eliminate swinging wires and shades, this simple gas pipe fixture is used in the Washburn Shops of the Worcester Polytechnic Institute. Wiring is beneath the floors (See chapter X)

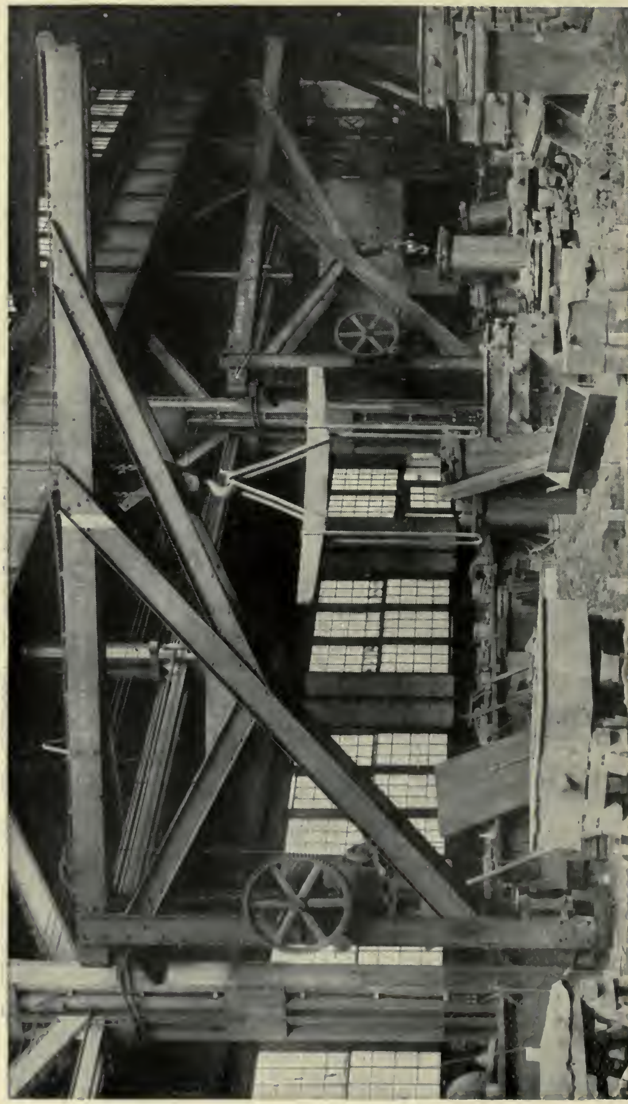


Plate IX: By swinging jib cranes on pin hinges in the foundry of the General Electric Company, a few cranes serve the entire length of the foundry. The traveling crane transports them from one location to another where needed (See chapter IX)

Manufactured material add say 15 per cent on $40.00 for handling	6.00
The remaining $43.00 is to be distributed according to the manufacturing labor performed on each article, viz. 86 per cent on $50.00	43.00
Total shop and general expense	$50.00

This would leave the detailed figures as follows:

	Material.	Mfg. Labor.	Bal. S. and G. Ex. 86 Per Cent on Mfg. Labor.	Total.
Material manufactured	$46.00	$50.00	$43.00	$139.00
Material purchased	11.00	......	......	11.00
Total cost of detailed parts				$150.00

From this it will be seen that the percentages on the detail parts will always vary as the proportions change, and the proof or check upon these figures is always present by first ascertaining how much of the shop and general expense in dollars and cents should be absorbed by the completed work, and then placing this in percentages to fit the case. Of course, every named item or separate part of the machine should be considered and assigned some proportion of the general expense.

System That Saved Labor in the Shipping Room

THE packing and shipping room of the average factory is, in almost every case, the worst organized department in the plant. A sufficient proof of this is in the fact that it is comparatively rare to find in a packing department any mechanical devices or labor saving systems. There is quite as much room for the exercise of ingenuity in this department as any other in a factory—more, in fact, because so little has heretofore been done to perfect its methods.

An arrangement which did away with the services of two men out of three, illustrates the possibilities. It is applicable wherever the product to be boxed is already packed in uniform cartons or is of uniform size.

The arrangement consists essentially of a pivoted circular platform provided with suitable rollers so as to rotate easily, and with angle bars fastened to the upper surface to act as guides or holders for the packing boxes as they are slid upon the platform from the truck or conveyor.

The packing boxes are delivered to the packer at the platform by a suitable conveyor, and are pushed directly upon the platform, which is turned until the box is opposite the table at which the cartons to be packed are delivered.

This table itself is supplied by an endless belt, finger, or any other form of light conveyor which may be best suited to the material and the location of the boxing room with reference to the department in which the completed goods are packed into the cartons or labeled.

The packing box being filled and nailed, the platform is rotated a quarter turn, and the box shoved out upon another conveyor to be carried to the warehouse or shipping platform.

If the packing cases are heavy, in order that the work may be further facilitated, the platform may have rollers in the upper surface to save labor in pushing boxes on and off. The platform may be flush with the floor or at any convenient height.

One man does all the work.

Part III

EQUIPMENT THAT INSURES MAXIMUM PRODUCTION

Cutting the Cost

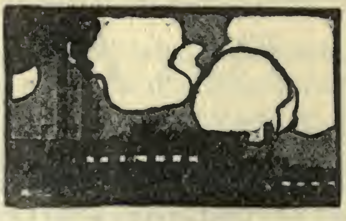
YOUR factory equipment is your cost reducer. Scrutinize each link in power production from coal pile to machine—boiler room, engine, shafting, belting. One manager saved fifteen per cent of his cost for power by a few simple changes.

Keep your product off the floor; cars, trucks, cranes, hoists, conveyors—all help reduce non-productive labor. A factory foreman saved seven dollars a day by keeping goods in process on trucks.

Good light, heat and ventilation pay. A factory manager by painting the walls cream-white toned up his whole working force. Hard to measure, he could "feel" the improvement brought about by this simple means

The preventive ounce is worth a pound of cure in machine protection as in medicine. Cold economy alone proves it cheaper to cover a gear than to pay for a finger. A broken crane rope can be sketched as a dollar sign.

Study your factory equipment—it pays.



CHAPTER VIII

Producing Power at Lowest Cost

A REGULAR inspection of shafting and belting by a man or squad of men responsible for the condition of the transmission machinery will go far to save coal. F. H. Willard, superintendent of the Graton and Knight Manufacturing Company, says:

"We have a man whose business it is to oil and inspect shafting and belting around the plant. In addition to this we find it advisable to have our mechanical engineer go over the shafting and see that it is kept in line, as shafting is very apt to get out of line on account of the buildings or floors settling. Moreover, as the load varies we are confident that a very large percentage of the friction load in most driven plants is due to shafting and machinery out of line, and to neglected belting.

"We occasionally take a card from our engine to show the friction load. This is usually done either at night or on Sunday when none of the machinery is running, and when compared with the average of an all day run, that is, cards taken every hour during the day, shows the percentage of friction load or power loss in shafting and belts.

"This percentage varies considerably in different plants in direct proportion to the class of machinery

TESTS OF FRICTION LOAD					
FACTORY	AVERAGE LOAD	AVERAGE FRICTION	USEFUL WORK	AVERAGE LOAD EFFICIENCY	LOSS IN TRANSMISSION
1	88.6 HP.	65.7 HP.	22.9 HP.	24.0 %	76.0 %
2	166.0 HP.	78.0 HP.	88.0 HP.	53.0 %	47.0 %
3	220.0 HP.	49.8 HP.	170.2 HP.	77.0 %	23.0 %

Form I: Tests in three factories, which show great friction losses in shafting and belting

used—that is, a plant using very heavy machinery, requiring considerable power, will show a small percentage of friction load, while a plant using light machinery like sewing machines, etc., will show a heavy percentage of friction load; therefore, no really accurate comparison can be made except between power plants doing work of a similar nature.

"This subject covers a field to which very little attention is given, and is one of the most important items of factory management. There are few factories in which the friction load is less than 30 to 35 per cent of the total load on the power plant, and while thousands of dollars are spent to save 5 to 10 per cent in the power plant, frequently twice as much is lost by the improper transmission of power through shafting and belts, this loss being due almost entirely to neglect."

What Gas Power Costs in a Textile Plant

THAT the small producer gas engine can be used effectively to reduce the fuel bill in the moderate sized factory is well illustrated by the power plant in

POWER REQUIRED TO DRIVE MACHINE TOOLS ELECTRICALLY				
MACHINES	CUTTING SPEED	TYPE OF MOTOR	HORSEPOWER REQUIRED	REMARKS
LATHES	20 FT. PER MIN.	SHUNT WOUND VAR. SPEED	HP = 0.15S − 1HP	S = SWING OF LATHES IN INCHES
BORING MILLS	20 FT. PER MIN.	DITTO	HP = 0.25S − 4HP	DITTO
MILLING MACHINES	20 FT. PER MIN.	DITTO	HP = 0.3W	W = DISTANCE BETWEEN HOUSINGS IN INCHES
LIGHT DRILL PRESSES	20 FT. PER MIN	DITTO	HP = 0.06S	S = SIZE OF DRILL IN INCHES
HEAVY DRILL PRESSES	20 FT. PER MIN.	DITTO	HP = 0.1S	DITTO
SLOTTERS 10" STROKE	16 TO 20 FT. PER MIN.	COMPOUND WOUND VAR. SPEED MOTOR	5	
SLOTTERS 16" STROKE			7	
SLOTTERS 30" STROKE			10	
SHAPERS 13" STROKE	DITTO	DITTO	3	
SHAPERS 18" STROKE			3½	
SHAPERS 24" STROKE			5	
SHAPERS 30" STROKE			6½	
PLANERS	DITTO	DITTO	HP = 3W	W = WIDTH BETWEEN HOUSINGS IN FEET
HEAVY PLANERS	DITTO	DITTO	HP = 4.92W	

Form II: Short-cut formulae for finding horsepower of motors to drive machine tools the government shop of the Hilker & Wiechers Company. Before the installation of the present power this firm operated their factory satisfactorily with a kerosene engine. The need for increased power, however, led them to install a fifty horse-power produce gas engine. Conversation with the company's secretary and with the engineer, brought out several interesting operating features.

The engineer in the factory not only looked after the duties commonly included in such a job, but acted as handy man about the shop, also. A visitor at the plant found him busy repairing a sewing machine on the second floor, about as far from the engine room as he could get. The visitor mentioned this apparent neglect of duty and learned that the engine required his attention only a small part of each day. In fact, about the only time the machine required any attention was in the morning and at night—about two hours total, for labor charges.

The secretary was enthusiastic on the subject of gas engines and rather naively stated the advantage of what the automobilist considers the chief drawback of this type of prime mover.

"If anything goes wrong with the gas engine," said he, "it stops. There's no danger of a cylinder head blowing out if the engineer happens to be in another part of the factory. If the machines stop, he goes to the engine room to see what's the matter."

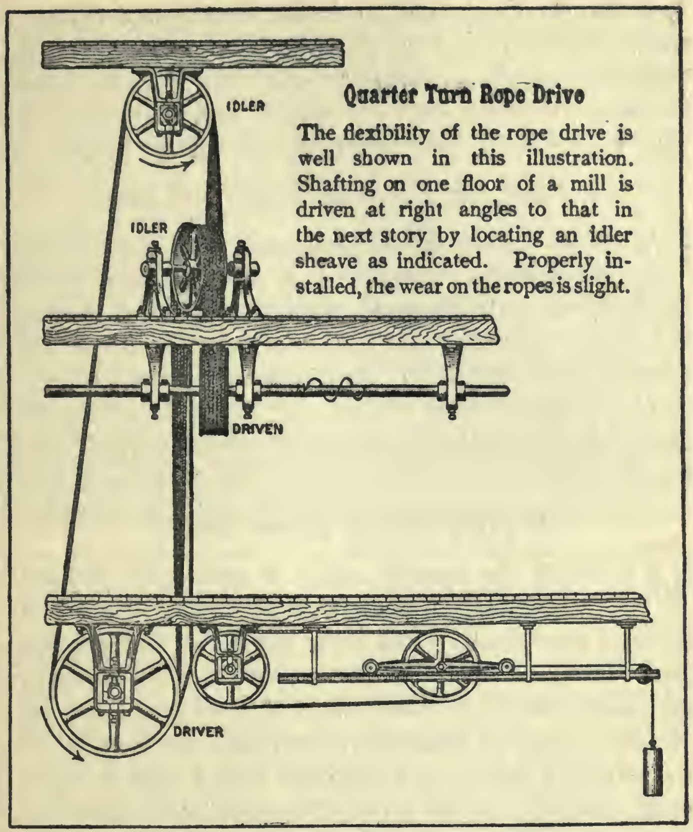
Some details as to the fuel consumption of this engine are interesting. Pea-coal costing from $4.35 to $4.60 per ton at the factory, is burned in the producer. When the shop is running full, from 45 to 50 horsepower drives the sewing machines. In addition to the sewing machine and line shaft, there is added to the load during winter twilights about 100 sixteen candle-power electric lamps, so that for perhaps an hour toward night during the period of short daylight a total of about 60 horsepower is used. However, the engine seemed to adjust itself very nicely to this load when the entire battery of lights was suddenly thrown on.

Under these conditions the gas producer calls for between 500 and 550 pounds of coal per day. For fuel, water, oil and attendance, the total cost for power at this plant, therefore, averages from $1.25 to $1.50 per working day.

As for depreciation, the enthusiastic engineer boasted that the only item of repairs in a year's run had been due to a blow-hole in one of the cylinder heads, which he had drilled, tapped and plugged with a machine screw.

Rope Drives for Quick Turns

QUARTER turn drives, difficult to make with belts, can be accomplished with ropes in both the continuous and multiple drive systems. In both systems the grooves should be separated on the face of the sheaves a distance slightly greater than the diameter of the rope used. In the nail mill of the American Steel and Wire Company at Newcastle, Pennsylvania, there is a cross drive of the multiple system. The sheaves of the drive are eight feet in diameter and the shafts fifty-five feet from center to center. The ropes are wire strand one and a half inches in diameter. A quarter turn drive is shown in the illustration. In this way a shaft on the second floor of a mill can be driven at right angles to the shafts above and below. Owing to the flexibility of the rope considerable variation from exact alignment is pos-



Quarter Turn Rope Drive

The flexibility of the rope drive is well shown in this illustration. Shafting on one floor of a mill is driven at right angles to that in the next story by locating an idler sheave as indicated. Properly installed, the wear on the ropes is slight.

sible although for the best operation, good mechanical construction is an essential as for belts and pulleys.

The possibilities of a quarter turn rope drive are well illustrated in the case of a woolen mill in Massachusetts. A horizontal shaft electric generator had to be driven by a vertical shaft water wheel. The distance between centers was sixteen feet. In this short space, the drive transmits 200 horsepower. The generator runs at 579

R. P. M.; the wheel at 205 R. P. M. To get the necessary speed relations, the smallest sheave had to be made 34 inches in diameter in violation of the rope drive rule that the smallest sheave must be forty times the diameter of the rope. Ten one and one-eighth inch ropes are used.

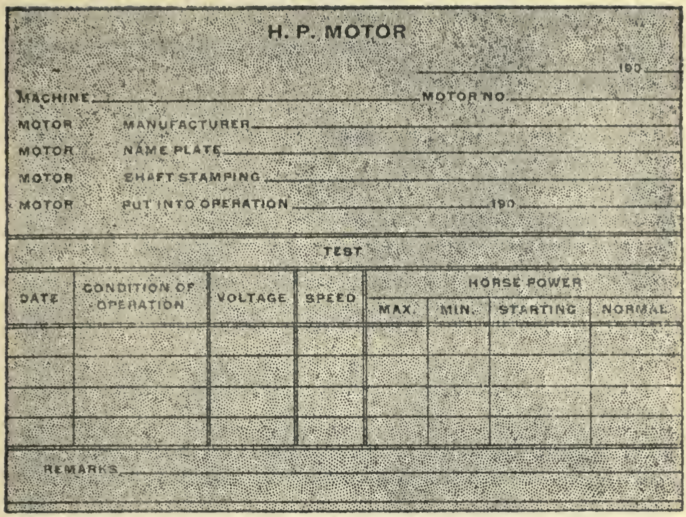
A Plan for Keeping Shafting Clean

ONE of the niceties of shop equipment is a shining main-shaft. Sometimes a long-handled brush fitted to half cover the shaft, wielded by the oiler, is used to keep up this part of the equipment. A little scheme for accomplishing this result automatically is used in one plant. Wooden rings, slipped over the shaft, travel up and down the lengths between pulleys and hangers, keeping the steel surface always bright and shining.

A Time Saving Motor Record

WHILE the electric motor is ordinarily counted fool-proof, so far as a machine can be, yet it is for that very reason often badly neglected. This is not good practice, for, if the best results are to be attained, each motor should be tested and inspected at regular intervals. It is not necessary to keep as careful watch of an induction motor, as is exercised over a delicate automatic machine, but the value of frequent and regular inspection is often overlooked. As essential as inspection is the filed record which shows where each motor is and what it does.

Such a record, with the facts about each motor in the plant compactly kept on a card, is shown in Form III. This method of putting on record the facts concerning each motor drive in the plant is used by the Edison Portland Cement Company and has proved of real value in caring for the working equipment.



H. P. MOTOR

________________190____

MACHINE ________________ MOTOR NO. ________

MOTOR MANUFACTURER ________________

MOTOR NAME PLATE ________________

MOTOR SHAFT STAMPING ________________

MOTOR PUT INTO OPERATION ________________190____

TEST

DATE	CONDITION OF OPERATION	VOLTAGE	SPEED	HORSE POWER			
				MAX.	MIN.	STARTING	NORMAL

REMARKS ________________

Form III: A simple card record that fixes the facts of each installation in compact form

The card is self-explanatory, but a few words as to the way in which it is used will prove helpful. The cards are filed in the office of the electrical superintendent and are arranged numerically according to the horsepower of the individual motors. In some industries it would be better to file the records according to the buildings or to machines they drive. In plants where there are many buildings both of these methods are recommended. Each motor has a card. These are first grouped according to the location of the motor and subdivided according to the machines they drive.

Records of this kind are particularly valuable when additions or alterations are to be made in a factory. With exact information as to the motors already installed, their location and the machines they drive, the engineer can figure at once the amount of new equipment necessary. Often, it is possible to utilize an old motor for new work, or machines can be rearranged and grouped to better advantage, and rigged with power-saving individual drives.

Department Power Records That Save Fuel

POWER HOUSE records form one of the simplest and most effective ways of keeping tab on the cost of power. By systematizing the cost of power, the daily records show immediately whether costs are above normal, so that leakage, defects and wastes can be probed for at once.

The H. H. Franklin Manufacturing Company has evolved a simple system of keeping track of its power costs which has proved very effectual in keeping the costs low. The plant is operated by electric power, each department being sectionalized and driven by its own motors. Power and lighting are measured and charged to each department in separate cost items. The electrical system simplifies this subdivision since, by electrical measuring instruments, the power used—each of the twelve power and the twelve lighting sections into which the factory is divided—can be accurately measured and charged up to the proper department.

At the switchboard a wattmeter is devoted to each department or section in the factory, and these meters (Plate V) show by number and label the respective departments for which they measure power. Records of the actual power used for lighting and for operating the machines are filed in a loose leaf ledger, on sheets similar to Form V. Separate books are kept for the lighting and power totals. With this daily record of power consumed the cost of power per day in each department can be accurately computed, since by simply multiplying the total kilowatts used per hour by the costs per kilowatt-

DAILY POWER HOUSE LOG

DATE 1907	HOURS BOILER SERVICE	POUNDS OF COAL	POUNDS WASTE USED	POUNDS OF ASHES	TEMP. FEED WATER	AVERAGE BOILER PRESS	AVERAGE BACK PRESS.	HOURS STEAM HEATING	MAIN ENGINE RUN	AUX-ILIARIES RUN	OIL MAIN ENGINE	OIL AUX-ILIARIES	NO. ENG-INEERS	NO. FIRE-MEN	NO. HELP-ERS

DAILY RECORD KILOWATTS POWER USED PER HOUR PER DEPARTMENT

DATE 1907	EXPERI-MENTAL BLACK-SMITH	REGULAR DEPART-MENT	METAL BODY DEPT.	MACHINE SHOP NO. 1	SAW MILL	MACHINE SHOP NO. 2	CHARGING STATION	CARPENTER SHOP	ASSEMBLY DEPART-MENT	ELEVATORS	MACHINE SHOP NO. 3	SPARE CIRCUIT	TOTAL K.W.
	1	2	3	4	5	6	7	8	9	10	11	12	
TOTAL													

Form IV (above): Record of power house costs, and (Form V) of electrical energy required by each department per hour. By this departmental division, a complete check is kept upon power costs and waste in every section of the factory hour the total figure is immediately available for purposes of comparison.

This actual cost per kilowatt-hour is made up of coal, labor, supplies and depreciation, the first three of which are daily computed from the log sheet (Form IV). Depreciation is figured as a net percentage. A summary of daily costs is compiled, which shows the itemized and total average cost of power per kilowatt-hour. By comparing the costs of each day's power consumption, any unaccountable rise in cost per kilowatt-hour automatically calls attention to waste.

Just what results this simple system has brought to the company can be surmised by an analysis of the daily power cost sheet for the plant.

Pounds coal used	30,400
Cost coal used	$41.80
Labor cost	15.35
Supplies cost	4.00
Depreciation	8.00
Kws. per day	3,389
Kws. per hour	141.2
Average cost, coal, labor supplies and depreciation per hour	$ 2.88
Average cost per kw	0.0204

Saving Money on Belting

ECONOMY in the use of leather belting can only be attained by purchasing the best grades of belting, made by firms of established reputation, and then by applying it and caring for it in an intelligent and proper manner. It is an easy matter to buy belting for 10 or 12 per cent less than is usually paid for first class goods. But it will be made from the leather cut too far from the center of the hide and consequently will have thin and soft spots, which, coming on the edge of the belt will permit it to stretch unequally. If a piece forty feet long is laid on the floor it will be impossible to make it conform to a straight line. Therefore, it will not run true on the pulleys, and if it is used on cone pulleys the edges will turn up and the belt will soon be useless. In situations when a good belt would run a year and still be in good condition, this kind of belt will not last three months. It is the poorest of economy to save ten per cent by putting in belts below the standard in quality. Bank discount is much cheaper.

There are various methods of fastening the ends of belts. The most common is by lacings. These are often carelessly issued and wastefully used. They should be purchased in certain widths and lengths and issued for lacing belts of certain widths. The following table gives these figures:

Width of Lacing.	Length of Lacing.	Width of Single Belt that it will lace.
¼ inch	18 inches	1 to 1½ inches
5/16 inch	24 inches	1¾ to 2¼ inches
5/16 inch	30 inches	2½ to 3½ inches
5/16 inch	36 inches	3¾ to 5 inches
⅜ inch	48 inches	5½ to 8 inches
½ inch	72 inches	9 to 12 inches

By purchasing lacings of these dimensions and requiring them to be used according to this table, one factory saved from twenty to twenty-five per cent in the cost of belt lacings for several years. Thin lacings should always be used for fast running belts, or wide double ones. The laces should be so applied that on the side next the pulley they run parallel to the edge of the belt.

Three Schemes for Reducing Friction Load

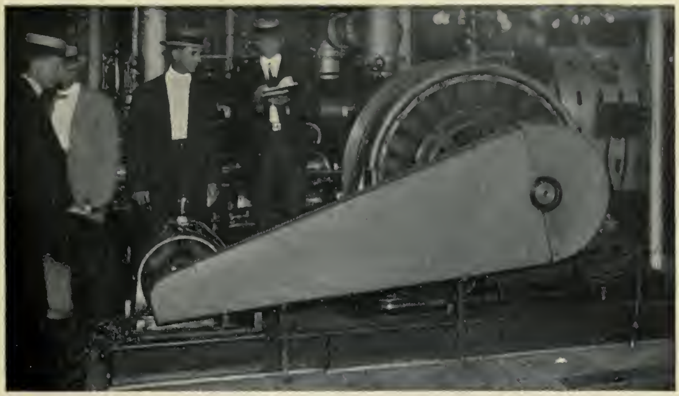
COMPARATIVE coal consumption is the ultimate test of the economy of power generating and transmitting machinery. Belts and shafting have been synonymous with power transmission for so many years that their relation to the coal pile is often overlooked. A glance at the table shown on page 79 emphasizes the importance of this feature of power production. Factory No. 3, in which transmission losses were lowest, had just been overhauled. This renovation saved sixteen horsepower.

Look over your plant and see if you are not wasting power in unnecessary friction. Fans, blowers, air-compressors and centrifugal pumps are apt to be overpowered. Blowers are commonly operated needlessly fast. In a small machine shop, the engineer reduced the friction loss in an air compressor by asking a few changes in the location of piping and compressor. By substituting a small portable electric desk fan for a wooden blade fan that was mounted on the end of a shaft a further reduction in friction was made. The combined change effected a reduction of 15 per cent in the amount of power required and consequently in outlay for power.

How Shafting Hangers Can be Quickly Shifted

THE re-location of machinery is often handicapped by the inflexible arrangement of shafting. It takes time to figure out arrangements for a change in machine location, to say nothing of the practical difficulties often encountered.

"The arrangement of shafting at our plant (the new shops of the Utica Drop Forge and Tool Company) is unusual, but has proved very satisfactory. Practically all the light comes from north-facing saw-tooth roofs, and the layout of shafting is therefore modified by this type of construction," said the superintendent of the works. "Our entire plant is driven by electricity; 275 horse-



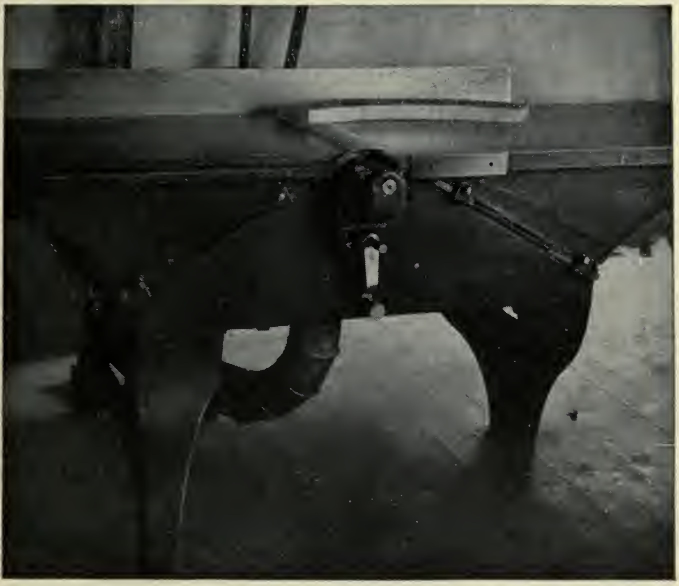
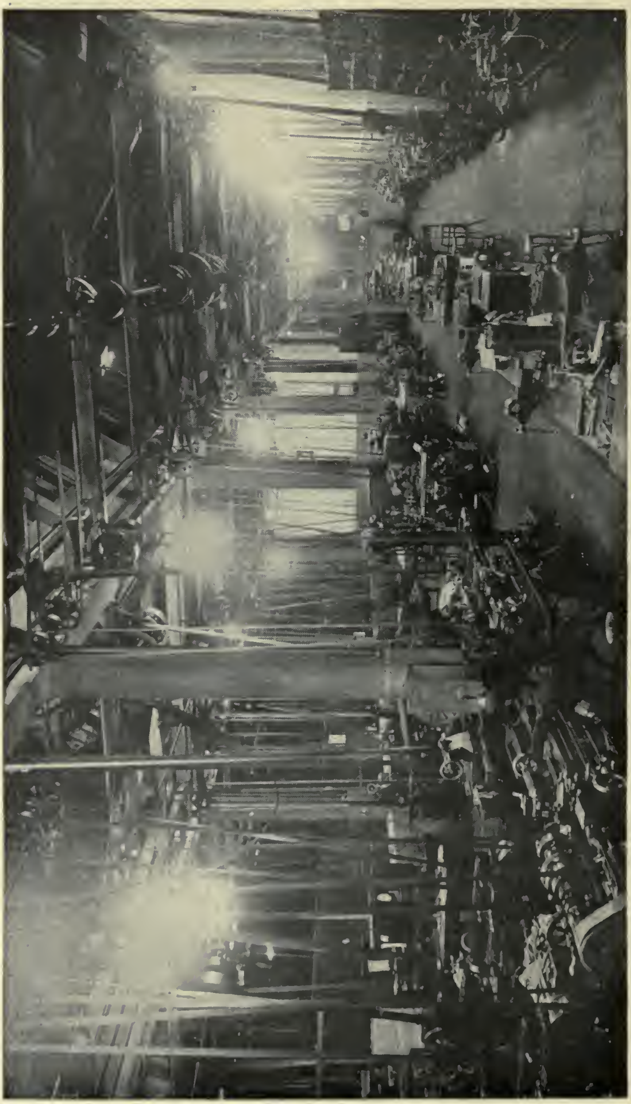


Plate X (below) and XI (above): Two devices which help reduce the accident risk. A belt shield at the Sherwin-Williams Company's plant, and (below) a planer guard at the General Electric Company's works (See chapter XI)



XII: Plate Mercury vapor lamps furnish a well diffused illumination in these machine shops. The lamps are rigidly supported just below the level of the line-shafting so as not to interfere with the free distribution of the lamps (See chapter X) power is purchased from the local company and transmitted from Trenton Falls eighteen miles away. The machinery in each department runs on a separate motor.

"All the main shafting is on the floor where it can be easily reached and does not interfere with the light. Each length of shafting is driven through a crab-clutch so that each may be driven independent of the others, except the center length to which the motor is connected. This construction makes it easy to oil the shafting, and since wire guards six feet high enclose the shafting, no one but authorized employees can get near it. All of our counter shafts are mounted on iron frames, built up from two-inch wrought iron pipe. These counter shafts are driven where possible from the line shaft on the floor. Where it is necessary to have extra driving shafts they also are mounted on an iron frame work." (See Plate VI.)

A Meter Record That Stopped a Leak

ELECTRIC meters offer possibilities for power measurements which are not altogether realized. The amount of power actually consumed in a factory is difficult to measure when the electric link between coal and machine is absent, and even in plants equipped with electric motors the wattmeter often will check losses which otherwise escape notice.

This point was rather interestingly shown in an isolated station recently. A new gas engine, operating on natural gas, had been set up and was carrying a lighting and small power load. When the equipment had been installed the switchboard was fitted simply with an ammeter and voltmeter, so that it was not easy to get continuous power readings. The incoming supply of fuel was measured by a gas meter.

After two or three weeks the engine had apparently "found itself" and was running well. The engineer of the installation, however, wished to get comparative data, so put in a wattmeter on the electric supply circuits.

When he compared the readings of gas meter and wattmeter, he found that about three times more fuel was being used than was consumed as power. A little investigation showed that the operating engineer, instead of using as little gas in his mixture as would give the best results, was running his engine with a charge containing a maximum amount of gas. With a re-adjustment of the intake valves, what might have been the annual fuel bill was reduced about two-thirds.

Keeping Up Steam Pressure

STEAM HEATING caused considerable trouble in a brush shop employing about 300 hands. During cold weather the foreman of a department was continually complaining about the heat in his room. But the engineer always clung to his statement that the steam was turned on.

The superintendent installed a graphic recording steam gauge of the ordinary type and quietly connected it with the steam main in the troublesome shop. The instrument kept tab on just when the steam was turned on and what pressure was recorded. The superintendent had a reliable record and the kicks were stopped.

Holding an Engine at Work

THE electrical engineer in a small machine shop and foundry had a similar experience. Alternating current electricity was used for power. When the foundry blower motor was switched on the line in the late afternoon, the engineer in the power house often let the speed of the engines drop as the load came on. As a consequence the electric lights grew dim for a time before the steam came up in the boiler. Yet the power house attendant was sure the engine held speed.

The engineer installed in his office a frequency meter. This registers the frequency of the alternating current which is of course dependent on the speed of the machines. Consequently when the speed falls off the frequency meter in the engineer's office tells the story.

It took some time for the power house attendant to understand just why the engineer telephoned so promptly when the speed fell off, but once he realized the cause, the trouble ceased. Steam is now ready for the load when it comes on and the meter remains as a moral restraint only.

Business Strategy

IN the days of small businesses and unsystematic methods, the manufacturer each morning planned his day's work. Tomorrow had to take care of itself—until tomorrow came. Nowadays, the successful manufacturer must know and plan his campaign a year ahead. Working space, equipment, labor supply, material, selling plan—all must be laid out months in advance, if he is to face competition.

Robert Daily

CHAPTER IX

Keeping the Product Moving

TWO men and ten minutes for a job that took eight men four hours—that visualizes the vital elements which make the crane essential in modern manufacturing. In a locomotive plant it used to take eight men four hours (at a cost of $5.14) to lift off the drives with jack screws a ten wheel locomotive weighing 132,000 pounds. Four men with pneumatic jacks can do the job in one hour. An electric traveling crane takes ten minutes, and, moreover, does the work without any confusion or discomfort to the workmen. Plate VII illustrates how easily, by this means, the largest engine can be lifted and deposited wherever the job requires.

With simple auxiliary apparatus the cranes can also do many unusual tasks. At the foundry of the Western Electric Company the big electric traveling crane saves the labor of several men in handling scrap. A box with suitable hooks on the sides is placed near the snagging department and into this the workmen throw all scrapped castings, sprues and pins. When full, the box is picked up bodily by the traveling crane and dumped on a platform near the doors of cupolas on the charging floor. A corner of the floor juts out over the main foundry to receive the scrap, which is then loaded into narrow-gauge cars, weighed, and thrown into the furnaces. The entire operation is a lesson in modern industrial methods.

Conveying Goods Cheaply by Air

UNUSUAL methods are occasionally adopted for inter-factory transportation. A Detroit paper box concern uses an exhaust fan for carrying its product from one department to the next through sheet iron ducts.

In the packing room are long rows of tables at which stand the packers. Before each employee, a spout leads down from the main duct to the packing table. There is a damper at each spout controlled by the operator in the store room.

When the stock gets low on the packing table, the packer signals to the store room, the operator opens the damper and more boxes flow to the table. Enough can be fed in a few minutes to last an hour or more.

This method of transferring boxes saves the usual expensive trucking and does the work swiftly, nor are the goods injured by this method of handling.

Handling Coal Economically in Power Plants

A PORTABLE electric hoist of moderate capacity has many uses about the factory. The problem of conveying coal to the boiler room or handling the ashes expeditiously is one which in many cases is quite an item of expense. With an electric hoist the entire equipment is controlled by an unskilled operator, who rides in the cage and is in a position to dump and handle the bucket from that point. An operator with an equipment of this class will handle a large tonnage at little expense for power. The coal may be handled by means of a grab bucket, unloading direct from the car and delivering to the boiler room.

Such small hoists can also be used in conjunction with cranes of various types about a plant for handling parts of machines expeditiously. Hoists of this character can be purchased which are capable of handling from one to fifteen tons.

The cost of an equipment is moderate and the operating cost is very low. The Yale and Towne Manufacturing Company state that one of their purchasers buying electric energy at ten cents per kilowatt hour, operates a small hoist at a cost of $0.000303 per foot-ton.

Novel Method of Transporting Grain

AMERICAN manufacturers receive few problems they cannot solve. There was installed in a flour mill of the Hong Kong Milling Company in China a system for handling bran shorts which aroused the enthusiasm of the Chinese. By means of a specially constructed fan, the bran is blown three-fifths of a mile from the fan, in a sixteen-inch, heavily galvanized iron pipe. Three and one-half tons of bran can be conveyed by this means in one hour. The conducting pipe slopes upward to a height of 150 feet at a point 1600 feet from the fan, and then declines to the point of discharge.

Two fans each driven by a direct connected electric motor are installed to insure continuity of service in case of accident to one fan. On account of the distance of the shipment and the lack of skilled labor in China, the piping was made up and shipped in lengths of sixteen feet. At one end of each section a hand hole was cut so the sections could be riveted and soldered tight.

Any doubt as to the success of this scheme was very quickly dispelled when the fan started. One of the milling company's employees in the receiving warehouse almost smothered before he was rescued.

Making One Hoist Serve for Three

SMALL cranes and hoists for handling materials in foundries and machine shops are particularly advantageous. A scheme for saving equipment and at the same time providing facilities for handling materials over a wide range of floor space forms a part of the foundry equipment of the Schenectady plant of the General Electric Company. (See Plate IX.)

Jib-cranes are hung from two or three upright columns by pin hinges. These are operated by compressed air and are provided with flexible connections to serve the floor space under the radius of the swinging jib. When the job in one part of the foundry is complete, the electric traveling cranes which serve the main floor pick up the jib bodily and hang it in a new position, where connections are provided for the compressed air supply for operating the hoist. Heavy floor work can be performed expeditiously in several parts of the foundry in this way without furnishing an individual equipment other than the hinges and air cocks.

Saving Time by Department Telephones

A TELEPHONE system expedites materially the handling of work in the factory. Systems can be installed either in conjunction with the main telephone center or independently. The superintendent of a moderate sized cutlery plant has found this system very satisfactory. He uses a dial type instrument by which he can call from his office any foreman in the plant. In the forge departments a large auxiliary gong sounds to call the foreman to the telephone.

When such a system is installed in the plant, put it in well. A cheap installation will cause endless trouble and get out of order easily. Wiring particularly should be done with care. Cables should be used as far as possible and the independent wires kept away from shafting and hot steam pipes.

Telephone conferences of two or three foremen and the superintendent save a great deal of time. With a telephone in each department, they are quickly and conveniently arranged.

Trucks That Save Steps

KEEP material in process on trucks and off the floor. This will keep the shop clean and the parts moving. This axiom was proved again at the garment factory of the Hilker and Wiechers Company at Racine, Wisconsin. Garments when finished, before being sent to the storeroom, were piled on a bench in the sewing room. In taking them to the storeroom the boy brought an empty truck up the elevator, loaded the garments from the bench and unloaded them again on the stock room shelves.

Trucks suitable for carrying the garments were built. Empties stand always ready for the garments as they are finished and as fast as a truck is filled, all the boy has to do is to keep the trucks moving, exchanging empties for the loaded conveyors.

In the stock room to facilitate handling the goods, the stepladder is placed on wheels. The man on the ladder can thus move it down the length of the aisle between the rows of shelves without dismounting every time to change his position. The step ladder on wheels takes the place of the more expensive trolley ladder frequently seen in shoe stores.

In another factory the office vault was distant from the factory office and duplicate records were kept, so that one set would be safe in the vault and the other convenient to the filing clerks. By mounting the filing cases on a truck and pushing it to the vault each night, a lot of useless record keeping was eliminated and both convenience and safety assured.

Getting Parts to Workmen Quickly

TIN cans, nowadays, are made entirely by automatic machinery. As far as possible the process of manufacture is continuous, the product traveling in its course from sheet iron to the labeled can in as straight a line as possible.

A can factory in Brooklyn recently solved one of its problems in a unique manner. The building was six stories high, and various operations were performed on each floor. When the finished cans left the machines, they were dipped in an acid bath to remove the dirt. Then it was necessary to dry the cans quickly after they had been dipped before labeling them. The dipping was done on the lowest floor and the labeling on the top floor, an elevator being used to transfer the cans from one floor to the other. The elevator shaft was enclosed and a blower and heater fixed at the bottom of the shaft. As the cans were carried slowly upward, they were heated and the current of hot air about them vaporized the moisture, and carried it away. By the time they reached the top floor they were dry ready for labeling.

Narrow Gauge Tracks for Quick Service

NARROW gauge tracks either with or without power locomotives for hauling trucks are great time and labor savers in the plant. Not only is such a system useful as a method of transportation, but it also, if properly installed, ties each department with the next and provides a more or less flexible routine for handling goods.

Typical of this latter feature is the layout for the plant of the Utica Drop Forge and Tool Company (see Plate VI). The shop is so divided that work progresses from the rear or south end to the front or north end of the plant. The various departments are each served by the narrow gauge track. In but one point does the work retrace a path with this system. A loop is made from the inspection department to the grinding and polishing departments and back again as the work is inspected between operations.

The transportation system is in charge of truckers wholly responsible for it, so that the time of the men is not taken in handling work between departments. Regular schedules are made by the electric storage battery locomotive and cars, so that work is not held up in any department.

Truck for Handling Varnished Parts

THE storage of newly varnished pieces is an important problem in the factory, and from the nature of the parts they must be handled carefully and as little as possible. At the plant of the Gunn Furniture Company, the superintendent has devised several trucks which meet very neatly the conditions of the varnishing room. These trucks are made up of the ordinary four-wheeled factory type, with uprights placed at distances suited to different sized varnished parts.

The unique thing about the truck is the support used for the varnished parts. Screwed to the uprights are ordinary hinges, the free half of which projects to form a ledge on which the varnished surfaces rest.

This hinge has several advantages. In the first place, the narrow edge of the hinge affords a clean support for the varnished surface. A second advantage lies in the ability of the trucker to stack the varnished parts closely and easily. The hinges can be opened out so that the pieces will not be sacrificed in piling them up, and as fast as one piece is laid on the truck the hinges for supporting the next piece can be swung in to hold it without disturbing the freshly varnished surface below. Piled closely in trucks in this way the varnished parts can be moved readily to the section of the room devoted to drying out pieces. Each truck of parts is marked with the date on which it will be dry enough to receive the next coat, so that it is necessary to handle pieces only once after they have been freshly varnished

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Get the Product

ACCOUNTING has been classed as "unproductive labor!" Why, it is the most productive labor in the whole establishment; its finished product is not expressed in thumb-rule guesses but in cost knowledge born of facts. In some lines it has done as much to reduce cost of production during the past five years as have the mechanical inventions during the same period. *James Logan*

CHAPTER X

Making Environment Count on the Balance Sheet

WHEN heating is done by live steam a good deal of coal is wasted during the transitory months of the year, when warm and cold weather alternate. When a hot day comes suddenly, all the windows are opened and the boiler in the power house helps heat outdoors. A scheme has been put into effect at the new plants of the Grand Rapids Hand Screw Company, where, as shown in Figure I, each bank of pipes is divided into two independent sections, one of four, the other of five steam pipes.

When the weather is very cold, both sets of pipes can be operated. In milder temperatures steam can be turned into four or five pipes. These different degrees of heat can therefore be obtained by the addition of two valves and a little extra piping. The first cost is insignificant compared with the saving in changeable weather.

Saving Light Cost in a Textile Plant

BOTH individual and group electric lighting have respective advantages in the factory. For large areas, foundries, machine shops, textile mills and other establishments where there is plenty of over-head room,

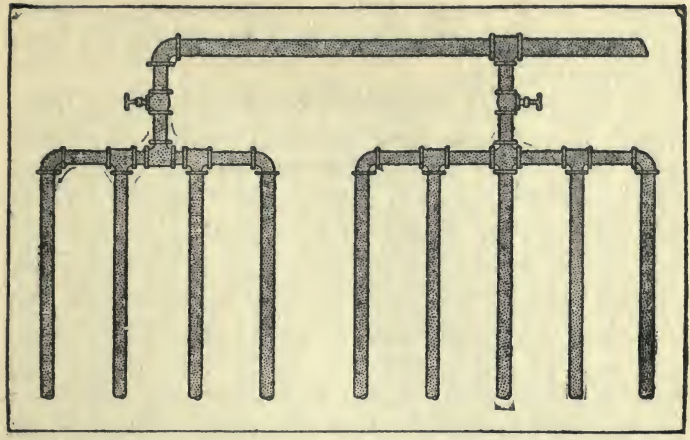


Figure I: An extra valve and two elbows permit economical steam heating combinations

electric arc lights with suitable diffusing shades are the most economical means of artificial lighting.

In textile mills this method of lighting is almost essential since color values are distinguishable most exactly by the arc light. Its spectrum is nearest that of the sun. To balance the light from the arc which has a tendency to travel around the edge of the carbons, a reflector is essential to distribute the light. Such an installation has been found satisfactory in the Olympia Cotton Mills in South Carolina.

For machine shops the same reflectors are desirable and good results have been obtained by this method of illumination. It is often necessary to provide auxiliary individual lights, for close machine work, however.

An Effective Individual Light

INDIVIDUAL electric lighting too often means a mass of overhead conducting cords and lamps which are in the way and interfere as well with the natural illumination. In a garment factory it is necessary, however, to light each sewing machine individually, as the work is necessarily close.

At the plant of Hilker and Wiechers Company, individual lighting has been installed without interfering with the natural illumination and without making use of unsightly drop-cords and shades. Double rows of machines run the length of the building, and the supply circuits for the lighting are strung on the under side of the machine benches. Midway between each two machines on opposite sides of the bench is a simple fixture built of quarter-inch gas piping. The vertical support is about twenty inches high and is topped by an elbow with a nipple, on which an ordinary keyed electric socket is screwed. A hemispherical reflector half encircling the bulb completes the simple device. The fixture is neat, inexpensive and effective.

How an Incandescent Lamp Increased Efficiency

GOOD light to work by is an investment too infrequently made in the factory. In comparison with the cost of labor, the cost of artificial light is trifling, but there are thousands of skilled mechanics who lose efficiency because of insufficient light.

A good electric system is undoubtedly the best and most flexible method of lighting. But, like other equipment, it must be intelligently installed and carefully maintained if the best results are to come from it.

For the ordinary factory the incandescent lamp is the most widely used unit of lighting. But general illumination is overdone; rather should the object be to install a high-power light placed at exactly the right position to cast the requisite amount of light directly upon the machinist's work.

In an eastern shop the combination of the general and individual lighting is ideal. The general lighting is cared for by fifty candle-power Nernst lamps. The individual machines have electric bulbs. The wiring is all below the floor and each lamp is held in a universal jointed fixture which permits it to be adjusted at any angle over the work. The lighting fixture does not take up any available space, because in this shop the machines are set back to back, and the fixture occupies a position between them. In such cases, particular conditions must govern the location of fixtures. (See Plate VIII.)

Such a method of lighting as this, besides the neat and workman-like appearance of the fixture, obviates the inconvenience of long pendant cords and "guy strings," which the workman inevitably adopts to hold his light in position. The wiring is also thoroughly protected.

After installation, such a system must be thoroughly maintained, and the lamps kept clean and in good condition. The result which follows from such an efficient lighting system can be figured out to the cent. Experiments have shown that a bare electric light bulb thirteen inches above the face-plate of a drill press and seven inches from the center gave 3.7 foot candles at the center of the face-plate. The dirtiest lamp in the shop was then substituted and gave 1.55 foot candles; while a new, clean lamp in the socket gave 5.7 foot candles. In other words, with the same current, a dirty lamp gave one-fifth the light a clean lamp radiated.

It evidently pays to polish electric bulbs.

Lighting That Increased Output

THE influence of sufficient and well distributed light in bringing about greater productivity is beginning to be more generally recognized among factory owners and managers. Two important aids which have recently come into use in this connection are "wire glass" and mercury vapor lamps.

Wire glass is a cheap article, which is just as effective in diffusing light and brightening dark rooms as the far more expensive prisms which have been in use for some years. This modern "wire glass" is furnished in panes of all sizes. A prominent automobile factory recently put up an addition in which the panes were all of this modern type of wire glass. The results were almost remarkable in diffusing the light in all directions, into corners and underneath vehicles in course of construction. The proprietors were so pleased that they put in new panes in the office part of their building, changing the entire appearance of the place and reducing their light bill by a large amount.

The other recent device mentioned—namely, the mercury vapor lamp—also possesses the peculiar and very desirable quality of diffusing light around corners, as it were. This light is best placed as high as possible in a shop, and the change from the brilliant light and dark shadows of the carbon arc to the soft and persistently diffusing light of the mercury vapor, is remarkable. The impression is most nearly that of daylight on a very slightly cloudy day. (See Plate XII.)

In office work the light is just as agreeable, except the disadvantage of all colors being changed, a red looking purple, a brown looking green, a blue looking pink, and so on. The principle of the mercury vapor lamp is very simple. A small amount of liquid mercury is inside a vacuum tube tilted so that the mercury remains in one end of the tube when the light is not on. When it is decided to turn on the light the tube is drawn into such a position as will insure a continuous stream

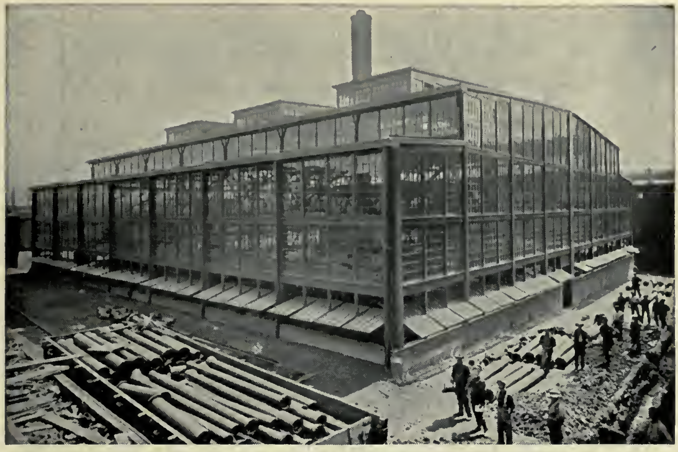


Plate XIII: Glass and steel are the principal building materials which make up this light, well ventilated foundry of the Michigan Stove Company. The air is clear fifteen minutes after a heat is off (See chapter XIII)

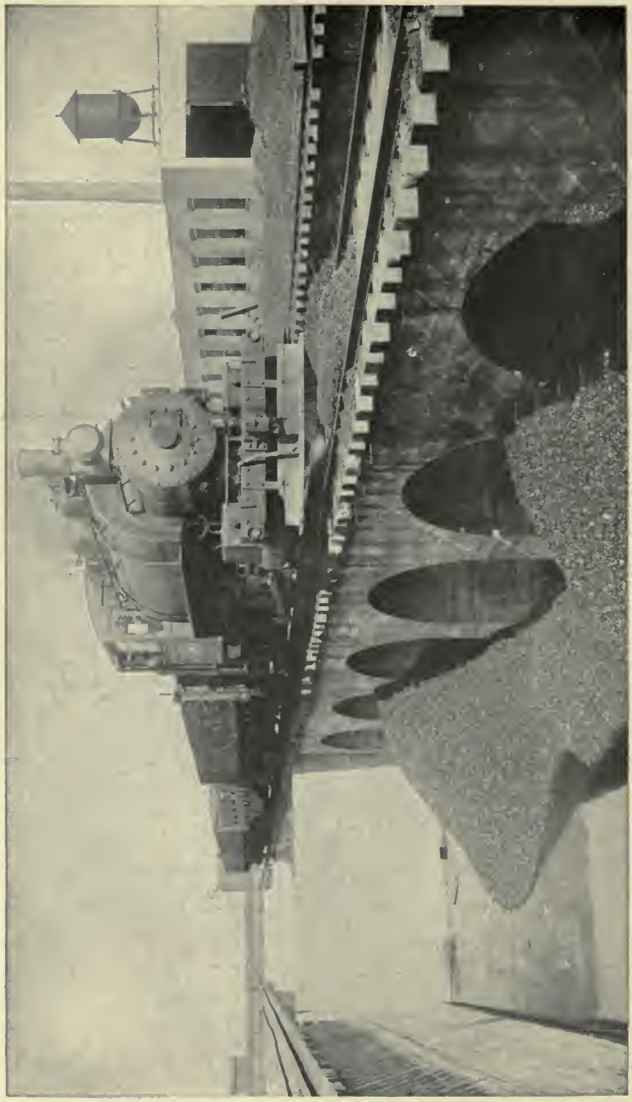


Plate XIV: Coal stored under water loses less of the gaseous components and thereby saves many heat units. The great cement lined bins shown here are used for under-water storage at the Hawthorne plant of the Western Electric Company (See chapter XIII) of mercury, making a liquid metallic connection between the two terminals, and closing the circuit. The electrical resistance of the mercury causes it to heat and vaporize, thus giving the light.

The power consumption of this light is remarkably low. It is claimed by the manufacturers that it is better than daylight for the eyes. The writer's experience with it is that no harmful effects have been observed. Office help are apt to complain on account of its color effect, but shop workmen, particularly where the light is at a considerable height over their heads, express unqualified praise for the light and its soft penetrating qualities.

Both of the above devices are likely to play an important part in modern shop betterment.

Economical Low Pressure Steam Heater

LOW pressure steam is a most excellent means of heating the factory. It has become particularly essential in the plant driven by a gas engine or by electric motors where high-pressure boilers are not necessary, or where, for other reasons, there is no exhaust steam to be had from engines.

A small factory for the manufacture of hardware provides a typical case. Electric motors are used to operate the machinery, and the electric current is generated by water power about eighteen miles away. The plant is a one-story structure 300 feet long and 136 feet wide, lighted by a saw-tooth roof. The height of the shop from cement floor to main beams under the saw-tooth roof is eighteen feet.

Two 100 horsepower boilers located in the forge room and fitted with automatic damper and feed water regulator supply steam for the heating system at a pressure of about fifteen pounds. Only one boiler is needed to heat the plant, but they are operated alternately so as to keep both in working order.

Steam is led to the center of the building in an eight-inch pipe, then delivered to separate coils. These coils are suspended from the main beams of the roof trusses at such a height that their lowest point is above the water line of the boilers. Condensation thus returns to the boilers by gravity.

By suspending the heating coils in this way, the roof is kept very warm, and troubles with snow and ice sometimes experienced with the saw-tooth roof are avoided. The heat, rising before it warms the lower part of the room, makes the roof warm. The boiler equipment enables a temperature of about 65 degrees to be obtained on the floor of the shop. This makes the roof considerably warmer, and no difficulty has been experienced with snow and ice. The gutters slope five-sixteenths of an inch per foot, and the water is conducted to a surface-sewer built below the frost line.

An Efficient Dust Collecting Hood

DUST collecting systems are of very general use in the factory, and form one of the great classes of protective equipment. Grinding operations in particular need to be thoroughly fitted with appliances of this sort. Details of the equipment are many, due to the classes of wheels and the work performed.

Cutlery involves a great number of grinding and polishing processes, and dust collecting equipment has to meet peculiar conditions due to the high speed of the polishing wheels and the nature of the work. At the works of the American Cutlery Company in Chicago, the dust collecting system has been very thoroughly worked out. The main exhaust pipe runs on the ceiling of the room below the row of polishing wheels. Risers through the floor with a special hood draw the dust from each wheel.

This hood is of unusual shape, not unlike a reflector for an electric light bulb, and has been found the most satisfactory form of hood, after much experimenting. It leaves the wheel free and at the same time catches the flying particles and sucks them into the conducting pipe.

The Ambition That Wins

ALL the great works of art, literature and science are great because they are part and parcel of the being who created them. They are the expression of an ideal, developed by intense application, not for love of gain, but for the love of achievement and the desire to excel.

The man who looks upon work merely as an everlasting grind, who is always looking for the quitting time, will never do really good work, for his heart is not in it. Of this kind of workers there is an over-supply in the world, and so the price is low.

But the man who works because he wants to accomplish—to do something better than it has ever been done before—to be a prize winner in the race for success; to him the whole world is open. *Walter H. Cottingham*

CHAPTER XI

Protecting Against Accident and Fire

OIL and inflammable liquids are bad fire risks in the factory. "The can of gasolene must stand on the fire escape over night or the janitor loses his head," said a factory manager. Several plants have very stringent rules for the use of inflammable liquids, but they are not enforced. Better have one rule and enforce it.

A small brick and tile building at the Western Electric plant houses all gasolene each night. The structure is completely isolated from the other buildings, and here at the close of work all gasolene is brought.

At the same plant the air oil house is placed next to the boiler room with a direct steam pipe connection through the dividing wall. If a fire should break out in the oil room the turn of a valve in the boiler room fills the oil room with live steam. A perforated pipe at the roof does the work. No fire can live in live steam.

Two Guards That Save Accident Expense

WOODWORKING machinery on account of its high speed is a prolific source of accident in the average plant. "Don't monkey with the buzz saw," is one of New England's colloquial proverbs, to which too many four-fingered men call attention.

A particularly neat device for guarding the buzz planer is shown in Plate X. A many-tongued circular guard covers the revolving knives. When a piece of work is pushed against the guard, a number of fingers corresponding to the width of a piece retract like the claws of a contented cat, while the rest of the high-speed cutter remains covered, so that the workman's fingers are safe.

Somewhat less automatic, is a sliding cover with adjusting thumbscrews. The cover completely envelopes the knives when no work is being performed. The cover is adjusted to various widths of work by sliding it parallel to the knife-bar and away from the guide, gradually uncovering the planer knives.

Economical Hinged Belt Cover

BELTS form a poor accident risk unless carefully shielded. Horizontal overhead belting is in general safely out of the way, although the oiler should be compelled to wear tight sleeves and his jumper tucked inside his overalls.

But vertical belts and short lines of shafting near the floor must be carefully guarded. Railings are often used for this purpose, but netting or metal belt covers are better. In one plant where the saw-tooth roof makes jack shafting necessary on the floor the shafting is completely enclosed by netting six feet high. Wooden or galvanized iron guards form a suitable means of protecting running belts, but these should be hinged in sections, so that the belting is easily accessible for repair or inspection.

Plate XI shows a neat and very efficacious belt guard tested with satisfaction at the manufacturing plant of the Sherwin-Williams Company. It is worth noting that the photograph also emphasizes another point: the necessity of inspection of protective equipment, if the best results are to be expected. Thorough factory inspection, coupled with careful analysis of accident cause and prevention, will put an end to "out-on-pay" cases, altogether too prevalent in the United States.

A Sprinkler System That Will Not Freeze

STORED lumber necessarily forms an unusual fire risk in the factory, and, since lumber is usually stored open to the weather or at best in covered sheds, the sprinkler system as ordinarily used would be liable to freeze.

One large woodworking industry has installed the dry sprinkler system for this purpose. In the dry sprinkler pipes, air under pressure takes the place of water. The water is brought into one end of the lumber shed, and there in a small steam-heated compartment is located a special air and water valve. The compressed air in the pipes balances the water pressure on the other side of the valve. When a sprinkler blows, the air pressure falls and water fills the system.

Another sprinkler scheme used in a machine shop built of non-combustible materials, protects the bases of the steel roof supporting columns should any inflammable material be piled at the bottom of the posts. Around each steel post, about fifteen feet from the floor, is arranged a "crown" of sprinkler heads. These in case of fire discharge directly at the base of the posts.

Furniture That Prevents Fire Loss

NON-COMBUSTIBLE equipment for factory offices reduces the fire risk and consequently the insurance rate. Steel lockers, desks, filing cabinets and tables are now available and should be installed, if the ideal of reducing fire risk is to be reached.

The modern sanitary desk even in wood is a step in the right direction, since it uncovers one more spot where rubbish might accumulate. One of the largest electrical concerns in the world is rapidly replacing all its wood equipment with steel or fireproof wood furniture. It is really an illogical state of affairs to build a cement steel building with metal window frames, wire-glass windows and cement floors and then fill it with wooden furniture, waste baskets, lockers and wooden office partitions. Such a building makes a good stove.

Organizing Against Fires

NO matter how thorough the equipment, apparatus for fighting fire in the factory works at low efficiency, unless there be organization. Even a less complete fire protective equipment, if complemented by a responsible routine in cases of emergency, will be more reliable than the elaborate apparatus.

Fire organization at the works of the Western Electric Company is excellent. Two sets of men make up the force, night watchmen and volunteer firemen. The night patrol service boxes are connected with the system of the American District Telegraph Company, so that if a watchman misses a beat, or fails to ring in at regular intervals, this fact is known at once at the office of the telegraph company, which telephones on a special wire to the factory watch headquarters.

In dividing the work of this night patrol five men watch from 5 o'clock in the afternoon until 12 midnight, and five other men from midnight until 7 in the morning. One man relieves and one man is off duty every two weeks with full pay.

The members of the fire brigade who serve during working hours are made up of volunteers of the shipping department in the various buildings. Men in these departments are chosen since their absence will interfere least with the regular factory work. The brigade is divided into three sections and made up of fifteen men, with a captain and two lieutenants. Each section includes either the captain or one of the lieutenants. For duty in the fire houses on Saturday afternoons and Sundays, four men out of the brigade are picked.

This brigade is drilled once a week, generally by pulling a box, or by testing some of the fire apparatus. One of the unique features of the equipment for getting men on the ground quickly is a hand-car, which stands ready on a track behind the fire department headquarters. On this car, men can get to the lumber yards at the opposite side of the plant in quick time without tiring themselves unnecessarily. Besides the regulars, certain members of the works' staff answer alarms.

Strict routine is laid out to be followed in case of fire. Every foreman in the plant has a set of instructions which cover the detail of fire protection apparatus in his department. The entire plant is inspected every two weeks by the building inspector. The insurance inspector, a technically trained man, also goes through the plant at regular intervals. Both look for causes and suggest remedies.

Inexpensive Shield for Set Screws

RULES regarding safety are strict in many shops. In one factory when a workman finds his machine out of order, he is not allowed to touch it until it has been inspected by the foreman and his permission obtained to run the tool. The company believes that the

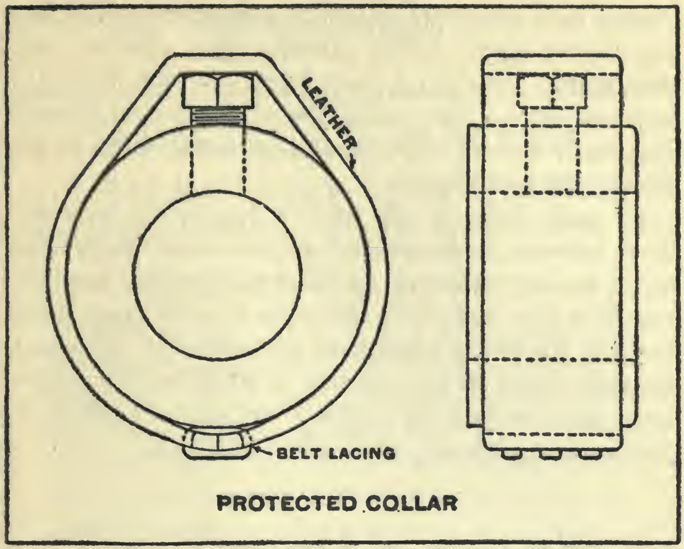


Figure I: By lacing a bit of belting around projecting set screws The Lidgerwood Company prevents accidents

time lost in following out this routine is more than made up by saving of money spent for "sick leave."

Couplings made with counter-sunk screws eliminate a prolific source of accidents, but a factory manager need not be deterred by expense from eliminating set screw troubles. The illustration shows how a bit of belting can be laced about a projecting set screw so that it can not catch in a man's clothing.

An Emergency Engine Stop

IT'S a long way from the third floor of a machine shop to the engine-room when a man's life depends on stopping the line shaft. Even the telephone takes time.

At the plant of the A. S. Cameron Steam Pump Works, the turn of a switch shuts down the factory.

Placed with its red letter sign in a conspicuous location, the electric signal button makes a most effective accident alarm. Nor has it been found essential in case of accident alone. The usefulness of the system is more frequently proved when repairs are being made on the transmission machinery.

No need, then, to lose time in journeying back and forth between the department and the engine-room when a belt breaks. One ring means stop, two rings start the engine slowly, and if the belt runs in good shape, three rings in the power house send the engine at full speed. In some shops an annunciator is added to the engine-room gong so that the engineer can tell at a glance in just what department the trouble is located.

Science in Using Time

TO the primitive savage, time is of no importance. With the progress of civilization, however, it steadily increases in value. As one desires more, he must produce more. Yet time is fixed. Production must therefore be more rapid.

So time has multiplied in value, because it stands for amazingly greater results. To the business man most of all, time has become a huge asset—his first item of capital. The wise executive invests his minutes where they will bring the greatest results—in working efficiency, in quantity and quality of output.

Part IV

MAKING THE BUILDING HELP PAY PROFITS

Build to Fit Business

STOP the little leaks. Take a look around your plant tomorrow with an eye for the little mistakes in building that are costing you cash each day—the little monuments to careless construction that let profits dribble into loss. No plant was ever so perfectly built that daily scrutiny will not reveal new opportunities to improve.

Changing conditions in your work make the old accommodations obsolete. Be alert to the demands of circumstance. Building to fit your business means greater efficiency, greater returns.

Your factory may be old—don't let that tie you down. A few dollars for lumber and a day's time will put a mezzanine floor for cases in the packing room and cut trucking expense in half.

Wire glass windows in the grinding room save bills for plain glass broken by flying knives and add to the shop's appearance.

These are but two out of a thousand schemes. Look for just such chances to pick up straying profits in your own plant. Keep your factory up to date—it pays.

CHAPTER XII

Building Plans That Save Money

THE newspapers not long ago told the story of a young man who built a steam launch in his room at the boarding house. After getting the craft finished, he discovered that he couldn't get it out by doors or windows. His landlady refused to let him tear down a part of the wall and instituted legal proceedings because the weight of the boat endangered her house.

This unwise boat-builder was in the predicament of a good many factory managers who fail to plan ahead. The time to decide on the location of departments is before the factory is built. The power house in these days of electrical power should be centralized with respect to the other departments so that the transmission lines will be short. If water or steam power and line shafting is employed an effort should be made to have the buildings, necessarily parallel or at right angles to each other under these conditions, logically arranged with respect to production. Don't forget that the straighter the lines of production the more efficient to the shop. The factory cost of your product often tells a story of an unappreciated waste.

A cost expert recently put his system into a rubber mill. The plant was electrically driven, with the departments grouped about the power house, each department with its separate stores of raw materials. A great deal of time was wasted in handling these materials and the scattered stores were harder to keep tab on. The power plant was moved to the rear center of the plant and all the raw stores were assembled in a big central storehouse located in place of the old power house. The change was simple and easily made, goods were received, disbursed and checked accurately and the entire course of production untangled to a remarkable degree.

One of the largest electrical concerns in the country is reputed to pay a man $50,000 a year to look over the plants, re-arrange them and cut down losses due to ill-made initial plans. It pays to think ahead, when profit and loss may turn on the location of a wall or door.

Putting up a Plant in a Hurry

ON June 25th, 1907, the plant of the Utica Drop Forge Company was entirely destroyed by fire. Eight months later a new factory was put in operation. Some novel methods of construction were adopted by H. W. Kelleman, the superintendent, to build the plant quickly.

When the plant burned, the employees were given the opportunity to remain at their old wages—and rebuild the shop. Practically all the men at once elected to do this, and the second day after the fire they were set at work clearing up the ruins.

To get the outside work done and the machinery under cover before fall, the most easily obtainable material and that which could be erected the quickest was selected. Wood framing, side walls and roof, and wrought iron pipe supporting columns make up the structure. Concrete foundations are used and the wooden side walls are so constructed that they can be replaced by concrete or brick later without interrupting in any measure the regular routine of the factory.

Although the roof and partitions are of wood, they are well protected by the sprinkler system. Moreover, the floors are of concrete, and the forge department is isolated from the rest of the building by a concrete wall, so that excellent insurance rates have been obtained.

Making the Most of Floor Space

TO MAKE the most of floor space in a plant the machines must be studied as a combination of producing units. Only by relating each machine with the others in such a way that production will follow in straight lines without confusion, can the highest economy of operation be attained.

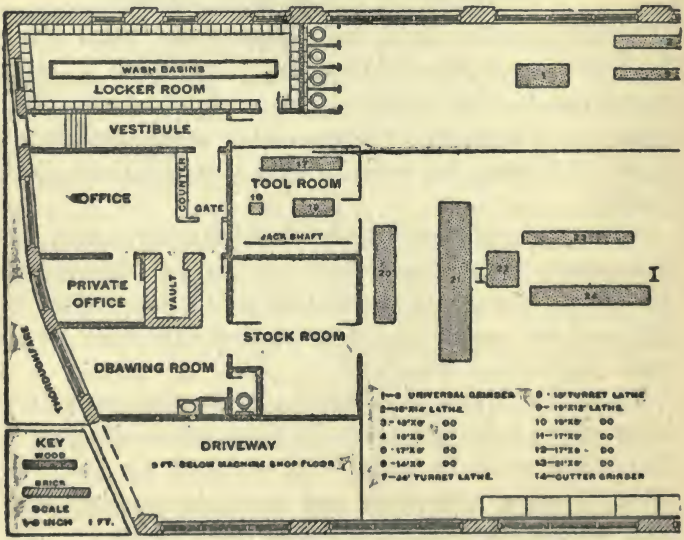
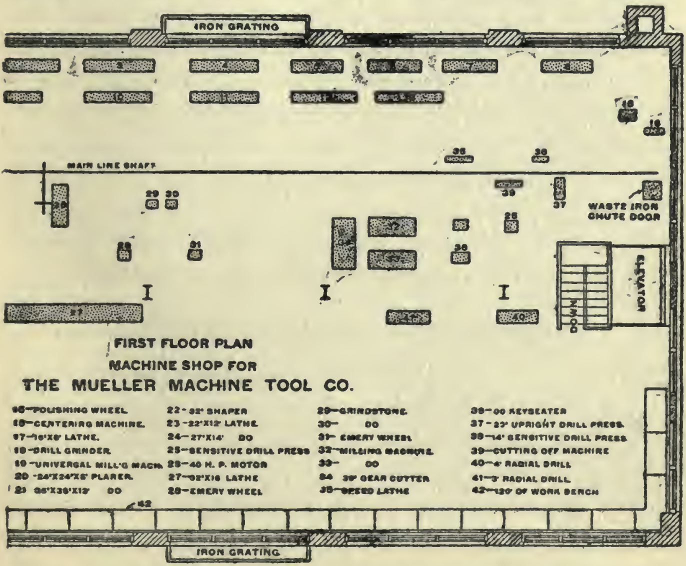


Figure I: In this machine shop of the Mueller Machine Tool Company, floorspace

If it seems best to build but one crane run-way, the heavier machine tools should be so placed, not only that the work can be turned out systematically, but that advantage can be taken of the crane in handling heavy parts at the machines.

Economy in construction argues for special machine foundations in as centralized a location as possible. A balance must be struck between the expense of special foundations at odd points and stretching the line of production a little in order to place the machines in the heavy foundation area.

Shafting arrangement also enters into the question of economical arrangement. Considered in time, the height of the shop roof may be gauged so that belt lengths to machine tools will be correct and adjustment of countershafting unnecessary. All these points



is well utilized by arranging the machines logically with respect to production planned ahead mean a saving in dollars and cents when construction begins.

In the shop floor plan shown in Figure I, all these points have been considered, as well as many others. A thoughtful consideration of this sketch will bring out clearly the advantages of orderly arrangement.

Raw material is unloaded in the basement by a crane and reaches the machine shop floor by way of the elevator.

At this point the construction work on the parts is divided; the lighter parts travel down the length of the shop, and the various operations are performed on the lathes. Cutting off and centering machines are located near the starting point. The heavier portions of the product are machined on the erecting side of the machine shop where heavy lathes and planers are set on concrete foundations.

This row of heavy tools is also placed near enough to the erecting side of the shop so that the same traveling cranes serve both the erecting floor and the heavy tools. The shop is driven by a forty horsepower motor, chain-connected to the line-shaft, which is divided into three sections by clutches. In this way it is possible to run a short length of shafting without running all three. The motor in the middle of the long line-shaft also divides the strain so that a lighter construction is possible.

Profits from Cement Construction

CEMENT is extremely useful building material for the factory. Monolithic, brick-sheathed and cement block buildings are all suitable for manufacturing. The General Electric Company recently erected a new factory office building between two older brick structures. The shell of this new building was constructed of cement and a single course of brick overlaid, to match

Plate XV: To save coal in winter the shipping platform is built inside the building so that a sliding steel curtain will enclose it. (See chapter XIII)

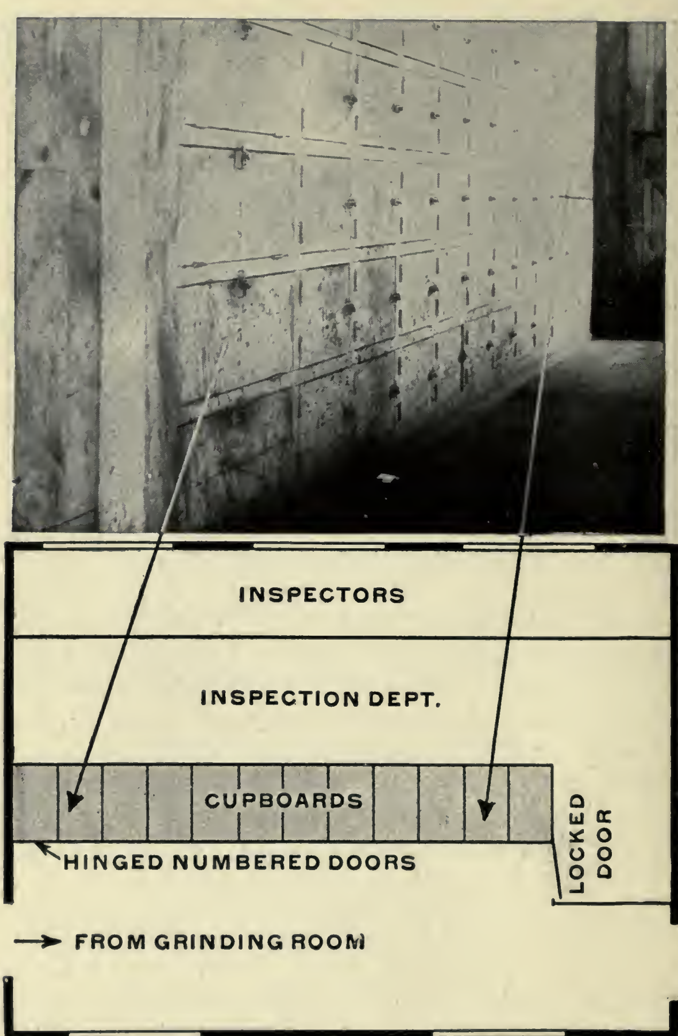


Plate XVI: This arrangement of cupboards for the inspection department at the Northampton Cutlery Company's plant systematizes the handling of the grinders' jobs and frees the inspectors from interruption by the workmen at all times of the day (See chapter XIII) the trimmings and general exterior of the earlier construction. The effect is excellent.

At the foundry of the H. W. Caldwell & Sons' plant in Chicago, a molding gallery has been built in the foundry. A thick cement floor has been found very satisfactory.

In addition to its uses in the buildings, proper cement is being used to good purpose for many details of construction. Industrial railway tracks embedded in cement concrete stay put. Heavy machine tools are proof against vibration on cement foundations. Either anchor bolts are set into the cement to hold the machine or the weight of the bed suffices. In a railroad shop the motors are supported on cement concrete platforms, swung from beneath the galleries on structural steel framework. This makes an enduring construction and does away with the wooden flooring generally used for the purpose.

The Grand Rapids Hand Screw Company have found cement useful in a variety of ways. Lumber costs money nowadays, and all that can be saved is worth while. In piling lumber at this plant, parallel cement supports have been laid at right angles to the freight tracks. On these, lumber is stacked to dry in the usual way. The boards ordinarily lying on the ground are saved and the permanency of the construction facilitates the handling of the incoming stock.

Penny Regulations That Save Dollars

IN a big plant, building inspection is just as important as in a city. It probably saves proportionately more dollars than any other equal expenditure of costs.

Rules as to floor and wall loads, fire protection and building administration in the Western Electric factory are so thorough and well defined as to amount almost to a science in themselves.

If a workman leaves his overalls rolled in an oily bundle under the bench in one of the big manufactories, the watchman has orders to destroy them. In the same plant the safe load for the floor is painted on the wall just inside the door. A building inspector is responsible for the enforcement of the regulation.

Out in the shops, white lines on the floors mark out the aisles so that the crane man in handling material and parts with the big electric cranes will not block a passage through the departments.

To insure the carrying out of the rules, strict obedience is demanded. If a watchman finds the gas burning or a can of benzine in the factory, his report goes direct to the superintendent.

To guard against fire, only safety matches supplied by the company can be used.

Team Work

TEAM work, cooperation, these words are what count in football or the manufacturing game. To have every workman intent on his job, to have each foreman interested in pushing his end of production, to have every department head working in a common cause without rivalry, these insure ideal conditions for the economic use of time and materials which makes the factory, large or small, a winner at production.

CHAPTER XIII

Building Equipment That Increases Output

THE secretary of a woodworking plant in Grand Rapids had a unique experience in connection with building his new factory. Riding home one night he overheard this dialog between one of his own workmen and an employee of a prominent concern located in the next block.

"Where are you working now?" asked the manager's workman.

"Neighbor of yours," said his seat mate; "but I don't think I'll stay long in the shop."

"What's the matter? Don't you like your job?"

"Yes; job's all right, but I don't like the shop. I've lived in the country and I like to see the grass and trees. I feel as though I were in a prison with those ribbed glass windows. I wouldn't lose any time looking at the scenery, but it makes working worth while. I'm going to quit next week."

To give a well diffused light, ribbed glass is often used in factories and this had been the secretary's idea. After overhearing this conversation, however, he changed his plans—the upper sashes are glazed with ribbed glass, but the lower sashes are clear.

"Good workmen are not too numerous in this town, and if the window construction will help me to keep my men, I'll build the windows accordingly."

In the same factory the window sills are laid in cement instead of showing an unfinished brick surface. In his old shop, the manager had noticed that moisture, trickling down the panes, settled in the upper courses of brick and rotted the lower wooden window sill. For twenty cents additional per window, the contractor laid the last course of bricks in cement and coated the sill foundation with the same material. This not only made a smooth and workmanlike job, but gave a waterproof surface.

A Foundry That's a Crystal Palace

FOUNDRY lighting and ventilating, on account of the working conditions, are particularly difficult. The Michigan Stove Company's foundry construction is therefore particularly interesting. This foundry was surrounded by high buildings, and for that reason was hard to ventilate and light.

As shown in Plate XIII, steel and glass are the principal materials of construction. The main structure is of steel resting on a six-foot brick wall. The building is square, 128 feet on a side, is fifty feet high to the top of the monitors and forty feet from the floor to the highest point of the roof proper. The side walls are thirty feet high with girders spaced sixteen feet between centers.

Before working out the details of the window construction a small model was constructed and the monitors finally built were the result of careful study. Three parallel monitors were built, arranged crosswise on the roof. Every second window in the monitors is arranged to be opened. All the other windows in the building are stationary except the lower row just over the foundation wall. These are all pivoted to swing open.

So satisfactorily does this window construction ventilate the building that fifteen minutes after the heat is off, the air in the foundry is clear.

Twenty-eight Per Cent in Storing Coal

UNCERTAIN coal supply, due to strikes, lack of cars and other conditions beyond the manufacturer's control, make the problem of coal storage a vital one. At the Hawthorne Works of the Western Electric Company, the problem has been solved by storing coal under water. Two underground cement lined storage bins, one of 4,000 and the other of 10,000 tons capacity, have been built. These pits are open at the top and are bridged by full gauge, parallel railways, as shown in Plate XIV.

Coal is either dumped directly into the pits from gondola cars or unloaded by a grab bucket crane, mounted on a car and drawn by a locomotive.

When coal is required in the power house, it is loaded by the same crane into dump cars and hauled on an elevated railroad to the bunkers over the boiler house. The coal in the pits is entirely covered by the water, and by keeping the bins flooded the company expects to reduce the losses in stored coal from 30 per cent to 2 per cent.

Giving the Workmen Good Light

SAW-TOOTH roofs furnish excellent lighting for single story buildings and for the top floors of multistory buildings. Like all exposed areas, however, some difficulties are present with this type of roof. There is considerable trouble due to leakage, and in hot weather the "greenhouse" nature of the construction is liable to make the floor below unduly warm unless ventilation is carefully provided for.

The arrangement for heating and ventilating the buildings of the Utica Drop Forge and Tool Company's plant has been successful in conjunction with the saw-tooth roof type of construction. All windows on the side of the building are arranged to open; the roof windows are permanently closed except in the forge department. Thirty-six thirty-inch ventilators are mounted on the roof of the plant, which is 300 feet long and 136 feet wide. These can be opened in summer and closed in winter. The ventilators in the forge department are fitted with smoke flues which terminate in hoods directly over the forge and operator. An opening in the upper part of each flue allows the heat and gases in the upper part of the room to escape.

Troubles due to saw-tooth roof leakage have been remedied in the plant of the Farr Alpaca Company's Holyoke, Massachusetts, plant, by an especially thorough arrangement of drainage gutters and drip downtakes.

The details of construction are shown in Figure I. Each tooth in the roof is supported so that it pitches properly from the high points to copper bowls from which the water is taken. Water of condensation is caught by a small copper gutter connected to the roof down-takes by small lead pipes. The water in the trough outside is carried in gutters of special construction, which is made clear by the illustration.

To make the trough tight, unusual precautions are taken. A sheet iron gutter is laid over asbestos one-sixteenth of an inch thick. This lay of asbestos and sheet iron covers the bottom of the trough between the glazed side of one tooth and the wood-roofed side of the next tooth, extending up to within three inches of the

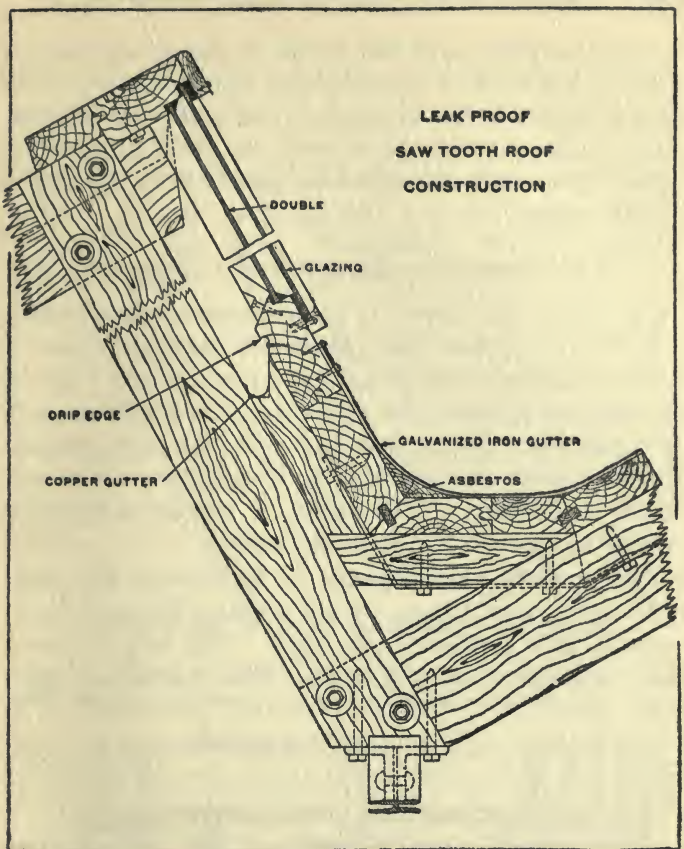


Figure I: The construction of a leak-proof, saw-tooth roof in an alpaca factory is here shown

glass on one side and for two feet on the roof opposite. The galvanized iron makes the roof firm to walk on and covers all defects in the planking, while the asbestos prevents moist air in the room below from condensing on the iron and dripping back into the room. A regular roofing material of five-ply asphalt is then laid in pitch over the whole.

For carrying away the water, copper bowls are set into the roof, each connected by a copper pipe to the sewer system in the basement. The down-take supporting column is made of channel iron. To protect this down-take pipe a galvanized iron shield is fitted over the copper pipe.

How Sewage is Economically Disposed of

WHEN the factory is located apart from a regular sewer system, the question of sewage disposal is often a difficult one to answer. Even if the plant is located on a river the pollution of the stream must always be guarded against and solids cannot be drained into the creek without bringing about bad sanitary conditions. Moreover, this course is rapidly being outlawed by the various state legislatures.

Under these circumstances the septic tank can often be adopted to advantage. Such a system has proved successful in a railroad repair shop. The tank is shown in the accompanying diagram. The closets and wash

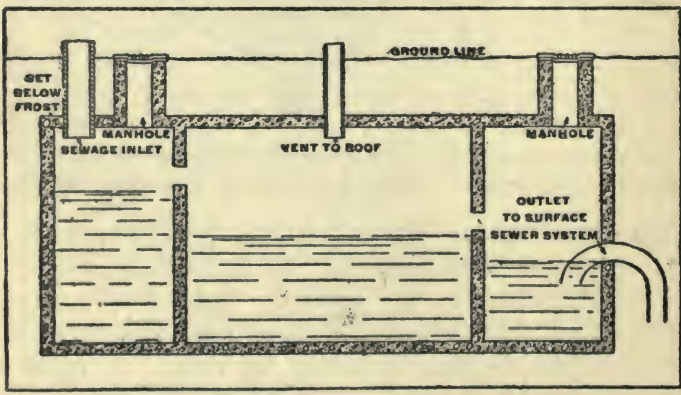


Figure II: A septic sewage tank for taking care of the sewage from an isolated factory basins are located on the second floor of the shops and are piped to a cement reservoir set in the ground below frost line. The tank is divided into compartments as indicated. When the sewage is trapped in the various chambers, a bacteriological action takes place so that the effluent from the end opposite the entering sewage is practically clear water. Periodically, at long intervals, the solid matter left in the chambers can be taken out through the manholes.

The outlet pipe from the tank is connected with a regular surface sewer which carries the drainage from the buildings. This surface sewer discharges into a piece of waste land near the plant. So well does the septic tank do its work that there is no trouble of any kind at the plant. A septic tank is built for each department and all discharge into the common surface sewer which carries away the roof and ground drainage.

A Money Saving Shipping Platform

ADVERSE weather conditions often interfere with shipments in the factory. To handle heavy machinery with the least effort it is customary to have the shipping platforms of such height that trucks can be backed directly against the structure, so that the loading can be accomplished without lifting considerable loads unnecessarily. Generally this requirement, however, necessitates an open shipping platform exposed to the weather, and not only do the shippers work at a disadvantage in the cold or wet, but a good deal of steam is wasted in the endeavor to heat the shipping room when the doors are open.

In large plants, special covered shipping floors are, of course, possible; but in the small plant, rather than go to the expense of building a covered addition, shipments are made in bad weather from an open platform under adverse conditions.

In the new machine shops of the Mueller Machine Tool Company this difficulty has been overcome by making the shipping platform contiguous to and under the same roof with the assembling floor. From the driveway outside the shop, the wagons are backed into the building through a twelve-foot doorway provided with a sliding steel curtain. (See Plate XV.)

When the weather is inclement this doorway can be closed and shipments made under good working conditions. The floor of the driveway within the building is three feet lower than the assembling floor so that the bed of the truck comes about flush with the erecting floor and the goods can be transferred to the wagon without trouble.

This enclosed shipping platform is about twenty-five feet long and twelve feet wide. Owing to the design of the building but a small part of the length encroaches on usable floor space in the erecting room. The greater part of the length parallels the partition wall of the factory offices which are under the same roof.

Built in this way, too, the cranes which serve the erecting floor can be used advantageously in handling the outgoing product. This design saves the expense of continuing the crane runway to the outside of the building over an exposed shipping platform.

The floor of the driveway is laid in vitrified brick and drains towards the center and towards the street. A steam radiator placed on the outside wall ledge helps keep an equable temperature in the shipping room. The entire scheme is a simple, but effective, method of handling goods quickly in bad weather without causing inconvenience to the men on the erecting floor.

In the city, where ground space is valuable and the shipping carried on in a crowded thoroughfare, such a scheme not only has the advantage outlined, but has an added reason for consideration in that the loading can be done without mutual interference between the shipping and the public traffic of the thoroughfare.

Where Underground Pipes Save Floor Space

IN all grinding and polishing work it is necessary to provide a very complete system of exhaust pipes to carry away the dust and other particles thrown off from the polishing or grinding wheel. Piping for this exhaust system necessarily takes up a good deal of space, which interferes not only with the light, but with the working space about the polishing machines.

In the polishing room of the Fox Typewriter Company, a very ingenious arrangement has been worked out, which takes that pipe out of the way of the men. The emery grinders are set in a row facing the windows on the basement floor. The exhaust piping is made of sections of tile and is laid underground, and the hoods from the various wheels are connected direct to this underground piping by the usual galvanized iron ducts.

Electric wiring can also be put under the floor to good advantage. At the plant of the N. P. Pratt Laboratory, Atlanta, the floors are laid of pine blocks, four inches square and two inches thick, set on end on a four-inch layer of concrete. The blocks are laid in a coal tar mixture and the cracks are filled with the same preparation.

The main electric circuits are run through the shop in conduits. To wire from the conduit to the motor, all that needs to be done is to remove a row of pine blocks leading to the nearest conduit and drill a hole through the roof of the duct. The conduit is then laid in the trench by removing the five blocks.

A V-shaped section is sawed from the blocks to fit over the new length of conduit, the blocks are re-set and the wires are then drawn through the conduit and connected with the motor.

This not only makes a neat and workmanlike job but the machines can all be used independently of the main conduits.

An Inexpensive Roof Drainage Scheme

ROOF-GUTTERS and spouts are items of material importance when depreciation charges are figured. Not only do they deteriorate quickly, but leaky gutters cause much damage in shops where the product is affected by dampness.

This difficulty with gutters is also greater in cold climates where there is a heavy fall of snow. A thaw followed by a hard frost will put all the surface water piping out of commission in short order, with good chances that some of it stays out of fix.

For this reason one of the newest Canadian factories is built with an overhanging roof from which the water drips directly on to cement "spatter-boards" which are drained to the sewers. Over the shop entrances, deflecting gutters are placed.

Shop Floors for Good Service

IN a New England mill is a form of floor construction which has been used there for some twenty-five years. The engineers there are especially enthusiastic over tar concrete sub-floors for factories.

The advantages of wood flooring for the lower floor of a shop in comparison with any other flooring, especially where men have to stand at their work, are too well recognized to require discussion. The wooden floor, moreover, permits great flexibility in changing the position of machines for which special foundations are not necessary. A wooden floor, of the ordinary construction, however, involves some fire risk and is liable to decay, especially when laid close to the damp ground. By placing a sub-floor of tar and crushed stone beneath the wooden floor, the resulting construction not only costs less than piers and head timbers with the excavation necessary to keep the required air space beneath a wooden floor, but also makes possible a fire-proof construction and gives an absolutely rigid floor for the shop.

Such a floor is built up in four layers similar to those shown in Figure III. The first or foundation layer consists of crushed stone, screened gravel or cinders mixed with enough tar so that it will compact properly under a roller or maul in a form to receive the second coat. If the ground is soft and additional strength is required, a foundation of cement concrete is desirable.

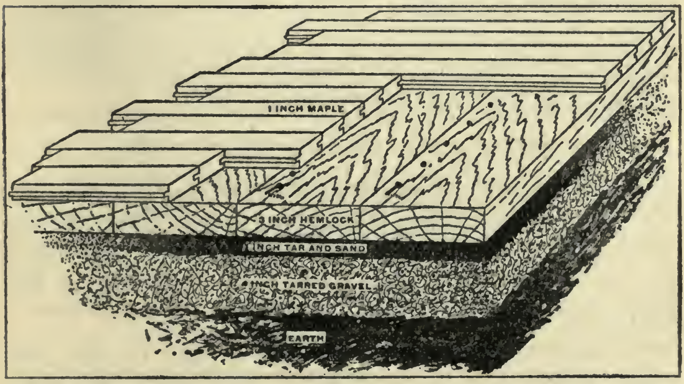


Figure III: Four layers built up as shown insure a moisture-proof, permanent shop floor

The second layer consists of fine sand or other material mixed with enough heavy refined tar or soft pitch to coat each grain of sand thoroughly and to fill all voids. If the voids are not all filled properly, moisture from the ground will reach the planks and cause decay.

Decay is, of course, the principal danger to be guarded against in placing the third layer. The plank must be thoroughly seasoned and dry. If the hardwood floor is laid on moist planks, the moisture may cause dry rot.

When this construction was first used it was thought necessary to have stringers or nailing strips on which to lay the planks. This is thought now to be unnecessary, and planks are laid directly on the soft tar concrete, leveled by pounding and then toe-nailed. This method of construction gives a floor with no space beneath the plank for moisture to get at. When stringers are laid directly on the foundation of coarse material and the space between them filled with tar and sand, there is nothing to prevent moisture reaching the floor from the ground. On the other hand, if the stringers are laid on top of the tar and sand, the air space beneath the plank increases the fire risk. When electrically driven machines are used, however, this latter scheme makes a neat method of wiring up the machines, as the conducting conduit can be laid between the stringers.

Drying Varnish by Electricity

VARNISHED parts necessarily have to be prepared under as dustless conditions as possible. In one plant, cement floors save refinishing; in another, sheet iron has been tacked to the wooden floor to prevent the dust from flying.

A simple and effective scheme is used by the Fox Typewriter Company for drying the varnish on typewriter frames. The high finish on the machines makes necessary most careful working conditions.

Gas has been used for heating the tin-lined storerooms in which the frames are dried, but trouble has been experienced with the moisture in the gas which condenses on the inside of the rooms and on the parts. Electricity for heating has proved very effective. An electric radiator is placed in the drying oven with an indicating switch on the outside. The temperature can be adjusted to any desired degree. The heat is dry and clear. It would be possible to rig up a thermostat in connection with the electric switch so that the temperature could be maintained automatically. But this adjustment of temperature is performed satisfactorily by hand, by watching the thermometer registering the inside oven temperature, and varying the heat of the radiator by the indicating switch on the outside.

Department Arrangement That Paid

PIECE WORK means careful inspection and the inspector must be unprejudiced in passing work. In the small shop where all are acquainted, some natural difficulties may be met in getting judicial inspection.

By a suitable arrangement of the inspection department, the superintendent of a cutlery plant cut out this difficulty and eliminated jealousy among the workmen.

It had been customary for the grinders to bring their boxes of work to the inspection department and to learn who was to inspect that particular lot by talking with the inspectors.

The diagram and photograph given in Plate XVI show how the difficulty is overcome. The inspection room is partitioned off from the hallway by a wall of cupboards with numbered, hinged doors. Boxes for the work are similarly numbered. When a man brings his work to be inspected he slides his box into the cupboard of the corresponding number. The backs of the cupboards are open and the inspector, unseen by the workman, takes out the box, carries it to the bench and looks over the work. He checks the job for damaged pieces and replaces the box in the cupboard where the workman can get it and make good any spoiled parts.

The scheme is simple and practical and has worked out well. In cases in which an understanding might exist between workmen and inspector, the chance for such coalition is done away with. The workman does not know who inspects his work and must rely on its quality alone to pass it.

Personal Contact Pays

I try to go through the shops as often as I can, to shake hands with the men and talk to them of their work. I do not believe an employer can be too familiar with his men; I have never found that I endangered discipline so.

I know all my superintendents, foremen and office men intimately and many of the workers in the shops are my old friends.

My personal contact with my employees and the establishment of friendly relations with them is the chief factor in the success of my business.

Richard T. Crane