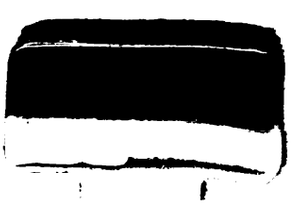
Success In the Small Shop



Success in the Small Shop

Success in the Small Shop

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FOREWORD

"SUCCESS IN THE SMALL SHOP" is the reality worked out from a definite idea in technical journalism in the machinery-building field. Early in the year 1914, there came into the possession of the American Machinist a mass of statistical information in regard to the machine shops of the city of Cleveland, Ohio. An analysis of these data gave a number of plotted pages and editorial comments published in September and October of the same year. But a more important result came from the study of the records from those 400 shops when it brought a new realization of the relative importance of the small shops compared with the large ones.

In number the smaller are perhaps in the ratio of 9 to 1 to the larger; in variety of work they cover all kinds of metal working and machinery building from the highest type of manufacturing to the simplest job of repairing; in equipment they have everything from the most highly developed, up-to-date machine tools with a full complement of cutting tools and attachments, to old lathes, ancient drilling machines, and a few handfuls of almost worn out small tools; in their management there are as wide differences as can be imagined; and financially they range from heartbreaking failures to successes that bring riches.

These facts were impressed so strongly by the Cleveland data, that a careful study was at once made of the place occupied by the small shop in the American machine-building industry, and the determination reached to procure and publish a series of articles devoted particularly to its importance, problems and needs. It was intended that the series should comprehend a large number of subjects, such as economic conditions, financing, accounting, management, machine equipment, small-tool equipment, selection of work, helpful devices, kinks and methods, and the like. The wish was to make the series of practical use to the many men who were battling with the problems and difficulties of a small shop. The first article was published in the first issue of January, 1915, and during the year fifty were presented in all. As a natural result, there were numerous comments and discussions about them offered by readers. These found their regular place in the then current issues of the American Machinist.

These fifty articles and a part of the discussions and comments they called forth have now been knit together into book form under the title, "Success in the Small Shop." The purpose is to make the material of further service in this permanent form, with the belief that the information will be helpful, not only to the man who actually owns or manages or works in a small machine shop, but also to men in larger shops where departments are so organized that to all intents and purposes each is a small shop by itself.

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Future of the Small Machine Shop

SYNOPSIS—Is there a future for the small shop; the one employing from one to twenty wage earners? Or do conditions point to an absorption of these small units by the big plants? These questions are answered in this article and figures are shown which prove that the trend of progress is in a direction favorable to the small shop.

Big John is the owner of a small machine shop, employing from six to twelve men, according to the goodness or the badness of the times.

His son, little Johnny, is afraid to go upstairs alone in the dark, for which failing Big John calls him a "fraidy cat." When he tries to find out just what it is that the boy fears, the only reply is, "I'm 'fraid sumthin' 'll git me!"

Big John doesn't sympathize with his boy's timidity. "The fool kid don't know what he's afraid of." Yet, strange to say, Big John has a bugaboo of his own that has deepened the wrinkles in his forehead. He fears the big shop, and this has made him believe that there is no future for his little one. He is afraid that the big shop will "get him." Ask him just what it is about the big shop that he fears, and he cannot state it in plain words. He and little Johnny should shake hands, for they are both afraid of the same thing — the unknown.

A Complex Bugaboo

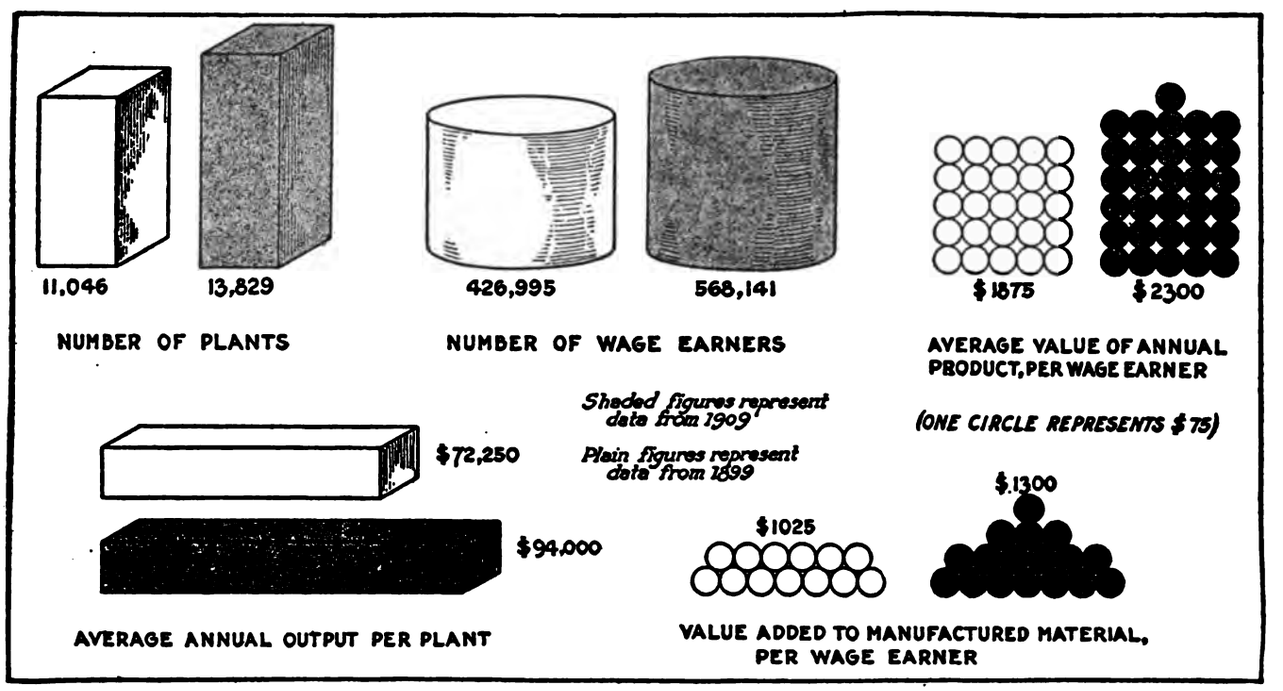
The fear of the big corporation is a vague, indefinite fear composed of many little definite ones, some of which should really be laid at the door of the little shop itself. Big John is afraid of the other small shops in the same line as his own, some of which bid unreasonably low for work. He fears cheap production in the big shops where handy men and specialists turn out the same piece day after day. He has doubt of his own ability to get the necessary accommodation from the banks, and also to make collections for work that he has done. He cannot see that his old equipment stands much chance against the brand new tools which have just been installed in the big plant up the street. He doesn't stop to analyze or itemize these things in this way, but thinks of them altogether and blames them on the big corporation.

We are going to tackle these little fears in detail, one at a time, and see if they are real or imaginary. But first let us look back and trace the progress of the small shop from the time that all shops were small, and few and far between into the bargain.

The Evolution of the Small Shop

In ancient days, before machine tools were thought of, fire was the medium by which metals were worked into useful shape. The smith was the forefather of the small machine shop, as well as of the modern blacksmith shop. His equipment was crude in the extreme, yet he was an important man in his community, for he had the skill to do what others could not. And doing this is one of the things that makes a small shop succeed today.

War was a mighty stimulator of industry even in those days, and it forced the blacksmith to become a manufacturer. The demands for spear-heads and battle-axes became so great that he was obliged to make them in lots instead of one at a time, not so much through a desire to lower the cost of making them, as to save his skin by promptly filling the order of his war lord. The same



Growth of Shops and Output in the Machine and Foundry Trades, Based on Census Figures

inspiration probably led him to mount a circular stone on trunnions, and thus speed up the slow process of rubbing an edge upon these weapons.

Machinery did not play much of a part in that age, nor for many years later. One hundred and thirty-six years ago, a mob destroyed the spinning machines just introduced by Richard Arkwright, believing that these crude machines would lessen the worth of their skill. Those were poor days for experimental shops! And only ten years before this, James Watt produced his steam engine, thus providing a motive power other than the water-wheel and the "horse power."

New York City, which today has over 2500 machine and metal-working plants, had in 1812 but one machinist of note, Henry Frasse, who built watchmakers' tools, models and experimental machines. In his shop the first steamboat engine is said to have been built, and it is known that he did quite a bit of experimental work for Robert Fulton.

Machine Shops 70 Years Ago

Thus far, all of the machine shops have been small ones. The day of the large shop has not yet come. Speaking of the City of Hartford, Conn., as it was 70 years ago, Joseph W. Roe states in the American Machinist: "The assessor's returns for 1816 gave only three 'machine factories,' with a combined capital of $25,000 and 45 men employed."

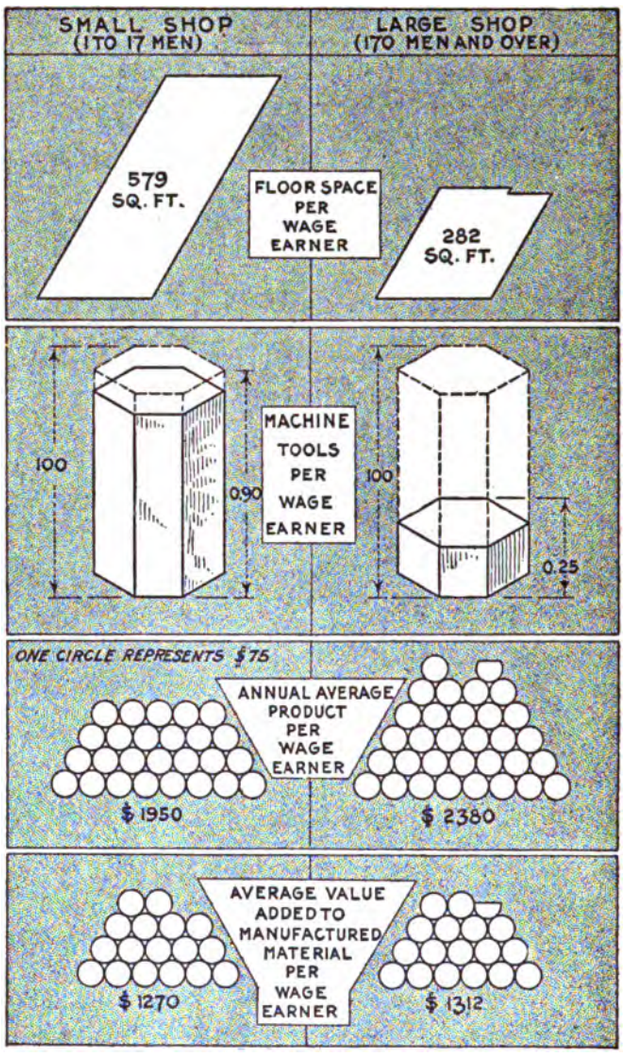
During the next 50 years came the rapid growth of the incorporated shop, going hand in hand with the easy inflow of investors' money. Quite a bit of this expansion was artificial, and many stockholders found to their sorrow that all of the moisture connected with forced liquidation and watered stock was not sufficient to prevent the profits from going up the chimney. A shadow was cast over the little shop which became darkest between 1899 and 1904. It was not caused by direct competition alone, but by other things more vague and dangerous.

Public sentiment demanded a correction of these evils, and the pendulum began to swing in the opposite direction. The number of small shops employing seven men or less, which had shrunk 34 per cent. between 1899 and 1904, increased 24 per cent. between 1904 and 1909, the date of the last government census. And while definite figures are not yet available, it is safe to say that the census to be taken this year will show an even greater increase during the last five years.

A Field of Work for Each

As a nation, we are quite apt to jump at conclusions. We will place a reformer who talks convincingly and interestingly upon a high pedestal, which, after a short time, we will kick from under him because he talks too much. Almost every movement is overdone and results in a reaction, so that our chart of progress is a series of zig-zag lines gradually approaching a happy medium. At one time there was quite a widespread belief that the best thing for a country was the extension of the big industrial units within it, which would result in low prices, high wages and general prosperity. We soon had the big units, but the low prices and high wages failed to put in an appearance. And the belief is gaining ground that a greater proportion of the small industrial units, with natural instead of artificial competition, will tend toward industrial prosperity, and help to do away with money juggling.

One thing is certain, there will always be room for the small shop. No one organization can completely fill a given field of activity and perform all of its functions equally well. We can represent a given field of work by a cubical box, and that part of the field that can be best covered by the large shop by a ball which will just go into the box. After the ball is in place there will be eight corners left unfilled, into which smaller balls may be placed, and there will still be spaces between the large and small balls and the box, into which still smaller ones may be put. In fact, no matter how many balls are introduced, there will always be room for smaller ones, for you cannot completely fill a cubical box with round balls. It is impossible for the big ball to take the place of the smaller ones, and it would be useless for the little balls to try and crowd the big one out of the place it is intended to fill. Big shops are finding that there are certain things that they are fitted to do and that others really detract from the main issue. To give an example: A few years ago nearly all big plants built their own jigs, fixtures and special tools. Now, many have them built to order in smaller shops, so that they may concentrate all



Comparison between Large and Small Shop Conditions and Output. From U. S. Census and Special Investigations

of their efforts on the real product that they are best fitted to make. A number of machine-tool builders stick to standard machines, but accept orders for special attachments and turn them over to small shops which have the skill and experience necessary to produce them. Big shops find it to advantage to restrict the size of their plants and their equipment investment so that they can work full time the year around, and take care of orders over their capacity by sub-letting certain parts to smaller shops when need requires. In these cases we find no interference between the fields of work of the large and the small shops, but rather a coöperation of benefit to both.

The small shop that is trying to do something that the big shop can do better is courting trouble and failure as much as the featherweight fighter who takes a notion to look for heavyweight honors!

Who Competes with the Little Shop?

Now, Big John, be perfectly honest with yourself, and tell us who it is that really competes with you, and why there isn't more money made by little shops. Who was it that cut you out of making those parts for the Ajax Co. when they wanted to get their big war order out in a hurry? Was it a big shop with individual motor drive and overhead cranes and a bonus system? Not by a long chalk! I heard you say yourself that Bill Jones, who has a shop half the size of yours, took that job away from you at a price which was less than your cost, notwithstanding the fact that his tools are so old that they have gray whiskers on them. You can't blame the Ajax Co. for taking the lowest bid. What you should do is to get out your hammer and knock some sense of proportion of costs and profits into old Bill's head. He figures his cost by the size of the blueprint and those parts happened to be drawn to a small scale. If it wasn't for the retired baker for whom he is building that perpetual-motion machine, the sheriff would have had him years ago. The competition that hurts the little shop isn't big-shop competition, but that of other small shops that don't know the cost of work.

Not All Sunshine in the Big Shop

Big John has broken the ninth commandment a good many times by wishing himself in Mr. Davis' shoes. He thinks it would be fine to be president of the big Ajax Co.; that is, of course, if he could take Mary and little John along with him. If his wish could be granted for a week or two, it would alter his notions considerably. He would find that while the Ajax Co., with its fine machine tools and specialist operators, is able to produce work at a much lower labor cost than he can ever expect to, it is forced to keep its selling prices high in order to earn a small dividend on its inflated capital stock. He would find that the overhead expense or burden in the big shop is almost twice as heavy as in his small one and that it has the most mysterious ways of growing, unless Mr. Davis sits up all night planning ways to prevent it. He would find that a given floor space in the big plant is used to more advantage for producing work than the same space in a small shop; but he would also observe an unbelievable number of nonproducers in the former and scarcely any in the latter.

He would find that Mr. Davis is not in close touch with the details of his business; that almost all of the information he receives is second hand, and that quite often it is inaccurate or purposely misleading. He would see that the shop system which Mr. Davis has had installed to protect his interests has involved a great deal of expense and red tape, so that when a man wants to get a ¾-in. capscrew from the stock department, he has to go through as much formality as if he were making a will. And perhaps worst of all, Big John would find that the dignity of his new position prevented him from getting into overalls and adding the finishing touches to some important job with his own hands, for being a real mechanic, he loves nothing better than to change cold metals into living machines.

The Final Proof

Several learned professors in a tropical country were arguing whether it were possible for a peculiar bug described by the natives to exist. After several hours of debate, they concluded that the insect was imaginary, producing a number of reasons why such a bug could not exist. Suddenly one of them felt a bite and looking down saw the exact specimen clinging to his leg. "Gentlemen," he exclaimed, "I am afraid there was a defect in our reasoning!"

After all, the strongest proof that small shops can succeed is the fact that they do. If you deny this you say in effect that 80 per cent. of American manufacturing plants* are failures, for this proportion of them are small shops employing less than 20 wage-earners! In the machine-tool-using industries there are 15,000 of the little shops, employing less than 20 men, to 1200 of the big ones, which employ more than 250.

The small machine shop is here to stay and to continue to make a profit. The really successful small shop is not afraid of the large one. Perhaps this is a reason why it is successful, for one who is afraid of his opponent is half whipped before he starts fighting. Let's get rid of the biggest obstacle first; the fear of the unknown which is the father of the big-shop bugaboo. Then, with clearer minds and stronger hands, we will be in shape to see and grasp success for the small shop.

An Unrecognized Wage Factor

By James Dangerfield

It is not sufficiently recognized that there may be wage factors other than simply the ability to excel in quantity or quality of work.

The late Ambrose Webster, founder of the American Watch Tool Co., was known for his originality of ideas in factory management. When I was employed by that company some years ago, the following conversation took place one day in the office:

"Mr. Webster, pardon the question, but why do you pay Morgan $3.50 a day? It seems to me you have other fully as good workmen who get only $3 a day, and I doubt if Morgan could go anywhere else and get more than that."

Mr. Webster replied: "You are right. As a workman Morgan could not command over $3 a day, but he is of such good disposition, always placing the best construction on whatever we do and saying a good word for the company when others are inclined to grumble, that his influence among the men is well worth an extra half-dollar a day."

* All industries.

The Selection of Work for the Small Shop

SYNOPSIS—The profits of any shop are made on what comes in and goes out of its doors. If the class of work that comes to it is not suitable, the chances for profit disappear before they really begin. Considerable thought may well be given to the profitable selection of work both in the small specialty shop and in the small jobbing or general shop.

Here is an epitaph that might suitably be written over the common grave of many shops that have passed away: "They bit off more than they could chew." Shop indigestion, which comes from a badly selected diet, often results fatally. To guard against this it behooves the small shop to be very particular about the work that enters its door.

The complaint is sometimes heard that the small shop must take whatever it can get and that it gets what the big shop leaves. This is a somewhat indefinite statement, even if true, as it does not tell if what is left is good or bad. As a matter of fact, all shops select the work that they do, either consciously or unconsciously; and it is my purpose to show how this selection may be studied with a view to increasing profits.

The little specialty shop illustrates the importance of this better than any other, because it does not have the variety of work going on all the time that we find in a jobbing shop. Actions are here reduced to their lowest terms, and it is not difficult to see how the selection of work affects a shop of this kind.

Jones had one of these shops up in Massachusetts. I put this in the past tense because Jones himself is now back at his former job in a large machine-tool shop in Worcester. A friend of his invented a wrench; a very ingenious and original affair, and secured a document from Uncle Sam, giving him the right to sue anyone else that made it. Jones took his money out of the savings bank, mortgaged his home, fitted up a shop and started to manufacture the wrench on millers and a royalty. Both he and his inventive friend had great expectations, for the wrench was quite different from anything else under the sun. They failed to take two things into account, however; one, that half of the small shops in New England appear to be making patented wrenches; and the other, that the average purchaser does not buy a wrench because it is ingenious and original, but because it will grab a nut and doesn't cost much. It was a case of poor selection, and one bad choice was enough to wipe out the savings of many years and to put Jones back at the bench for life.

The Smith Wrench Factory

It was not because Jones selected a wrench when there were so many others in the same field; for just around the corner was a man named Smith, who was getting rich on wrenches. He had a reversible ratchet affair, in which most of the parts could be made of malleable-iron castings, and he knew where to get these so close to pattern that a little brushing and polishing was all that was necessary to finish them. A bench, a small drilling machine, a polishing stand, and plenty of storage bins for the parts comprised all of the equipment necessary, and one man and a boy finished an almost unbelievable number of wrenches in a day. As a result of a good selection, Smith bought castings at 6c. a pound, sold wrenches at 50c. a pound, and went home at night with a clear conscience. Smith, himself, wasn't as good a mechanic as Jones, but he was a better chooser.

Profitable selection of work means choosing something that will sell after it is made and which can also be made at a cost which will give a profit. To sell and to keep on selling, the article must be useful, right in principle and correct in design. In the specialty shop the selection is concentrated into one vitally important decision. One mistake is often one too many.

Blinded by Big Profits

A clear and unbiased mind is necessary to make this important selection, as the inducement of a low cost and apparently large profits will often make one close his eyes to defects in real usefulness or proper design. This was the case in a small incorporated specialty shop in the Central States, which had earned a good return on the money actually invested by manufacturing a patented automobile accessory.

The article, as it had been made, depended more for its popularity and usefulness on good design and construction than upon the value of the patented features; something that is not at all uncommon with patented devices. All went well until the old shop foreman left to take a better job and a new one arrived. This man, not seeing much chance to make a showing by reducing the cost of article as it had been made, set about to see what he could do by changing designs and materials. As a result of his efforts, something "just as good" at a much lower cost was exhibited, still retaining the patented features. The Board of Directors ordered 100 of these put out for a six months' trial, but the possibility of doubling profits so easily had a strong influence on their judgment, and made them ready to find excuses for the few that did not prove satisfactory. Inside of a year they were making the "improved" type exclusively. At the end of another six months they were wishing that they had never seen it.

Those of the hundred sent out for trial which had proven unsatisfactory were really the only ones that had been thoroughly tested out. This experience, which would have been a fatal one in a plant that did not have plenty of money back of it, was due to a poor selection caused by the tempting influence of excessive profits.

Can a Jobbing Shop Select Its Work?

Thus far, we have been speaking only of specialty shops, and it is quite evident that with them the selection of work is of vital importance. When it comes to the small jobbing shop, it is a little more difficult to see where its busy proprietor can take time to select the work or how he can afford to exercise selection at all. Consciously or

unconsciously, however, all small shops pass the work that they do through a very fine screen.

A broad selection of work is made in the first place by the geographical location of the shop, influenced by the nature of the industries in the surrounding country. An oil-field shop in Texas or California, by its location, eliminates the likelihood of getting repair work on textile machinery, and the shop in Massachusetts is equally barred from fixing up disabled reapers or harvesters. Even the physical location of a shop within a restricted district has its effect on the class of work that it will handle. The former is usually an unconscious or "can't be helped" selection; the latter is more often chosen with a view to the work that is to be done.

Some Factors That Influence the Choice of Work

The size of the plant and its physical arrangements have a great deal to do with its selection of work, although in the lumber regions one may occasionally see a logging locomotive being overhauled outside of a machine shop not much larger than the engine cab! But in general, the class of work that may be handled profitably is restricted to that which can be gotten through the shop door, and which can be carried away after it is finished.

The available supply of cash is an important factor in dictating the selection of work. It tells very plainly how big a job may be attempted within a given period, just as the size of a reservoir supply pipe limits the quickness with which it may be filled with water.

Equipment helps to make the selection of work by having something important to say about the size and quality of the parts that may be machined upon it. But by far the greatest limiting factor is the personal *ability* or the sum total of the *skill* and *knowledge* of those who are employed in the plant. This is really what does the work, whether it be the kind that is selected or that is thrust upon the shop. And this is the deciding factor in determining competition. If you wish to prove this statement, advertise for a man capable of digging ditches and for another capable of designing bridges, and you will have a striking illustration of how skill and knowledge eliminate competition.

All of the other factors, such as capital, location, building, and equipment, weigh but lightly as compared with ability.

The profitable selection of work means choosing it in accordance with the limitations of all of these factors, and of avoiding that which capital, location, plant, equipment or ability are not properly fitted to handle. Upon this selection depends the future success of the shop, and the more conscientiously and carefully this is done the greater will be its chances for success.

Using the Sieve

The first step toward making use of this is to determine as nearly as possible what the limitations are. Start in with the ability part first, as it is the most important. Map out the half dozen things that the combined ability in the little plant will enable it to do better than the Jones Jobbing Shop, or the other shops in the neighborhood. Then take the question of equipment. Is it of proper nature, and in a proper condition to take care of the half-dozen things that ability fits the shop to do best?

Thus one factor at a time may be disposed of, until there are, as a final result, one or two things remaining which ability, equipment, plant, location and capital fit the shop to do to the best advantage.

Someone may object that he gets a job which fills all of these conditions but four or five times a year. In that case it is only four or five times a year that he is making his maximum possible profit. And more of this will depend either on getting these jobs more frequently, or of developing the five factors so that more things lie in this profitable field. In itself this analysis will be of value, for it will reveal where some of the factors are working at cross-purposes, and show what effort must be made to get them all pulling together in the same direction as ability.

Don't Starve in the Meantime

Doing the kind of work that it will be profitable to select does not mean turning away everything else that comes to the door and starving to death in the meantime. The selection of a profitable line of work is something that may be made far in advance of its fulfillment, just as a youth chooses the profession of medicine long before he is qualified to prescribe pills. In making this choice he has placed a goal ahead of him which his ambition will urge him to reach, and most surely he would never be a physician if he had not previously determined to become one. And the small shop will never get into the line of work which is most profitable for it if it does not go through this process of analysis and hold out the result of it as a goal for future attainment.

Combination Jobbing and Specialty Shops

Oftentimes one will find a jobbing shop devoting a part of its efforts to making a specialty. This may be the least considerable part of its business at first, although not the least important, for if it is properly chosen and pushed, less and less time will be given to odd jobs and more and more to the specialty, until the demand for a product that is right has eliminated the odd jobs altogether and transformed the jobbing shop into a real manufacturing plant.

The selection of a profitable line is not sufficient in itself, any more than it is sufficient for an angler to say, "I will catch such and such a fish." It is quite necessary for him to go out with bait and tackle and coax the fish away from its accustomed haunts, and it is equally necessary for the small-shop manager to be as diligent in coaxing the desirable line of work into his doors. The public may make a road through the woods to the home of some man who builds the best mouse trap, but they will find him more quickly and come in larger numbers if he puts up a wireless outfit and makes known his location and what he makes.

Searching the Field

Time was when the village grocer took what business drifted into his door without question and was glad to get it. Nowadays, he makes an analysis of the number of families within the radius of his delivery, figures out how much each of them should purchase per week in his line, and then sets aside a certain portion of this as the share that he is going to get. The small-shop owner who wishes to extend his business on profitable lines will study the possibilities of his market with the greatest care. The small-repair-shop owner will know the location of every considerable piece of equipment in his line within a ra-

dius of from five to twenty-five miles, depending on his ambition and the thickness of population. The man who builds experimental and model machines will make it a point to know the names of all the patent-office patrons who live in his vicinity, each of whom is a potential customer, and he will also make sure that each of these individuals know his name and has a good idea of what he is able to do.

The selection of work in the small shop is just as important to its ultimate success as a man's choice of a career. In either case when successful it really crystallizes into specializing at what one is best able to do. But the fact that a shop has started life without a very definite ambition and is doing work that does not bring much profit should not discourage its owner. A shop doesn't get old as quickly as a man, and many successful men have spent half of their lives just groping about for the right way.

It's never too late to begin!

Protecting Bright Articles From Rust

By A. L. Haas

The ease with which bright surfaces of steel or iron will tarnish is one of the vexations of the machine builder.

Machines and other goods for export are often subject to tropical temperatures before reaching their destination. Cases consigned to the Far East are subject to the humid conditions of a ship's hold for considerable periods. For obvious reasons it is difficult to insure adequate ventilation below decks, and as a consequence, especially when passing through the Suez Canal in summer, the temperature may easily be sufficiently high to melt grease and the atmosphere such that rust will easily form. Under such conditions special care is necessary.

One instance within the writer's knowledge may serve to impress the importance of the needed protection. A very expensive 24-in. end-measuring machine, the accuracy of which depended on the sighting of fine intersecting lines by a microscope, arrived in such poor condition that the lines were obscured by rust, and it had to be returned for recalibration. The instrument was thoroughly slushed when packed, and the only explanation possible is that the grease became fluid and the atmosphere attacked the unprotected metal.

It is necessary therefore to obtain slushing compounds of known melting points, which should be above 125 deg. F. From another consideration—acidity—the material should be of mineral origin, such as petroleum jelly of high melting point.

The low melting point of many greases and the subsequent troubles incident to complaints from oversea destinations have led some shippers to revert to the old white-lead and tallow coating. This is mixed with 4 lb. of tallow to 1 lb. of white lead, the latter being stirred into the melted tallow. Because of the acid in the tallow this coating must be removed at the earliest opportunity, using kerosene or turpentine; but there is no doubt that it protects from rust.

Protecting Small Articles

The question of protective coatings against corrosion is most difficult in the case of quantities of small-size articles. It is difficult to slush them effectively; to pack in solid grease is out of the question; simple oiling is insufficient and to apply lacquer by hand is prohibitive on cheap goods.

A method which has been giving first-rate results in the case of buckles, rings and harness fittings generally may help to solve this vexed question elsewhere. Cheap varnish is diluted to two or three times its volume with methylated spirits. On account of evaporation, the mixture is made up as required.

The apparatus consists of two oil drums each minus one end. An ordinary 5-gal. drum, which is 11 in. in diameter, has ½-in. holes punched in the bottom and sides. The other drum may be of 6¾-gal. capacity, of 12 in. diameter, or a 10-gal. drum, which is larger still.

The larger vessel is filled about one-quarter full and the articles to be treated put in the smaller vessel. The perforated drum is lowered into the liquid, immersing the articles to be coated. Withdrawing the smaller vessel immediately, the major portion of the fluid drains back again in a minute or so. To finish draining and to harden the coating, the contents are then shot out on a wire draining surface and in 15 min. are ready to pack.

The process is really a cheap and effective form of cold lacquering in bulk. The articles remain bright for long periods of time, while the coating is not in the least obvious—in fact, it can hardly be detected—so that the appearance of the goods is not altered. Articles so treated will stand a long sea voyage, arriving at their destination in perfect condition, and will then keep free from rust for 12 months.

The quality of bright buckles 5 gal. of the mixture will cover has to be seen to be believed. Hundreds of gross can be treated daily by the addition of ½ to 1 per day.

Draining the Pieces

An effective draining bed can be procured in the shape of a wire mattress. An inclined pan beneath it with a draining hole at one corner, completes the apparatus.

The materials for the previously outlined process are commercial and easily procurable; the coating is cheap and effective and articles so treated show no undue disposition to stick together. This process would serve for bright bolts and nuts, short bright wire rods and coils of bright strips.

It is surprising how many users of hydraulic machinery are unaware of the necessity for packing spare leathers in grease. These leathers should be made from oil-tr material. But in spite of this initial dressing, leathers stored for any length of time deteriorate even in a temperate climate. Where tropical conditions prevail it is imperative to pack such goods in tin boxes and run solid with melted tallow. Leather being an animal substance, grease of similar origin is preferable.

Insulating Tape for Small Belts

By B. S. Greenfield

I have found a very cheap and useful substitute fo flexible leather belts used for driving light machinery that is, a piece of ordinary friction insulating tape, such as is used in any electrical shop. This is twisted on itself and no coupling whatever is necessary, the ends sticking together when joined and twisted. No trouble has been found in running these at high speed, or in using them crossed or around pulleys of small diameter.

Specialization in the Small Machine Shop

SYNOPSIS—Specializing is not always building a specialty. Visits to a large number of successful and unsuccessful small shops show that, as a general rule, the successful ones specialize to a large extent. This article tells of various ways in which this has been done.

In one of the large manufacturing cities of the Middle West many small machine shops are located upon one street, which might appropriately have been named "Machinery Avenue." They are really so close together that in stepping from one to another a stranger cannot help but contrast the varying conditions which exist within them.

The door of the shop that I first entered had a sign over the top which read, "General Machine and Foundry Work." Inside was the usual assortment of jobbing-shop tools in the rather usual condition of repair. A partition separated the machine shop from the foundry, and in one corner of the latter stood a cupola which looked as if the next charge might tumble it over. If it had not been that the "power" was on, one would have thought that this was a deserted shop, for there was no sign of life within it. As I stood at the bench wondering what had become of the occupants, a man entered the door through which I had come a few moments before. It was the boss, who had run in next door to borrow a tap.

"Business is bad," he replied to my question. "I'm only running three days a week and have closed the foundry altogether. This is a little job I am getting out for a breakdown. But there is no money in this business nowadays!"

"I see from your sign," I observed, "that you do a general machine and foundry business. Just what does this include?"

"Oh, anything that comes along. I'm an all-around man myself and can tackle anything from cast rolling-mill gears to watch and clock dies."

"You appear to have plenty of room in this little shop," I remarked, "and yet your field of work is a large one. I should think that you would have been forced into larger quarters long ago!"

An Encouraging Contrast

The next place that I visited was a shop of about the same size bearing a sign that read, "Triumph Gear Works —Cut, Bevel and Spur Gears Only." Inside was an appearance of encouraging activity; all of the machines were running and the smoke was coiling up from very respectable cuts. The owner was busy touching up a hob on a cutter grinder.

"I am glad to see that you are busy," I remarked. "Don't you make anything except cut gears?"

"No, sir, and I have my hands full making them," he replied.

"Who is putting up that three-story concrete building next door to you?" I asked.

"I am. This shop has been too small for the last couple of years. I have had to turn down lots of work for lack of capacity."

"You are being crowded out," I exclaimed, "and yet your field of work is a small one."

Here was a remarkable contrast. The shop with a big field of work had nothing to do, and the one with a little field was being forced into larger quarters!

The reason for this contrast is not hard to find. There is plenty of evidence that the small shops which specialize are the ones that are making the most profit. Assuming that each of these two shop owners had equal natural capacity and energy—the first spread his over such a large area that it was as thin as butter on lunch-counter toast; the other restricted his energies to a small area and covered it more thoroughly than anyone else in his territory.

Capitalizing Ability

One small shop employing six men has an equipment composed almost exclusively of hand screw machines. Its owner specializes in this line of work, and his field consists in doing contract work for large shops on lots which are too small to put on an automatic machine. These big plants, of course, have hand screw-machines of their own, but they do not happen to have anyone who can equal this man in rigging up to cut corners, nor do their foremen take as much interest in the work as he does in promoting his own profits. These things and the fact that the burden in the little shop is often much lower than that in the big one enable him to make a comfortable profit on this line of work even though his selling price must be based on the big shop's cost.

This man capitalizes his mechanical skill and his ability to make hand screw-machines and their operators deliver the goods.

In another small but prosperous machine shop the work consists of designing and making cutting tools exclusively for boring and reaming. Its owner capitalizes his thorough knowledge of these two operations and makes money at it. In this case he does not have to be particular to get his own product out at a low cost, but his tools have to cut corners, when installed in the customers' plant, if he is to expect a continued demand for them.

Various Kinds of Successful Specialization

Specialization along somewhat different lines is encountered in a combination brass foundry and finishing shop, where from 10 to a dozen men are employed. Although this is a jobbing shop, the output is restricted to one grade of metal in the foundry and to one class of work in the shop, namely, that suited to quantity production on "screw machines," as the brass finisher calls small turret lathes. During my visit these people were turning out trolley wheels at a low selling price, but at a fast clip, and were making money at it.

Another variety of small-shop specialization is found in a two-story brick establishment, within which, at the time of my visit, the wheels were turning merrily, although there was no sign upon the building to indicate what it was or made. Judging from the aroma that greeted me as

I entered the office, the owner was fond of good cigars and also able to buy them.

In response to my questioning I learned that this man builds the "special orders" for a large machinery-manufacturing plant which makes a practice itself of sticking to big lots of standard machines. The owner of the small plant is particularly well fitted to do this, as he worked for six years at the big plant and was one of their best "all-around" assemblers. He started out for himself with a small "general" shop, but found that there were too many others of the same type. Thinking along the lines of what he was most skilled at doing produced the idea of the "special-order" shop, and he found that the big plant was favorably impressed with the opportunity to get these specials built for their customers, and well built, outside of their own plant. He keeps six men going at this work and has no selling or collection expense, as the completed machines are shipped and billed from the big plant.

This man capitalizes the desire of the big plant to build standard machines, in connection with his own skill and experience.

One man who believes that the small shop has a future is the proprietor of a steel-casting foundry in which six men are kept busy making sound steel castings of thin section. As long as he can keep on turning out work that is free from blow-holes, he is not going to worry about competition either from large or small shops.

Capitalizing Inventive Skill

One would not expect to find much specialization in a shop building experimental machines where one machine differs from another to an extent limited only by the customer's imagination. It does not take long, however, after entering one of these interesting places, to see that specialization does not always mean dealing with similar things. In fact, this is extremely specialized work. The owner or manager of such a shop must possess the instinct of inventive design to carry out the crude ideas of others and put them into successful working shape. Building unsuccessful special machines, even where someone else is responsible for their design, will not bring success. The man who does this kind of work successfully is capitalizing his skill in inventive design and the rare mechanical genius that is required to make such things work after they are translated from paper into iron.

I might almost propound as a conundrum the question, "When is a variety not a variety?" In some big stamping plants, for instance, you find an endless variety of pieces of all shapes, sizes and designs, varying from a talcum-powder box to a phonograph fixture—but it is all one kind of work. It is not as if there were locomotives and watches being turned out in the same plant. Specialization does not have so much to do with the product as with the means used to produce it.

It would require a great many more pages than are available to describe all of the ways that small shops specialize for profit. Even then the job would not be complete, for new plans are being formed and worked out every day. There are small stamping shops that make parts for the makers of machine tools that make machinery that makes something else. There are repair shops that make a specialty of being expert at some one particular machine, such as the printing press, the cotton gin, the harvester, or the automobile. In fact, even the automobile repair shops specialize in the class of work and the make of the car. There is the little oxyacetylene-welding shop, and the die-sinking shop where tool steel is given a value equal to its weight in gold. There is the shop that builds special machines ordered by superintendents and master mechanics who know very distinctly just what they want; and there is the shop that builds special machines ordered by customers who haven't the least idea of what they want. So on without number, but in the case of each successful shop, you will find it doing the thing it can do best, in the best way it can do it, and you will find that this "best" is a little better than the general average.

Unsuccessful Specialization

I must tell about two unsuccessful little shops before finishing this part of the story. One of them was a boiler-repair shop, the proprietor of which I found sitting in front of his empty shop "cussing" the gas engine and the oxyacetylene torch, which had combined to take away his business. He was evidently a specialist in the art of "cussing" and had it down to a fine point, but I could not see where it was going to help him fill his shop with work. If he had "made friends with the enemy" and kept up with the procession, he would not have had an empty shop, or felt like "cussing." This was the case of a man who specialized on something that was no longer profitable in his immediate locality.

The other was the most impressively unsuccessful shop I have seen, and at the same time one of the smallest. It was housed in a little room on the sagging floor of a dilapidated loft building, and outside of the door there was a sign which read, "John Smith, Gunmaker. Repairing Also Done." If it had not been for the repairing, John Smith himself would have been done long ago. Imagine trying to make a living by whittling out double-barreled shotguns on a bench lathe, a sensitive drill and a hand miller! John had grasped the idea of specialization, but, like the monkey and the hot poker, had gotten hold of the wrong end. He was doing what a little shop had no business to do—specializing in something that is distinctly a large-shop proposition. Day after day, alone in his little room, he spent hours of laborious toil giving shape to some part that is produced in the big shop in the same number of minutes.

The Handicap of the "General" Shop

After one has seen all of these little shops, and contrasted and compared what he has seen, some things stand out so prominently that it is impossible to overlook them. One of these is the handicap of the "general shop."

It may be said that the small shop which specializes properly may expect a considerably greater margin of profit than the "general" shop. There are exceptions to this as to every rule, one of them being that of the general repair shop, the owner or foreman of which is particularly expert at this class of work, and who has exceptional knowledge of the causes of disorder of the machines within his territory. Here again, we are coming back to specialization of a certain kind. In general lines of work, where there are many equally skilled in doing the same thing, competition is only a matter of a certain investment representing the cost of the physical means of doing the work. Any good mechanic with a few thousand dollars can start in the general machine-and-foundry busi-

ness, and the only advantage that an established plant will have over him is in its established trade, which after all, does not count for much, unless the trade is compelled through the quality of the work.

All of the evidently successful small shops specialize in one way or another. They get away from the "general" work which offers so little security from competition. They do the thing that they are fitted to do a little better than the average shop can do it, and as a result, their spheres of action do not conflict with those of the big shops, nor with the spheres of other little shops in their neighborhood.

After all, the successful small shop is only another example of the survival of the fittest.

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Machine-Shop Memories—The "Hobo" on the Night Shift

By T. E. White

It was a few years after I had learned to keep my elbow down when filing that I had my next scrap. Of course I had some few little bickerings during the interval, but they were minor affairs of no particular interest. In fact, I don't know that the scrap I am going to tell about now will prove interesting, but at any rate it was not commonplace, as it had some ludicrous features.

I was on the night shift in a large shop, running a light lathe. One night, shortly after I started there, they put another man on the vacant lathe next to mine. He was a typical "hobo" machinist. Anyone could spot him for a "tourist" in a minute. He carried himself with such an air of easy assurance that he won my admiration immediately. He came in the first night, took his calipers and scale out of his vest pockets, his hammer out of the waist band of his trousers, unwrapped a brand-new pair of overalls, donned them, and started up the lathe. Well, he turned out to be in some ways a most agreeable companion, as he was, like most hoboes, a tireless talker and had seen a number of curious things.

Jersey with a Small "j"

He had served his time at the Union Iron Works in 'Frisco and had worked in every big town between there and Sparrows Point. He was a Californian and most exasperatingly proud of it. He had at times a very overbearing way with him, and he could "get my goat" any time he went after it. As an instance, one of his favorite methods was, at about 11 o'clock in the evening, to announce, "Well, here in jersey (he always used a small "j" when speaking of Jersey) they are going to bed, but out in 'Frisco they are just getting ready to go out for an evening's pleasure."

Now, that looks all right on paper and sounds all right, too, if an ordinary person says it. But not the way he could say it! He seemed to assume some sort of superiority for the 'Frisco folks, to the corresponding detriment of the Jerseymen, because the latter, in their dire ignorance choose to live in a country that receives the sun three hours earlier than 'Frisco. That was one of his ways of stirring me up.

Micrometers in Texas

I was easily stirred up in those days, being about 19 and large for my years, and I didn't try hard to keep my temper. One night, after he had been doing a little quiet prodding about 'Frisco, he began to work eastward. The place next dear to his heart was Texas. He saw that I was using a 1-in. micrometer. He had a great contempt for that instrument, and it annoyed him to see me using it, for he burst out suddenly with "There ain't a micrometer in the whole state of Texas."

I told him that that was pretty rough on Texas, but I needed mine to do some of the fine work I was getting, and that if Texas was depending on me for "mikes" they would have to suffer. He sniffed at that—he had a nasty habit of sniffing. "Well," he said, "if you ever pulled a mike on a boss down there he'd 'can' you in a minute."

I allowed that the boss would be a "damfool" to fire a man for using or owning a good tool: "Well," he said, "a good mechanic ought to be able to do a good job with calipers, and if he can't work as close with calipers as anyone can with micrometers he ought to be fired, 'cause he ain't a machinist, he's a handy-man."

Marching Through Georgia

I swallowed that all right, and he worked a little farther east, halting at another favored spot of his—Georgia. He regaled me with a long and highly colored account of the manifold virtues of that state and its inhabitants and finally announced that the people in Georgia were very different from the people in jersey, inferring by his manner that the people in Georgia were a much superior people. I was engaged in chucking a difficult casting and let him ramble along until he must have thought that he wasn't going to get my goat that night, because he got careless and made a reckless statement. "Yes," he announced, "down there if you call a man a liar he'll take you out the next morning and shoot you, but here in jersey (small "j") if you slap a man in the face he'll go home and pray or else have you arrested."

Some Questions and Answers

That settled it. I jerked him up quick. "You've lived in Georgia, haven't you?" I inquired. "Yes," he said. "Lived there long enough to feel like a native?" I asked. "Yes," he said, "I lived there quite a while, and I know just how they feel about those things."

"All right," I said, "I'm a Jerseyman and I guess you're a Georgian, and I just want you to try a little experiment, and then you'll know how they feel about those things in Jersey. Slap me in the face, please, and see what happens."

"Oh, no, I've got nothing against you," was his reply. "Well, I've got something against you, then," I said; and I slapped him as hard as I could.

After a while the rest of the gang pulled us apart, and we shook hands and never had any more trouble. I liked him and he liked me, and we would never have had a word if we had been working days, but your patience is more easily exhausted at night, and it's easier to get in a mixup on the night shift than it is in the daytime.

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Electric Ovens in Field Hospitals are being used by the Germans to bake bullet and shrapnel wounds and thus hasten the wounded soldiers' return to the battlefront. The disabled arm or leg is placed in the oven, while a nurse keeps watch on the temperature. Some ovens permit the wounded man to sit so that wounds in the abdomen or back are similarly treated.

How the Little Shop Grew Big

SYNOPSIS—A manufacturing plant is not always large because of growth, addition often playing a more important part than self-development. When we find a successful large shop which has actually grown from a single cell and has not expanded artificially nor increased by combination with or the acquirement of other established plants, we have an example of growth, pure and simple, that is worth studying. This article tells how and why a pioneer electric-motor shop attained success, and gives some of the lessons learned by it.

Twenty-seven years ago three men were working in a one-room shop in New York City. One of them bent over a drawing board constructing the plans of a small 3000-volt electric motor to operate on arc-light circuits. His partner, who had just finished hand-winding a field coil, was watching the uncertain fluctuations of a galvanometer as he tested the insulation. The third man, a machinist, divided his attention between a lathe, a miller and a drilling machine, which constituted the machine-tool equipment. A desk standing in one corner of the shop served as an office, and at this the two partners, when not engaged in testing, designing and drafting, or in directing the efforts of the lone machinist, took turns at financing, purchasing, accounting, patent soliciting and selling. With but the two partners to do all this, there was no lack of variety in their daily work!

A quarter of a century is a long or a short time, depending upon how you look at it. It is a long time for two men to keep in step, side by side, and for a growing plant to remain under one ownership and management. It is a short time for a shop starting with three men to increase through normal growth until it employs 1800 men. Today, these same two men of the little shop can be found still working side by side at the offices of the Crocker-Wheeler Co., at Ampere, N. J. One of them is Dr. S. S. Wheeler, the other, Prof. F. B. Crocker.

I wonder if any who have not actually been through it realize the difficulties that beset pioneers in any new line of industry. Think, for example, of the difficulty in the early days of convincing a man that he should go to the expense and trouble of introducing an insignificant little wire-coil contraption called an electric motor between his already connected steam engine and line shafts. There was scarcely an argument that could be brought to bear upon him, especially as most of the central stations that did exist in those days were generating 3000-volt current for arc-lighting service and frowned upon the use of motors on their lines. The high voltage used for this service caused many fatalities and made people afraid to have it in their buildings. It was necessary to use a governor to keep the motor from running away when the load was thrown off, the one made by the little pioneer shop pulling the armature out of the field with

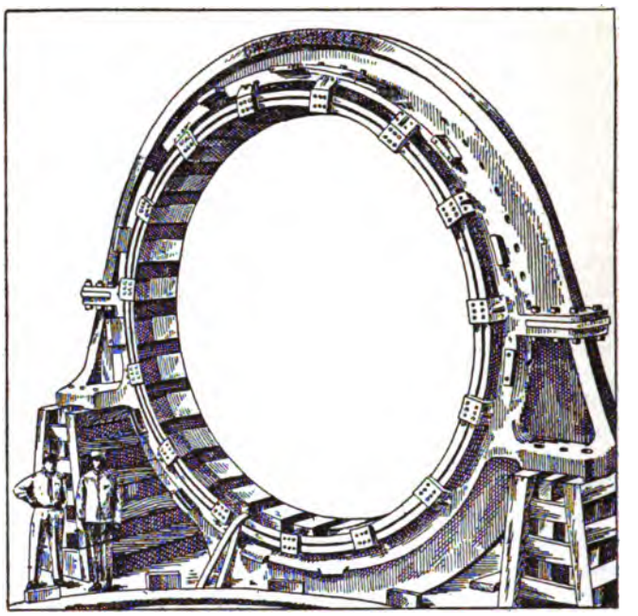

FIG. 2. ONE OF THE LARGEST DIRECT-CURRENT GENERATORS EVER BUILT

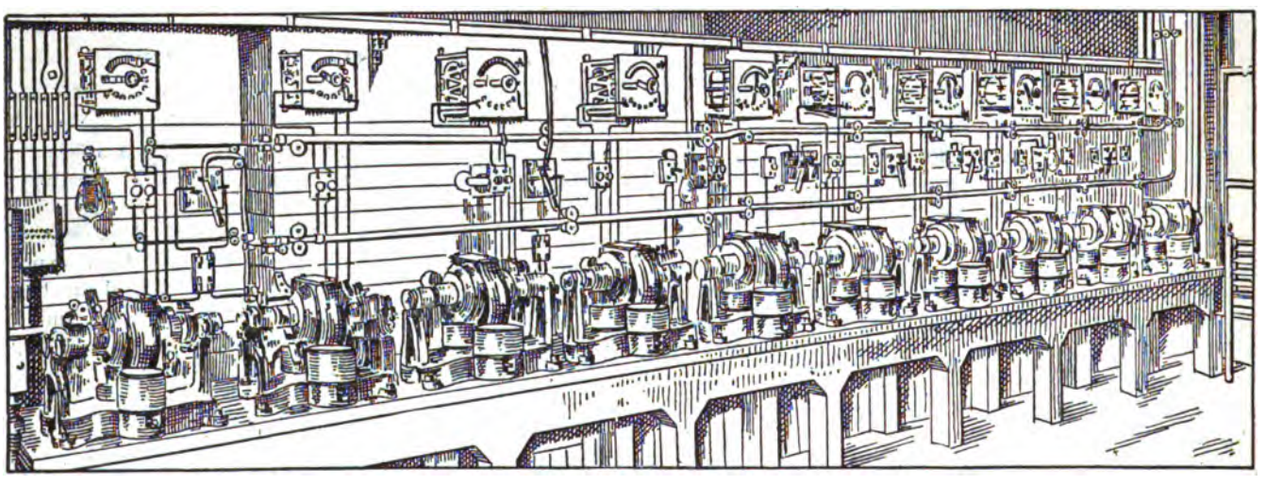

FIG. 1. TEN OF THESE DYNAMOTORS REPLACED THIRTEEN THOUSAND BATTERY CELLS

decrease of load and pushing it back again as the load increased. As may be imagined, facilities for building motors were very crude—all winding was done by hand, and it took three months' time, using the entire capacity of the little shop, to produce one 3-hp. motor.

Success in Spite of Unfavorable Conditions

Conditions more unfavorable to success could hardly be imagined, especially as this was in 1888, and the expiration of five years was to usher in the panic of '93. Luckily, we cannot see very far into the future, or many who have struggled to success would have been discouraged at the outset. Confidence in ultimate success is necessary to win a struggle of this kind, and it kept the founders of this company hard at work in the face of these obstacles.

Meanwhile came the introduction of the low-tension, constant-voltage current, which was to make the use of motors a practical possibility. Adapting itself to this new development, this little shop produced machines suitable for it, and their market increased so that they were forced to look for larger quarters. In 1890 they left their little 40x60-ft. floor space for a larger shop on the third floor of a loft building, where they occupied a space 50x 200 ft. and employed 75 men.

An Ill Wind That Blew Some Good

A few years later came the business depression in which many well established shops were to throw up their hands. It hit the little motor shop pretty hard, for not only did people stop buying such luxuries as motors, but the agent with whom they had their largest account went into bankruptcy.

But the hard times became really a spur to industrial progress. The necessity for retrenchment during such times fosters ways and means for doing things economically. In this case it caused the Western Union Telegraph Co. to seek a more economical way of generating electric current than by the use of primary batteries. The "dynamotor" was the solution of this problem, and the Crocker-Wheeler Co., being well fitted to make them, received orders which pulled them through the period of depression.

The two founders of the company, who up to this time had taken care of all the engineering, found that they had too much other work to give their time to the details of design. So they employed as assistant engineer, Gano Dunn, who had just received from Columbia the first degree of Electrical Engineer ever granted in this country. Mr. Dunn afterward became one of the presidents of the American Institute of Electrical Engineers, an honor, by the way, that both Prof. Crocker and Dr. Wheeler have also had bestowed upon them.

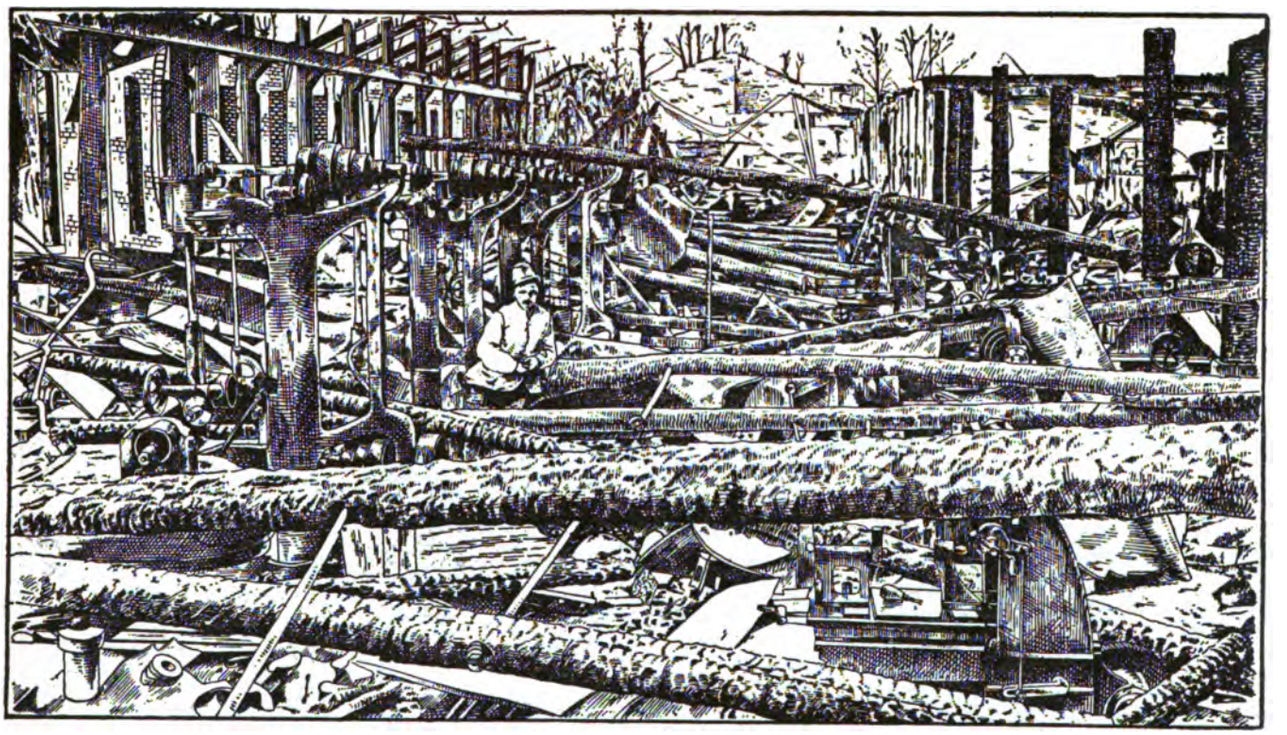

Fig. 3. Three Days after This the Machines Were Running Again

Crowded out of the City

With the development of motors of larger size came larger and heavier castings. The third-floor loft occupied by this company accumulated a dangerous weight of stock. The collapse of an overloaded building in the near neighborhood clinched the determination to get down on the ground where the safe load per square foot is only limited by the amount that can be piled upon it. Shipping expense was also a factor with such a heavy product. The only solution was to move to the country, and, accordingly, they purchased grounds and buildings outside of Newark, N. J., which had formerly been used by a company manufacturing spiral-welded pipe. In accordance with a continued policy of making haste slowly, little change was made in this plant, except that the brick floors were replaced by wood. One or two machines were installed from time to time until in 1895 the value of the plant

equipment and merchandise amounted to $350,000. Pretty good growth from a three-man shop in 1888!

A Crushing Blow

It would seem that the little motor shop had passed safely over the roughest part of the road. Orders were coming in and machines were going out and, best of all, "staying put." Then came a bolt out of a clear sky, and most of the visible effects of the previous years of work were wiped out in a few hours. The photographs which were taken after the fire tell the story much more eloquently than words could picture it.

Fortunately, the brick walls were left standing, a few tools had escaped complete destruction, and the power house in a separate building was untouched. Within three days a canvas roof had been stretched from wall to wall, individual motors installed to drive the few machines that were in usable condition, and manufacturing

The Danger of Over-Building

The tendency to over-build seems typical of the American shop owner. Plants or their parts are expanded in good times to a size proportionate to the available volume of business at that time, and when the tide of demand has ebbed you find them working at one-half or one-quarter capacity, with the overwhelming burden of maximum investment distributed over minimum sales. The same thing is true with the human equipment. Men are taken on in good times until a number is reached sufficient to deliver the maximum output. When the recession begins, shops are forced either to disrupt and disperse a large part of this force, which has involved a considerable outlay to train to the work, or to maintain a larger working force than necessary, for a time at least, with consequent loss. The solution for this in dull times is the extension of manufactured stock, which is a

Fig. 4. All of the Visible Effects of Years of Work Wiped Out in a Few Hours

was again in progress, on a small scale it is true, but forming a basis for quick recuperation, and leading to the seven-fold larger plant of the present day. This was a striking proof of the flexibility of motor drive, demonstrated by accident in the plant which had been chiefly instrumental in furthering its adoption.

The history of this growth has been cited in detail in order that the reader may judge of the soundness of some conclusions which have been reached by the two founders of the company as a result of the difficulties which they have met and overcome. It is impossible to grow from substantially nothing to a plant and merchandise value of $2,500,000 in 27 years without receiving jolts and bumps which leave impressions and which point the way to future avoidance of the same troubles. Shops which are now small, but which have the same ambition to become big, may profit by them.

quicker asset than increased plant and equipment, and overtime with the normal force to meet the extreme demands of a boom. This may be termed the Principle of the Conservation of Cash on Hand, and nothing talks more forcibly in the manufacturing world than the available almighty dollar!

Money Is Made on the Established Lines

While there is sometimes considerable glory to be gained by being a pioneer, there is not a great deal of money in it. If one is more anxious for the latter than the former, he is more likely to get it by being the second or the third in a given field than by leading the procession and incidentally finding the pitfalls by stumbling into them. The things that eat up profits are the mistakes that are made. It may be said in general that the cost of new work is almost always under-estimated, and that

profits are made on the established lines. In the development of many new lines, there is apparently a large margin of profit, but by the time that the engineering and development work has been figured, the same amount of energy and money put into the established lines would usually yield far greater profits.

This does not mean that new departures should not be made, but that they should be made with great caution. The extension of the old lines, through finding new uses for them and making minor changes to suit, is more profitable than developing altogether new ones. Changes may be divided into two classes—those that you want to make and those that you are forced to make. There are usually enough of the latter in the average shop without doing or making too many of the former!

Recurring Periods of High Burden with Growth

You doubtless have seen cases of periodic vibration in a shaft as the rotative speed is gradually increased. At times it will disappear altogether, then at another speed it will come on again, alternating between a great deal of vibration and none at all. The same thing holds true in the gradual growth of a shop, except that, instead of vibration, the thing that increases and decreases is the

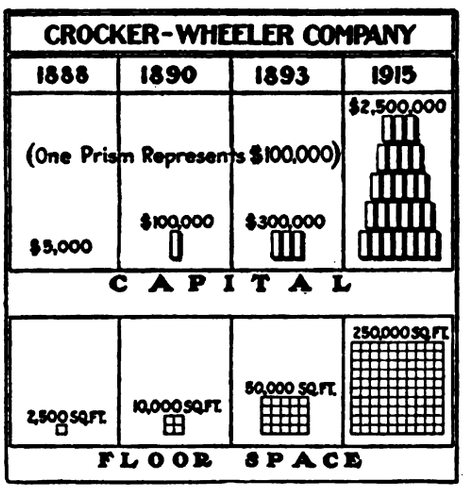

Fig. 5. Evolution of a Small Shop

relation between the total burden of expenses and the total output.

In the one-man shop this ratio is high, since the single worker must interrupt his productive work and spend considerable time in getting orders, repairing and making tools, collecting accounts, purchasing materials and keeping the books, and during this time his production ceases. As the number of men employed increases, this "expense vibration," as it may be called, diminishes, becoming least in the shop having from 15 to 20 men, with one executive who is able to carry the details of the business "in his head." Beyond this point comes the necessity for dividing responsibility and the introduction of more or less system, after the installation of which the expense vibrations are again quite likely to assume larger proportions.

As the shop increases in size from this point, and the rough edges of the new system are worn smooth, the expense vibrations decrease once more and become a minimum for this phase where the number of men employed and the volume of output are best suited to the system and conditions. Growth beyond this point, unless methods are materially changed to keep pace with it, results in another increase, for many shops may be too large to make a maximum profit. In them you will find that the "red tape" which has been spread as a net to prevent the escape of profits has in fact entangled the hands of the workers, upon whom profits depend. When this point is reached it is well to turn to the committee form of management, by which the advantage of personal touch may be carried into the ranks of a large organization.

Why It Grew

You have seen *how* the growth of this shop took place from the three-man beginning. Now comes the question: *Why* did it grow? I am going to tell you the reasons. It had a useful product. Its founders made themselves masters of the arts in which their product was manufactured and supplied. They threw every ounce of energy into its production. These three things are the keys to success, and with them, neither panic nor fire nor the difficulties that attend the introduction of a new thing can prevent a little shop from growing big.

Small Shop Defensive Weapons

Competition keeps us all on the jump. It is as unpleasant a blessing as could be devised. In fact, most of us regard it as the old-fashioned scholar did the birch rod and the strap.

In general, however, competition is a good thing and we could not get along without it. A decade ago people were talking about the dangers of competition; today we are "busting the trust" to get more of it!

There are four weapons with which competition may be fought; namely, money, ideas, skill, and a club. The first and last are the most common weapons, probably because they are the most easily picked up, except that money is sometimes hard to find when the shop is small.

The most effective weapons for the small shop are skill and ideas. Without one or the other of these, the small-shop man has no excuse to be in business for himself; he is in the same fighting trim as a 12-in. mortar which has run out of ammunition. One who is without these qualities must hire someone else who has them, if he expects to have a fighting chance.

Capital in itself has very little power beyond that gained by its ability to hire skill and to buy the results of originality. The small-shop owner who has real skill and good ideas need not worry about the big shop putting him out of business.

There is one kind of competition—and it is the most disastrous kind that the small shop is called upon to meet—which necessitates the use of a club. This is insane competition from other small shops which through ignorance or "pure cussedness" bid for work at figures that cannot fail to result in loss. These are the fellows who squeeze the profits out of the other small machine shops in their territory. They seldom get the same job twice, nor do they stay in business very long unless they change their tactics. If the results of their ignorance injured only themselves, it would not matter much, but other small shops are also involved.

A small shop association that will drive home the true meaning of the word "cost" will accomplish a profitable and much needed job.

Interest and Depreciation in the Small Shop

SYNOPSIS—Selling prices are not established by those why buy, but by those who make the things that are sold. If profits are lacking, it is up to the manufacturer, not the customer. Items of manufacturing expense that are overlooked are direct cash discounts unconsciously given. This article deals with two such items—interest and depreciation.

Some shop owners in figuring profits reason about the same way that "Hi" Perkins does. Hiram has a valuable piece of property at Goshen Corners, but he does not get anywhere near as much annual return from it as he should, or as his neighbors do from similar land.

I pointed out to him at one time that he was not getting a proper return on the money invested, considering the fertility of the land and the labor that was put upon it. His answer was illuminating.

"Investment!" exclaimed Hiram. "There hain't a cent of my money invested in this place. My old man left it to me, and the mortgage was lifted nigh two year before he died. As for labor, there hain't a hired hand on the place. The old woman does the housework and the cooking and the chores. Me and the two boys do all the heavy work. I raise hogs and sell them fer clear money. Raisin' 'em don't cost me nary a cent, for the fodder I feed 'em on comes right off my own land. Ef that hain't good, profitable bizness, then I don't know it when I see it!"

I suppose if Hiram's father had left him good interest-bearing stocks and bonds in addition to the farm, he would have been able to give his pork away and still make a good profit on it!

Shops whose products are such that they enter a strictly competitive field find that their selling prices are pretty well established by the amount that the other fellow is willing to take for making the same things. The other fellow may have had one of several reasons for making his prices low. He may, perhaps, be able to turn the work out in good shape at a low cost, and at the same time make a fair profit, in which case the only thing to do is to take your hat off to him until you have polished up your methods sufficiently to make him take his off to you. But more probably, he has established these low prices because of a lack of knowledge of what work really costs him, in which case education along these lines is the only hope for him and for those who unfortunately have to compete against him.

Money in the Bank versus Money in the Shop

A peculiar thing about money is that the longer you leave it alone the more capable it becomes of working for you, providing its place of residence is a good, safe bank that pays interest. Unlike a factory building or its equipment, money does not decrease in value or need repairs to keep it going. Also, the possession of a sufficient quantity of it insures an income without the necessity of its fortunate owner doing work other than keeping a watchful eye on the bank cashier and going at regular intervals to get his interest.

Equipment Account — Page 16

Item	Date		Inventory (continued) Forward-							
							$	6	8	4	5	00
465	12	6	12	1-16" B&B Engine lathe, 10 ft bed, quick change feed, taper attach. Condition good. Present value including mach belts and installation			2	2	5	00		
466	12	6	12	60 ft. 1 15/16" line shafting, c'plings, 8-16" pressed st drop hangers with self oiling bgs. 10 cone and cast iron misc. pulleys. Estimated present value				8	5	00		
	12	6	12	Total present value of equipment at date of purchase of shop.						$	7	1 5 5 00
				Extensions to Equipment and Equipment purchased from depreciation fund			Dep't			F	Extension	
467	1	4	13	#65 Standard Punch and Shear Cap. 3/4 x 3/4							1	7 5 00
				Freight								1 4 40
				Foundation								8 95
				Belts								1 6 80
				Erection								1 2 50
468	2	10	13	1-10 Hp Spark electric motor, with starting box and adjustable base. To replace the old one now driving machine shop. (Delivered)			2	5	0	00		
				Erection					6	45		
				Belt.				2	1	40		
				Wiring				3	1	65		

Fig. 1. A Small Shop's Equipment Account

Money invested in a shop seems to lose this easy income-earning ability and must be supplemented with considerable hard work before it begins to make returns. The shop owner also finds that he has exchanged legal tender which does not shrink in value with age for buildings and machines that do, and which also require frequent repairing to keep them in running condition. The interest that the money invested in a shop would bring if it had been left in the bank, and the depreciation on plant and equipment, must be considered a part of the manufacturing expense and must be accounted for in addition to the other more familiar item of cost before the shop owner can begin to figure a profit.

Interest should be figured at not less than 2½ per cent., preferably 3 per cent. per annum, on the entire investment, including the working capital. How many small shops take this into account as a part of their costs? Those that do not, really permit their customers to have the use of this money without paying for it!

Another bad habit that is quite prevalent among small-shop owners is to forget to pay themselves any wages. They take their own compensation out of the "profits," forgetting that profits cannot begin until all legitimate expenses are paid. The cases of Jones and Smith will illustrate this point, and will also show why interest must be made a part of the cost.

Both of these men are equally skilled mechanics, and both have accumulated the comfortable sum of $10,000. Smith invests his in a shop, keeping some of it for work-

ing capital, and at the end of the year, after paying running expenses and depreciation, figures that he is $2000 to the good. "Pretty good work," says he, "for a little shop like mine to earn 20 per cent. when the big fellows have a hard job to declare 6 per cent. dividends!"

Meanwhile Jones has kept his money in the bank and his job at the iron works. His income from the first item is $300, and from the second, $1200. The first has been earned without physical or mental effort on his part, and the second has been quite independent of the fact that he keeps ten thousand "iron men in jail."

Evidently there has been a flaw in Smith's reasoning when he figured his "profit." Assuming that he is as good a man as Jones, without capital, by working for someone else, he could have earned $1200. Also, his money being as good as Jones', if deposited in the same bank, would have brought him a similar return of $300. So that really he is but $500 better off than his friend who has no shop, and his manufacturing profit is only 5 per cent. instead of 20 per cent. In addition to this he has subjected his money to a much greater risk than has Jones, and has carried a heavier burden of responsibility.

Depreciation and Repairs

The relation between depreciation and repairs is a confused one in the minds of some small-shop owners, who are of the opinion that by keeping their machinery in repair they offset depreciation. The fact of the matter is that machinery will depreciate even if never used, progress and improvement making more back numbers than wear and tear. Consider, for instance, a $2400 automobile of the vintage type of '01, which has never been outside of the storeroom of the factory that built it. Today, it will not bring one-tenth of its original price, even with a couple of extra tires as an added inducement. And while automobiles depreciate in value much faster than machine tools, due to the fact that people like to be seen in a car of this year's model, the same thing is true with all machinery. A shop with tools 40 years old would be handicapped beyond hope, even if its doors had been sealed up the day after the equipment had been installed.

In the average small machine shop, the depreciation on buildings amounts to between 2½ to 5% per year, depending on their construction. Land does not, as a rule, depreciate, but has a tendency to increase in value, sometimes to an extent which must be accounted for by offsetting the increase against the plant depreciation. When manufacturing space is rented, it is up to the owner of the property to look out for these items, and the shop man need not worry about them.

On equipment, depreciation will vary from 5 to 10 per cent., assuming in the first case that the machines will last for 20 years and in the second that they will have to be replaced in 10. It is best to take an average depreciation on equipment at not less than 7½ per cent., which will allow for an average estimated length of service of 13.3 years. If the sum set aside is less than this, it will hardly be sufficient to keep the equipment in uptodate condition.

In some plants, particularly large ones, equipment is divided into several classes, each of which carries a different rate. There will be a 5 per cent. class, for example, that contains rugged, durable equipment of such nature that changes in design are not likely to make it obsolete. Among other things in this group we find industrial tracks and cars, cranes, chain blocks, etc. In a 7½ per cent. class we find the more durable and expensive machine tools—big planers, boring mills, and the like. In the 10 per cent. division, which is the largest, are the greater bulk of machine tools and electric motors. In the 15 per cent. class we find those tools which will probably last between six and seven years, grinders, and special machines that are likely to become obsolete or superseded by something superior. So it goes all the way up to the 50 per cent. class, where we find patterns given a two-year lease of life. Such refinement is, of course, out of the question in the small shop, and it will be quite sufficient to have but one rate for equipment and one for buildings.

Money set aside for depreciation must really be regarded as a fund with which to purchase new equipment. As a

Depreciation Acct. Equipment

		Dr.				Cr.	
Jan 1,13	Set aside for depreciation			Jan 4,13	To purchase of 10 Hp		
	on equipment for 1913	536	63		motor, item 468, and		
					installation and wiring	309	50
				Jan 13,13	To sale of old motor	18	50

Fig. 2. How the Depreciation Account Is Handled

general rule it should be expended as soon as possible, in order that it may earn larger returns than if left in the bank.

The little shop that is struggling to get a grip, and whose owner has a hard time keeping his head above water, will not be able at first to get hold of much more money than enough to pay the interest on its debts, let alone setting any aside for the purchase of new equipment. Sooner or later, however, this practice must be begun, for otherwise the value of the original investment will shrink and there will be nothing available to bring it back to its original proportions.

Equipment purchased from the depreciation fund does not add to the original investment, but simply keeps it intact. It is scarcely necessary to say that neither interest nor depreciation should be charged against such purchases.

Extensions

Money spent for equipment in *addition* to that set aside for depreciation goes to increase the total investment and must be charged both with interest and depreciation. Thus, the investment account, from which the interest and depreciation charges are obtained, is kept uptodate by additions for extensions which are usually made once a year; in other words, the interest and depreciation charges are not altered except at yearly intervals.

The question may arise in connection with some purchase: "Should this go into the investment extensions or into running expenses?" If you are sure that the article will be of repeated use through a number of years, put it into extensions. If you are not sure of it, put it into running expenses and make the customers pay for it during the coming year, instead of giving it to them on the installment plan!

As a suggestion for a simple method of keeping a record of these items, Fig. 1 may be of interest. It represents part of the equipment account of a small shop and shows how the annual interest and depreciation charge

for equipment is obtained. Note that the cost of installing and erecting the machines, freight, foundations, belts and countershafts is made a part of the investment, so that their cost will be spread over a number of years and not charged against one year's profits.

The method of taking care of extensions is also shown, these items being put down as the expense is incurred, but not used to correct the original investment until the end of the year.

In Fig. 2 the ledger form of the equipment depreciation account is shown. Notice that the sale of old equipment

	Capital Investment Jan. 1, 1914	Extensions to Investment 1914	Total, Corrected to Jan. 1, 1915
Land	$2,500.00	.....	$2,500.00
Buildings	1,875.00	$645.00	2,520.00
Equipment	7,155.00	718.25	7,873.25
Working capital	2,125.00	500.00	2,625.00
	$13,655.00	$1,863.25	$15,518.25

CHARGES FOR 1915

Taxes (based on preceding year)	$125.40
Interest on total investment (3% on $15,518.25)	465.55
Depreciation on buildings (2½% on $2520.00)	63.00
Depreciation on equipment (7½% on $7873.25)	590.49
	$1,244.44

DEDUCTIONS

Bank interest on working capital earned during year	$35.00
Credit balance of equipment depreciation account	*125.00
	$160.00
Total corrected taxes, interest and depreciation charges for 1915	$1,084.44

* Could also be handled as an extension to investment.

FIG. 3. HOW THE INTEREST AND DEPRECIATION CHARGES ARE FIGURED

is *credited* to this account. The depreciation rate assumes that the machines will have no value at the termination of their forecasted length of life; therefore, money received from them offsets part of the annual depreciation.

The final statement, or summary of the year, is shown in Fig. 3, which gives an idea of how the charges for the next year are derived from the preceding year's records.

It will be noticed that each equipment item is given a number on the equipment account. The same number should be permanently placed upon the article itself in the shop. You then have a record of the value of your plant and equipment that will go a long way toward substantiating any claims that may arise in case of fire, and this one thing is sufficient to warrant the small amount of effort required to keep these simple book records. But do not keep this record at the shop unless you have a fireproof safe.

When the machinery and the plant are purchased, the investment figures are not made from the total amount paid, but from inventory figures of their present worth. Otherwise, the man who made a bad bargain in buying would be charging his customers for his poor judgment, and the man who made a good bargain and obtained a good deal more than his money's worth would be giving away what he gained through a shrewd purchase.

Bear in mind that selling prices are not established by those who buy, but by those who make the things sold, and that if profits are lacking, it is up to the manufacturer, not the customer. And remember that every time you overlook an item which should go into manufacturing expense, you are making the customer a present of actual money and are helping to make small shops unprofitable investments.

The Small Machine Shop and Apprenticeship

Five years ago there were in the United States about 15,000 small machine shops employing less than 20 men each to 1,200 large shops employing more than 250 men each. These totals have of course changed since the time of the last census, and it is likely that the proportion has also changed. We may confidently expect that when the census figures now being tabulated are available, we shall find a large increase in the number of small shops and a small increase in the number of large ones. The small machine shop is increasing in national importance.

Employers have emphasized, and practically everyone else has admitted, that the cadet mechanic should acquire his skill in the shop. In the future the small shops will need men just as much as the large ones. In the aggregate they will need more men. Now what are the small shops doing, and what can they do, to train apprentices? How are they carrying their share of the burden of training mechanics for tomorrow?

As a matter of fact they are doing practically nothing. Boys will be found in the average small machine shop, but, as indenturing is not common and as the belief is common that the old apprenticeship is dead, they are merely looked upon as producers with limited skill and ability. What the boy learns, he picks up.

However, one of the best places for a boy to get an all-around machinist's training is in a small machine shop employing, say 20 men or less. Not many of these shops have any of the highly organized automatic machines that form such a large part of the equipment of a big plant, but every one does have all of the fundamentals—lathes, planers, drilling machines, millers. These are the four basic kinds of machines. As an offset to the absence of the specialized machines is the great variety of job-shop work. The small jobbing or repair machine shop does not know what repetition work is. Every job that comes along requires something new by way of planning, rigging up, or tools. Thus one of the best places to train the all-round mechanic in resourcefulness is the small job shop.

In a previous issue of this journal, page 81, the fundamental principles of apprenticeship training as approved by the United Typothetæ were presented. That organization is blazing the way for all the print shops in the United States. Is it too much to ask that some association of machinery builders blaze the way in a similar fashion for the small machine shops? The plan might include an accepted form of indenture and rules for its execution, uniform courses of instruction with modification for various kinds of shops, approved textbooks, and a satisfactory method of coöperation of school authorities and machinery manufacturers.

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Using the Drilling Machine to Advantage

By J. Ames

To get better results from the drilling machine have it indexed, giving the revolutions per minute of the spindle for each change of speed and also the different feeds. Then see that the drills are run at the proper speed and feed.

Be sure that power feeds are used, as you get a cleaner hole and do not break as many drills as in hand feeding.

High-speed drills cost more, but pay in the long run.

Unexpected Advantages and Contingencies in the Small Shop

SYNOPSIS—Accidental advantages sometimes give the shop owner the opportunity to make unlooked-for profits. In the small shops these windfalls are often given to the customer through a lack of knowledge of how to handle them. Unlooked-for disadvantages are usually frequent enough to more than make up for these "lucky strikes." The object of this article is to show how unexpected advantages should be used and unanticipated misfortunes guarded against in the small shop.

A fortunate adventurer, after a day or two of easy prospecting, stumbles over a "lucky strike" of immense value. The bulging yellow nuggets have cost him only a few dollars' worth of time and grub stake.

If he were like some shop owners, he would add 100 per cent. to this cost as a selling price for his find and congratulate himself on making such a large percentage of profit. He does not do this because the material that he has discovered has a fixed standard of value, unlike the products of a machine shop or factory where actual values are hard to determine.

The man who owns a small machine shop is not at all likely to stumble over a gold mine, or to get anything of value, including experience, without working hard for it. Occasionally he has a stroke of luck, and then is quite likely to give the results of it away to his customers. The story of "Old Bill" and the natural-gas well illustrates this generous trait.

Bill's shop, with the exception of a few occasional odd jobs, was devoted to making steel springs. For many years he had used coal as the fuel for his spring-tempering furnaces, and was always careful to see that his customers paid for the coal when they handed over the money for the springs.

Old Bill's Natural-Gas Well

As time went on, natural gas was discovered in the neighborhood, and Old Bill soon possessed a well of his own on land back of the shop. After the bills for coal stopped coming in, he found that the springs were costing him considerably less and decided to reduce the prices to get more business. He had been under no expense in connection with the gas well, since it had been put down on speculation by well drivers who took a portion of the gas in return for their trouble.

Old Bill had every right in the world to give several hundred thousand cubic feet of first-class gas away every month, or to blow himself up with it, or make any other foolish use of it that he wished. But after 18 months had passed, the gas began to decrease in pressure, until finally it petered out entirely, and the dingy face of the coal-wagon driver was seen once more with the same regularity as in past years in the vicinity of the spring shop.

Bill was surprised at the skeptical and incredulous way in which his customers accepted this reason for putting the prices up again. Instead of thanking him for the gas which he had presented to them, they handed him all kinds of uncomplimentary remarks and a number took their business elsewhere.

The trouble with Old Bill was that he did not know how to make use of an unlooked-for advantage. He should have sent himself a gas bill on the first of every month to drive home the cash value of his "lucky strike" and then should have banked an equivalent amount in a "contingent" fund to take care of accidental and unexpected setbacks.

Advantages of this kind, which come to a man entirely without his seeking them, are likely to disappear as quickly as they come. Anyone who figures on these things is a gambler, and the small shop cannot afford to shelter one who pursues such a pastime during business hours. Using these things as a basis for fixing selling prices is as bad as saying to your customers: "I am going to play the races, and I promise to give you all of the winnings, but will pay the losses out of my own pocket!"

Who Pays for the Special Tools?

A more frequent case of the same type of unexpected advantage is that in which special tools made for some past job are found to be exactly right for a piece on which quotations are asked by another customer. These tools have been paid for by the original customer, therefore what is more natural than for the shop man to make no charge for them in this case, hoping thus to get his price under that of a competitor.

This is bad policy, for in so doing he is helping to establish a fictitiously low price-standard for the type of article in question. The second or third man who buys this article is not entitled to a lower price than the original customer who paid the cost of the special tools.

Another objection to cutting prices on this account, and a more selfish one, is that the fortunate customer who receives the low price may some day have a piece almost like the preceding one, but just different enough to make the available tools unusable. In this case he will be quite sure that he is being "soaked" with the extra charge that is made.

Bargain-counter sales make the public look with suspicion on honest prices representing fair wages to those who make the goods. One man is not likely to get all of his prices low, and if he did it would not matter much, for he would soon cease to exist as a shop owner. The danger lies in many shops making occasional prices at or below cost, and thus tending to lower the standard of values among purchasers.

Domestic Economy

Whether a man does or does not pay a salary to his wife for being his cook and housekeeper is a matter of taste and mutual domestic agreement regarding which it is up to the peaceably inclined outsider to be strictly neutral. But when Mrs. Small Shopman becomes the bookkeeper and office manager, it is timely to say that the laborer is worthy of her hire, and that such services should

not be presented to the customers by omitting their value from selling prices merely because the shop owner does not pay out actual cash for them. All of the items of cost are not represented by the actual expenditure of money, as you saw in the case of "Hi Perkins," who thought he could sell his pigs at a low price because the farm had been left to him without encumbrance.

The case of the occasional over-bright apprentice who is able to do a man's work at a boy's pay is somewhat similar. The shop owner who is so fortunate as to possess such a paragon should not use the apprentice rate of pay in estimating the selling price of work which the boy will be asked to do. Possibly before the job is actually landed and in the shop, the boy may "get wise" to his value and ability to deliver the goods, and will go to another shop which will pay him accordingly. Self-protection, as well as the general welfare of the trade, demands that such reasons as these shall not be used for excuses to cut prices.

Do not misinterpret me into saying that unexpected and unusual advantages should not be used. My point is that they should be used to increase profits and *not to decrease prices.*

The small shop that is struggling for a start may say that such distinctions are impossible to make. It is true that a shop of this kind is an exception to most of the rules of shop accounting, by virtue of the fact that it has to be. The owner during the first anxious months is not working for profits so much as for a living and for a fighting chance to succeed. To lay aside a sum for depreciation and interest is out of the question when it is nip and tuck to meet the payroll and the incoming bills for materials. To ask a man in these conditions to choose carefully between transient and permanent advantages is like requesting a man struggling in the water to be particular about choosing the object that he grasps. But—*don't cut prices!* Your competitors have the advantage of you if you are new at the business. With all of the accidental advantages that good luck can muster together, it is not likely that you can actually produce work cheaper than they, even omitting such items as depreciation, interest, and the like, from your costs. How then can *you* make a profit if you cut prices? And without profits you will have as much chance of climbing the hill of success as an auto with an empty gas tank!

After the shop is established, if these unexpected and unusual advantages remain with you, do not use them to shave prices, for a man who is forced to use crutches of this kind to compete with those less fortunate is a lame duck and is subsisting on a form of charity which is likely to injure the rest of the trade.

Making Use of Real Advantages

Real advantages that are permanent may be properly used either to increase profits or to reduce selling prices to get a larger volume of business. A foundry located in the coal and iron district avoids much expense of freight on the materials that it uses. It is, therefore, in a position to make better prices to the trade in its vicinity than a shop which is at a distance from the source of supply of raw materials. One would not think of asking the first man to maintain such prices that the second man could compete with him on his own ground. He has a permanent advantage in his location and is entitled to the business by virtue of it.

Skill and originality are permanent advantages that justify price lowering, providing a good profit is made on the work at the revised price. The man who can do work at a low price and make a profit at it, is entitled to all of the work he can handle and his competitors' respect into the bargain, providing that this profit is made from skill and originality and is not a fictitious one made up of unexpected or unfair advantages.

What Happened to Johnson

Johnson had a little shop located in a loft building where he paid an annual rental of so many cents per square foot of floor space. He had often congratulated himself that the landlord had to pay the depreciation and interest on the building, and that his only expense for housing and heating was this fixed annual sum. Above and below him and on each side the space was occupied by a manufacturer of clothing whose business had increased rapidly. The president of this concern needed the space that Johnson was using, and being a man who usually got what he wanted, Johnson found that his lease could not be renewed. It cost him quite a bit to get his machines transferred from the old place to the new location, and quite a bit more to get them relocated and ready for business. In the meantime, the delay had been an expensive one and had cost him several orders. Paying for all of these things had put quite a crimp in his working capital and the profits for that year looked very small indeed. In thinking over things, Johnson came to the conclusion that in some way or other the customers should be made to pay for these unexpected setbacks which were quite likely to happen to him from time to time.

On investigating he was surprised to find that many big plants and uptodate small ones have what they call "contingent funds" for the purpose of providing for the unforeseen. A small per cent. of the total annual receipts is banked or invested in a way that it can be quickly converted into cash, and in the course of time there is a "war chest" available on which to draw for the unusual and unexpected. Thus, lawsuits, accidents and the like are paid for in advance on the installment plan by the customers, for the annual amount which is set aside for this purpose enters into the "fixed charges," then into costs, and finally into selling prices.

Johnson determined to set aside several hundred dollars a year for this purpose and in order to kill two birds at one shot he invested it in life insurance of a form that is quickly convertible into cash. Thus his family was protected against the contingency of his death and at the same time a fund was established to protect his business against contingencies of other kinds.

The Size of the Contingent Fund

What sum should be set aside for this purpose? It depends first on the amount of profit being made, and next on the disposition and policy of the owner. Some firms with big profits go so far as to insure themselves against a loss during dull times. The small shops will do well to make provision only for the most probable happenings, and leave refinements in unexpectedness to those who have plenty of money with which to buy them.

Remember that the investment account is reserved for certainties; that probabilities belong to running expense, and that the contingent fund is for possibilities.

Keeping Track of Manufacturing Expense in the Small Shop—I

SYNOPSIS—The small-shop owner cannot afford to burn his fingers with fancy cost records that only an expert accountant is able to comprehend. At the same time, it is quite essential for him to know "where he is at." This article describes a simple way in which labor items are handled with the purpose of obtaining a periodical statement of manufacturing expense.

A medical examiner once asked a colored man if he had ever had appendicitis, whereupon the dusky brother replied: "Ah's dun had Plymuf Rocks an' Rode Ilam Reds, boss, an' Ah specks if you cud describe the pearance of dem chickens what you menshuned, Ah cud tell right off if I eber had dem kind."

No doubt if some one could make clear just what a cost system is, many shop owners would be surprised to find that they already have such a thing. In simple language, a cost system is something that will show the shop owner "where he is at" financially—what he makes a profit on and what causes him loss. It has been miscalled so many times, and made in name to cover so many different kinds of activities, from ordering castings to fining a man for being late, that its real meaning has almost been forgotten. That is why in the big plants, when the whisper goes round, "they're going to put in a cost system," everyone looks for an all-around upheaval, starting with a rearrangement of the machine tools and ending quite often with the "bust up" of the system or of the plant itself!

FIG. 1. THE SIMPLEST DIVISION OF SHOP ACCOUNTS

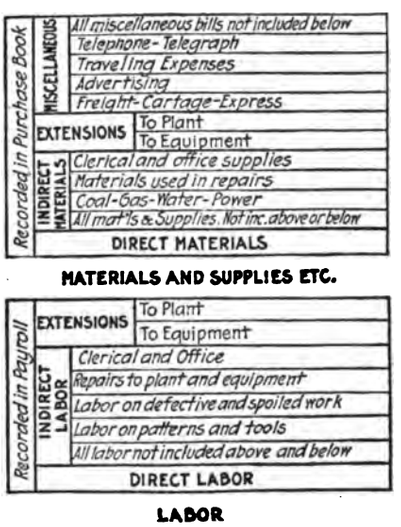


FIG. 2. A MORE ELABORATE SUB-DIVISION OF SHOP ACCOUNTS

A "cost" as most people understand it is a figure representing what it costs to get out a certain job. In the best of cases and where much money is spent to arrive at it, the individual cost is likely to be two parts of "know" and one part "guess," because of the elusive "overhead expense." You may know this accurately as a total and yet not be able to fairly divide it between jobs, just as you may know John D's total wealth and not be able to guess how much he has in his pocket.

Manufacturing expense is something that we can put a finger on definitely and say "here we have it." It will be the sum total of all the costs during the period for which it is figured, providing these costs are correctly known. It represents the outgo, just as the money receipts represent the gross income, and the difference between these two items for a certain period, after being corrected for "inventory" as I shall explain later, represents the profits for that period.

A cost may be compared to a photograph of one member of a family; manufacturing expense to a composite portrait of all of them. By looking at the photo you can get no idea of what the group will look like, whereas the composite picture will lead you to quite a definite idea about the features of the individuals. A cost will not throw much light on the sum total of manufacturing expense, but the total statement will illuminate the individual cost. Fortunately, this sum total, in addition to being so useful, is very easy to get, even in small shops which feel that they cannot increase the clerical help.

Any shop, however small, can so arrange its accounts that without intricate bookkeeping it may obtain an accurate record of total expenses for a given period. Having this, it may obtain accurately the total cost per hour of work done, which is of great value in estimating the cost of new work and figuring selling prices. In addition to this, by a simple subdivision of the accounts, or entries, into the payroll and purchase book, it is possible to determine very accurately the "overhead expense." Having these two valuable items, the small-shop owner will have an advantage in real information over hundreds of big plants which have fancy cost systems and high-priced accountants.

THE USE OF TIME CARDS

Labor is an easy item to handle as far as accounting is concerned. The shop man is in any case obliged to know how many hours a week each man in his employ is "on the job" in order that he may get the weekly pay envelopes ready. In many small shops, the owner "takes up the time" himself, although he would not carry the water bucket or sweep the floor as long as the boy was present. Sometimes he does this with the idea that it is the only way to get accurate results.

Do not take up the time yourself, Mr. Small-shop-man. In the first place, your own time may be spent to better advantage in bigger ways, and in the second place, the extra accuracy thus gained, if any, isn't worth it. Have your men make out timecards, even if there are but two or three employees all told. It makes them think

and saves you work, both of which are worth while. It may seem easier to take it yourself than to bother showing a lot of "bone-heads" how to report their time, but then it's considerable easier and faster to walk than to ride a motorcycle before you know how.

Speaking of accuracy, the practical mechanic who has very definite ideas of how close to size mechanical parts must be finished sometimes loses his sense of proportions when it come to figures. He can distinguish between the quarter-inch "blacksmith's hair" and the ∓ 0.0005 limit, but is inclined to think that the time cards

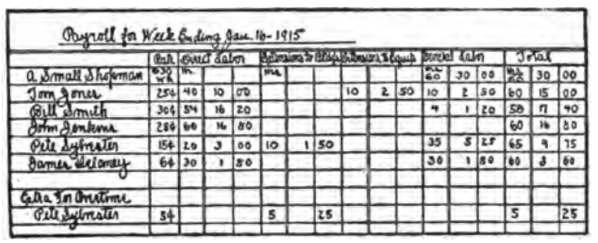
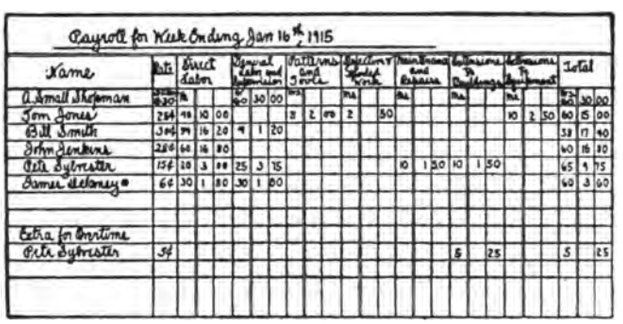


FIG. 3. SIMPLEST FORM OF CLASSIFIED PAYROLL, ARRANGED ACCORDING TO THE SUBDIVISION SHOWN IN FIG. 1



Note: The boy does not fill out a time card. His time is split equally between direct and general labor.

FIG. 4. A CLASSIFIED PAYROLL FOR A SMALL SHOP, ARRANGED ACCORDING TO THE SUBDIVISION IN FIG. 2

and cost sheets which contain the most detail are the most accurate. A time card for the small shop in the shape of a pine board written upon with a burnt stick would serve the purpose with as much accuracy as the finest engraved forms on linen paper, if both were made out with the same amount of intelligence. The board would be rather clumsy, however, and paper is better for the purpose, but plain unprinted paper will be quite good enough. Save the printer's ink for advertising the goods!

The first step toward getting things in shape for obtaining a periodical expense statement is to divide the items up into "accounts," as shown in Fig. 1 or Fig. 2. The first is the simplest possible form in which to handle them and the second is somewhat more detailed. You cannot get along with less than the number of items shown in Fig. 1, although you could have ten times as many as shown in Fig. 2. The choice is up to you, remembering that it is foolish to multiply subdivisions unless you gain more than it costs you to make and maintain them.

Whatever selection of accounts is made, must govern the arrangement of your payroll and purchase-book; the two records which will make it possible to figure manufacturing expense. In Fig. 3, a payroll form suitable for the simplest subdivision of labor accounts is shown. That for the more detailed accounts is represented in Fig. 4. Notice that the hours, as well as the wages, are allotted to each account. This is for the purpose of obtaining the "cost per hour," and of figuring the overhead on the basis of so much per hour.

Tom Jones' time cards, which go to form the second entry on the detailed payroll, are shown in Fig. 5. There are many small shops in which it is desirable to keep close track of the time spent on each job so that charges may be made on a "time and material" basis. These cards of Tom's are arranged with that in view since all of the "direct labor" is allotted to different jobs. His card would be somewhat simpler if this was not done; that for Jan. 14, for example, would appear as shown in Fig. 6, which is a card suitable for compiling a payroll of the simple form of Fig. 3. A man may wish to obtain only two or three individual costs out of several hundred machines or jobs, and in that event would be foolish to go to the trouble of allotting all of the direct labor against individual orders. It is a matter of choice, like ordering soup at a restaurant, and may be called for when desired.

DIRECT AND INDIRECT LABOR AND EXTENSIONS

There are three things that the shop owner must distinguish clearly one from another if his results are to be of use. These are direct labor, indirect labor and extensions.

Direct labor is that which actually goes on the article or machine being made and which can be allotted against

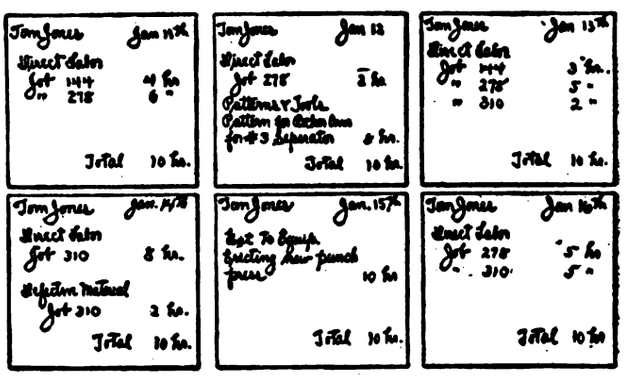


FIG. 5. TOM JONES' TIME CARDS FROM WHICH ENTRIES ARE MADE ON THE PAYROLL

it without difficulty on a time card. Actual machining, assembling or erecting time can be easily handled in this way. The Boss's time in supervision, that of the sweeper and oiler or the fireman and engineer cannot be thus handled. Sometimes an item of work done takes so little time that it is not worth recording individually, in which case it is put into indirect labor with these others. For instance, painting a machine after it is built or putting skids under it are really direct labor when closely analyzed, but for practical purposes it is much better to put the painters' and shippers' time into indirect labor without itemizing it

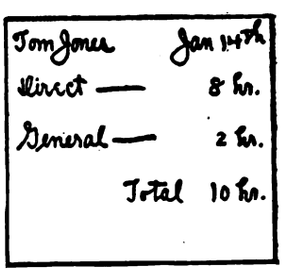


FIG. 6. TOM JONES' SIMPLIFIED TIME CARD

on individual jobs, at least in the small shop where simplicity comes first.

Extensions are kept separate because they go into investment, as described in a previous article. Time spent in building a home-made machine tool or in erecting a purchased one or in building an extension to the shop goes into these accounts, the former under extensions to equipment and the last under extensions to buildings, or "plant," as it is commonly called. Labor on jigs and patterns, unless it is quite certain that they will last for many years, should be classed as indirect, and not under extensions. Items will arise which will be difficult to classify. In such cases remember that the more conservative plan is to put them into indirect labor.

It is quite likely that Jimmy Delaney, the apprentice, will jump about from one job to another quite a bit. He may start the day by planing a bracket in the "jumper," then spend an hour or two straightening out the bar stock in the steel rack, after which there are some nuts for him to polish. In the afternoon he must chase down to the brass foundry for a few delayed castings, returning to find that there are some levers for him to drill before quitting time. If the small-shop owner who hands Jimmy his $3.60 per week expects to make an accurate subdivision of the lad's time he will have his hands full. The expense and trouble are likely to amount to more than Jimmy's wages. Hair-splitting is an expensive luxury for the small shop.

This is where some of the big cost systems make a mistake. Fine subdivision or splitting up does not mean accuracy, but increases the liability of error. In Jimmy's case, let the shop owner make an arbitrary division of his time and let this stand until it needs to be changed, not bothering with a time card unless the boy works on a job where the total time must be kept.

Remember that many a man lets $14 worth of profits walk out of the front door while spending $7 worth of time trying to stop a 15c. leak in some dark corner.

♣ ♣

Small-Shop Sunshine—Compensations

Isn't it great how a fellow's friends crowd round and encourage him when he says he is going to start a shop of his own? Among other cheering words, he hears: "It can't be done." "Nine out of ten who go into business for themselves fail." "It was all right 20 years ago, but today the small shop has no chance."

The funny part of it is that twenty years ago "they" were saying the very same things. Those who started that long ago remember how they were told to stick to the two-dollars-a-day job at the iron works and not risk chances for a twenty-five cent raise by starting for themselves. Horrible examples were brought forth and dangled in front of their eyes by anxious friends, until they felt as blue as if they had been caught breaking jail.

I'll bet there was one who did not throw cold water on your plans—Mrs. Small Shopman, and she was the one who had the most to lose if you fell down. When the hash and baked beans had coaxed your nerve back out of its hiding place that night, you sprung your plan on Mary, expecting her to finish what little the boys had left of it. Didn't know what a good partner she was, did you? Instead of smashing your plan with a 10-ton hammer, she said, "All right, John, I know you can do it, and I'll help!"

There's a law called "the survival of the fittest," and these Job's comforters who tell you "it can't be done" are simply the means whereby this law works out. If a man isn't discouraged by what they tell him before he starts, he is the right fellow to go up against the bumps that come later and to survive them.

As for there being no chances for a small shop today, don't let them get away with that! There are 15,000 small machine shops in the United States today, and if ten times as many small shops failed as do big ones, it's because there are twenty times as many of them.

The trouble with all of us is that we have a good ear for bad news. As soon as Mrs. Jones gets a divorce from her husband, the reporters are after it, but they don't rush to get a column of how Mrs. Smith has darned her husband's socks for 40 years. Many a small-shop owner carries the key to his own cash box, whereas in the big plant they appoint a board of directors to keep tabs on the president!

The boss and the men also get more out of life in a small shop than in a big one. The boss knows what is going on, which is a satisfaction often denied the owner of a big shop, and the men feel at home—not as if they were in a hotel or a strange church. Some shops are so big that a man has to work in them 20 years before he begins to feel at home. By that time he is ready to quit or gets fired.

The plant that starts big is the exception. How many that started big five years ago are still in business? I've seen a good many successful plants, and 99 out of 100 of 'em started with the boss wearing overalls.

It's really a big handicap to start any other way. Nature puts us into the world as babies, and makes us learn as we grow. A man who had to begin life at the age of 20 years wouldn't know the difference between carbolic acid and castor oil, and some of the ready-made shops don't know the difference between efficiency and deficiency, which is just as dangerous.

The secret of making a little shop grow is to keep plugging. The owner of a big plant asked the man how he was getting on, and the department head replied that he was plugging along. "Yes," answered the boss, "And if you don't keep plugging, I'll plug you!" That's what Nature does to us if we don't keep at it.

The small-shop owner does not have to put on style. If things go wrong he can go home and kick the cat around the kitchen, whereas, if a big-shop owner did this, the cook would quit, and the front hall would be too full of china vases and Italian marbles for this purpose, to say nothing about the shock to the butler's feelings. The small-shop owner can look forward to increasing his business in much greater proportion than can the big-shop owner, and if his foot slips, he hasn't as far to fall. So really, there are compensations for the small-shop owner after all.

Keeping Track of Manufacturing Expense in the Small Shop—II

SYNOPSIS—The handling of material for the purpose of arriving at an accurate record of manufacturing expense follows in general the treatment advised for labor items in the last issue. This article deals with the way in which materials and other purchases are brought into the "cost per hour" of running the shop. The simple combined day book and ledger shown is suitable for use in the small shop where an accountant is an impossible luxury.

There is a machinery manufacturer who every year puts on the market a number of new designs. He is obliged to fix his selling prices on estimated costs. The cost clerk compiles a detailed estimate for each machine, figuring the weight, material cost and labor for each of the hundreds of individual parts. When he takes his figures in to the "old man," the latter merely glances at the totals, disregarding the details entirely. Then he shuts his eyes, throws back his head and after a moment announces that the cost is either too high or too low, and states what he thinks it should be. Almost every time the "old man's" guess proves to be nearer right than the carefully prepared estimate. Putting it mildly, he has the cost clerk "hoodooed."

"The old cuss has a calculating machine in his head," he frequently exclaims. "I don't see why he wants me around here when he can guess like that!"

The "old man's" calculating machine works as follows: "Total estimated weight, 400 lb.—let's see; that type of machine will cost me 15c. a lb. including material. That makes $60." His simple method, based on common sense and experience and avoiding detailed subdivision, is on the whole more accurate than the complex estimate with its accumulated error.

Purchase Book — Page 54.

4 Weeks, ending Jan 30th, 1915.

Date Paid	Check No	Date of Bill	Item	Purchased from	Direct Materials		Indirect Materials		Extensions to Equipment		Extensions to Plant		Miscellaneous	
				Bd.	458	60	110	25	235	56			17	35
Jan 15th	1428	Jan 1st.	4000 lbs cast iron bar stock 3" rd.	Jones & Co	70	00								
"	1429	"	Frt.	B & O									12	43
"	1430	Jan 6th	Cartage	Brown									3	25
Jan 15th	1431	Jan 3rd	Bond of lumber for new casting shed	Am Lumber Co							35	00		
Jan 15th	[illegible]		10 lbs white lead					50						
Jan 15th	1435	Jan 12th	10 Bags of Cement, Foundation for											
			1 Load of Gravel } new Planer	G.H. Smith					8	50				
Jan 15th	1436	Jan 8th	20 lbs Cold Rolled high speed steel 3/4 x 1 1/4"	To supply Co			12	40						

THE SMALL SHOP'S PURCHASE BOOK

Last week we looked into a simple method of handling labor with the purpose of arranging accounts to finally give us the "cost per hour" of doing work—a unit that will be of great value in estimating and which will rival the "old man's" cost-per-pound in simplicity and accuracy. This week it is up to us to dispose of *material* with the same end in view.

We must make the same three distinctions between Direct, Indirect and Extension Materials as we did in taking care of labor. There is very little difference between labor and material anyway when you get right down to keeping track of them. Both must be paid for, and one is as likely to have as many blow-holes and seams in it as the other. A cynical shop-owner once told me that his idea of the difference between them was that one had a vote and the other hadn't! As far as small-shop accounting is concerned, the handling is very much alike.

THE THREE SUBDIVISIONS OF MATERIAL

Direct materials are those which go directly into the product and *which can be accounted for on a material cost sheet.* Some things which really should be called *direct* are handled as *indirect* because it is impossible or impractical to allot them to individual costs. For example, it is scarcely practical for the small shop with a variety of work to measure the amount of paint used on each machine. Therefore paints are treated as "indirect" and lumped for the year, to be cared for in the final summing up as a part of the "cost per hour" of running the shop.

Extension materials are those used to increase the value of the plant or the equipment. Many shops handle purchases of complete machines and the like under these accounts, classifying them as "materials." This is a good way to take care of them, unless an "equipment account" is used for that purpose as described in a previous article.*

Indirect materials comprise all material purchases that are left over from these two classes—supplies, small tools, oils, all maintenance materials and the like, go into this pigeon hole, as well as some really direct materials which are put there for convenience. Often this account is subdivided extensively, where the shop owner considers it important to have separate records for different commodities. The larger the shop, the more the necessity for this subdivision for the *purpose of control of expenses*—not because it makes accounting easier. If proper control of these expenditures may be had without subdividing, lump them by all means.

The small shop need pay no attention to the distinction between so-called "raw" and "finished" materials. This

* Interest and Depreciation in the Small Shop, Vol. 42, p. 14.

is only of value to the shop that keeps a perpetual stock inventory and has a system of issuing materials from stockrooms and keeping track of them by means of stock orders. It is one of the luxuries that small shops are able to do without. The small-shop owner doesn't need a perpetual inventory system to tell him what materials he has on hand, but he does need some decent bins and racks to keep the stuff in, instead of cluttering up the floor with it. When we are used to things we don't notice their faults; the old homestead looks better to us than a marble palace. But after climbing mountains of castings and avoiding veritable wire entanglements in the form of bar stock placed across likely passageways in nine small shops out of ten, it is hard to believe that there isn't some deep underlying reason at the bottom of the disorder. Possibly the small-shop owner, familiar with the paths, figures that it gives him a strategic advantage and a good start on the bill collector!

One record book properly arranged will act as a day book, and also serve to classify the various material accounts. A sample page for the simple division of accounts is shown in Fig. 1. Items are entered into this book *as they are paid for,* the unpaid bills being kept together in a "bills-payable" envelope or, better still, distributed between the cards of a "tickler" file which will show the date when they are due.

It will be noted that a column is provided for the "check No." If the returned checks are filed by number, this gives a very complete voucher system, that costs practically nothing to maintain.

Why Big Shops Record the Stock Disbursements

The question has probably occurred to some of you, "If such a simple record and procedure will enable a shop to figure its manufacturing expense, why do many of them go to the expense and trouble of recording stock and stores *disbursements* as they are made, instead of entering up the total amount of the bill when it is paid? Is the former method more accurate?"

Yes and no. If the object is to obtain a statement of manufacturing expense weekly or monthly, then the disbursement plan will be more accurate, for you may buy enough on one invoice to last over six months, in which case one month's material expense would loom up as big as a barn and the succeeding five would be insignificant little things. If you are content with an accurate yearly statement (which is a lot better than most shops are getting), the purchase plan will on the average give as close results as the other. There are two ways in which you could measure the quantity of water used in your house or barn—one would be to let it run into a receiving tank and keep track of the number of times that this is filled and emptied; the other would be to put a water meter on the supply line. The big shop's stock-disbursement system and the records resulting from it put a meter on the consumption of materials by means of which you can tell at any moment how fast it is going out. The small shop cannot afford the expense of such a meter and has to catch materials when they enter instead of when they leave.

As far as accounting is concerned, it doesn't make a bit of difference whether the materials are recorded in the expense accounts at the time that they are purchased or when they are used in the shop. The first method gets them a little closer to the time that the money is actually spent by the shop owner and a little further away from the time that he gets his return from the customer. A profit statement, as we shall see in a later article, simply gives a line on the difference in rate at which money comes in and goes out. No scheme, however elaborate, can tell you how much you have actually made today or this week or this year, unless your business has been bought and sold within the period that you are measuring. The money that you pay Tom Jones this week for working on stock may not come back to you for six months or a year in the shape of a customer's check, and the money that you received today from old man Smith for fixing his printing press covered labor that was done 30 days ago and material that had rested under a bench in your shop for three years. The farmer is not the only one who must wait for the harvest. The shop man who sows money and hard work in his shop in the spring cannot figure on gathering the results of it in the fall! And unfortunately, there is no seed which the shop owner can secure that is guaranteed to come up at all.

The Miscellaneous Account

The miscellaneous account is a convenient receptacle in which to deposit that which is neither fish, flesh or fowl, or in more appropriate words, neither labor, materials or fixed charges. This is the place for freight and express charges, traveling expense, advertising, telephone, telegraph, tickets for outings and other charitable expenses. It is quite likely that it will contain a more varied assortment of odds and ends before you finish with it than any of the other pigeon holes in which items of manufacturing expense are docketed. As the shop grows this account may have to be subdivided to keep track of the items properly. At first, put them all in one bin for simplicity sake.

When you are in the market for an article, it is a good plan to show what you have paid for it before, not because that in itself prevents you from getting stuck, but because it *helps* to prevent such an occurrence. Some shops keep a record of all prices and quotations, either on cards or in a book, usually classified under the name of the commodity. This means making a separate and additional entry of each item—a small thing where there are plenty of clerks with time on their hands, but a big thing in the small shop where the boss himself has to do it if it is done at all. The way to get the results without the trouble is to use the receipted bills for this purpose and file them in a letter file under the name of the commodity.

"That is all right," you say, "but what if alcohol and zinc are both billed to you on the same sheet? Which wins, A or Z?"

A condition of this kind is avoided by issuing separate orders for the alcohol and the zinc, in which case the probabilities are that separate bills will be rendered. Or the price notations can be transferred to your duplicate copy of the order and that filed instead.

What Are You Going To Do With It, Now That You've Got It?

That is all there is to keeping track of manufacturing expense in its simplest terms. Of course it can be elaborated without limit, and is, especially by those who make a profession of elaborated system. It don't make you feel any better when you go into a restaurant and

find that a big French name hides a small baked potato, but it gives a tone to the menu and permits of fancy prices. It's of no use to keep a fancy record of castings on hand when you can count them in half the time.

A small boy in Philadelphia had the right idea. A street faker was holding forth on the advantages of buying his little book on algebra. As an illustration of its usefulness he cited the following problem which his pamphlet would enable one to solve: "A man has a certain number of children and a certain sum of money. After giving them each an equal amount, he has three cents left. How many children has he?" After listening to the impressive delivery of this problem the boy piped up: "Say, mister, couldn't the man count 'em?"

Don't put a machine or a system in your shop that you cannot use after it is installed. Don't buy a complicated machine or use a complicated method where a simple one will answer your purpose.

Two Kinds of Machine-Shop Bosses and the Results

By Arthur S. Day

I have had a good many bosses in my time, but there is one who stands out among them all for getting the best results, both as to quality and quantity. He is not a large employer of labor or prominently known in the mechanical world, but I firmly believe that, given the proper opportunity to demonstrate his system in a large shop, he would be very successful.

I made his acquaintance by answering his advertisement for a horizontal boring-mill hand. He wrote me to call for an interview and, after making a few inquiries as to my experience, told me to come to work that afternoon. I found that the mill had been recently installed and quite a few tools and fixtures would be needed to produce the work economically. This made it necessary for me to use almost all of the standard machine tools, such as the lathe, shaper, miller, drilling machines, etc.

After working an hour or so I became aware that the boss was watching me closely—so closely indeed that I was very much annoyed. The next day he watched me still closer, and I began to get mad. The next day it was still worse; but by that time I had come to the conclusion that I was shortly going to be minus a job and I resigned myself to the worst, feeling that I had done my best, was up against a crank and didn't want the old job anyway, even though it was the period of depression following the panic of 1907.

The Effect of Encouragement

But the next day his demeanor changed entirely; in fact, he acted almost like a human being, and from that time on until I left his employ we got along famously. For skilled mechanics he had three grades of wages. I started at the minimum, but the second week was advanced, and before the month was up I was one of the three highest-paid mechanics in the shop.

I had lots of opportunities to observe his tactics with other new men. He would watch them closely for the first few days and if he was satisfied with them he would encourage them to do their best. If he was not satisfied with them he would waste no time in letting them go. His plan resulted in discipline superior to any other shop I was ever employed in.

For a short time he was superseded by another man with different views. This man's idea was to employ $10 mechanics. After about a week's trial of this class of labor it became apparent that considerable time was being spent patching up defective work. An investigation showed that under the new régime about one-third the former quantity of work was being produced in the same time, the quality of work was away below par and repair bills for tools and machinery were "unholy." It did not take long for the management to tumble to the new state of affairs. The old superintendent was replaced and in a short time all was running smoothly again, thus demonstrating that his system was economical and practical.

The Purposeless "Hustler"

I had another boss who was just the reverse of this superintendent. He was so full of nervous vitality that if he were riding downward on a freight elevator he would jump from it when it lacked 6 ft. of the floor and by the time it reached the floor he would be in the toolroom. His haste was so great that he did nothing thoroughly. Consequently his instructions were inadequate and the work suffered accordingly. The men looked upon him as a joke and only worked when he was in their immediate vicinity.

I have seen the men and boys in that shop waste nearly a whole afternoon throwing a dead parrot from one machine operator to the other; on another occasion it was a dead snake. Once they rigged up a life-sized dummy and placed him on a pile of castings, making it appear as though a workman was "soldiering." When the boss saw it he started on a hen canter for the supposed delinquent worker, and as it was located in a shadowy part of the shop he did not realize that the "horse" was on him until too late.

His misspent energy finally resulted in lifting him clear out of a job. As a friend of mine once remarked, "What does a chicken accomplish by flopping around after his head is cut off?"

To True an Oilstone the "Mechanical World" suggests the following method: Take a piece of soft pine board of any thickness, about 8 in. wide and 3 or 4 ft. long. Lay it on a bench and fasten it with a handscrew or other clamp. Put on some clean, sharp sand screened about as fine as that used for plastering work. Use no water, and rub the stone back and forth over the board in sand. This will give a flat surface to the stone in a short time. Care should be taken to move the stone on straight lines, so as not to give it a warped surface. The board can be saved by boring a hole in one end and hanging up out of the way. If a fine surface is wanted, a finer grade of sand or sandpaper may be used to finish with.

Running the Small Shop by "Dead Reckoning"

SYNOPSIS—This article tells how the small-shop manufacturing accounts are finally crystallized into a "cost per hour." It also describes a simple way to take care of "overhead." Estimating the probable cost of work is made easy if these methods are followed, and the small-shop owner who secures a knowledge of the underlying principles is working toward "instinctive accuracy."

The old gentleman who was holding forth in the smoking car was an ex-whaler captain. He had been East for a visit to his grandchildren and was now returning to sunny California, where he looked forward to breathing real air and eating real meals once more. Thirty years of adventurous travel in the seven seas, half of the time as a whaler captain, had given him a fund of experiences, one of which he was relating for the benefit of his fellow travelers.

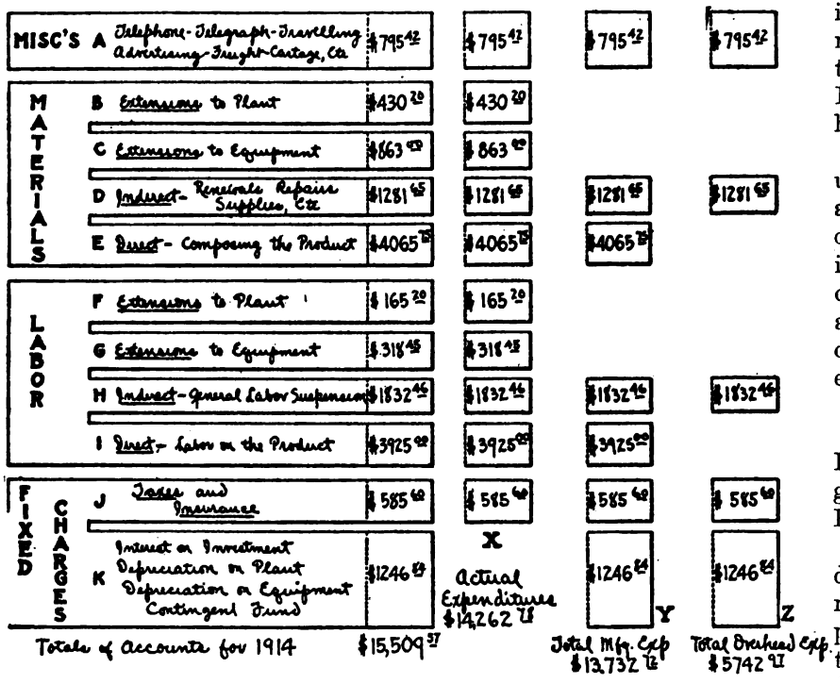


FIG. 1. GETTING RESULTS FROM THE MANUFACTURING ACCOUNTS

"Most of you fellows use figures every day in one way or another without giving much thought to what the results of an error may be. With a sea-captain it is different. It is seldom that one of us who has seen any length of service has not at one time or another found himself in a position where the lives of all on board ship depended upon the accuracy of his figures.

"I never realized the responsibility connected with juggling the ten numerals that we find on the first page of the arithmetic until I had been a captain for some years. It so happened on this trip that we were homeward bound after a successful season in the Behring Sea. In order to make the Pacific, I laid a course for a certain pass through the Fox Islands, through which I had taken my ship several times in previous years.

"For the following three days the sky was overcast and we were obliged to run on 'dead reckoning.' This did not cause me any worry until the second day, when my barometer indicated that a northwest gale was due within the next 24 hours. During that time I must find that one narrow navigable opening between 100 miles of rocky islands or face the certainty of losing the ship and ourselves upon a precipitous lee-shore.

"You can imagine how anxiously I looked for the sun to appear so that I could check up the 'dead reckoning' of our position, which of course was obtained more or less by guess-work. The next day at noon the sun came out for a few moments, and I was able to take a sight. It checked up our course as correct, and I ordered the helmsman to continue it. In three hours we should sight land.

"At three o'clock the lookout in the crow's nest reported land three points to starboard. I climbed up and inspected it with a powerful glass. Familiar as I was with the peculiar formation of the shore at the entrance to the Pass, my heart suddenly dropped, for I had never seen this place before!

"I rushed into the cabin and checked up my figures. Then I called the mate and we went over them together. Neither of us could find a mistake. Not knowing what else to do I ordered the same course held and went below to snatch an hour of sleep to prepare for what was coming. At five o'clock the mate pounded on the cabin door.

"'Where are we?' I asked.

"'Right smack in the middle of the Pass,' the mate replied. Before the gale broke we were safe in the broad Pacific.

"We had approached the pass from a different angle from previous trips, and naturally the shore-line from this new point of view looked unfamiliar. Since that time I have had a new respect for figures, and I see to it that my calculations are so carefully made that I can place absolute confidence in them."

Unfortunately, the small-shop owner cannot afford sextants and chronometers that will locate his financial latitude and longitude with accuracy. He must run on "dead reckoning," which means getting such records as he can and then correcting them by good judgment.

The equipment account, the classified payroll and the purchase book described in previous issues are the simplest means for him to use. Let us assume that the small shop has kept such records for a period of six months or a year. I have shown in Fig. 1 the summary of the manufacturing accounts for the given period and have given certain values to each account. These are repre-

sented as detachable coupons, which we will sort in various ways to accomplish various results.

How the Coupons Are Sorted

The first sorting, in column *X*, gives the actual expenditures. These are $1246.79 less than the sum total of the accounts for the same period, for the reason that the actual expenditures do not include interest and depreciation charges. Actual expenditures are important in one sense—you cannot keep on spending more than you have very long—but you cannot use them for the purpose of "dead reckoning."

The second sorting of these coupons gives us the total manufacturing expense, as shown at *Y*. This differs from the actual expenditures in including the coupon *K*, covering interest, depreciation and contingencies, and omitting coupons *B*, *C*, *F* and *G*, which represent extensions. These, which form an addition to investment, are cared for in coupon *K*, and are therefore properly omitted from the total manufacturing expense as individual items, in order not to include them twice. The sorting represented at *Y*, really represents the *current expenses* during the given period.

The overhead expense is obtained by sorting the coupons as shown in column *Z*. This sorting does not include any items not included in the total manufacturing expense *Y* and also omits coupons *E* and *I*, representing direct material and labor. This sorting is supposed to include all items of expense which cannot conveniently be represented on a cost sheet in itemized fashion.

Distributing the Totals

The total manufacturing expense and the total overhead expense are impressive figures, but the shop owner cannot make a great deal of use of them in their present form. A patent-medicine manufacturer might have an enormous tank of medicine in his plant, it would represent a vast amount of dollars and doses, but unless he could secure small bottles with which to distribute it, it would be of no use to his customers or himself. We must have a means of distributing these totals to the various jobs that are done from day to day, before they will mean a great deal.

The simplest and best way for the small shop to handle this distribution is to do up these totals in hourly bundles. The payroll form shown on page 20 has provided the necessary packages by keeping track of the direct-labor hours. Let us assume that the total of these for the period for which we are figuring amounts to 15,000. Take the total manufacturing expense, $13,732.72, and divide by this quantity. The result is a trifle over 91½c. per direct-labor hour. This is the figure that includes the material which goes into the product and the wages paid to the producers, as well as all other expenses. In other words, your average producer, in connection with the material that he works upon and the shop charges which are due to him, costs you 91½c. for every hour that he works on a job.

A more useful figure is obtained by subtracting coupon *E*, the direct material, from the total manufacturing expense before dividing it up into hourly packages. Thus, $13,732.72 minus $4065.75 equals $9666.97. Dividing this by 15,000 we get 64½c. per hour, which represents the total cost of manufacturing, without the material used on the job. This figure is more useful than the previous one because very frequently much more material will be used in proportion to labor on one job than on another.

The last unit figure is that which represents the overhead expense per direct-labor hour. It is obtained by dividing the total overhead expense, $5742.97, by 15,000. The result is a trifle less than 38.3c. per direct-labor hour, this figure representing the manufacturing expense without the direct materials or the direct labor. The three units which we have secured might be called to distinguish them, the *unit total expense, the unit total less material* and *the unit-overhead.* The following examples may help in showing some ways in which these units will be of service to the small-shop owner.

Some "Dead Reckoning" Observations

Unit total manufacturing expense, per hour, 91.5c.

Unit total manufacturing expense (less material), per hour, 64.5c.

Unit overhead, per hour, 38.3c.

What rate per hour must I charge in order to make 75c. per day on each producer, assuming that the customer pays me on a time and material basis?

Seventy-five cents per day on a 9-hour day is 8.3c. per hour. The total manufacturing expense, less material is 64.5c. per hour. Therefore you must charge 64.5c. + 8.33c., or 72.83c. Better make it 75c. per hour straight, for I think Bill and Tom are going to hit you for a raise pretty soon.

I have a job to bid on, and figure that material will cost me $52. Estimating closely, the work will require 80 hours' time, it being what I would call an "average" class of work. What price should I charge to make 15 per cent. on total cost?

Average work costs you 64.5c. per hour, without material. I should therefore estimate your cost as follows:

Material	$52.00
Other expenses 80 hr. at 64.5c.	51.60
Total	$103.60
15% profit	15.54
Selling price	$119.14

But 15 per cent. is too little for a job of this kind, unless you have quite a number of these machines to build.

If instead of using men of average skill on this job, I arrange the work so it can be done in the same number of hours at a direct-labor rate of 15c. per hour, and make my price $120, how much profit will I make?

This is where the total overhead rate comes in handy. The cost will be as follows:

Material		$52.00
Overhead 80 hr. at 38.3c.		30.64
Labor, 80 hr. at 15c.		12.00
Total cost		$94.64
Selling price	$120.00	
Cost	94.64	
Profit		$25.36 or 26¾%

I have a job of planing up some castings furnished by the customer. These will keep my big planer tied up for 25 hours. How should I charge for them? The planer hand gets 30c. an hour.

The direct labor will amount to 25 × 0.30, or $7.50. Since the biggest machine in your shop will be required for this job, the average overhead of 38.3c. an hour will not be enough. This is where common sense and judgment come in. The expense of running that planer is at least twice the average hourly expense. If you charge regular rates for it you will lose money. It will cost you at least $1 an hour for work done on that machine, in-

cluding the operator's pay. Soak them $35 for the job, brother, and if any of your competitors want it bad enough to do it for less, let them have it. A good chooser can pick the plums and discard the lemons!

Avoiding the Rocks

There are dangers in using a ratio, or percentage, such as we have obtained, and these should be understood by the shop owner in order that he may not be misled. These are somewhat similar to the error that might be expected in measuring a man with a rubber scale. In other words, the unit is not a fixed one. It can be used for estimating, if it is corrected at intervals of six months or a year, but it must not be used for comparisons between distinct periods, as is illustrated in the following case:

Smith was manager of a shop which boasted of an uptodate cost system that had been installed by a firm of experts. While Smith was an enthusiastic advocate and believer in his cost system, he did not have the first idea of the principles underlying it. Jones was an ambitious foreman of a department in this plant. While he had plenty of skill and good horse sense, he did not know the difference between an expense ratio and a Bulgarian bacillus.

Jones thought he had done a good thing when he doubled the output of his department with slight additional expense; but he had not calculated on Smith, and on the cost system. He was called on the carpet and given a great overhauling because the total expense per hour, less material, had jumped from 75c. to $1. He found it difficult to convince Smith that the fact should also be considered that 200 pieces were produced in an hour by the man who formerly produced 100. Smith forgot that the conclusions made from the cost per hour, or from an expense rate of so many cents per dollar of labor, must be influenced by the *quantity of work produced during that hour,* or by the *value of the labor bought with the dollar.* Overlooking such things is cultivating an appetite for forms and an indigestion for facts.

It is well known that certain elements of overhead expense are constant and to an extent independent of the output. The fixed charges are the same whether a plant is run at one-half or at maximum capacity. This is why it pays to keep as near as possible to the limit output of the shop, and that is one reason why the small shop which employs less than six men sometimes has a hard struggle. The investment, fixed charges, and a great many of the other indirect items are as large for a one-man shop as for one in which there are four to five workmen, and the burden per man is necessarily much higher for this reason.

Good Judgment the Main Thing

No matter what method is used for dividing up the total burden for a given period among the jobs worked upon during that time, the result can only be an approximation. This will be made clearer by looking at Figs. 2 and 3 in which a total burden is shown divided in two ways—proportionately to direct labor, in Fig. 3, and as it really should have been applied.

The various jobs worked upon during the period are shown at *A, B, C, D, E, F, G* and *H,* in Fig. 3. For convenience and simplicity, the burden in Fig. 3 is taken as 100 per cent. of the direct labor. Taking some of the individual cases for study, we have at *A* a job which was largely completed by hand work. Very little machining was done, and the amount of direct labor spent on this job amounts to over twice as much as the materials entering into it. According to the approved method of applying burden, it is made equal to the labor on job *A,* Fig. 3, whereas actually it was a great deal less in this case. The job consisted mainly of bench work that required very little power, took up but a small portion of the floor space of the shop, and did not require much attention from the boss. All of these things tend to reduce that portion of the total burden that job *A* should be called upon to bear.

On the other hand, job *B,* consisting mostly of boring-mill and planer work, made a lot of trouble in the shop, and required strenuous efforts on the part of the boss to get it out on time. According to the approved method of distributing burden in Fig. 3, it is made equal to the labor, whereas it was really much greater. The expensive tools used on this job really cost much more per hour than the pay of the operators.

It is seen that even the practical methods of dividing up the overhead expense on individual jobs, gives results which are far from representing actual facts. There are no means of overcoming this without excessive red tape, and the only thing to do is to give this subject care-

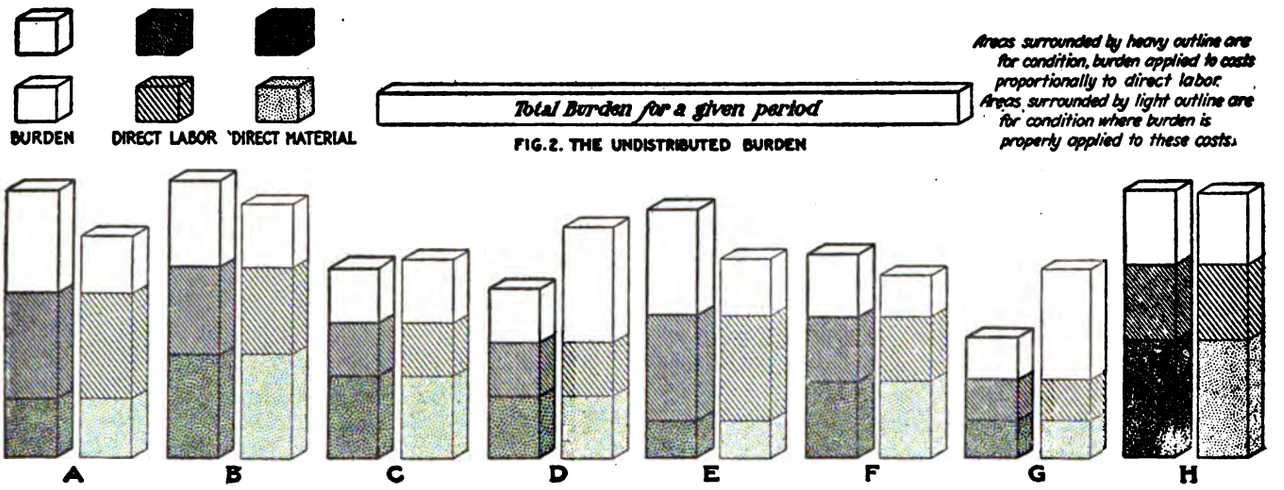


FIG. 2. THE UNDISTRIBUTED BURDEN

FIG. 3. THE BURDEN DISTRIBUTED PROPORTIONALLY TO DIRECT LABOR AND PROPERLY DISTRIBUTED

ful thought and make mental corrections for these factors when figuring on the cost of work.

The manufacturer who does not make such allowances is confronted by some very perplexing problems. One man had a good deal of galvanized-iron work to make in connection with the machines that he built. As the number of men in this line of work increased, he took occasional outside jobs in order to keep them busy during slack times. Some of these were quite similar in size and shape to what he had been making, and one day, as a matter of curiosity, he called for costs on similar work made inside and outside of the shop. Imagine his surprise to find that a job built outside cost 30 per cent. less than when made in the shop by the same men. It took him some time to discover that the extra inside cost was due to the regular overhead expense applied on all labor, and after this experience he placed less reliance on figures and more on judgment.

The skilled navigator, by intuition born of long experience, will keep very close to his course by dead reckoning. But he will occasionally wish to check up his position definitely by means of real observations. So in the small shop, while the hourly units are of great value in estimating costs and keeping track of the course in a general way, accurate observations are necessary from time to time in order to fix the real financial position of the shop owner. Dead reckoning is valuable in the degree to which it is intelligently applied, and the small-shop owner must be able to make allowances by intuition for the conditions which he knows exist, but which cannot be expressed in figures.

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Defects in Pattern Shops

By George Clark

We have in the wood-working department a turning lathe of one of the best makes that is equipped with hand tool rests and cross-tool carriage with hand-screw feed. The feed screw in the cross-carriage has been renewed once and this new screw repaired three times during the past fifteen months, because of broken feed wheel and bent feed screw. The cause of these troubles was the dropping or throwing of the carriage on the floor when changing to the hand tool rest.

I corrected this trouble in the following manner: Back of the cone head I attached to the lathe bed an iron table flush with the top of the lathe carriage. This table has a T-slot like the one in the lathe carriage and so located that when the carriage is moved up close to the head the cross-head can be moved over on to the table and clamped out of the way, safe from damage and ready for use in an instant.

Another nuisance that should receive the attention of lathe builders is the throwing of oil from the lathe bearing and countershaft. There are still a few pattern makers that take a pride in their personal appearance as well as their work, tools and surroundings. If the ceiling were twenty feet from the floor there are some foremen who would still consider it good practice to put the countershaft up there. When it is possible and practical I put the lathe countershaft on the side wall, so located that, with the aid of a turning tool the shifting of the cone-pulley belt is within easy reach of the workman.

Small-Shop Sunshine—More Compensations

The small-shop man goes up against some peculiar people in finding a market for his goods; but he has at least one thing to be thankful for—it is not often that he has to cater to the taste of a feminine buyer. There may be cases in which the boss's wife or stenographer has quite a little to say about how he runs his business, but as a rule she doesn't mix in the equipment end of it. If she did, the machine designer would be at his wits' end for cute little frills with which to beautify his product, and the boss of the painting gang would require a correspondence course in matching up the latest dress shades.

A razor manufacturer says that this feminine buying caprice has forced him to produce a safety razor. The ladies won't buy the open-blade type of razor because it is such a horrid and cruel-looking thing! They prefer the neat little silver-plated arrangement, with the blades covered up in metal boxes where you can't see them. Besides, they cost more, which is a strong point for feminine buyers.

You didn't know that the ladies shave? Well, they don't, but their purchases in this line represent a large percentage of the total, especially during the holiday season. They buy them as presents for their male relatives and friends, and being feminine they buy the cute little kind, for instance, the little safety corn razors, that they themselves would use if they had to.

The machinery business is one of the few that still practically remains a man's business all through. Sometimes one of the gentler sex tries to break her way into it, but as a rule she doesn't get very far. You will find one starting to take a course in a technical school. She is determined to put on overalls—er, overskirts, and show what a woman can do. The course in wood-turning is so interesting! Perhaps being without a rival among so many nice young men accounts for a part of the interest. When it comes to the foundry work our feminine trade scholars will begin to lose heart. Bench-molding is not so bad, but in floor-molding, the postures are anything but graceful, especially if one attempts to follow the styles in skirts!

At a future day things may be different and the machine shop not so exclusively a man's proposition. Our census tells us that we have 37 lady lumbermen and raftsmen, 405 coal miners whose first names denote the feminine gender, 31 female blacksmiths, 73 machinists and millwrights who use back combs and psyche knots, and 52 lady iron-molders. The only job which they have passed up is the boiler maker's.

Some day, if things keep on going as they are, and the ladies are as anxious to take charge of the process of making all the money as they are at present of spending it all, we may see a locomotive built by lady machinists, from iron and steel produced by lady miners, molders and furnace tenders, and driven by an engineer and a fireman wearing the latest style in split skirts. Where will the men come in? Will they have to be on hand in the roundhouse to shoo away the rats and mice?

This is a long way off, thank goodness, and in the meantime the machine shop will continue to be essentially a man's stamping ground.

Inventory in the Small Shop

SYNOPSIS—A great many manufacturers take inventory from a sense of duty without analyzing its purpose. In this article inventory is regarded from a number of viewpoints, and methods are described which are applicable to small plants that do not have complete cost records available for pricing purposes.

If a man has money enough, he can usually get what he wants. A manufacturer in one of our Western cities used to "take it out" of the cost clerk when the final figures for a job which had been shipped did not show enough profit. The cost clerk, being very obliging as well as diplomatic, thereupon took pains that his boss should have a very good margin of profit—on paper, at least. All parties appeared to be well pleased with this arrangement; the cost clerk avoided many unpleasant interviews, and the proprietor had the pleasant sense of personal well-being that comes with a good digestion, a poorly working conscience and a supposed profit on sales.

A more common cause of self-deceit is found in the inventory. The value of this in the same plant and for the same period may vary from a certain amount to five or six times as much, each figure being perfectly correct and justfiable according to the point of view from which it is made.

The most modest and conservative point of view from which the shop owner can regard inventory is that which would accompany a forced sale of his plant and its contents after an unfortunate career in which his product had been found unsaleable at a profit. In this case there would be no "good will" to be considered. Special tools and equipment which could be used only for the unsuccessful product would be worth merely scrap values, as would any parts of the product which were in stock in partial stages of completion. Also, in placing values on an inventory which is taken on such a basis, it is almost impossible to estimate the forced-sale figures even for standard machine tools in good or fair condition. Patterns will have no value, except as material for firewood or tooth picks. Costly tools, jigs and dies which when new represented many dollars a pound, shrink in value to a few cents.

At the opposite extreme, the point of view regards inventory as a statement of actual plant and product values, considering the business as a "going" one. This is the point of view of a manufacturer who is about to take in a partner or to make a profitable and proper sale of his going business.

In between these two extremes are various shades and degrees. In some plants we find the inventory regarded as a general comparison with not as much attention paid to the actual totals as to the relations between them for different years. Sometimes the purpose of inventory is made largely to serve the purchasing department and the shop, as a sort of tabbing off of materials against orders. With so many different ways in which this thing may be regarded, it is evident that one must be selected for the small shop before real headway can be made.

Some Wrong Ways to Look at Inventory

The point of view of the forced sale is out of the question, although many accountants insist that it is the only proper one. For the owner of a successful shop to take the viewpoint of one which is bankrupt, for the purpose of inventory, is like asking the policeman on the beat to put on convicts' stripes when he reports at the station house. No doubt there are some shops regarded by their owners as successful, which should be classified as failures, just as there are some policemen who would be more suitably clad in the horizontal stripes than in the blue and gold. However, the point of view is as far removed from the correct one in the one case as in the other.

The small-shop owner who takes an inventory is most likely to do so for the purpose of securing a profit statement on the preceding year's business and of comparing this with a previous one to see whether there has been an increase or a decline. On the average, he will not be interested in the forced-sale point of view, nor will he wish to adopt the maximum values quite natural for one who has a plant or business to sell. He will wish the total figure to be conservative, so that it will not be misleading, and he will wish to have it comparative, so that he can place this year's results alongside of last year's.

What should the inventory represent? Should it be a combination value of the plant, equipment, and manufactured goods, or should it be confined to the products? Should the values assigned to the product parts represent their total cost including burden or should they be figured on a material-and-labor basis only?

The Confusion Coming from Costs

The inventory is most frequently figured on the basis of cost. Sometimes it is figured on the basis of selling prices, in the case of a standard article on which a large finished stock is carried. The cash valuation of this is usually placed at a certain percentage under the actual selling price. Where inventory is based on cost, the unit cost figures usually taken are those which represent the average for the preceding year.

This often leads to peculiar results, as illustrated by the experience of a small manufacturing shop in which current cost values were used in making up the inventory. The owner of this shop was very much surprised, when he received the totals, to find them lower than those for the preceding year. He was quite positive that a greater amount of finished stock and of partially completed parts were on hand when this inventory was taken than at the time of the preceding one. He called in the bookkeeper, who also acted as cost clerk. "Jones," said the shop owner, "there is a mistake somewhere. I know that there is more finished stock on hand now than there was a year ago, and yet the inventory value is much smaller. How can you explain this?"

After investigation, Jones came back with his explanation, "We made a big cut in labor cost this last year, therefore our inventory prices for the same pieces were much less this year than last. This was more than enough to overcome the greater amount of pieces on hand."

"In that case," exclaimed the shop owner, "'I don't think much of inventory. The less the cost and the more money I make, the less the inventory valuation!"

Here is the big drawback to an inventory based on cost, and it is no doubt one of the principal reasons why accountants favor the forced-sale plan, in which values do not fluctuate widely. An inventory figured on shop cost often tends to defeat its own purpose, for the more that a job costs and the less profit that is made upon it, the higher the inventory total is boosted.

The trouble arises from the fact that labor is an item that is difficult to weigh or measure. In the case of materials, the fluctuations from year to year are not great; a dollar's worth of cast iron purchased this year and the amount that could have been purchased for a dollar a year ago could hardly be distinguished. A dollar's worth of labor is an unknown item, unless a piece-price system is in use or other standards are available—refinements that most small shops do not keep on hand.

What to Include in Inventory

If the small shop maintains an equipment account, as described in Vol. 42, p. 181, there will be no necessity for taking inventory of any items which are included in this classification. This at once eliminates the buildings, machine tools, and similar equipment, as well as line shafts, pulleys, hangers, belts and the like, which are part of the "appraisal" and do not belong in the inventory. Product parts, supplies and small tools, which are not part of the investment but are considered as running expenses, should appear in the inventory.

As we shall see in a later article, in using inventory for the purpose of getting a profit statement, we make use only of the difference between the inventory at the beginning and the end of the period in question. It is the difference and not the totals that is used. This difference is supposed to represent the loss or gain in manufactured stock and supplies during that period. It is evident that if the cost values assigned to the manufactured stock fluctuate widely from one period to the other, this purpose is defeated.

Another important thing from the small-shop's point of view is the scarcity of itemized costs. The small shop which attempts to keep costs on the work going through usually does so on the total or order-number plan, and makes no attempt to record the itemized costs of various operations. In addition, there are a large number of small shops which do not attempt to figure individual costs at all. Fortunately, all of these advantages and disadvantages work together into a very simple solution.

Taking the Inventory by Weight

The inventory plan that I recommend for the small shop consists in pricing the product parts at so much per pound. Material and labor prices are separated when established, and afterwards combined for computing the value. Material prices are taken from the current market reports, and labor prices are either figured or are arbitrarily set. It is not hard to arrive at an average "cost per pound" for the labor on your product, and having this, modifications may be made into classes to suit the coarser and the better grades of work. The figures given in the accompanying table will show how the classification may be made.

STANDARD LABOR VALUES PER POUND for average machine work weighing less than 100 lb. (Current material values per pound are to be added to these figures to obtain the total cost per pound for inventory pricing. Assembled and partly assembled machines to be priced from the cost records.)

FINISHED MACHINED PARTS

	Grade A	Grade B	Grade C
Weighing 5 lb. or less	10c.	6c.	3c.
Weighing 6 lb. to 25 lb.	5c.	3c.	1½c.
Weighing 26 to 100 lb.	3c.	1½c.	¾c.

PARTLY FINISHED MACHINED PARTS

Weighing 5 lb. or less	5c.	3c.	1½c.
Weighing 6 to 25 lb.	2½c.	1½c.	¾c.
Weighing 26 to 100 lb.	1½c.	¾c.	⅜c.

(Classified by principal operations.)

GRADE A—Parts finished all over or worked to close limits. Parts finished on an engine lathe or having a large amount of bench work.

GRADE B—Planer, hand screw machine, turret lathe and miller work.

GRADE C—Drill press, automatic machine or cheap work in general.

Remember that inventories in a going plant that is not interested in selling stock are for use only in comparison and that, therefore, an arbitrary rating such as is illustrated here is quite proper so long as it is conservative and saves labor.

In taking an inventory on this plan, it is simply necessary to weigh the totals of the product parts as divided into the given classes. Work in process is considered to be half way between rough and finished, and the prices for this are taken as one-half the finished prices. Completely assembled machines may be handled either on the weight basis or at a figure representing their cost, if this is obtainable. Materials are priced at the current market reports, as are also items of supplies, such as bolts, nuts, studs, oils and maintenance materials. It is convenient to have separate report sheets for various classes of product, such as brass and bronze, cast iron, steel work, forgings, etc., and this can be very easily arranged in taking the inventory. Each page is totaled, and these totals are again combined to form a grand total or summary of the inventory.

By maintaining this same standard of values between consecutive years for the labor cost, the inventory results which are secured will have a value as comparative records. Their accuracy will be fully as great as the average inventory, which is taken with more regard to getting it over than to getting it right.

Inventory is often considered as a "clean-up time." Material which is no longer serviceable is weeded out and sent to the scrap pile. The cleaning-up process should begin ahead of the inventory instead of after it. The results are likely to be more satisfactory all around.

Fifty per cent. of the time spent in taking shop inventories is thrown away, for the average shop owner does not know why he wants it, how to get it or how to use it. I have seen hundreds of dollars spent in big plants simply to observe the established custom or habit of inventory, when it would have been cheaper and just as well for the manager to have shut his eyes and "guessed" the total. A good label for the small-shop man to paste in his hat is "know what you want and why you want it." If it finally soaks home, it will give him a big start on many large-shop owners.

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The electric power distribution for the Panama Canal operation and lighting will require 246 miles of lead-covered cable, which is about 40 per cent. of the total amount placed by the largest electric power company in the United States during the 20 years preceding 1908, states "Engineering News." These cables will be carried through the lock walls in vitrified clay ducts. On account of the large amount of cable to be placed in the ducts, a special device using an electrically operated winch was resorted to.

Profits in the Small Shop

SYNOPSIS—Should profit be figured on cost, selling price, or total investment? There is almost as much confusion on this point as there is regarding "nonproductive" labor, "overhead" expense and other impressive terms that represent simple things. The object of this article is to obtain a clear common-sense view of the profit problem.

Three men were discussing the question of profits at a machinery builders' convention. There seemed to be a difference of opinion among them as to what constituted a reasonable percentage of profit for a certain machine that each of them built. The first man said that he expected a return of 20 per cent., the second man thought that 15 per cent. would be about right, while the third man stated that he would be well pleased with 10 per cent. This great difference of opinion led to a warm argument which was settled only when a disinterested friend suggested that they express their expected profit in money instead of percentages. The two extremes were not 5 per cent. apart in actual dollars and cents!

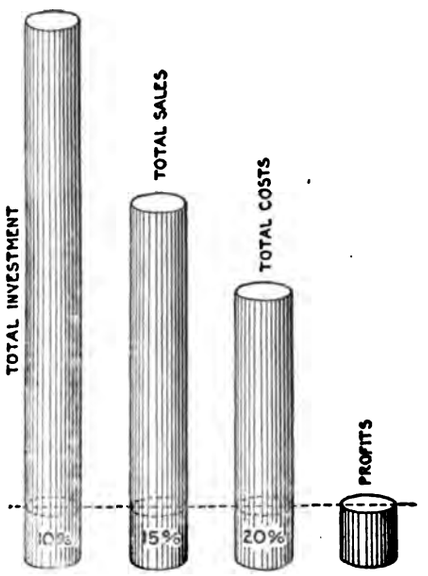


FIG. 1. WHICH SHALL WE MEASURE IT BY?

Each of these gentlemen looked at the profit question from a different point of view. The first figured his percentage on a total cost; the second based his on the total sales, while the third figured it on his total investment.

Manufacturing profit must be distinguished from profit on the total investment before we do anything else. The man who figures his manufacturing profit from year to year does not know how much his plant is worth until he tries to sell it, and neither can he tell what his total profit has been during that period until the sale has been completed. But the average shop owner is in business to stay and not like a real estate dealer or promoter, intent on making a profit by turning the whole thing over to someone else. What he is interested in is the manufacturing profit and not the total which includes the sale of the plant and business. This former may be defined as the total expenditures for manufacturing expense during a given period subtracted from the total receipts during the same period.

SOME MORE DISTINCTIONS

A man in Michigan invested $2000 in a small repair shop. He was a good mechanic but a mighty poor bookkeeper, and being unmarried he did not have a wife who could act in that capacity, nor did he feel that he could afford the expense of a hired bookkeeper. He used "horse sense" in figuring on work, and, to tell the truth, made a better attempt at it than a great many who were using six decimal places and an adding machine. He kept no accounts, and the bank with which he was transacting business was a leather bag in his breeches pocket. What he made over and above running expenses he considered to be his salary and promptly spent it, not having any intention to make his plant larger.

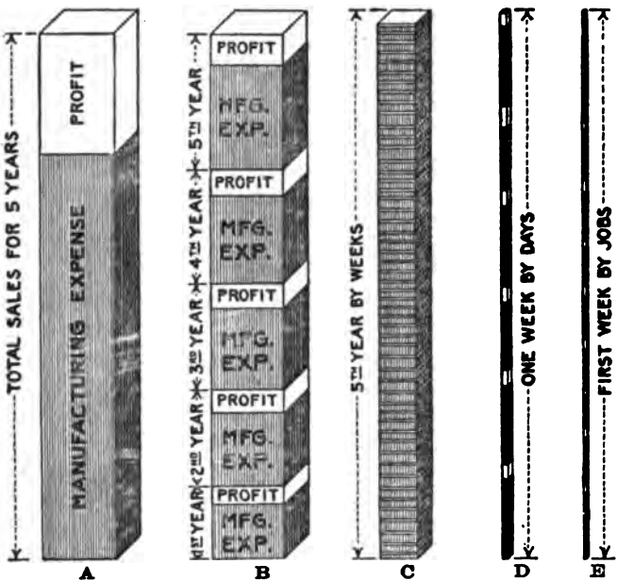


FIG. 2. FIGURING PROFITS IN VARIOUS SUBDIVISIONS

At the expiration of four rather happy-go-lucky years, he decided to sell his shop and establish himself on a fruit farm. There had been no extensions to the plant since he bought it, and no machinery had been purchased, but notwithstanding this he managed to find a man who gave him $3000 for it. A friend of his, acquainted with his peculiarities and curious to know how he figured his profit on the deal asked him what it amounted to.

"Well," he replied, "I sunk $2000 into the business and I took $3000 out, so I figure I made a profit of $1000 from my shop."

"You're wrong," his questioner replied. "The $1000 profit did not come from your shop, but from your ability to find an easy mark."

VARIOUS DEGREES OF SUBDIVISION OF PROFIT PERIODS

Profit, to carry meaning, must be expressed either in connection with a period of time or with a definite quantity. The fact that profit of $10,000 has been made is

cheering news, especially if you are the man who has made it, but Bradstreet's representative wants to know if this is the result of a life time, or one year, or a single job, before he will write it down in his album.

If you will refer to Fig. 2, you will see that manufacturing profit may be figured in various degrees of subdivision over various periods of time, beginning with an undivided profit statement, as shown at *A*, in which the whole thing is figured up after a lapse of a number of years. At *B* the profit figuring has been done at yearly intervals. It might have been carried down to weekly intervals as shown at *C*, and I believe that some plants go to the extreme of having a daily return of profits made, but there are not many who carry things to this degree of refinement. A still further subdivision would be to figure the manufacturing expense and profit on each job, and at *E* we have an example of this showing the same work *D* handled in this manner.

The more frequent the subdivision, the less will be the *real percentage of accuracy* of any one profit statement. This is almost like saying that the more pains you take to find out where you are, the less you know about it. While it is not exactly that, it must be admitted that a statement of profits over a period of years, such as shown at *A*, would be very close to a correct one. With extreme subdivision, as shown at *E*, it is like slicing a loaf of bread into a great many pieces, in which case we are quite likely to lose some of the crumbs.

One thing that makes it impossible to obtain an exact statement of profits for a given period is the fact that labor and material which is purchased today may not go to the

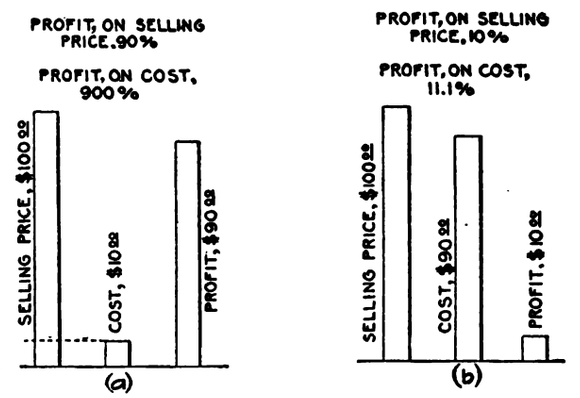


FIG. 3. COMPARISON OF PROFITS ON COSTS AND SELLING PRICES OF INDIVIDUAL JOBS

customer for many months and that the money which we receive today from our customers is for work done several months ago. Material that we ship this year and receive payment for may have been built the preceding year, and while it is accounted for in the inventory, inventories themselves are simply approximations. The best we can hope for in figuring profits is to determine the difference between the rate at which money is going out and that at which it is coming in.

How frequently profits may be figured will depend upon the frequency with which the shop owner is willing to take an inventory. There are some classes of work on which it is not difficult to maintain a *perpetual inventory*, and in such cases profit figuring is a very simple proposition. In the average small shop, once a year will probably be quite frequent enough to do this, since the owner will have to add this task to his own well loaded shoulders.

WRONG WAYS TO FIGURE PROFITS

There are two reasons why profits should not be figured as a percentage of costs. The first is that it is an inaccurate method of figuring them. The "overhead expense" as it is applied to an individual cost is simply an approximation, and to figure a profit on an approximation

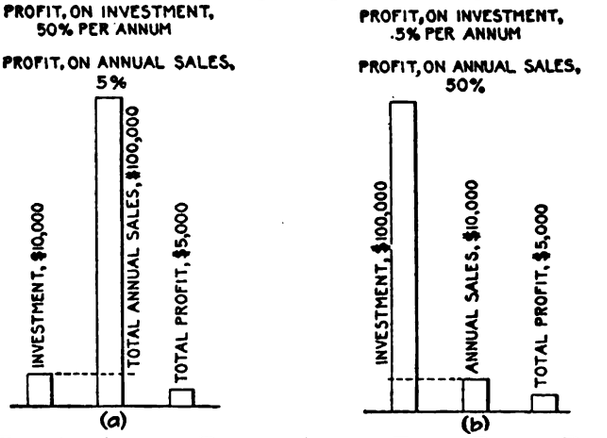


FIG. 4. ANNUAL PROFITS ASSUME THEIR PROPER PERSPECTIVE ONLY WHEN PLACED ALONGSIDE OF INVESTMENT

of this kind will give us a very approximate profit at the best.

In second place, we must not forget to distinguish between the percentage of profit on an individual job and the annual percentage of profit earned by the shop. There is no harm in saying that a certain cost shows a profit of so much, but this has no relation to the amount of annual profit, since it does not state how many times the money invested has been turned over. A profit of 5 per cent. on the total cost may amount to a return of 10 per cent. on the investment, providing the original investment has been "turned over" twice.

In the general machinery-building trade it is out of the question to base the profits as a percentage of the sales, either in individual cases or as an aggregate for the year, although this is the usual plan in the grocery business or the drug business, where the retail costs are the jobbers' selling prices. To figure a profit on the sales is to figure on a profit, since the sales themselves include the profit.

Take, as an illustration of this, the exaggerated case shown at *A*, Fig. 3, in which the profit is 900 per cent. of the cost. If stated on the selling price, this profit shrinks to 90 per cent., because *it is figured on itself*. At *B*, in the same illustration, is the opposite case (and the more usual one) in which the profits do not form the most conspicuous feature of the landscape. In this case there is not a great amount of difference in the two percentages.

THE CORRECT STANDARD

The correct standard against which to compare the total for the year or other period to get a percentage is the total investment, as shown in Fig. 4. This brings the comparison down to an absolutely fixed basis by which the money value of our efforts can be judged and the return on a given investment compared definitely with what it would bring if invested in standard securities.

The two following cases will show why this is the

proper and desirable way to figure the percentage of profit:

Suppose you have a patented article of merit, inexpensive to manufacture, which the expenditure of a few hundred dollars enables you to place on the market. We will say that your total investment is $500 at the start, If you find that there is a ready market for your product and that you have no difficulty in making prompt collections through the inducements of a cash discount, you are able to turn the money over very quickly. At the end of the year your total manufacturing expense has been $2000, and your total sales, including the value of the inventory stock, has amounted to $3000. Figuring profits on the basis of cost, you have made 50 per cent.; figuring it on the basis of the investment, you have made 200 per cent.

An opposite case is illustrated in a great navy yard in which equipment has been installed for the purpose of building battleships. Here we have an enormous investment, comprising drydocks, shops of all kinds and complicated handling facilities. An enterprise of this kind in private hands may show an apparent profit over costs of 35 or 40 per cent. on a single battleship; but when the total profits for the year are compared with the total investment, we find that the annual return shrinks to 5 or 6 per cent.

From these two extreme cases it is evident that the only logical way to figure profits is to compare them with the original investment. The great fact for the manufacturer to keep in mind is to *secure the maximum return from the least capital invested.*

The small-shop's profit statement is made by subtracting the total expenses during a given period from the total income for the same period. Sometimes the *sales* for the year are used in figuring income and sometimes the *shipments.* The latter will be the best plan in the small shop where the amount to be charged the customer is not always known in advance of shipment.

Making Up a Report

The total expenses are obtained from the shop records, the total manufacturing expense, as described in a previous issue, being corrected for inventory. If the inventory this year is smaller than last year, it is evident that we have been drawing on last year's stock to fill this year's shipments. In that case, the difference between the totals of the two inventories must be added to manufacturing expense, thus decreasing the profits. If this year's inventory is larger than last year's, it shows that the shop has not only taken care of the shipments but has also built up stock, and the difference must be *subtracted* from the total manufacturing expense. Inflated inventory values depict false profits, but I assume that the small-shop owner has not wished to fool himself and has therefore been conservative in putting a value on his stock.

The following is a typical small-shop profit statement or *periodical report,* as it might better be called:

STATEMENT, Jan. 1, 1915

Shipments 1914, including bill receivable			$22,185.90
Total manufacturing expense * for 1914	$16,238.40		
Bills payable	498.25		
		$16,736.65	
Inventory, Jan. 1, 1915	$6,849.30		
Inventory, Jan. 1, 1914	5,932.25		
		917.05	
			15,819.60
Manufacturing profit, 1914			$6,366.30

* Includes interest on investment, depreciation of plant, buildings, etc. (See page 25.)

Increasing the Purchasing Power of the Small Shop's Dollar

One of the places where the big plant is supposed to have it over the little one is in its ability to make favorable purchases. This is due to the fact that it has larger quantities to buy and naturally is sought after as a customer. Again, it is for this same reason less expensive, per dollar of sales, to sell to the large plant. No more time is required to sell a thousand dollars worth of material or supplies to the big plant than would be needed to take the little fellow's order for ten feet of belting and a gross of screws. Naturally, the small plant has to pay for this extra expense which is involved on its account.

Another advantage which the large shop has in purchasing is that it usually employs for that purpose a specialist or purchasing agent. We all know that when we do one thing exclusively, we are more apt to do it in the best possible manner than if we do a little of everything. The big-shop purchasing agent follows the markets, gets the best terms and discounts, and saves his pay because he is on to the buying game.

What the little shop gains in a reduced overhead expense rate, it loses through unfavorable buying. The proprietor, who is already mechanic, designer, bookkeeper and general manager, adds the role of purchasing agent to his many accomplishments. Five divided by five is one, but five divided by one is five, which is another way of saying that the smaller the number of things that we attempt to look after, the more likely we are to get bigger results.

The solution of the purchasing problem for the small plant may lie in a number of them getting together and doing it in common, just as for economic reasons they find it profitable to get together in one building and rent floor space and power. Of course the combination for purchasing does not present such an attractive saving in initial investment as is presented in buying power instead of making it, or in renting floor space instead of building or buying a plant. But all things considered, the annual expense saving might be found to be greater.

The Names of Things

The names of things vary in different parts of the country; but one of the strangest was recently found in Tacoma. Here a sign read "White Metal Sheaves," meaning white, or hard, cast iron to withstand wear. But in most parts of the country this would be known as "white iron," as white metal is a common term for any sort of lead-tin-zinc alloy, such as babbitt.

This brings to mind the British use of the term machinist, the only criticism being that it is not our usage, which is hardly a criticism that will hold water. This refers to the term "machinist," which we apply to the maker of machines. The British apply this to the user, instead of the maker, and it is quite common to see signs and read advertisements for "machinists on ladies' waists," "machinists for laundry work," etc. All of which goes to show the desirability of uniform usage to prevent confusion and misunderstandings.

A Successful 20-Man Shop

SYNOPSIS—Here is a small shop that uses many of the advantages which are thought to belong exclusively to big shops. While doing this, it retains the favorable small-shop features, the result of the combination being strikingly successful.

There are certain refinements which have come to be looked upon as belonging to the large manufacturing plant. Therefore, when one enters the Fischer Machine Co.'s shop in Philadelphia and notes the clean floor, sheet-iron and wire-net lockers, new and high-grade machine tools, and nitrogen lamps for illumination, he is quite apt to fancy himself in some department of a large shop. And

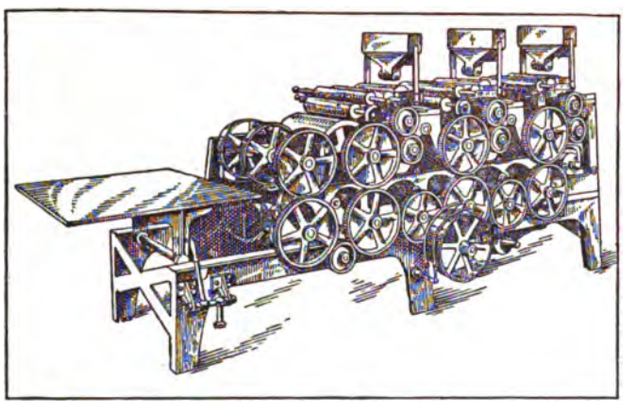


FIG. 1. A SMALL SHOP CAN DO BIG WORK AND MAKE IT PAY

on finding that this is really a small shop, in which but 20 men are employed, he is quite likely to jump at another wrong conclusion—this model shop must be a rich man's hobby, and not a self-supporting institution! In reality, it represents the gradual evolution coming from 15 years of existence and plenty of hard knocks during that period, combined with the somewhat rare case of a shop owner who knows when his plant has become large enough and is able to resist the natural temptation to make it larger.

We are not apt to correctly estimate the importance of little things. Actions which appear trivial are of immense importance in shaping human destinies, although in these things years, instead of days, elapse between the sowing and the harvest. Back in the '90's, a boy was working on some gears in a printing-press shop. He had a piece-price on his work, and filled with the natural boyish desire to see how much he could make, he went ahead at a pace which doubled his wages for the week. The short-sighted management of the concern immediately cut the price in half. This dash of cold water had a galvanic effect upon the ambition of the lad. Instead of transforming him into a systematic skulker, it clinched strongly two determinations—one was to get into business for himself, and the other, never, as an employer, to cut a piece-price given to one of his men.

In 1900, we find this boy, now grown to be a man, in partnership with another in the smallest kind of a small shop, in which Fischer and Risley played the combination parts of proprietors, superintendent and gang. The shop was a little affair covering about 1000 sq. ft., and they engaged in the line of work with which experience had made them most familiar—printing-press repairs. In a shop of this kind one must needs be an all-round man, for in addition to hustling for business, there are patterns to make, work to be done on the lathe, drilling machine and bench, and hardest of all, the collections—a job that was dedicated to Saturday mornings.

As time went on, a man was added now and then, until, in 1903, there were four men in the shop, in addition to the bosses. Now came an opportunity that drew heavily upon the reserve supply of self-confidence before the partners could see their way clear to grasp it. For a firm rated at $2000 to tackle an $80,000 contract was like a puppy trying to devour a side of beef for dinner. The job in question consisted in building all of the tools, jigs and fixtures and the first 1000 guns for the Philadelphia Arms Co., now known as the Fox Gun Company.

A BIG ORDER FOR MACHINE TOOLS

To complete this job, it was necessary that they have $6000 worth of new millers. These were ordered of

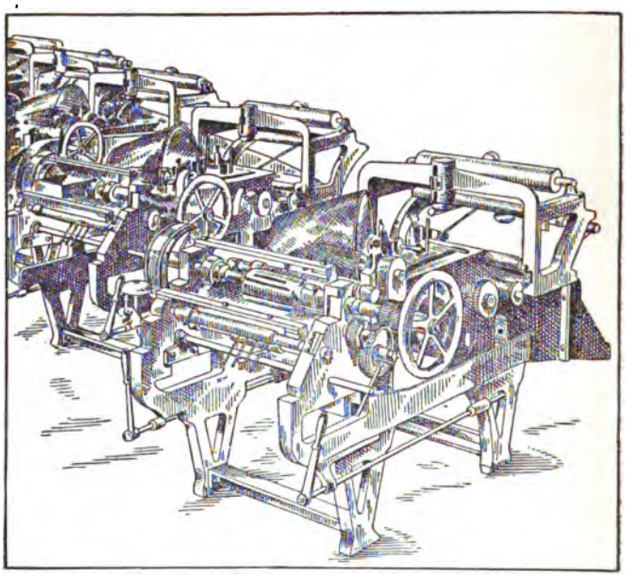


FIG. 2. PAPER-BAG MACHINES ARE ONE OF THE ESTABLISHED LINES

Brown & Sharpe. When the officials of that company saw a $6000 order coming from an unknown concern with a $2000 rating, they decided to investigate. The two partners had a visit the next day from a cold-blooded New Englander, who put them on the scales and weighed them to the fraction of an ounce. The result of this investigation must have been satisfactory, for shortly afterward the millers were received.

To be successful, it is necessary to sidetrack all half-measures. The acceptance of a contract of this size for a specified and guaranteed completion within one year meant the immediate transfer of the shop to larger quarters. It meant putting on a large force of men immediate-

ly, and working them overtime every night for almost a year. It meant a great deal of strain and anxiety upon the shop owners, but it also meant reputation and money when completed. That it was completed successfully is evidenced by the partners being urged to sell out and take charge of running the plant of the Philadelphia Arms Co. Fischer would not listen to persuasion, being determined to stick to his shop; Risley, on the contrary, thought the chance a good one, so the partnership was dissolved.

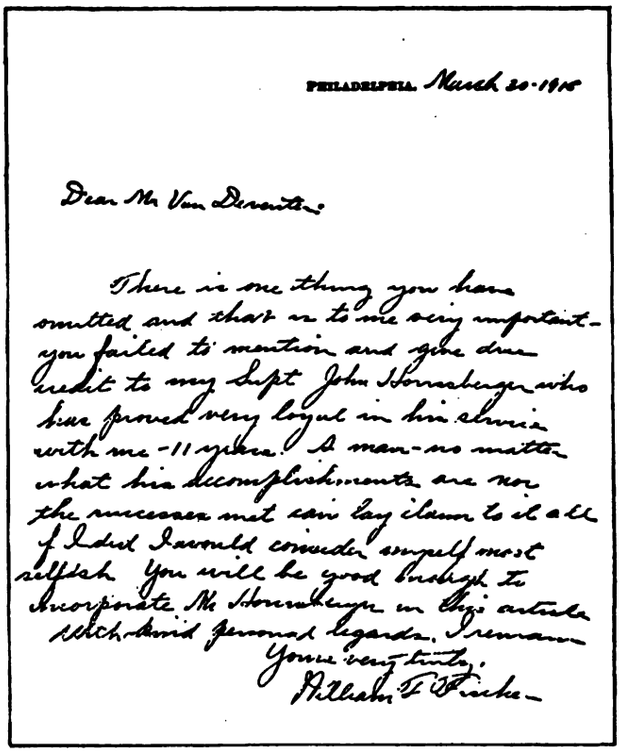
A taste of high quality duplicate work had given Mr. Fischer an appetite for repetitive manufacturing, instead of the cruder repair work with which he had started. First, came automatic machines for making nets, jigs, fixtures and special machinery, then paper-bag machinery; two and three-color rotary printing presses, and the oil-grooving machines familiar in automobile shops.

At the present time the home of his shop is a four-story steel and brick structure in the heart of Philadelphia. The business is not incorporated, being owned entirely by Mr. Fischer. The Fischer Machine Co. furnishes power for the building, the source of this being a 60-hp. De La Vergne crude-oil engine.

An Enviable Overhead Expense

I doubt whether there are many other shops in this country which can show a smaller total overhead expense compared to the sales value of the output. In the office one finds but one clerk, aside from Mr. Fischer. In the shop there is a superintendent who does considerable productive work, and a laborer, a part of whose duties is to look after the operation of the power plant in the basement.

The cost of all work is carefully recorded by means of



PHILADELPHIA, March 20 1915

Dear Mr Van Deventer:

There is one thing you have omitted and that is to me very important- you failed to mention and give due credit to my Supt John Sonnenberger who has proved very loyal in his service with me - 11 years. A man - no matter what his accomplishments are, no the successes met can lay claim to it all if I did I would consider myself most selfish. You will be good enough to incorporate Mr Sonnenberger in this article which I send personal regards. I remain

Yours very truly,

William F Fischer

Fig. 5. This Letter Shows Two Reasons for Mr. Fischer's Success—a Good Superintendent and His Own Desire to Give Credit Where It Is Due

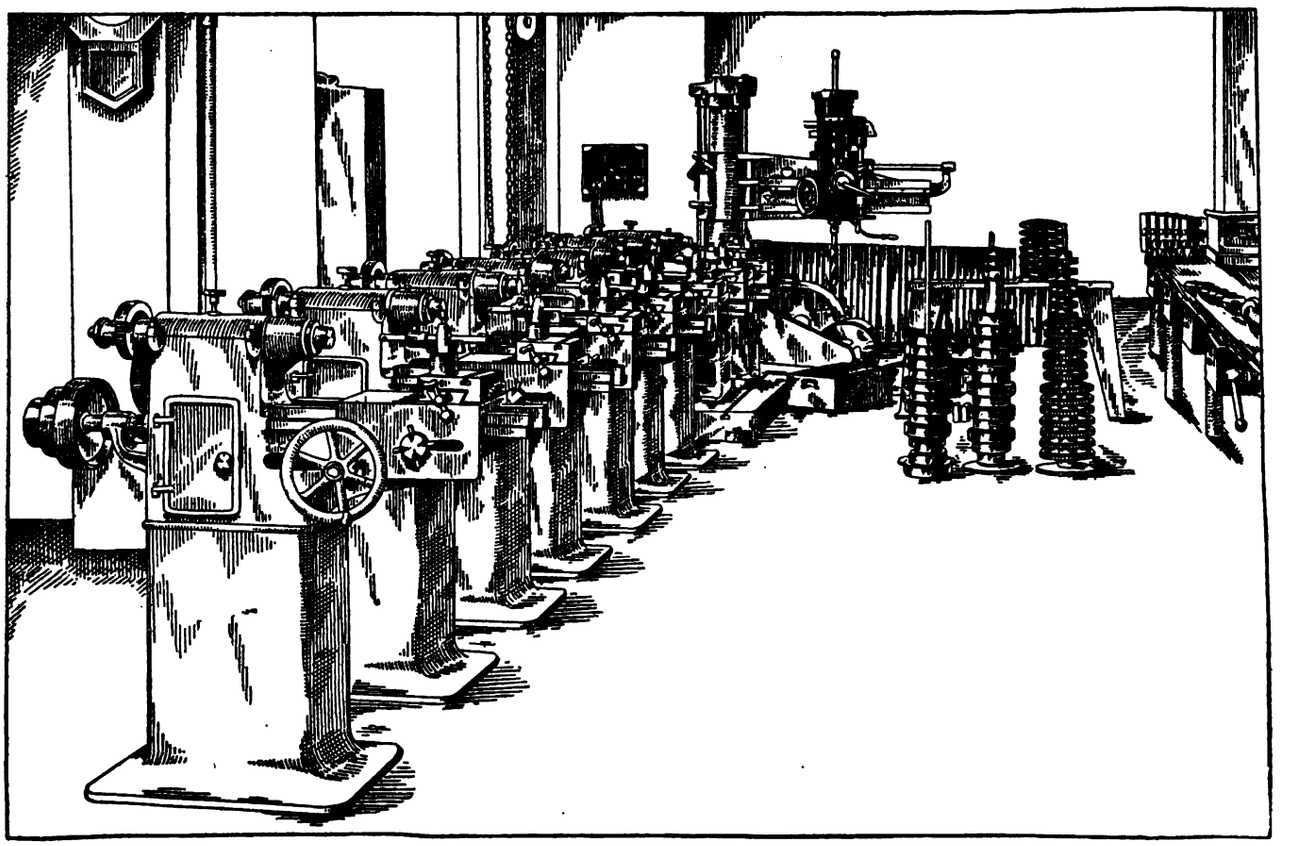


Fig. 3. A Clean Floor and Quantity Production Help Profits

a simple system. Each job that goes into the shop is given an order number, and time is sent back from the shop upon these same numbers, being tabulated and checked by the clerk.

Methods of Caring for Small Tools

The methods employed to care for small tools are unusual for a small shop. Not only are wooden boxes or blocks provided for the reception of these tools and fixtures, but they, in turn, are inclosed in locked cupboards to which the superintendent has the key. The more commonly used small tools, such as drills and lathe tools, are kept in an open crib. No tool checks are issued, the belief being that those employed in this shop have been with the firm long enough to be either trusted or busted. The superintendent takes charge of issuing tools from the tool-crib when they are required. This insures that his attention is called automatically to the set-up for a new job, with the result that it is given proper supervision.

The prevailing method of pay is by day-work. Occasionally, on jobs which are likely to prove monotonous, a bonus is offered to make the work more attractive. The resolution never to cut a price when once given has been kept; in fact, the policy toward employees is a more liberal one than usually found even in large shops.

One notices that the shop walls and posts are not covered with "safety-first" slogans. After all, it is more productive of results to have the safety idea embedded in the minds of the employees than it is to distribute signs so profusely that they are regarded as indifferently as sprinkler heads.

There is a noticeable absence of the miscellaneous litter that clutters up the floor of too many large and small plants. All of the machines under construction are arranged in orderly groups and are kept in racks or cupboards until needed. The day laborer who has the honor of being the real "non-producer" in the shop appears to be as skillful with the broom as he is in manipulating the crude-oil engine, and due to his accomplishments in this line, the floor presents a remarkable condition of neatness.

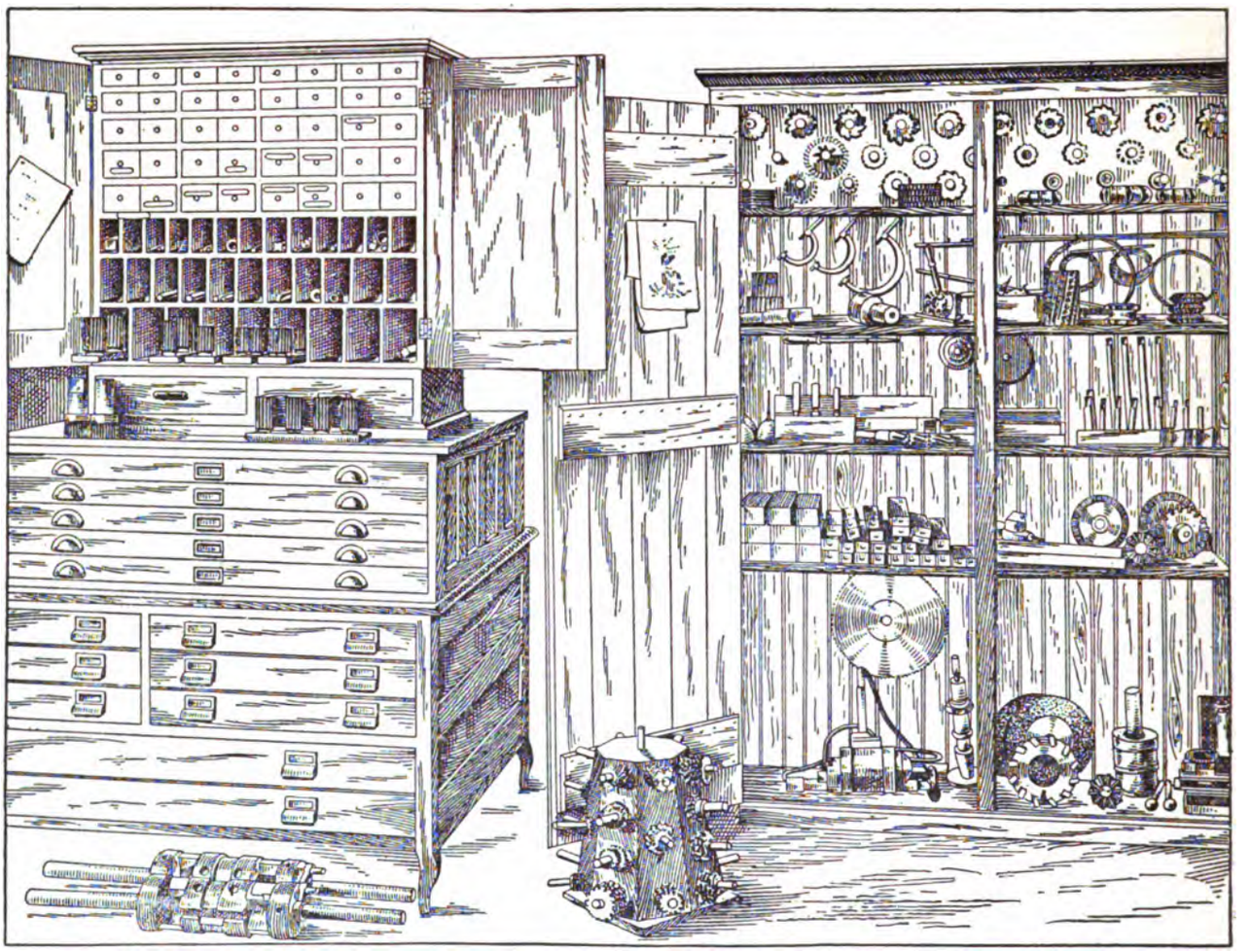


Fig. 4. An Orderly Shop Inspires Confidence and Raises the Credit Rating

Lessons of Experience

Like most successful manufacturers, Mr. Fischer has not failed to gain experience which is helpful to others. One of his observations is that a small machine shop, as a rule, has a hard struggle until it grows to the point where at least a half-dozen men are employed. The man who attempts to build or manufacture machinery as an employer, must make his profit by guiding the efforts of others. The average production of the mechanics in this country, measured in dollars and cents, is less than $2500 per year per man. This, it must be remembered is the selling price measure, and from this must come the cost, leav-

ing a figure which represents the profit per man to the shop owner. A profit of this kind ranges from nothing to $300 or $400 per year per man, the latter amount being exceptionally high. With less than six men, therefore, unless the work is quite out of the ordinary, the small-shop owner will not have to worry much about what to do with his profits. In addition to this, it takes five or six men to absorb the "shop charges," or overhead expense, and to reduce them to a point where they cease to be excessive.

According to the experience of this shop owner, it pays to use good machine tools and to keep them in first-class condition. The average of the tools in this shop is less than four years. The patriarch is an eight-year-old grinding machine the use of which is such that accuracy is not needed. Ten per cent. depreciation is charged on the purchase price of the tools, which would not be enough for such frequent renewals were it not for the fact that their good condition when sold causes them to have a high salvage value.

It is Mr. Fischer's belief that there is a great deal more profit to be made in manufacturing goods of high quality and high price, than in adopting the opposite policy. In other words, the additional cost necessary to obtain a quality a little better than the average is more than offset by the amount that a customer is willing to pay for a machine in which this is embodied. A customer's first order may come on price, but his next five or six are likely to be based on quality.

Above all, do not try to make all the profit. The temptation to do this will often lead to the purchase of machines that are far from good investments and the employment of men who run up your expenses unduly. It is easier to put a man on than it is to discharge him when he is not needed; and often, before the knowledge that he is not needed is brought home to the shop-owner's mind, a great many unnecessary hours have been put in and paid for. It is cheaper to buy such services outside and maintain a simple line of work in the shop, with a low overhead, and it is more profitable in the end, even if the other fellow does get a chance to make a few dollars out of your contracts.

In the AMERICAN MACHINIST, page 80, the following definition was given of success: "Making friends of your customers through the quality of your work; friends of your workmen through the quality of your treatment; and as much money as you can without losing the pleasure of living." Altogether, I think that the Fischer Machine Co. represents a successful shop when measured by this definition, and its experience is an added proof that the small shops can be just as successful as the larger ones.

✣

Enlarging Hacksaw Capacity

BY AXEL HALVORSEN

The other day I had to cut off a couple of pieces of tool steel from a 6-in. round bar. The only lathe was busy and the power hacksaw had only 4 in. capacity and a 12-in. blade. By making a new connecting-rod from a piece of 1¼x⅝-in. cold-rolled steel, 1¼ in. longer than the one on the machine, I was able to cut off the blanks by turning the stock over twice. This gave a good job, requiring about three hours.

I used a couple of C-clamps to hold the stock against the solid jaw of the vise, which was just high enough.

Success and Size of the Shop

It is sometimes said of a man: "Jones is a very successful manufacturer—look at the enormous plant that he owns."

A good deal depends on how we define success. Even if it is defined as the ability to get dollars, while Jones may get more dollars than Smith, who runs a little plant up the street, he may not get as many dollars per man employed, and on the basis his success may not be as great as that of Smith.

The most successful surgeon would not be called because he charged the highest fees, but because he had the largest percentage of successful operations. His reputation, however, would also be based somewhat on total number of cases, since if he operated successfully on one patient and then retired from the profession his percentage would be 100, but it would not establish a reputation.

One of the most successful shops in this country boasts of but a dozen machine tools and covers but a few hundred square feet of floor space. It has been owned by one man for 20 years, and he has not wanted it to become any bigger than it is. If it were any bigger, he would feel that he could not put on overalls and get right down to work himself, which is what he likes more than anything else. He set out to have a shop of his own, to turn out good work and to make a comfortable living, all of which he has accomplished. Success to somebody else might mean sitting behind a mahogany desk with brass trimmings and pressing buttons for reports from the shop, but to him it means getting his hands dirty and his face, too, when necessary.

Incidentally, while not owning a share of stock outside of his own little concern, this man is the founder of many of the large industrial plants in his city. He has had a habit of teaching his men to think, which, by the way, is dangerous if you wish to keep them. A number of them after attaining this accomplishment started into business for themselves, some reaching money success, some size success, and one or two quality success, but none of them rivaling the "old man" in his particular success field.

After all, success is really doing what you set out to do, whether it be to make money or to paint wonderful pictures or to rob a bank. The popular notion of it is rather hazy. It must be modified by the characteristics of the individual whom we are measuring. A successful bull-dog would make a rather poor showing as a canary bird.

How's this for an attempt at a definition of success for the shop owner? Making friends of our customers through the quality of our work; friends of our workmen through the quality of our treatment; and as much money as we can without losing the pleasure of living.

Is it an impracticable combination?

✣

Carbon Paper for Blueprints

BY H. K. BOYER

In making sketches or small working drawings, draftsmen frequently make a carbon copy of the sketch or drawing. The carbon paper may be used to advantage as a negative tracing (for making "blue line on white background" prints) by using it as a tracing in connection with ordinary blueprint paper. Of course, new carbon sheets must be used, and no erasures should be made before placing a hard surface between the drawing paper and carbon sheet.

Floor Space and Storage in the Small Shop—I

SYNOPSIS—The small shop, when compared with the big one, falls down badly in the economical use of floor space. A square foot of floor space in the big shop is made to earn almost twice as much as a square foot in the little shop employing from 6 to 20 men. Yet this is not an inherent advantage of big shops, but has come from careful planning and study. How the little shop may profit by the same study is told in these articles.

The sense of order is very largely a cultivated sense and very seldom a natural or inherited one. Go back to your boyhood days and ask yourself whether, in getting ready for bed, you carefully and systematically hung each garment on its proper hook, or whether the floor of your room looked like a map of the Sandwich Islands done in calico, worsted, wool and shoe leather. When my boy's bedroom presents the least aspect of order at night, I turn back the bedclothes to make sure that he has undressed! The orderly small boy is almost as rare a specimen as the one that always has a clean face and hands.

The "natural" mechanic has about the same degree of systematic instinct as the average small boy. His mind works in an orderly way in constructing mechanical results, step by step, but the sense of system is often lacking. It is the most natural thing for him to throw material on the floor, just as it is for the boy to put his clothes there.

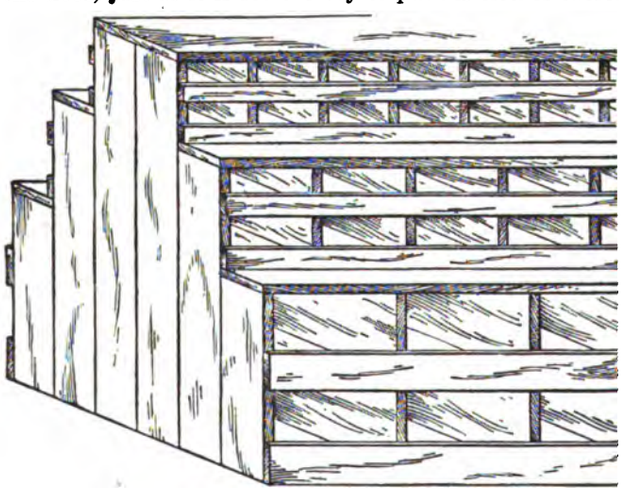


FIG. 1. OLD-STYLE SOLID WOOD BIN. DARK, DIRTY AND UNALTERABLE

This may be one of the reasons why, to a stranger, the average small-shop floor resembles a Chinese puzzle that is impossible to solve.

In the big shops, order and systematic handling of stock and floor space do not, as a rule, come from the efforts of skilled mechanics. There is a very plausible saying that almost all shop "system" originates in the office, and where you find a shop in which the floor space is economized through the systematic handling of stock and materials, you generally find "nonproducers," as they are called, employed to maintain this condition of order so that the "natural" as well as the unnatural mechanics may get what they need most easily when they need it.

A NECESSARY COMBINATION

It is probably a good thing that these traits are separated in different individuals. A high-grade mechanic or designer cannot burden his mind with details outside of the main purpose without considerably lowering his batting average. But the owner of the small shop must be an exception. If he is not a first-rate mechanic or, at least, if he has not a good mechanical mind, he is not likely to succeed. And if he hasn't a pretty good sense of order, he is very likely to fail.

Inventive and mechanical ability alone will not make a successful shop manager. Some of the brightest inventors and mechanics can spend money at a rate fast enough to keep the fattest purse looking like a punctured Zeppelin.

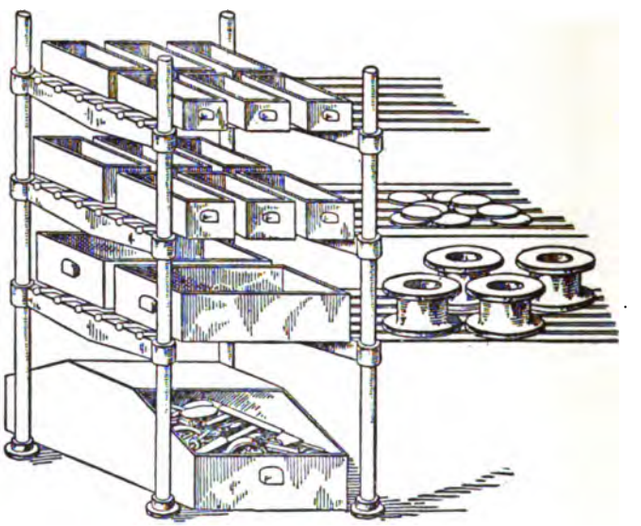


FIG. 2. STEEL RACKS AND TOTE BOXES. LIGHT, CLEAN AND ADAPTABLE

The sense of order, while it applies to many other things in the small shop besides the disposition of machines and materials, is made evident most strongly by the arrangement of these factors. One can tell at a glance whether it is present or sadly lacking at the shop. The credit man and the representatives of Dun or Bradstreet take it into account when they are sizing you up. The customer who looks you over to see if you can handle his work is influenced by its presence or absence—that is, if he and his work really amount to much. Your own personal standard is unconsciously affected by the degree of order existing in your shop, as is also that of every man who works there. Moreover, the possibility of growth of the shop is absolutely limited by it.

MEN, MACHINES AND MATERIALS

Men, machines and materials are the three things that take up floor space. They are the three things on which

the small-shop owner must build his structure. Men do not differ very much in the amount of room that they take up individually—except on the street cars or in similar places—so we may dismiss them from the problem of best utilizing the square foot of floor space.

Machines, wrongly placed, often take up many more square feet of floor space than they should, by preventing its use for other purposes. The planer may be mentioned as one machine that has no apparent respect for floor space. It protrudes itself into the most desirable locations and has a haughty but irresistible manner that compels people and things to keep out of its way.

But materials are the greatest offenders; without them, every shop would be clean and almost every one would

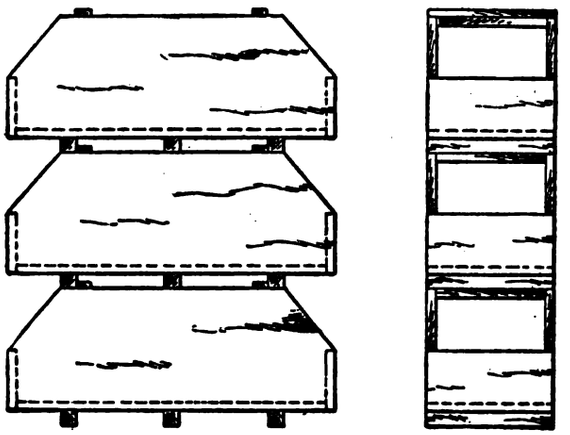


FIG. 3. WOODEN TOTE BOXES STACKED INTO RACKS ON THE SECTIONAL-BOOKCASE PLAN

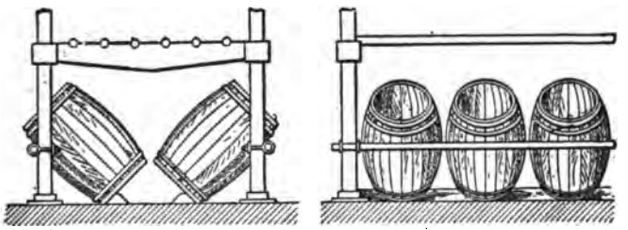


FIG. 4. TILTED KEGS USED FOR BOLTS, NUTS, WASHERS, ETC., ON THE "GROUND FLOOR" OF RACKS

be orderly. Unfortunately, we cannot eliminate materials from our machine shops and still keep them busy making things and money. But we can divorce the storage of stock and materials from the actual space used for machining and erecting, and thus effect a compromise that not only makes an orderly appearing shop, but reduces the cost of the work done and increases the earning power of each square foot.

ARRANGING MACHINES TO INCREASE EARNING POWER

Even in a jobbing shop, where there is not much uniformity in the sequence of machines used, the location of the machines with respect to each other and to the various doors and shop windows has a big effect on their productive capacity. The machines capable of producing the closest work, and on which fine measurements are required, will lose less time when placed in a well-lighted position than when stuck in a dark corner. Yet, too often, tools take their places in the row in first-come-first-served fashion, without regard for anything except avoiding an extra shaft hanger or the trouble of moving other machines already in place.

There is only one feasible way to determine the best arrangement of machine tools and shop conveniences—place them first in one position and then another, until the best is found. That is the way they do it in the big shops. But they do not move the machines themselves, nor the storage racks and tool-cribs and the like. Instead

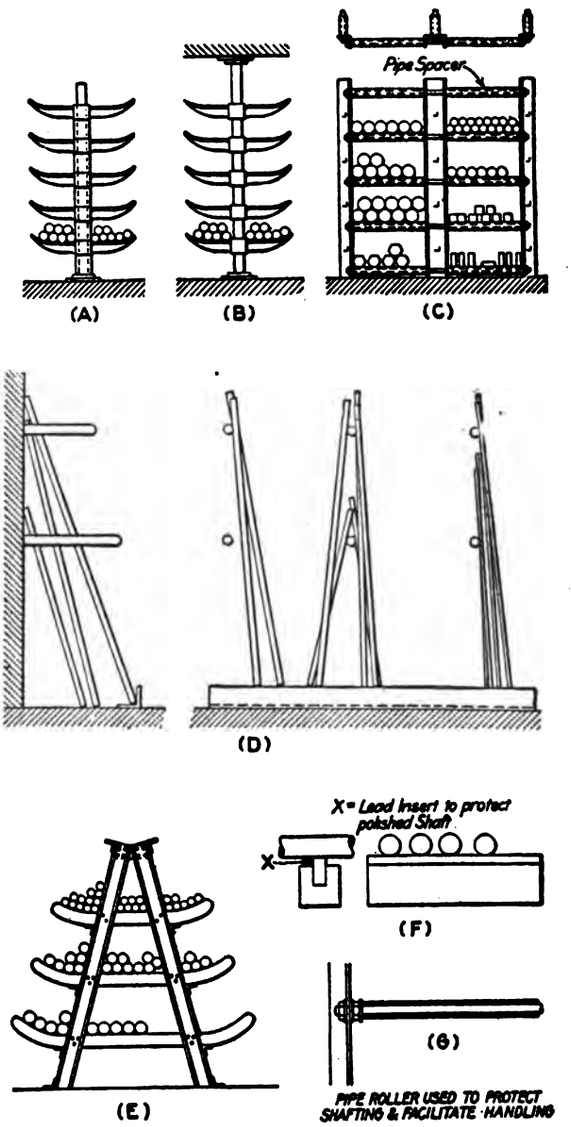


FIG. 5. VARIOUS WAYS OF STORING PIPES, RODS, BARS AND OTHER LONG PARTS

of this, a plan of the shop is laid out on a piece of drawing paper tacked to a board. All of the doorways, openings, windows, posts, etc., are shown, the whole being in fairly large scale—not less than ¼in. to the foot. Then pieces of light cardboard are cut into squares or oblongs of the same scale, to represent the floor space required by the various machine tools, work benches, tool cupboards, storage racks, and other items of shop furniture. These are juggled about on the shop floor, as represented upon the drawing board, until the arrangement is found that is most suitable all around. Some of the points considered while doing this are: Proper illumination; ease in placing and removing work from the machines; trans-

portation of heavy work; proper driving power; space for additions; spaces for work in process at the machines; proper clearance for safety of operators, and, at the same time, the most economical use of floor space. In the small shop, particular attention must be paid to clearance for over-size jobs, such as cutting threads on 16-ft. pipe lengths on a lathe with a 10-ft. bed, or turning 8-ft. diameters on a 5-ft. mill. For the capacity of the machines in a small shop is not limited by the distance between housings or the lengths of beds or the swing over the ways, but by the number of ounces of gray matter in the brain of the owner.

The Natural Evolution of a Stockroom

The idea of a stockroom is preceded by that of the bin, which goes back to the days of the savage who cached food and valuables in holes in a cliffside or in rock crevices. His purpose in doing this was security, not convenience. Later on, when the old silversmiths and goldsmiths separated from the rest of the shop the rooms in which the raw and finished materials were stored, it was with the

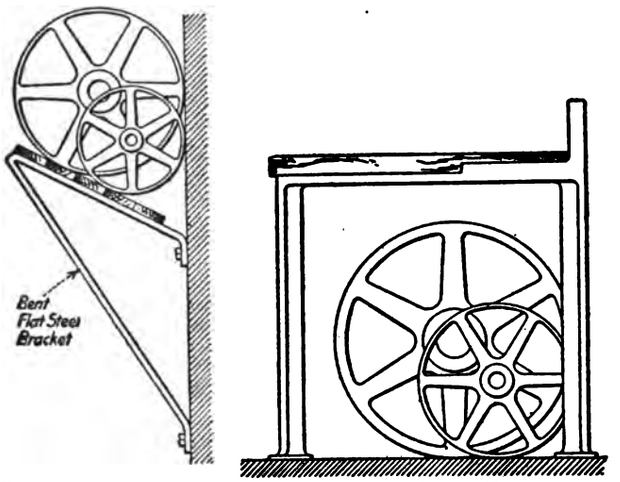


Fig. 6. Heavy Pulleys under the Shop Bench and Light Pulleys Go Overhead

same end in view—to keep the mischievous 'prentice boys from converting the stock into coin through a sleight-of-hand process.

Protection or security is still one of the main reasons for a stockroom in any shop, large or small. There are certain materials and supplies that are much better locked up than left lying in the open, and it is hard to draw the line that distinguishes these from those that do not require this precaution. The desires to steal for profit and to "borrow" for the purpose of building machines at home will continue as long as shops are being operated. The latter, especially, is a failing that is often looked upon as being quite excusable and not at all morally wrong. But it costs the shop owner just as much as if the material were taken to the nearest junk shop and converted into cash.

Admitting that it is necessary for the small shop to have a number of locked cupboards in which to keep bronze, brass, valves, fittings, and the like, is it not more economical to protect all of this material with one padlock by partitioning off a space as a stockroom within which are open bins containing the valuable materials? The protection is just as great as with the individual lockers, and there is but one key to lose, instead of several. The construction will be found to be cheaper, and it will permit of the safe storage of a great deal more than individual cupboards ever could.

The statement is sometimes made that the small shop hasn't room for a stockroom. As a matter of fact, having a stockroom economizes space instead of wasting it. If such a convenience is not had, materials and supplies usually are placed on the shop floor, and there is but one layer of this available. On the contrary, the stockroom racks have six or eight times as many layers in the form of shelves, so that a square foot of stockroom space has from six to eight times the efficiency of the same space on the shop floor, considered from the storage viewpoint.

Modern Storage Bins

The old-style storage bin was made of wood and built by the carpenter. It was dark, dirty and unalterable. Usually, it sagged in the middle so that a row of these bins resembled an array of hammocks at a popular summer resort. A typical bin of this kind is shown in Fig. 1. Modern storage racks are the work of the pipe fitter or the sheet-iron worker. They are light, clean and adaptable, and reduce the fire risk. The fixed bin is becoming a thing of the past, the sheet-iron tote box having forced it back to the woods. Such boxes in a modern storage rack are very flexible, as indicated in Fig. 2, and all things considered, this type of storage furniture is much cheaper than the wooden bins. Sheet-iron tote boxes in standard sizes and patterns are offered at low prices, and it does not pay to make them except in cases where the shop owner fills in odd moments which would otherwise be idle and yet must be paid for.

One of the latest and best developments in stock-storage methods is the transfer truck. The use of this is by no means confined to the big shop. In fact, where the small shop intends to install a stockroom, the transfer truck with its system of stacked truck boxes will be found to cost considerably less than permanent racks, in addition to its advantage of flexibility. The leading points in its favor are the saving of time in loading and unloading, and that trucks need not be tied up for the purpose of storing material. These advantages will appeal to the small manufacturing and specialty shop more strongly than to the small jobbing shop.

Expanding a Reamer in Hot Water

By George E. Holmes

Recently, upon reaming a 3½-in. hole for a bushing for the delivery-cylinder shaft of a rotary printing press, it was found impossible to even drive the bushing into place. Owing to the worn condition of the reamer, the hole was several thousandths too small. The other reamers of this size were worn even more than the one used.

But the press erector had a happy thought which he put into execution and saved the fit. He secured a pail of hot water, placed the reamer into it for a few minutes, then took it out and immediately reamed the hole again. The bushing went into place without any difficulty. The hole was now slightly larger; the expansion of the reamer by heat had brought it up to the correct size without much trouble or loss of time.

Floor Space and Storage in the Small Shop—II

SYNOPSIS—In the small shop, stock-racks and the like are seldom designed for the load that they will have to carry. The usual way to build these structures is to choose material that happens to be handy and looks husky enough for the job. As a result, the construction is often more expensive than it should be. This article gives tables of safe loads for various shapes, sizes and spans commonly used in shop-rack construction.

In one fairly large shop that came under my observation, the storage racks were all built by the boss of the labor gang. The process of building included also that of designing, for it was left entirely to him to choose the size and weight of the materials that were used. In doing this, he, in common with King Khufu, builder of the pyramids, had one object fixed firmly in his mind—to pick materials of such proportion that no load could possibly affect the structure disastrously, and thereby bring confusion and disgrace upon him.

It must be said in justice to him that none of his structures ever collapsed. His metal "safety factor" was a large one. Where a 2x¼ angle would have done the work, he selected a 4x⅜ on general principles.

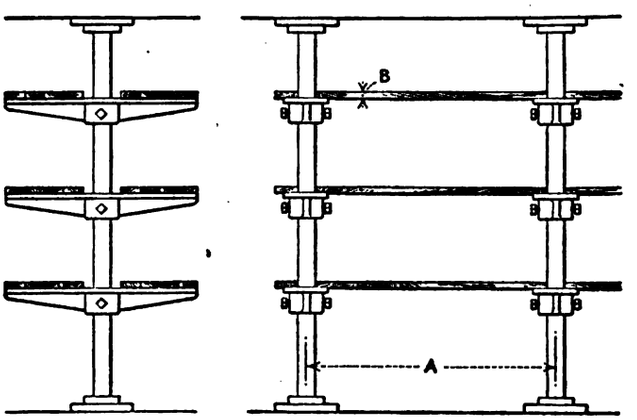


FIG. 1. RACK OF BAR AND BRACKET CONSTRUCTION PLANK SHELVES

This man was a good practical mechanic, but he was not familiar with the carrying capacity of stuctural-iron shapes for short spans and columns, although he could have come pretty close to telling how big an I-beam to use for a 5-ton crane girder to span the width of the shop. His employer evidently lacked the same knowledge, for he made no complaint, although he was not of a disposition to spend money unnecessarily.

It is safe to say that in the comparatively few small shops that have good storage facilities, there are very few racks indeed that are built with a proper conformity to the loads that they will carry. And this is no exclusive fault of the small shops, for as indicated in the first paragraph, it is quite commonly present in large shops as well.

SHEET STEEL MAKES THE STRONGEST RACK FOR ITS WEIGHT

Undoubtedly, sheet steel as a material for storage racks has no equal when measured by its supporting ability per pound of rack. But in order to get this strength, the sheets must be bent and formed into box sections—something that is not easy to do unless the shop is equipped with sheet-metal-working machines. It is out of the question, then, for most small shops to do anything with sheet-steel racks, except to buy them. If they can spare the money for this, it is a good investment, especially if the rack is to go on an upper floor on which it is necessary to keep down the "per square-foot" load.

The small shop will do well to buy its shop furniture instead of making it, except where the labor necessary to do this is at hand and must be kept employed. In other words, it is a good "fill-in" job for the small shop. If the labor were to be employed especially for rack building, the chances are that the cost of the structure would exceed the amount for which a better one could have been bought. When a rack is to be built, however, build it right. Build it so well that other shop owners when they see it will want some like it. It is not impossible that this will result in a profitable line of business for you, as it has for others.

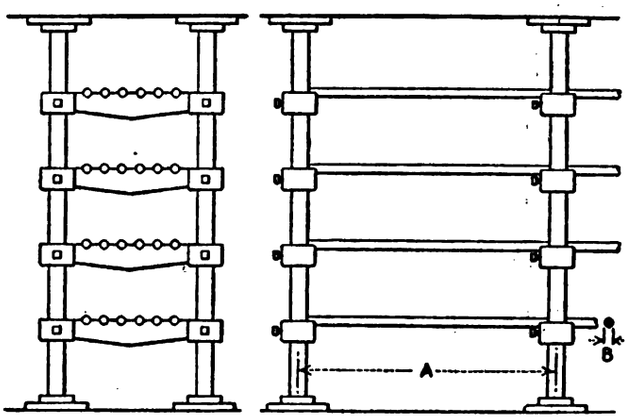


FIG. 4. RACK OF BAR BRACKET AND ROD CONSTRUCTION
(For safe load on bar columns, see Fig. 2)

USING THE TABLES FOR SAFE LOADS

The proper selection of material for storage racks is made easy by using the tables of safe loads that are presented here. They are figured with a safety factor of four, which is amply conservative for the dead load on such structures. It will be noted that loads are given both for columns and for horizontal stringers. A word of explanation about both of these may help.

There is nothing very flexible about a piece of ½-in. gas pipe, 6 in. long. Used as a column, it would support a wagon containing a ton of coal, if the latter could be balanced upon it. But take a 16-ft. length of the same diameter, and it is as flexible as a fish pole and would buckle under the weight of a coal-wagon driver alone.

So, in figuring the safe load on a vertical column, one thing that must be taken into account is this tendency to buckle, which depends upon the way in which the load is applied and upon the *greatest unsupported, or unbraced, length*. In the tables, the loads on the columns are taken as vertically applied, and if the stringers are fastened so as to produce a bending action on the column, this must be accounted for by allowing a larger size for the member.

Safe Loads on Horizontal Stringers

The loads given for these members are "uniformly distributed." The distinction between this kind and a "concentrated load" may be illustrated in homely fashion by means of a 6-ft. plank resting on supports at each end and an accommodating 6-ft. man—one by the way with a fairly uniform cross-section and not of aldermanic proportions. If the man lies down on the plank the load is "uniformly distributed"; when he stands upon it, the load is "concentrated." If the plank is just strong enough to hold the man standing up half-way across the span, it would hold both him and his twin brother when stretched at full length. So, in using the tables for stringers, in case you are figuring on a concentrated load, it will be but one-half of that given.

Estimating the Load to Be Carried

Cast iron, steel and similar metals weigh, roughly, 450 lb. to the cu.ft. But it is seldom that we get a solid cubic foot of any metal. Castings usually have core holes that lighten them, not to speak of blowholes. Even a keg of nails is nearly 50 per cent. air. If we take the maximum load on a storage rack as 200 lb. per cu.ft., it will be exceedingly safe, as a shelf or bin is rarely filled over two-thirds of its height. This, of course, is considering the heaviest class of metal storage. When wood patterns or other light materials are to be considered, 50 lb. per cu.ft. is an amply sufficient allowance.

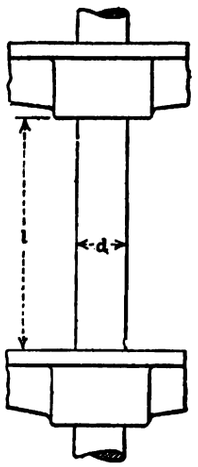


Fig. 2.

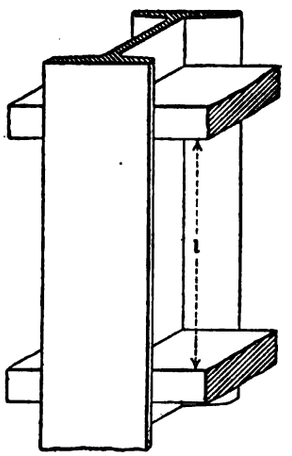


Fig. 7.

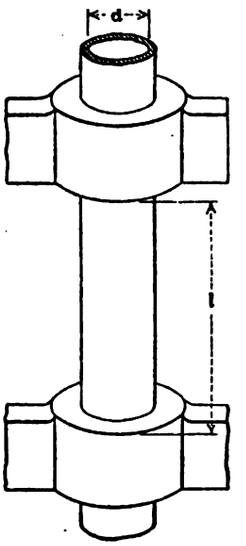


Fig. 10.

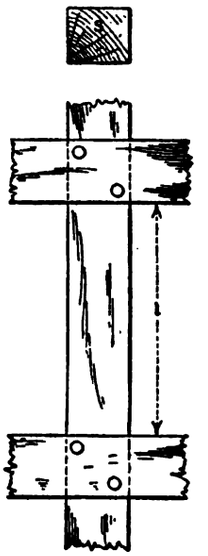


Fig. 13

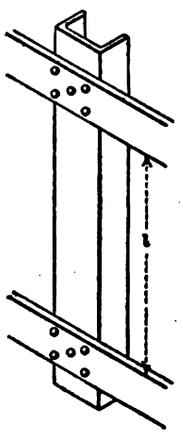


Fig. 16.

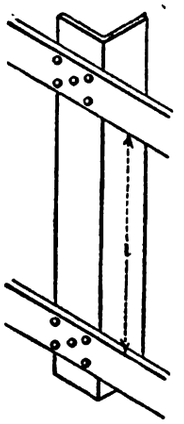


Fig. 17.

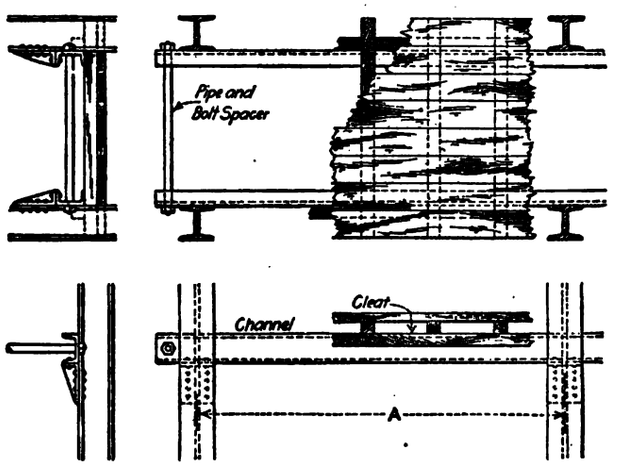


Fig. 6. Rack of I-Beam and Channel Construction

Suppose it is wished to build a storage rack 3x12 ft. with three shelves, the rack having a total height of 6 ft. Let us see how the tables work out. The cubical contents of the rack will be $3 \times 6 \times 12 = 216$ cu.ft. At 200 lb. per cu. ft., the total load will be $200 \times 216 = 43{,}200$ pounds.

Taking for a trial, six vertical columns, which arrangement gives a 6-ft. span for the stringers, the load per column will be 43,200 divided by 6, or 72,000 lb. This is considering that each column carries one-sixth of the load. But, in this case, we must make allowance for the fact that the center columns will be more heavily loaded; in

fact, if the shelves were uniformly loaded throughout, the two center columns would be obliged to carry one-half of the total load, or 21,600 lb., each one of them having to support one-half of this, or approximately 11,000 pounds.

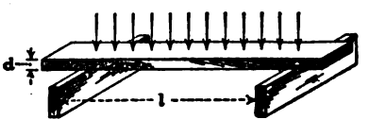
Assuming that the greatest height between shelves is 30 in., an inspection of the tables tells us that a 1½-in. solid steel bar, or a 2-in. standard iron pipe, or a 4x4-in.

l = Maximum unsupported or unbraced length, inches.
d = Diameter, inches.

SAFE TOTAL LOAD, POUNDS

	d =	1 In.	1½ In.	2 In.	3 In.
l	18 in.	8,500	21,000	38,000	87,000
	22 in.	8,100	20,000	37,000	86,000
	30 in.	7,000	19,000	35,200	85,000
	48 in.	4,800	15,000	31,000	79,000
	60 in.	3,750	12,500	28,000	75,000

FIG. 2. SAFE TOTAL LOAD ON ROUND STEEL SOLID VERTICAL BARS

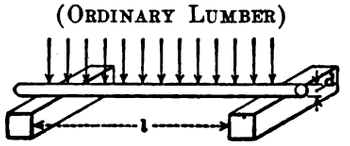


(Load uniformly distributed)
l = Length between supports, inches.
d = Thickness of plank, inches.

SAFE LOAD IN POUNDS PER FOOT WIDTH OF PLANK PER SPAN

	d =	1 In.	1½ In.	2 In.
l	36 in.	445	1,000	1,800
	48 in.	333	750	1,350
	60 in.	267	600	1,080
	72 in.	222	500	900
	96 in.	166	375	677

FIG. 3. SAFE LOAD ON FLAT WOODEN PLANKS (ORDINARY LUMBER)



(Steel bars, with load uniformly distributed)
d = Diameter of bar, inches.
l = Length between supports, inches.

SAFE LOAD IN POUNDS PER BAR PER SPAN

	d =	½ In.	⅝ In.	¾ In.	1 In.	1¼ In.
l	24 in.	56	120	205	490	950
	36 in.	41	80	137	326	638
	48 in.	30½	60	103	245	478
	60 in.		48	82½	195	382
	72 in.		40	68½	163	320
	96 in.		30	81½	122	239

FIG. 5. SAFE LOADS ON HORIZONTAL BAR SHELVING

pine post, or a 3-in., 4-lb. standard channel, or a 2x¼-in. angle, would amply suffice.

The greatest load on any one shelf span will give us the maximum load per stringer. Assuming that we have a shelf 2½ ft. high by 3 ft. wide by 6 ft. span, we get 45 cu.ft., and a 200-lb. load per cu.ft., and a total load of 200 × 45 = 9000 lb. This, of course, is to be carried on two stringers, giving 4500 lb. for each. Examining the tables, we find that for a 6-ft. span with this load, we may use either 5-in., 6½-lb. channels or 4-in., 7½-lb. I-beams. The weight of the stringers is rather out of proportions, however, to that of the columns. By reducing the span to 4 ft. and using eight columns instead of six, we reduce the shelf capacity per span to 3 × 4 × 2½ = 30 cu.ft. At 200 lb. per cu.ft. the load will be 200 × 30 = 6000 lb. For each stringer, it will be one-half of this, or 3000 lb. From inspection of the tables, we find that we may use a 3-in., 4-lb. channel, or a 4x⅜-in. angle, or a 2x8-in. pine stringer, or a 3-in., 5½-lb. I-beam. Increasing the number of columns, naturally reduces the load on each one, but these are light enough to keep the 2x¼-in. angle column and use 3-in., 4-lb. channels for stringers, which will make an excellently proportioned rack that will hold all that you will ever pile upon it.

WHAT A WORK BENCH IS FOR

Do you really know what a work bench is for? Very few people do. Let me describe the average shop bench and see if it will help to clear up the idea of its purpose.

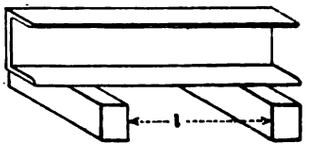
As to location, we usually find it slapped up against a wall. Those parts that happen to be in front of windows

l = Maximum unsupported, or unbraced, length, inches.
s = Rated size of beam.
w = Weight of beam, pounds per foot.

SAFE TOTAL LOAD, POUNDS

	s =	3 In.	4 In.	5 In.	6 In.	7 In.	8 In.
	w =	5.5 Lb.	7.5 Lb.	9.75 Lb.	12¼ Lb.	15 Lb.	18 Lb.
l	18 in.	19,500	27,000	36,000	45,000	55,000	67,000
	30 in.	18,500	25,500	33,800	43,000	53,000	64,000
	48 in.	15,500	22,000	31,000	40,000	50,000	61,000

FIG. 7. SAFE TOTAL LOAD ON STANDARD I-BEAMS USED AS VERTICAL COLUMNS



(Uniformly distributed)
l = Length of span, inches.
s = Rated size of channel.
w = Weight of channel, pounds per foot.

SAFE LOAD PER SPAN, POUNDS

	s =	3 In.	4 In.	5 In.	6 In.
	w =	4 Lb.	5¼ Lb.	6½ Lb.	8 Lb.
l	24 in.	5,500	9,500	15,000	21,500
	36 in.	3,680	6,340	10,000	14,400
	48 in.	2,750	4,750	7,500	10,800
	60 in.	2,200	3,800	6,000	8,600
	72 in.	1,820	3,170	5,000	7,150
	90 in.	1,375	2,375	3,750	5,375

FIG. 8. SAFE LOAD ON HORIZONTAL CHANNELS

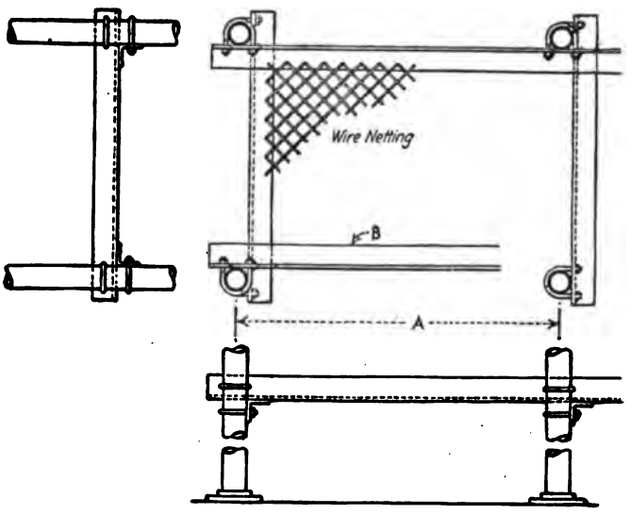


FIG. 9. RACK OF PIPE AND ANGLE-IRON CONSTRUCTION

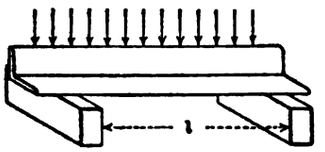
are well lighted, and incidentally well ventilated. The other portions are enveloped in gloom. This may be the reason why so many bench hands have acquired the art of filing and chipping and scraping by means of the "touch system" instead of looking at their work. It may also be the reason for many poor fits and high costs. The fact that the bench is against the wall cuts its usefulness in half, for 90 per cent. of the work done upon any shop bench is done on its outer 12 inches. The rest of the surface is used for storage of parts, tools, dirt and dinner buckets. But it is the space underneath the average shop bench that invariably reveals its true character. Here you

may find fifty-seven varieties of spoiled work, broken tools, "government jobs," worn-out overalls, old shoes and a crusty part of yesterday noon's ham sandwich. It is a

l = Maximum unsupported, or unbraced, length, inches.
d = Diameter, inches.

l	d =	1⅛ In.	2 In.	2½ In.	3 In.	3½ In.
	18 in.	10,800	14,900	24,000	31,800	38,600
	22 in.	10,500	14,600	23,600	31,400	38,000
	30 in.	9,900	14,000	22,800	30,600	37,300
	48 in.	8,000	12,200	21,000	28,600	35,000

FIG. 10. SAFE TOTAL LOAD ON STANDARD IRON PIPE USED FOR COLUMNS



(Uniformly distributed load)

l = Length of span in inches.
s = Rated size of angle.

SAFE LOAD PER SPAN, POUNDS

l	s =	1½ x 5/16	2 x ¼	2½ x 5/16	3 x ⅜	4 x ⅜	6 x ½
	24 in.	520	1,240	2,400	4,200	7,600	23,000
	36 in.	347	830	1,600	2,800	5,100	15,400
	48 in.	260	620	1,200	2,100	3,800	11,500
	60 in.	208	500	960	1,672	3,000	9,200
	72 in.	173	415	800	1,400	2,540	7,700
	96 in.	130	360	600	1,040	1,900	5,750

FIG. 11. SAFE LOAD ON STANDARD HORIZONTAL ANGLES

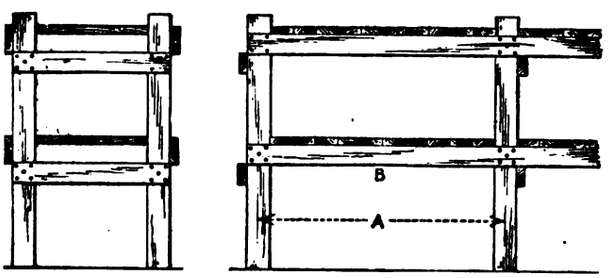


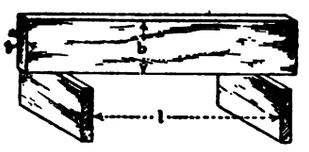
FIG. 12. RACK OF WOOD CONSTRUCTION

l = Maximum unsupported or unbraced length, inches.
s = Size of post.

SAFE TOTAL LOAD, POUNDS

l	s =	2x2 In.	2x4 In.	3x3 In.	3x4 In.	4x4 In.	4x4 In.	6x6 In.
	18 in.	3,780	7,550	9,800	13,000	18,500	27,600	43,500
	24 in.	3,180	6,380	9,000	12,000	17,800	26,100	42,500
	36 in.	2,180	4,350	7,150	9,500	15,000	22,400	39,000
	48 in.	1,510	3,020	5,520	7,400	12,700	19,000	36,000

FIG. 13. SAFE LOAD ON ORDINARY PINE POSTS



(Distributed load)

t = Thickness.
b = Depth.
l = Length of span in inches.

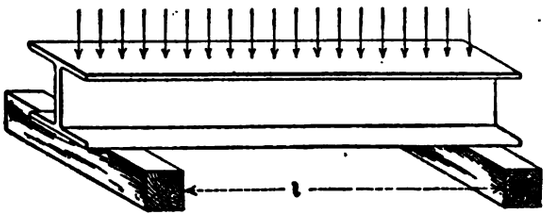
SAFE TOTAL LOAD, POUNDS PER SPAN

l	t =	1 In.	1 In.	1½ In.	1½ In.	2 In.	2 In.	2 In.
	b =	3 In.	4 In.	4 In.	6 In.	4 In.	6 In.	8 In.
	36 in.	333	595	890	2 000	1,180	2,670	4,750
	48 in.	250	445	667	1,500	890	2,000	3,560
	60 in.	200	357	534	1,200	710	1,600	2,850
	72 in.	167	297	445	1,000	590	1,330	2,380

FIG. 14. SAFE LOAD ON ORDINARY PINE HORIZONTAL STRINGERS

cosmopolitan place indeed, and its true beauty is only appreciated by the rats that infest it.

Some day the fixed bench will be unknown in the up-to-date shop; the handwriting on the wall already forecasts this. The vise itself will undergo a transformation, becoming divorced from the bench and standing on its own feet, supported thereon by a cast-iron column adjustable in height. Think of the advantage of being able to approach the vise from all sides, instead of having free access



(Uniformly Distributed Load)

s = Rated size of beam.
w = Weight of beam, pounds per foot.
l = Length of span, inches.

SAFE TOTAL LOAD, POUNDS PER SPAN

l	s =	3 In.	4 In.	5 In.	6 In.	7 In.	8 In.
	w =	5.5 Lb.	7.5 Lb.	9¾ Lb.	12¼ Lb.	15 Lb.	18 Lb.
	24 in.	8 500	15,000	24,000	36,500	52,000	71,000
	36 in.	5,700	10.000	16,000	24,000	34,700	47,000
	48 in.	4,250	7 500	12,000	18,000	26,000	35,000
	60 in.	3,400	6 000	96.000	14,500	20,800	28,400
	72 in.	2,840	5.000	8.000	12,000	17,300	23.600
	96 in.	2.130	3,750	6,000	9,000	13,000	17,750

FIG. 15. SAFE LOAD ON STANDARD I-BEAMS IN BENDING

s = Rated size of beam.
w = Weight of beam, pounds per foot.
l = Maximum unsupported or unbraced length, inches.

SAFE TOTAL LOAD, POUNDS

l	s =	3 In.	4 In.	5 In.	6 In.
	w =	4 Lb.	5¼ Lb.	6½ Lb.	8 Lb.
	18 in.	14,000	18,600	23.600	28.800
	30 in.	13.000	17,200	22,200	27,500
	48 in.	10,800	14,800	19 800	24,400

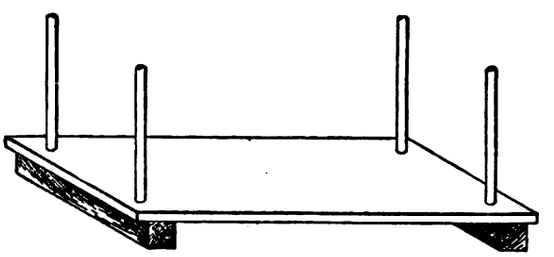
FIG. 16. SAFE LOAD ON STANDARD CHANNEL COLUMNS

s = Rated size of angle.
l = Maximum unsupported or unbraced length, inches.

SAFE TOTAL LOAD, POUNDS

l	s =	1½x5/16	2x¼	2½x5/16	3x⅜	4x⅜	6x½
	18 in.	6,500	11,300	17,800	25,800	35,500	72,000
	30 in.	6,000	11,000	17,500	25,400	34,500	71,000
	48 in.	5,200	10,000	16,500	24,500	34,200	68,000

FIG. 17. SAFE LOAD ON STANDARD ANGLE COLUMNS



(Allowing for Depth of Thread)

Diam., in.	½	⅝	¾	⅞	1	1¼	1½	2
Safe load, lb. per bolt	1500	2400	3600	5000	6600	10,000	15,000	27,500

FIG. 18. SAFE LOAD ON BOLTS USED TO SUSPEND SHELVES AND MEZZANINE FLOORS

only at the front, and not being obliged to crawl upon the bench to deliver a rear attack!

But these things are possibly beyond the dreams of the small-shop owner at present. Keep them in mind, however, and when you move into your new and larger quarters have common-sense work benches, portable vises and a stock-storage room.

✣

At a meeting of the American Physical Society, Prof. C. W. Chamberlain, of Denison University, Granville, Ohio, presented and demonstrated his compound interferometer, by which it is possible to measure 0.00000005 of an inch. It is next to impossible for the human mind to conceive the minuteness of a measurement of this kind. It is equal to the apparent size of the head of an ordinary pin viewed at a distance of 227 mi. or the size of a silver dollar viewed at a distance of 9000 miles.

Small Shops and the Small-Tool Problem

SYNOPSIS—There is a distinct relation between the nature of the work done in a shop and the proper small-tool supply. We find some cases where there are too many small tools and more where there are not enough. In a measure, and a large one, this determines the profit. In this article, an attempt is made to throw light on this relation and to show how far the small shop should go in acquiring a small-tool enquipment.

The good old-fashioned temperance reformer abounded in striking anecdotes aimed to drive home the bungs and smash the bottles. His efforts were as energetic, although of a different kind, as those of the more notorious and attention-compelling lady who succeeded him and who left a trail of broken glass in her wake.

His most powerful appeal consisted in drawing contrasting pictures showing the ravages of rum, somewhat as follows: First reel—happy home; family sitting at table; turkey on the platter; baby sucking drumstick; phonograph playing in the corner; everybody happy. Second reel—Father takes to drink; mother takes in washing; sister Susie sewing shirts for sweatshops; furniture gone; nothing to eat except bread and water; baby howling; phonograph broken.

At times our reforming friend would reverse the contrast and tell of the poor old staggering "soak" who signed the pledge, reformed, advanced rapidly through his natural ability, finally becoming a judge and handing out 60 days to every unfortunate example of overdone hilarity that was brought before him!

In spite of the melodramatic crudity of a good part of his efforts, they were not without their intended effect, for there was truth underneath it all, and this truth was more easily grasped by his hearers because of the contrasting pictures that he presented, which had the effect of turning the object around so that they could see both sides of it.

So in bringing up the subject of the small shop and its small-tool problem, I am going to start by describing two contrasting shops—one in which there was a lack of small tools, and another that had too many.

The shop that had too large a small-tool supply was called to my attention by a salesman who handled this line of goods. Can you imagine a small-tool salesman admitting that any shop could have too much of his own product? To tell the truth, he did not know that this was what ailed the shop in question, but he knew that something was the matter with it, and as its owner was one of his best customers, he felt interested in its success.

The Shop That Was So Up-to-Date That It Was Out of Style

The man with the first straw hat in the spring always looks mighty queer to me even if his hat is of the latest style. Most of you have seen people who were dressed in such extremes that they looked old-fashioned and queer. This shop that I visited was so extremely up-to-date that it could not turn out work at a profit, and this, from a financial viewpoint, which is really the vital one, made it sadly behind the times.

The owner of this shop was a "bug" on the subject of efficiency. He read everything that was ever published on this subject and tried to adopt it. Possibly his source of greatest pride was his toolroom. It was really as complete and as well kept a department of this kind as you could find in a small shop. I followed him with great interest as he led the way from one expensive cabinet to another. First there was a complete set of master gages put carefully away on felt lined shelves and used only for reference purposes. For shop use there was a complete duplicate set of rings and plugs. There were so many of these that the collection would have put an automobile-shop toolroom to shame. The assortment of finishing reamers was unusual, comprising all of the thirty-seconds through a wide range, and a good many of the sixty-fourths as well. To cap the climax, the shop owner called my attention to a new acquisition in the shape of a complete set of Swedish gages which had come in the week before. He intended to use these to check up his master gages, so as to be sure that his shop standards were accurate.

This toolroom was in itself beyond criticism; but considering the kind and variety of work done in the shop, it was as out-of-place as an Irishman at a peace celebration. A toolroom cannot be judged upon its own merits any more than a nose; in either case one which will do very well with certain surroundings will be entirely out of keeping in other environments. In this case, the shop was a "general shop" and rarely had duplicate work to produce. The great variety of diameters and fits that were encountered in the shop made it almost impossible and entirely impracticable to maintain the kind of standards that are found in manufacturing plants with a small variety of work. The fact that he was trying to do this in his attempt to be considered strictly up-to-date and efficient was imposing a deadly burden upon the operation of his shop and eliminating the chance of making a fair profit.

This was a case of incorrectly sizing up the "main chance," and such are not as uncommon as would be thought. In many shops, the standard of accuracy is often held so high and unreasonably inflexible, that it prevents the shop owner from reaching over to grasp his legitimate profits.

The Shop That Economized on Tools and Lost on Profits

The contrast to this case of unfortunate up-to-dateness was found in a would-be specialty shop in another city a thousand miles away. No doubt you can find a shop in your own neighborhood that will fit this description, for it is a much more common case than the first. The proprietor of the one I am describing had developed a sensitive drill that had some excellent features, but he was attempting to manufacture it in the ways with which his

training had made him familiar. He had plenty of money to enable him to go at this matter in the right way, but it had all been made in his jobbing and repair business, and the conditions which he had encountered in making a success of this work had ground into his system a set of ideas which he could not change, even if he could be made to admit that they were wrong. He could not grasp the underlying principles of manufacturing in quantities. He laughed as loudly at standards and limits as he did at the suggestion that he buy some machine tools that had been made in the Twentieth Century. As a result, he whittled away at a rate that did not forecast much profit, and I am afraid that he will find himself in "hot water" as soon as his customers begin to call for repair parts and try to fit them.

As for his toolroom—there wasn't any. If you had good eyesight, you could find his tool equipment scattered about under the various lathes or stuck inside of the cabinet bases of other tools. The idea seemed to be to put them in the most unlikely places, but for what purpose it would be hard to tell. It is true that there were a couple of soft sheet-iron snap gages stuck in one corner, but by their appearance they had been used for hammering blocks or shims, and I would not have dared to trust them. In all fairness, however, I must say that there was a reamer; at least, it had been one at one time. It had plenty of room for chip clearance in the spaces where teeth had formerly been, and it looked as though the apprentice boy had been in the habit of using it instead of an arbor when he had pulleys to turn.

These two shops that I have pictured present a wide contrast, but there is one point in which they resemble each other—neither of them made much money or ever will, unless their owners change their small-tool policy. The first will have to quit being so refined and the second will have to take on a little more polish.

Easy to Solve the Problem in the Specialty Shop

It is comparatively easy to lay down a proper small-tool policy for the specialty, or small manufacturing, shop. Here you have large quantities and frequent, or rather constant, repetition of operations. The variety of operations in a shop of this kind is small. Clearly established standards, limit gages for each machine operation, accurate master gages for reference, and reamers and special tools kept in first-class condition, are collectively a policy which cannot be beat where the product is established as to merit and worth and is made in large quantities. It pays to get the best small tools that money can buy for such work, and as many of them as are required. "Penny wise and pound foolish" applies here more forcibly than anywhere else in the line of shop activity. A tool that saves the fractional part of a cent each time that it is used will pay for itself in an incredibly short time when the quantities are large. The value of interchangeability on mechanical specialties is so well recognized in cutting down assembling costs that there is no need to comment on it in this article.

What Standardization Is and What It Costs

No manufacturing plant however small can be successful until it standardizes its product. This really resolves itself into setting the limits for machining various parts. It has nothing to do with accuracy, as this word is commonly understood. When you say that a certain hole is to be finished between 3 and 3¼ in. diameter, you standardize that size just as much as if you said it was to be between 2.999 and 3.001 in., although the former limits would not be considered as resulting in very close accuracy. In other words standardization means setting a definite measure for the acceptance or rejection of a piece. Nine-tenths of standardization begins and ends with the size of machine holes. The limit on a hole, for example, determines what limits can be put upon the spindle or plug that is to fit within it. For economy in time where holes are held to ordinary manufacturing limits of accuracy, it is convenient to use finishing reamers. Here is where the expense begins. A reamer will not in itself guarantee the maintenance of the limit set, for like everything else of human make, it has an unfortunate disposition to wear. On account of this failing, it is necessary to maintain inspection gages with which to check up the size of the hole, and it is equally necessary to have master gages or micrometers to check up the accuracy of the inspection gages from time to time. All of this involves the maintenance of a rather expensive equipment, including as one of its elements the process of inspection, without which the use of standards is as futile as trying to put out a fire by mental science.

While standardization means expense, it also means profit when applied to work for which it is suitable. As the fellow who had the repair shop in the Klondike said, with some exaggeration probably, "I can't use reamers up here; it's so blamed cold that they shrink a thirty-second in the wintertime!"

If but one hole of a given size is to be finished, and there is little possibility of it being repeated, it would be very foolish to attempt to standardize it by these means. The cost of the reamer, inspection gage, master gage and the like, and their maintenance, would amount to many times the cost of finishing the hole by means of fine cuts and frequent calipering. Or putting it another way, if every job in the shop involved different sizes and diameters, the extent of the small-tool equipment necessary to standardize the work completely would be such as to make it prohibitive. The difficult question is where to draw the line. In the repair shop, a great deal of the work consists in working to the other fellow's limits. It is often more profitable to fit a piece to a hole already made, even if the hole is not standard, than it would be to incur the extra labor of enlarging the hole to a standard size.

Standardization in the Jobbing Shop

Standardization does not help conditions of this kind. In the jobbing shop, conditions are more favorable, for while the work itself varies considerably, the class of workmanship applied in a given shop is usually more or less of one quality. Certain sizes recur from time to time with more or less frequency; some more than others. The solution here is to adopt a partial standardization on such sizes as are found to recur most frequently and extend this only as conditions demand it. There is very little use in buying a 2 7/64-in. reamer, if you only use it two or three times a year, for it will eat up enough interest while lying on the shelf to more than pay for the extra time required by a few light cuts in the lathe. But, if this dimension is found to recur frequently, say every week, or 50 times a year,

I would consider it absolutely necessary to have one of these reamers, and also to establish a standard for this dimension and to have the necessary gages wherewith to measure it.

It is evident that the question of standardization is one that tells very largely how many small tools (including gages and the like) must be kept available. But there is another reason for the purchase of small tools which must not be overlooked, and one that applies very strongly.

Small Tools as Time Savers

No one will question the value of a complete set of twist drills, even for the repair shop. Unfortunately, their value does not lie in the fact that they establish a size standard, as the holes resulting from the passage of a twist drill bear very strong earmarks of the man or apprentice boy who ground them. They are needed because they save time. There is a limit, however, even to their use as time savers. When you get up into the large sizes, the work that calls for them becomes scarcer and their cost becomes higher. There is evidently at some place a line which separates profitable small-tool investments from unprofitable ones. While it is impossible to determine this line definitely, it is possible by simple means to tell very nearly where it is. The principles involved are the same as in the question, "When to use jigs and fixtures?" and will be explained in the following article, which deals with that subject.

In the meantime, it will pay to give a little thought to the question of balance. Are you carrying a No. 10 toolroom on a No. 3 shop? If so, it will be as uncomfortable as No. 10 shoes would prove on No. 3 feet. The reverse is quite true also, for a No. 3 toolroom on a No. 10 shop will pinch so badly that it will produce corns rather than profits.

♣ ♣

Small-Shop Sunshine—A Dinner-Bucket Dialogue

It was lunch hour at the little jobbing shop. Mike, the blacksmith, removed a generous bucket of coffee from the sheet-iron cover that transformed his forge into a stove each day at 12 o'clock. Just at this moment, Axel Johnson appeared at the door leading to the machine shop and viewed Mike with affected astonishment.

"Vot you bane doin' here, Mike? Aye taut you bane goin' get a yob at das big plant," said Axel.

"Yez did, did yez?" said Mike. "Begorry don't strain yer brhain be tinking wid ut, or yez'll hove to boy a new hot. I wouldn't take the dommed job!"

"Aye say," replied Axel. "Aye suppose day vouldn't pay you only yust vat you bane worth, and you couldn't bane afford to take it."

"It's their mithuds Oi disapproves av," said Mike. "Oi see thot to get rid of yez Oi'll hove to tell yez all about ut. They hove a palmist up there to hoire the hilp. 'Tiz a woman duz ut."

"Yumpin Yimminy!" exclaimed Axel. "You bane better tell dat to das marines!"

"Oi wint to the office and sthated me bizness," continued Mike, ignoring the advice. "An a little bhrass bhuttons sez 'Come in 'nd set down, the implement superinthendent will see yez shortly.' 'All roight, me bye,' sez Oi. 'Here's a nickle to boy yerself a outermobeel wid.'

"After a whoile he comes out agin wid a grin all over his face and sez, 'Come this way if you plaze, sor.' So Oi stheps in thro a door wid a 'Privit' soign on ut. There wuz a woman settin' at a disk mussin up some phapers.

"'Well,' sez she, 'phwat do yez want?'

"'It's the implement superintendent Oi wants to see mam,' sez Oi.

"'Oi am the imployment superintendent,' sez she. 'Come in an hov a seat.'

"'Yis, mum,' sez Oi.

"'Wot's yer prisint vacation, me good fellow?' she arsks.

"'Faith, an I nivir had one, mum,' sez I. 'Oi've always wurreked full toime.'

"'Wot's yer thrade, if thot shoots yez betther?' sez she.

"'Blacksmith, mum,' sez Oi. 'An without an aquel ot it."

"'We'll see about that,' sez she. 'Lets hove a look at yer hand.'

"I lays me duke on the thable, and she begins to tell me fortin. 'As a blacksmith,' sez she, 'ye're a misrabel failure, and if yez ain't yez aut to be. Yez hove a typpykal plahner hand.' At this, she pulls out a tape measure and calipers up me fingers, makin notes the whoile on a piece of phaper.

"'Oi see thot yez are adapted to run the 54-inch phlaner on which we hove a vakancey at prisint,' sez she. 'But I also obsarve from the angle thot the back of yer head makes wid yer neck that yez are likely to grind too much side clearance on roughing tools. The shape uv yer lift thum indikates, howiver, thot yez are careful an prefer the use of sody-wather to lard ile as a cooling compound.'

"'Yis mum,' sex Oi. 'An bein so fond of the wather, Oi praysume it should be a Pond Planer. Howiver, Oi must thank yez fer the hand reading, mom, uts as thrue as enny thot Oi've paid a qharter fer. But Oi cannot take the job. Oi'm goin back to the little shop; they may be bhad, but they ain't crazy."

"Yust a minnut," interrupted Axel. "Do dey bane hire das president das same vay?"

"No," replied Mike. "They pickhed him out be his waist misure. He's got the biggest cirkimfirince in town."

Jigs and Fixtures in the Small Shop

SYNOPSIS—No one can deny that jigs and fixtures are great time savers when conditions are suited to their use. There is a big chance for errors in judgment in their choice and use, however, that sometimes results in loss instead of gain. In this article an attempt is made to guide the small-shop owner or manager to a proper choice. A plan is outlined which will help to determine if the proposed jig, fixture or tool will be a good investment.

"It will pay us to have a jig for that piece, Mr. Jones," says the foreman.

"Can't see it that way, Henry," says the boss.

One is looking at the time saving in the shop on an operation which to his mechanical mind is taking much longer than it should. The other is keeping a watchful eye on his bank balance and trying to keep within limits of a certain small-tool-investment total which he has decided should not be exceeded.

The difference of opinion on this subject is one that begins to exist as soon as one man looks after the means of getting out the work and the other man pays the bills. In fact, this difference sometimes exists in the mind of the small-shop owner who has to do both. When he puts on his shop spectacles, various jigs and tools seem to be absolutely necessary, but when he changes them for his office eyeglasses in order to look over his bills payable and balance, it is just as strongly evident that the old way of doing business will have to be good enough for some time to come.

Every question has two sides to it, except those that have six or seven. The jig and fixture question must be included in the many-sided class, for there are almost as many ways of looking at it as there are viewpoints for a cubist picture. A great deal of money is unwisely invested on this account, but on the other hand, a great deal of possible profit is let go by for lack of spending enough. There is but one general way in which to attack this problem logically, and that is from estimating what return can be made on a given investment.

What a Shop Man Sees in a Jig or Fixture

It hurts a real mechanic to see a job done in a makeshift way when he knows of a much better method. I suppose an expert operating surgeon feels the same way when he sees an injury that would have made a "beautiful" operation cured by simple means. Strange to say, the patient does not feel this way about it at all. He lacks the "artistic" point of view in looking at such things, and sees only his own general welfare, and if he has any say in the matter he is going to take the simplest course of treatment that will bring results, one that will not upset his system any more than necessary.

Another peculiar thing about making improvements in the way of doing things in the shop is that there is no apparent limit to it. I have never yet seen a jig or fixture built that could not be bettered. Everyone who has had to do with designing and building these things knows that he could better them the next time. At the same time, it is hardly possible to stifle the natural disgust that arises in having to strap a piece fast to the faceplate, line it up, and nibble away at it, when the same thing could be slapped into a fixture and machined in "jig time."

What the Boss Has to See

The boss must look beyond the mechanic's point of view and take many more things into consideration. His question is not "Will it save time?" but "Will it pay?"

The problem is really harder in the big shop than in the small one. A small shop hasn't any too much money to spend for what is really necessary, and this simplifies matters a whole lot. As the darky in jail for indulging his taste for poultry said, "It sure am a load off ma mind not to hab to decide between chicken and duck for dis Sunday dinnah."

What Sometimes Happens to Jigs and Fixtures in the Big Shops

It is a dangerous thing for a machine-shop foreman or a superintendent in a large shop to be a mechanical genius—not dangerous for him, but for the owner of the shop. One absent-minded genius of my acquaintance used to spot a job in the shop that was going too slow to suit him, spend three or four days in working up a highly ingenious jig or fixture and then hand the drawings over to the tool maker. This worthy would wait as long as he could before starting the job, knowing that his boss would meanwhile get another "bug" and forget all about it. Of course, some of them had to be made, and this was where the firm lost money, for instead of being satisfied with what he had done, the ingenious superintendent would at once have another idea, much superior, which would result in discarding the expensive apparatus. Fortunately, this toolroom, like most others, had a limited capacity, and this, with the well-intentioned smothering on the part of the foreman, kept the firm from losing more than it could afford to.

In the big shop, making the jigs is not the only expense that is incurred by their use. They must be stored, issued and kept track of. The latter requires quite a comprehensive system in itself, and in many a big shop there are jigs which have cost good money and are lying idle simply because they are overlooked and not connected with the job by means of a definite system.

The feature of rivalry is one that costs the large shop money for jigs and fixtures. Unprofitable tools are sometimes kept in use to preserve the reputation of their originator, particularly where he has the say in such matters. And when one foreman is succeeded by another, it is not an unknown occurrence to have most of the defects in manufacture that have been previously met with, attributed to the jigs and tools for which he was sponsor.

I have cited these things to cheer up the small-shop owner a bit by showing him how much worse off the large-shop owner is in these matters. The small-shop owner does not need an elaborate system to keep track of his jigs and tools; very often he can count them on his fingers. And any mechanical genius which is displayed is in such close connection with the pocketbook that it is properly and promptly restrained and held within profitable limits. On the other hand, the small-shop owner's

problem with respect to jigs, fixtures and special tools is greater, since, having less money to spend for them, he must make each cent that he spends bring in the very greatest amount in return.

The First Step in Finding if an Investment Is Profitable

There are several distinct steps to be taken in any shop to determine if an investment of this kind is permissible. The first question is, How much will it save? The least important part of this, and the one which very often looks largest to the shop man, is the length of time that is cut from an operation. The most important part of it is that of the quantity in which the piece is made or the number of times that the operation is likely to be repeated within a given period. One cent clipped on an operation in one of the big automobile plants would warrant an expenditure far greater than to save $10,000 in the cost of a special machine of which but one is to be built.

There is another question that comes in with that of quantity, and that is the one of rates. In looking at this we must see beyond the rate of pay of the mechanic himself to that which we may imagine we are paying both mechanic and machine. A jig that takes a job away from a heavy expensive machine and puts it on a lighter and cheaper one, not only saves the difference in operating time and the difference in operator's rate, but saves the wear and tear on the large expensive machine and leaves it open for something else.

How Long Will Its Usefulness Last?

The second question to ask is, How long will the usefulness of the jig or fixture last? Here is where a good many fall down. One shop owner said, "I am figuring 10 years for my machine tools, and surely these jigs and fixtures are much more durable and have no moving parts to wear out." He was looking at it in the wrong way. Very few jigs and fixtures die a natural death, and very few of them retire on a pension after a long and useful life. Most of them are kicked out without ceremony in their prime. Changes of design have more to do with this than any other one thing. A universal jig or fixture is rare.

Estimated Annual Saving Effected	Probable Life One Year — Per Cent. Earned on Investment					Probable Life Two Years — Per Cent. Earned on Investment					Probable Life Five Years — Per Cent. Earned on Investment				
	10%	20%	30%	40%	50%	10%	20%	30%	40%	50%	10%	20%	30%	40%	50%
$10	8.60	7.90	7.30	6.80	6.40	15.10	13.20	11.60	10.40	9.40	27.80	21.80	17.80	15.10	13.20
20	17.20	15.90	14.70	13.70	12.80	30.30	26.30	23.20	20.80	18.90	55.50	43.50	35.70	30.30	26.30
30	25.80	23.80	22.00	20.60	19.20	45.50	39.50	34.90	31.20	28.30	83.30	65.20	53.50	45.50	39.50
40	34.50	31.80	29.40	27.40	25.60	60.50	52.60	46.50	41.60	37.80	111.00	87.00	71.40	60.50	52.60
50	43.10	39.70	36.80	34.30	32.10	75.70	65.70	58.10	52.00	47.20	139.00	108.80	89.30	75.70	65.70
60	51.70	47.60	44.10	41.10	38.50	91.00	79.00	69.80	62.40	56.60	167.00	130.00	107.00	91.00	79.00
70	60.40	55.60	51.50	47.00	45.00	106.00	92.00	81.40	72.90	66.00	194.50	152.00	125.00	106.00	92.00
80	69.00	63.50	58.90	54.90	51.40	121.00	105.20	93.00	83.20	75.50	222.00	174.00	143.00	121.00	105.20
90	77.60	71.50	66.20	61.70	57.80	136.00	118.50	105.00	93.60	85.00	250.00	196.00	160.00	136.00	118.50
100	86	79	73	68	64	151	132	116	104	94	278	218	178	151	132
200	172	159	147	137	128	303	263	232	208	189	555	435	357	303	263
300	258	238	220	206	192	455	395	349	312	283	833	652	535	455	395
400	345	318	294	274	256	605	526	465	416	378	1110	870	714	605	526
500	431	397	368	343	321	757	657	581	520	472	1390	1088	893	757	657
600	517	476	441	411	385	910	790	698	624	566	1670	1300	1070	910	790
700	604	556	515	470	450	1060	920	814	729	660	1945	1520	1250	1060	920
800	690	635	589	549	514	1210	1052	930	832	755	2220	1740	1430	1210	1052
900	776	715	662	617	578	1360	1185	1050	936	850	2500	1960	1600	1360	1185
1000	860	790	730	680	640	1510	1320	1160	1040	940	2780	2180	1780	1510	1320
2000	1720	1590	1470	1370	1280	3030	2630	2320	2080	1890	5550	4350	3570	3030	2630
3000	2580	2380	2200	2060	1920	4550	3950	3490	3120	2830	8330	6520	5350	4550	3950
4000	3450	3180	2940	2740	2560	6050	5260	4650	4160	3780	11100	8700	7140	6050	5260
5000	4310	3970	3680	3430	3210	7570	6570	5810	5200	4720	13900	10880	8930	7570	6570
6000	5170	4760	4410	4110	3850	9100	7900	6980	6240	5660	16700	13000	10700	9100	7900
7000	6040	5560	5150	4700	4500	10600	9200	8140	7290	6600	19450	15200	12500	10600	9200
8000	6900	6350	5890	5490	5140	12100	10520	9300	8320	7550	22200	17400	14300	12100	10520
9000	7760	7150	6620	6170	5780	13600	11850	10500	9360	8500	25000	19600	16000	13600	11850

Estimated Annual Saving Effected	Probable Life Seven and One-Half Years — Per Cent. Earned on Investment					Probable Life Ten Years — Per Cent. Earned on Investment					Probable Life Fifteen Years — Per Cent. Earned on Investment				
	10%	20%	30%	40%	50%	10%	20%	30%	40%	50%	10%	20%	30%	40%	50%
$10	34.20	25.40	20.30	16.90	14.40	38.50	27.80	21.80	17.80	15.10	44.20	30.60	23.50	19.00	16.00
20	68.00	51.00	40.60	33.80	28.80	77.00	55.50	43.50	35.70	30.30	88.30	61.20	47.00	38.00	32.00
30	102.00	76.50	61.00	50.60	43.30	115.50	83.30	65.20	53.50	45.50	132.50	92.00	70.40	57.00	48.00
40	136.50	102.00	81.20	67.50	57.60	154.00	111.00	87.00	71.40	60.50	177.00	122.50	93.80	76.00	64.00
50	171.00	127.00	103.00	84.40	72.00	193.00	139.00	108.80	89.30	75.70	221.00	153.00	117.00	95.00	80.00
60	205.00	153.00	122.00	101.00	86.50	231.00	167.00	130.00	107.00	91.00	265.00	184.00	140.00	114.00	96.00
70	239.00	178.00	142.00	118.00	101.00	270.00	194.50	152.00	125.00	106.00	310.00	214.00	164.00	133.00	112.00
80	273 00	204.00	162.50	135.00	115.00	308.00	222.00	174.00	143.00	121.00	354.00	245.00	187.50	152.00	128.00
90	307.00	229.00	183.50	152.00	130.00	348.00	250.00	196.00	160.00	136.00	398.00	276.00	211.00	171.00	143.50
100	342	254	203	169	144	385	278	218	178	151	442	306	235	190	160
200	680	510	406	338	288	770	555	435	357	303	883	612	470	380	320
300	1020	765	610	506	433	1155	833	652	535	455	1325	920	704	570	480
400	1365	1020	812	675	576	1540	1110	870	714	605	1770	1225	938	760	640
500	1710	1270	1030	844	720	1930	1390	1088	893	757	2210	1530	1170	950	800
600	2050	1530	1220	1010	865	2310	1670	1300	1070	910	2650	1840	1400	1140	960
700	2390	1780	1420	1180	1010	2700	1945	1520	1250	1060	3100	2140	1640	1330	1120
800	2730	2040	1625	1350	1150	3080	2220	1740	1430	1210	3540	2450	1875	1520	1280
900	3070	2290	1835	1520	1300	3480	2500	1960	1600	1360	3980	2760	2110	1710	1435
1000	3420	2540	2030	1690	1440	3850	2780	2180	1780	1510	4420	3060	2350	1900	1600
2000	6800	5100	4060	3380	2880	7700	5550	4350	3570	3030	8830	6120	4700	3800	3200
3000	10200	7650	6100	5060	4330	11550	8330	6520	5350	4550	13250	9200	7040	5700	4800
4000	13650	10200	8120	6750	5760	15400	11100	8700	7140	6050	17700	12250	9380	7600	6400
5000	17100	12700	10300	8440	7200	19300	13900	10880	8930	7570	22100	15300	11700	9500	8000
6000	20500	15300	12200	10100	8650	23100	16700	13000	10700	9100	26500	18400	14000	11400	9600
7000	23900	17800	14200	11800	10100	27000	19450	15200	12500	10600	31000	21400	16400	13300	11200
8000	27300	20400	16250	13500	11500	30800	22200	17400	14300	12100	35400	24500	18750	15200	12800
9000	30700	22900	18350	15200	13000	34800	25000	19600	16000	13600	39800	27600	21100	17100	14350

(Table includes 6 per cent. interest on money invested over and above the per cent. earned)

Example 1. What is the maximum permissible investment on a special tool that will have a probable life of 1 year and save $300. during that time? Answer—If 10 per cent. return on investment is expected, $258; if 50 per cent. return is demanded, $192.

Example 2. What is the maximum sum I may spend for a lathe that will last for 10 years, and save me $200 per year over the present machine? I expect a return of 30 per cent.

Answer—$435.

TABLE OF MAXIMUM PERMISSIBLE INVESTMENT TO ACCOMPLISH A GIVEN SAVING

Appliances for the oddly shaped pieces that most folks manufacture, like clothes for oddly shaped people, must be made to order. There are no "hand-me-downs." When the piece is retired, the jig goes with it, and if your jigs are to have 10 years of infallible life, it means practically that you are going to build the same old machine for that period of time, and if you can stand still for 10 years without losing your place in the procession, you must have an exceptionally dead line of work.

Conservative shop owners figure the probable life of their jigs, fixtures and small special tools at not over one year. During this space of time they must not only pay for themselves, but pay the interest on what they cost and bring in a profit besides.

How Much Will It Cost?

Many a man would lose less money, if he paid less attention to keeping track of the cost of his products and more to keeping track of the cost of his jigs and tools. It is as easy to keep time and weigh material on a job of this kind as it is on work that is going to be sold. One advantage of doing this, outside of the fact that it tells you how much you have spent for this kind of work, is that it gives you a line on how much it will cost in the future.

If your jigs and fixtures average 25c. per lb., it is not unreasonable to figure the cost of a proposed one on this basis. But unless you have records of cost on this line, your estimate on future costs will be more or less of a blind guess, and the whole process of figuring out whether the investment will be a profitable one will be shrouded in more or less doubt.

One reason why jigs and fixtures have been such a burden from this standpoint of cost is that all ideas of reason seem to be dropped in the presence of these things, and a sense of awe and mystery replaces them. The average tool maker is likely to take his problem too seriously and make his work too expensive. It is not his fault, and I do not intend to criticize this admirable feeling of the dignity of a tool-maker's profession, for it is a profession rather than a trade. But when you sell complicated, finished and accurate machines at 3c. per lb. and make money on them, you are going some and you must eliminate all display to accomplish it. The textile people do this, and their jigs, which you may see illustrated from week to week in the American Machinist, are plain to the point where they might almost be called crude. Yet they "bring home the bacon" to the people who use them, and they should be studied by all small-shop owners who wish to cut out the frills and get down to facts.

Permissible Investments

What is a permissible investment in a tool, jig or fixture, supposing that you had the money or the means of getting it? The appliance must not only pay for itself during its probable life, but must pay the interest on its cost and bring home enough profit over and above these two items to make it worth while bothering about. The whole thing resolves itself into balancing the first cost and probable life of the appliance against what it will earn or save. The actual steps that I have detailed above are summarized as follows: First, estimate the probable saving that the appliance will make. If you can't estimate this, don't make it. Second, assign a probable length of life to it. If you are in doubt about this, follow the common practice as indicated in the following classification: Jigs and fixtures, one year; small standard tools, two years; standard machine tools of a delicate nature, 7½ years; ordinary machine tools, 10 years; heavy machine tools, 15 years. Third, estimate what the appliance will cost. If you buy it, this is an easy matter, and if you make it, you can at least make a fair estimate. Fourth, pick out a minimum per cent. return that you will expect.

Having these things figured or estimated, use the accompanying table as a guide as to how much may be spent for the device in question. And remember that if you cannot be sure, or fairly sure, of a certain minimum annual saving or a certain length of usefulness or a certain maximum cost, you had better not throw your money away on a jig or fixture.

How to Prevent Breaking Small Taper Reamers and Taps

By B. Geist

Considerable care is required in handling small taper reamers on the drilling machine on account of their tendency to "dig in." While this has been overcome to a certain extent by the use of spiral flutes, it does not entirely eliminate the trouble. The reverse spiral flutes do not allow the chips to work out as freely as straight flutes, consequently they choke up, and when this happens the result is usually a broken reamer.

I recall one instance where this trouble was overcome by a simple kink, at the shops of the Universal Adding Machine Co., St. Louis, Mo. They were assembling sections on shafts by drilling and reaming for small taper pins; this being the general practice for that class of work. To avoid breaking the small taper reamers this operation was given to their "careful man," who did not take any chance of the reamer's choking. His method was to allow the reamer to cut about ⅛ in. in depth, then raise it and clean off the chips with a brush, repeating these operations until the proper depth was reached.

Now it is possible that the reamer would not have choked once out of ten times and could have been lowered to the correct depth without having to raise it to clean off the chips at all. But that one time would probably have cost a new reamer.

The operation in this case was speeded up and made safe by simply transferring the job to an up-to-date, ball-bearing drilling machine on which provision is made to adjust the tension of the belt that drives the spindle. The kink was to adjust the belt just tight enough to pull the reamer, keeping the tension at such a point that the belt would slip if the reamer choked. No trouble was experienced by the belt slipping off the pulleys, as the pulley driving the spindle was flanged on the lower side and a piece of strap iron was clamped to the shifter rod to prevent the belt slipping off the cone pulley. With this arrangement the output was more than doubled, and the reamers were used until worn out. A friction chuck would have taken care of this job in practically the same manner, but none was available at that time.

This kink applies equally well when using the automatic tapping chuck on the drilling machine for tapping holes for small screws. We tap holes for 8-32 screws in cold-rolled mild steel ¼ in. thick, which is generally considered impracticable. All that is necessary is to keep the belt tension below the breaking point of the tap.

Repair and Care of Small-Shop Equipment

SYNOPSIS—The state of repair in which machine tools and small-tool equipment are kept helps to determine the money-making capacity of the shop. It is sometimes said that small shops cannot afford to be too particular in this respect, but as a matter of fact, it costs less to keep machinery in first-class condition than to maintain it on the edge of general breakdown. Shop tools must be regarded as the equivalent of actual cash and kept in condition to earn interest. This article throws some light on accomplishing this result in the small shop.

"All-around mechanics are getting scarcer than hen's teeth," remarked the small-shop owner as he chewed the stem of a well-stained corncob pipe. "Only last week I had a fellow from the arsenal who was supposed to be a crackerjack and gave him a tryout. It wasn't long after he got his job chucked in the lathe before he came running over to me and asked for a left-hand side tool. When I told him to go over to the fire and forge one up for himself, he pulled off his overalls and quit. I

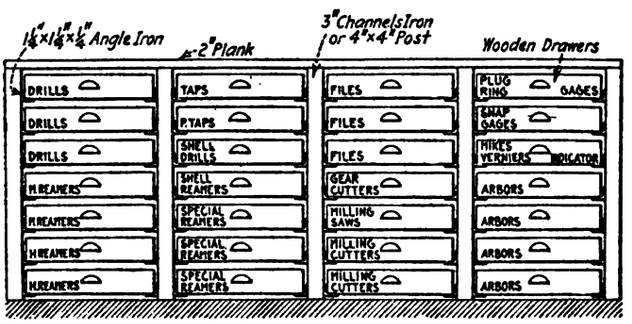


FIG. 1. A CABINET FOR FINE TOOLS THAT ECONOMIZES SPACE

tell you we don't get the big all-around men we used to get!"

The fact of the matter is, the machinist's trade has grown too big for any one man no matter how big he may be. In the old days, an all-round machinist was a carpenter, pattern maker, tinsmith and blacksmith as well; sometimes adding to these main lines the accomplishments of draftsman, foundryman, millwright and engineer. Nowadays, life is too short to acquire all of these accomplishments and have any time left in which to use them. The small-shop owner must recognize the uselessness of looking for "all-round" men, and he must arrange working facilities and tools with this in view, if he is going to stay in the game.

THE EXTRA COST OF KEEPING TOOLS IN POOR CONDITION

The repair condition of machine tools has improved with the gradual fading away of the "all-round" man. Not because he was not able to make a proper job of anything that he tackled, if you gave him time enough, but exercising his varied accomplishments left him no time to spare. Again, it took more skill to successfully manipulate a machine that was on the verge of a breakdown, and this made the same artistic appeal to his sense of skill as that which makes an aviator smoke cigarettes in close proximity to the gas tank when several thousand feet above the earth.

When a machine tool is on the verge of going to pieces, it is about as good a money-earner as a race horse with a wooden leg. You cannot make money out of either of them no matter how much coaxing or doping is done. Yet, the same man who allows his machinery to go without care until it has suffered very much in earning power is often the one who, when buying a new tool, will insist upon its being 101 per cent. perfect. It doesn't hurt this kind of a man to run a bill, but it hurts him to pay it. He says to himself, "The blamed

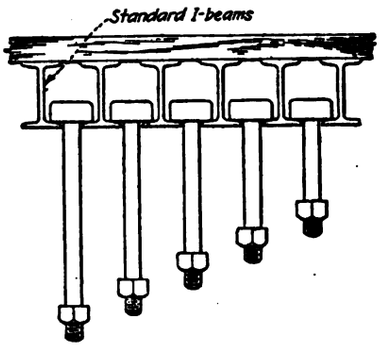


FIG. 2. IT COSTS A LOT MORE TO LOOK FOR SHOP BOLTS THAN TO MAKE AND USE A RACK LIKE THIS

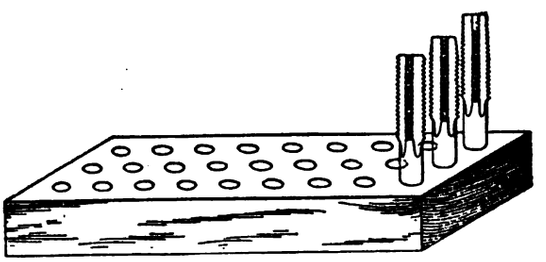


FIG. 3. DO NOT LET TAPS LIE AROUND WHEN IT IS AS EASY TO PUT THEM IN A WOODEN BLOCK

thing is paid for now, and from now on has got to earn money instead of costing it."

You must keep on putting money into an enterprise or a machine tool, for that matter, if you expect either of them to keep on earning. The main thing is to make the smallest expenditure for the greatest return. Applied to machine tools, this means the smallest expenditure that will keep them in first-class condition, for only in that condition can they be expected to make their maximum return.

In the big shops which are uptodate, this is cared for by having a regular time for inspection or overhauling of machine tools. Special men are kept for this purpose, and if the shop is large enough, these are di-

vided up so that each one will specialize on a few different machines, with which he will become perfectly familiar.

This, of course, is out of the question in the small shop. The latter, however, may gain the same end by simpler

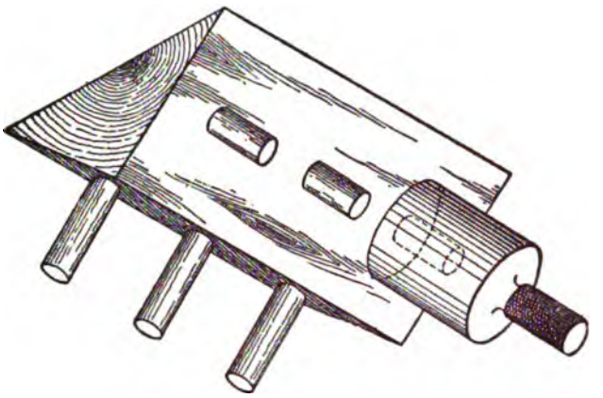


FIG. 4. PLUG GAGES MADE WITH HOLES IN THE CENTER CAN BE STUCK ON WOODEN PLUGS

means. The purpose of overhauling, or inspection, is simply to anticipate breakdowns and make repairs before their need becomes evident through a stoppage. This same object is accomplished in the small shop by the owner insisting on trouble being promptly reported and not allowed to run without being remedied. He can bank upon it that trouble will have to be fixed at some time, and the longer it runs, the more fixing it will take. It is a good deal easier to take the burrs off a slide or to adjust a gib to remove friction than it is to put back four or five teeth in a gear that stripped because of a failure to do so.

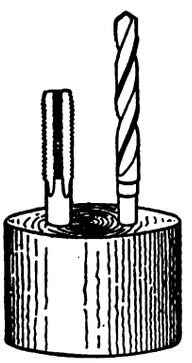


FIG. 5. TAP DRILLS AND TAPS IN ONE SET

HOW THE CONDITION OF SMALL TOOLS AFFECTS THE EARNINGS

If the owner of the shop himself is working on a job, he is quite likely to see to it that the tools he uses are sharp and with proper cutting and clearance angles. In fact, he will take a few moments to make sure that the tool is right before starting the job, in order to save time in the end. Some of the men that work for him are more easy-going on this point, and as long as the

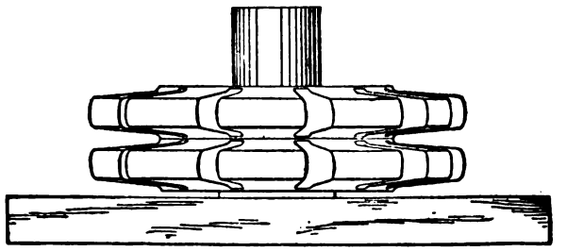


FIG. 6. MILLING CUTTERS, GEAR CUTTERS, ETC., ON WOODEN PEGS

boss does not object, are perfectly willing to turn the outside of a sugar roll with a toothpick. Time doesn't mean much to some fellows except when multiplied out into a week's pay envelope.

I do not intend to advocate a central tool-grinding department for a shop with less than 20 men employed, but I do claim that it will pay the owner himself to look over the small-tool equipment regularly and to satisfy himself that he is not losing money on account of its condition. And in view of the exceedingly wide range of ideas on the subject of tool grinding, it will pay him to keep a few template gages for clearance angles at the grinding wheels. These are to be used by the different machine hands in grinding rakes and clearances on tools.

MACHINE-TOOL RECORDS

A complete record of each machine tool should be kept, as suggested in the article entitled "Interest and Depreciation in the Small Shop," page 14. It is quite necessary to have a record of this kind, if for no other reason than in case of a fire. Small tools need not be

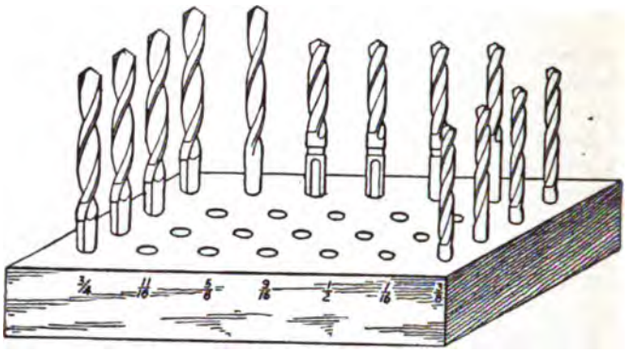


FIG. 7. KILLING TWO BIRDS WITH ONE DRILL BLOCK

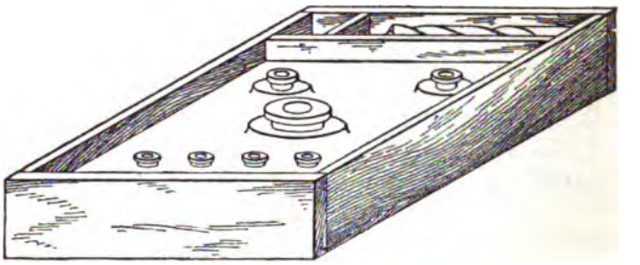


FIG. 8. WHEN YOU SPEND $50 FOR A JIG, SPEND 50C. ON ITS INSURANCE

recorded individually in most small shops. Those made from tool-steel bars, lathe tools and the like, should be plainly marked or stamped with the shop initial as a means of identification and to prevent their taking wings. The cost of small tools is recorded in the purchase ledger, as described in an article entitled "Keeping Track of Manufacturing Expense in the Small Shop," page 19. Aside from these records, further elaboration will not pay in most small shops having 20 men or less.

GOLD COINS AND GREENBACKS LYING AROUND

Almost everyone has a very definite idea of the value of a five-dollar gold piece or greenback owing to his practical experience of the difficulty of getting hold of one of them. After greenbacks or gold pieces are converted into jigs and tools, the idea of value becomes more confused. The thirsty mechanic on a hot summer day will associate the idea of a dollar with its ability to buy 20 tall, frothy glasses of thirst-quenching beverage,

whereas he will often regard a jig or tool that may have cost $10 as simply a chunk of iron or steel, to be thrown under a bench or otherwise carelessly disposed of when he is through using it.

The small-shop owner must cultivate the art of seeing the gold underneath the cast iron and the steel, and he must appreciate the need of caring for the jigs and small tools. Thus, when he spends $50 for a jig, he at least should spent 50c. on its insurance by making a box to protect it. A bit of wood used as a buffer will keep the edge on a reamer blade much more cheaply and easily than this edge can be put back with a grinder.

The Visible and the Invisible Methods

There are two distinct ideas of tool storage, combinations of which may be seen in any shop that makes a pretense at orderly care of its tools. What I call the visible system is that in which all of the small tools are kept in sight, in open racks or strung up upon pins and pegs upon wall boards and wall spaces. The invisible system of tool storage is that in which the tools are kept in drawers or cabinets and are thus out of sight.

In most toolrooms you will find a combination of these plans, but with evidence of more partiality to

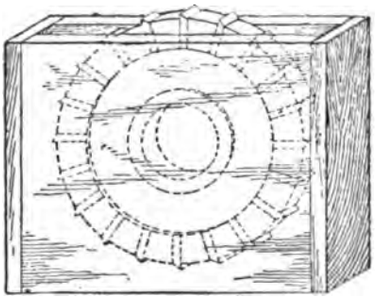


Fig. 9. An Ounce of Prevention Applied to Milling Cutters

one or the other. The visible system is the cheaper to install, but the less economical in floor space. For the small shop that wishes to make the most out of each square foot of floor space, the rack and drawer construction shown in Fig. 1 will be found advantageous. This is not an attempt at a closed cabinet, but simply an open rack with wooden drawers taking the place of shelves. It will be found cheaper than a cabinet and more effective and usable than a plain shelf rack. It may easily be converted into a cabinet by the addition of sliding doors, or it may be locked simply by dropping an iron rod across each stack and fastening it there with a padlock.

It costs a lot to dodge around looking for bolts and nuts for shop use. If an accurate balance sheet could be drawn up, it would show a good many hours wasted that way in the course of a year. A bolt rack such as shown in Fig. 2 will pay for itself very quickly in most small shops. It is only a little thing, but it belongs to that family of little things that cut the payroll when enough of them come to live in a shop.

Cruelty to Cutters

A man must knock around a bit to keep sharp, but it is just the other way about with a cutting tool. They get dull fast enough in doing their work, and it is an unfair handicap to let them rub and bump against each other. Why should taps and drills, for example, be allowed to come in contact, when it is so easy to make wooden blocks for them, as illustrated in Figs. 3 and 7? Watch the boy next time he puts a drill in the rack and see if he doesn't throw it in against the others cutting edge first. The drill block kills two birds with one stone, for in addition to stopping this abuse, it prevents the boy who is breaking ⅛-in. drills on oil holes from getting away with it without the boss knowing. The reserve supply of drills being kept under lock and key makes it possible to let the men help themselves from the drill block without losing track of them.

The small specialty shop can make use of the big manufacturing-plant's scheme of keeping tools in sets. Tap drills and taps; drills, machine and finishing reamers and the like, which are used together, should logically be kept together. This scheme saves time. It is illustrated in Fig. 5.

The Usefulness of Wooden Pegs

You have had some illustration of the usefulness of wooden blocks with holes in them. The wooden peg runs them a close race in the matter of tool-storage utility. Plug gages, if made with holes in the center, can be stuck on pegs, as shown in Fig. 4. Ring gages are cared for in the same way with pegs or plugs of larger diameter. Milling cutters and gear cutters can be stacked upon

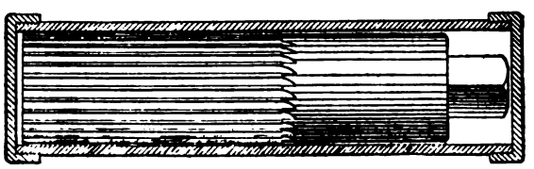


Fig. 10. Brass-Tube Protection Case for Expensive Hand Reamer

them in a way similar to that shown in Fig. 6, although the scheme may tempt the apprentice boy to indulge in an expensive game of quoits.

The matter of insuring jigs against damage has already been mentioned, but needs to be emphasized. By the time an accurate jig has received one or two bumps from a truck loaded with 4-in. bars, it begins to get a kink in its back and refuses to deliver interchangeable work. The wooden box shown in Fig. 8 not only insures against these bumps, but provides a place for keeping the loose bushings, or even the drills and reamers that are used with the jig.

It is a big problem to learn how to properly *choose* equipment, and it is a bigger one to learn how to properly *use* it. But in the shadow of these two big problems, the shop owner must not overlook the less impressive but equally important problem of *caring for* equipment.

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Germany's Steel Production for March, 1915, according to official data in "Stahl und Eisen," was 1,098,273 metric tons, against 1,634,297 tons in March, 1914, and 946,191 tons in February this year. The March production was made up of 567,964 tons of bessemer ingots, 567,671 tons of openhearth ingots, 45,278 tons of steel castings, 8,105 tons of crucible steel and 9,255 tons of electric steel. It is interesting to note that the March production this year exceeded the March production last year of bessemer ingots by about 6,000 tons, of basic steel castings by over 7,000 tons, of acid steel by about 1,200 tons and of electric steel by 1,000 tons. The total output for the first quarter of this year was 2,008,254 tons, against 4,746,562 tons to Apr. 1, 1914, a decrease of about 37 per cent.

Why too Many New Customers at Once Made Trouble

By John R. Godfrey

It certainly does seem at times as though mortal man was never satisfied. Here we have been complaining about hard times, each blaming it on the other fellow's political party, as is our wont, and then comes along the great European war. We all agree this is bad from every point of view, but—and there are several "buts" due along about this time—it has jumped some of us from the depth of despair to that other bane of machine-tool builders—having more orders than we can possibly fill.

That is exactly the position of one of my particular friends, who builds a somewhat special machine, although it has been on the market for some time. As soon as it was found that this particular brand of machine might be utilized to advantage in machining those diabolical messengers of death known as shrapnel, orders began to come in thick and fast; not only that but they came in bunches—bunches of 25 to 50, and sometimes of 100 machines.

Now, in normal times this would have been considered an unmixed blessing, as it practically eliminated the expense of selling, reduced office costs materially and seemed highly desirable in every way. More "buts" crept in, however; in fact, the whole machine-tool business at this time seems full of them.

Complaints from All Over the Map

More men were hired and everything moved to get out the large quantity of these machines that were required. Lots of fifty were distributed at various points on the map and everything seemed to be all that could be desired. But one fine morning complaints came in from three points, each one several hundred miles from the others, that something must be done to make the machines turn out the promised product. Production was the one thing desired, and this was the very thing which was not forthcoming.

Demonstrators were dispatched posthaste to the different points with widely varying success. One young fellow, who made up in sand what he lacked in actual training and experience, stuck on the job and fought things through to a finish, but the other two came home with their tails between their legs, half acknowledging to themselves that the customer was entirely right and the machines were not all they had been cracked up to be.

The basis of the whole trouble was that these machines had gone into shops that were entirely unfamiliar with their class of work, shops which had taken up the manufacture of shrapnel in order to keep going and which had no men trained for handling this class of machine.

Propositions of this kind are bad enough when only one or two machines are involved, but when practically the whole equipment is included, when there are fifty machines which the shop is depending on for its output and there are no men familiar with any of them, even the best demonstrator has his work cut out for him. As a matter of fact the demonstrators usually went in pairs, but even this did not make much of an impression on the whole shop for some little time.

These demonstrators soon got the production coming in the right direction and proved that the guarantees were not dreams of the imagination; but it is quite another matter to keep up such a production with men who are not familiar with the machine and, what is worse, are afraid of all new machines on general principles. This is not because present-day shopmen are less intelligent than the old-timers, but because they do not as a rule get the chance to handle different machines and then too, there are more kinds of machines to handle than formerly.

The Reason Why

But it seems to me there's a reason underlying it all that we are too apt to overlook. And that is, the average boy who is brought up on a miller never realizes that it is a first-cousin to all the rotary cutting machines and only once removed from the planer and the shaper.

True, they may look entirely different, but, boiled down, it can be shown to any ordinarily bright shopman that they all have marked similarity, that all movements come from similar mechanisms and that when a man understands one, he can readily master any other machine with a little patience, if he will just stop being afraid of it. Of course, he will not be a star operator at first, and he will have to learn cuts and feeds. But these are usually laid out for him anyhow, and he has little choice in the matter. If, for example, he comes to realize that a grinding wheel is really a milling cutter and will retain its shape nearly as long if the right wheel, the right speed and the right feed are used, he will feel better about getting acquainted with it than if it was an entirely different animal from any he had ever seen.

And all this would have a widespread influence on the introduction of new machines, especially under such conditions as now exist. It would save builders of new machines thousands of dollars if they could send them out without having to keep demonstrators going through the country keying them up to somewhere near the production they ought to develop.

When we all realize this more fully we will insist that the public schools pay more attention to such prevocational education as will familiarize boys with the fundamentals of machines. Then, any new machine will appeal to them simply as a new variety of something they already know about. And while it may have a few different handles, they must operate in practically the same way through very similar levers, cams, screws, etc. When we get this finally established in our schools we shall worry less about trade schools, because the problem will be nearer to solving itself.

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The investigation of fusible tin-boiler plugs has been completed at the Bureau of Standards and presented for publication. It is believed that there can now be no excuse for boiler explosions from imperfect plugs, if the bureau findings are followed, namely, to use tin to 99.9 per cent. purity and free from zinc, a requirement easily met, but which has not been the actual practice in many cases.

Pattern-Making in a Small Shop

SYNOPSIS—The small jobbing pattern shop is a live institution that has come to stay and has a future. This article describes an uptodate New England jobbing pattern shop and illustrates its modern equipment. An exceptionally neat work bench and a direct-connected motor-driven planer are interesting features.

Worcester, Mass., is the home of some pretty sizable businesses, but it is more widely known as the home of a great number of small shops. Probably no manufacturing business has ever started there except on an almost microscopic basis. Some have grown until they outgrew

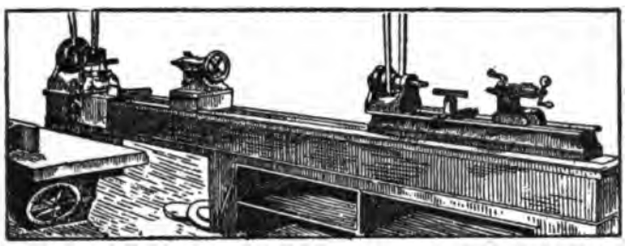

FIG. 1. A WAY TO MAKE USE OF LONG LATHE BEDS

the capital of the original owners, who have stood on the side-lines and watched others build upon and profit by their foundations. Others have profited by this example and have religiously clung to their own shops and preferred to be content with lesser renown and more profit.

It must be granted that when a proprietor is his own superintendent, salesman, treasurer, chief designer and auditor, any increase in size makes it necessary for him to shed most of these responsibilities. Then the shop must grow out of the class of small shops before it will again provide him with the net profits that he drew while performing all these functions, as well as playing capitalist and occasionally helping with a broom.

A FIELD THAT IS NOT OVERCROWDED

One field that is seldom overcrowded is jobbing pattern-making. Many a machine shop has a pattern-making

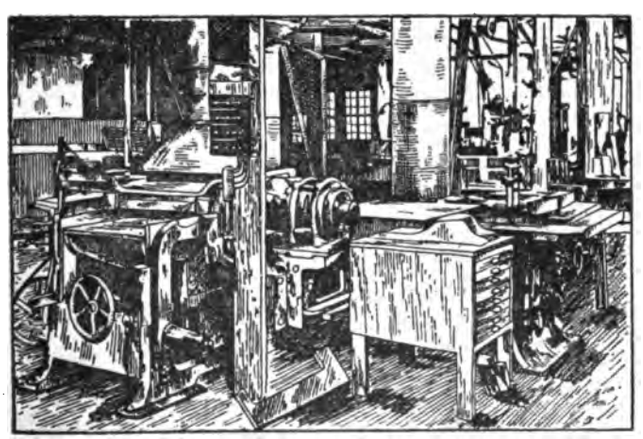

FIG. 2. THE DIRECT-CONNECTED MOTOR-DRIVEN PLANER

department, but this is extremely expensive because it is so necessary to keep the two or three pattern-makers busy. New machines and attachments are continually added to a line which is probably overburdened at the end of the first year. Where there is a jobbing pattern shop within convenient reach, there is fair certainty that patterns can be obtained for less money than if made in one corner of a machine shop with the limited equipment which is almost sure to go with so small a side issue. The most important thing, however, is that when the designing department of a shop finds itself obliged to O.K. actual bills for pattern construction, it is very different from simply sending an order to a pattern-maker whose wages and expenses are a part of the fixed charges of the shop and where the cost of an individual pattern is never known.

THE "CORNER-SHOP"

The equipment of the "shop-corner" pattern shop is usually limited to a single lathe, a combination saw, a jointer and, possibly, a bandsaw. Specialization and division of labor is impossible because there is no one with whom to divide the work. Supposing that the shop af-

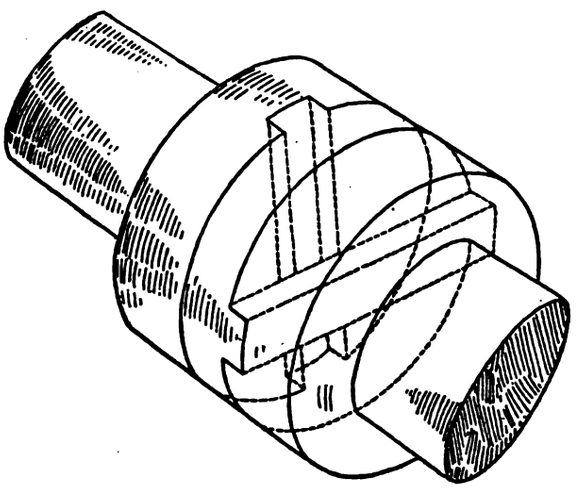

FIG. 3. OLDHAM COUPLING FOR DIRECT-DRIVE PLANER

forded exactly enough work the year around to keep the pattern-maker busy, even then the cost of making patterns, while it might appear low on the books, would be high because of the impossibility of surrounding a lone pattern-maker with machinery and other equipment equal to that which is not only possible but essential in a jobbing shop. Add to this the fact that nothing short of a miracle will make the amount of pattern-making in a shop fit the number of pattern-makers, and the reason for the existence of the jobbing shop is apparent. This appeals to many machine shops large enough to maintain quite a respectable corps of pattern-makers on the basis that it puts a damper on the too-ambitious department of design. Keeping up to date is desirable, but the "shop-corner" pattern shop is a constant temptation to nibble at new designs rather than to wait for an entirely new idea to be developed.

The equipment of a jobbing pattern shop should include almost as complete a wood-working plant as a small furniture or cabinet shop. The single saw bench should give way to two or more machines, each carrying saws for particular kinds of work, so that time will not be lost changing saws for a five-minute job. Mortising and tenoning machines are not needed often, but if they are used only one day a week, they save their own cost in a short time. Mortising and tenoning by hand, especially

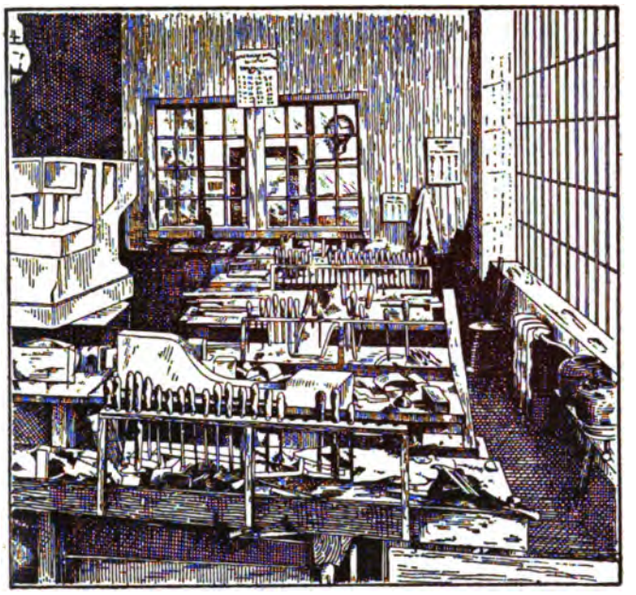

FIG. 4. NOTE THAT THE BENCHES ARE NOT JAMMED UP AGAINST THE WALL

on small work, is a slow and unsatisfactory process. The single lathe of the corner shop must be replaced by two or more sizes of lathes on beds and one on a post or the rear of a large lathe for faceplate work. In Fig. 1 a way is shown by which floor space may be saved. The small lathe is mounted on the little-used bed of the large lathe where it is out of the way almost all the time and from which it can be removed in a few minutes, if a long column pattern is to be turned.

THE CYLINDER PLANER

The jointer is still necessary, but it must also be supplemented by a cylinder planer of sufficient weight and driving capacity to take a heavy cut whenever it is necessary to reduce the thickness of the stock materially. No one machine operates to reduce the size of the scrap pile so much as a planer. It may do it by cutting it into chips, but it does enable one to use up stock almost to the last splinter by making it so easy to thin it down. The planer shown in Fig. 2 is a good heavy machine of the ordinary type, but with the additional feature of being direct motor-driven. This illustration does not clearly show the connecting coupling between the motor and the cylinder, but it is what is known as an Oldham coupling and is better shown in the line drawing, Fig. 3. The center portion is made with projecting parts running across its two faces and at right-angles to each other, so that if the motor and cylinder shafts do not happen to be in exact alignment, there will be no binding on either. In this case the central part is made of fiber which is calculated to eliminate the noise and rattle that might develop as the parts wear loose.

THE UNIVERSAL SHAPER

Bandsaws and jigsaws are a matter of course, as is also a vertical drilling machine and a drum and face sander. One machine that is not usually found and, when found, seldom used to entire advantage is very desirable, that is, the shaper, or universal woodworker, which is shown at the right of Fig. 2 with its two vertical spindles. This particular shaper is interesting because of its motor drive. The motor was made with a special shaft with an extension to take an additional pulley on the other end. These pulleys each drive a spindle through a quarter-twist belt, one in one direction and the other in the opposite direction. The motor and drive are generally covered with a box. These shapers are usually considered dangerous machines, and for that reason they are often omitted from pattern-shop equipment. On the other hand, they may prove to be very safe machines, for the very fact that they are reputed dangerous makes men quite willing to keep away from them. In the shop in which these pictures were taken, one man is assigned the care and operation of this machine and no one else touches it. As the illus-

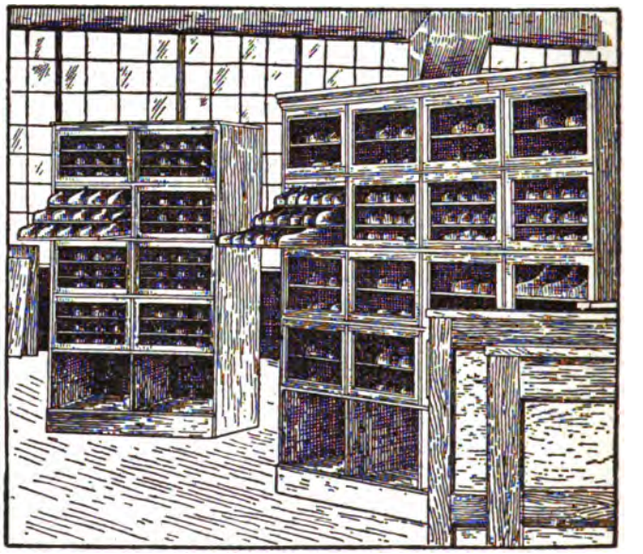

FIG. 5. SIDE LINES SOMETIMES HELP BY KEEPING THE WORKERS STEADILY EMPLOYED

tration indicates, the cutter may be so closely guarded that it seems almost impossible for a man to get his hand in its way except by intent. What remaining danger there is comes from the possibility of a cutter breaking in such a way as to be thrown out of the front of the machine or from a man forgetting that the cutters are whirling around so fast as to be almost invisible.

A GOOD ARRANGEMENT OF BENCHES

Each individual pattern-maker is expected to furnish all the small tools that his work requires. Most of them take a very considerable pride in the possession of more than they need, a spirit that might be emulated by machinists more than it is.

An arrangement of benches which varies from the stereotyped bench along the wall, and to advantage, is shown in Fig. 4. Each individual bench is at right-angles to the wall and the light, and has a lighter back bench

on which the workman builds up his patterns, thus saving the work bench for actual cutting operations. By this arrangement each workman has a sort of private stall open on the side toward the machinery and with both benches equally well lighted.

The jobbing pattern shop has one special advantage over the "corner of the shop" in that its machinery, which is necessary but which with a small crew must necessarily be idle much of the time, is adapted to cabinet work as well as to pattern work. It would probably not be wise to allow his cabinet work to run into more difficult interior finish or a great deal of veneered work or highly ornamental carving, but the class of work shown in Fig. 5, which shows fixtures for store windows and for displaying shirts and socks is especially suited to fitting into a pattern shop where the balance of trade makes it necessary that some of the men should be able to shift from one class of work to the other to keep them busy.

Time and Material Loss

There is a noticeable tendency in all these jobbing pattern shops to build up an organization of the quicker-working men in the industry. It is natural, for competition is properly keen. These shops usually do work by the hour and stock rather than by the piece, so every job that takes longer than the man who ordered it expected that it would is an inducement for him to shift to some other shop in the hope of getting the work done at less expense. Then too, the business of a pattern-making shop is the making of patterns, while the business of the man in the corner of the big shop is a rather indefinite combination of trying to oblige everybody and keep busy at something or other all the time.

We are indebted to A. L. Bemis of Worcester for the illustrations which we have used in this article, as well as for interesting suggestions as to ways in which such pattern shops may prove successful.

Minimum Equipment

Those who are not familiar with machine shops in sections where repairing instead of manufacturing is the rule are forcibly impressed with the comparatively small equipment used to handle work which is large in both variety and size. The typical machines seem to be the lathe, the radical drilling machine, the vertical boring mill, and the open-side planer.

Of course, there are other machines, but these four stand out noticeably. The open-side planer is a "friend in need" for many of the jobs, which are often as large as can be carried into the shop. The boring mill, too, has to be enlarged occasionally by the addition of a side head, while a lathe without a set of "raising blocks" is hardly considered complete.

The work done is both interesting and astonishing. Unfortunately, the observer rarely arrives at the opportune moment to see and photograph the most interesting jobs. They have usually just left the shop and the rigging has been dismantled—or else the job is coming in next week and they have planned already for it. But this equipment mentioned, with the addition of a welding outfit—usually of the oxyacetylene variety—gives a small plant a capacity far in excess of its size. And the welding outfit has much to its credit.

Interesting Applications of Flame Welding

The Baker Ice Machine Co., Omaha, Neb., is using oxyacetylene welding extensively and successfully in making refrigerating coils and in similar work. It is yielding a great saving, not only in the actual making of the joint, but in material as well. In helical coils, for example, it is much easier to wind the coil, welding on new lengths as they become necessary, than to use couplings of any form. This is particularly true of return bends where wastage of pipe is otherwise often considerable.

These welds cost about 4c. each for 1¼-in. pipe, with other sizes in proportion. This is but a small fraction of the cost of couplings. The welded pipes have the added advantage of staying tight and of not being affected by the refrigerating material.

In this connection some of the experiences of this company with welding are of particular interest. It has been found almost impossible to repair cracks in cast-iron pump casings that have been used for brine. The brine seems to affect the iron in such a way as to make a good weld out of the question. The same thing has been found with steel casting under similar conditions. Cast-iron firepots for furnaces act in the same way, although in this case it is probably the sulphur instead of the brine which affects the metal.

Another interesting job was the making of a good-sized tank or boiler which had to be galvanized, the dimensions being approximately 42 in. in diameter by 72 in. in length. The part had to stand 200-lb. pressure per sq. in. The boiler maker did not want to tackle the job for several reasons. If he riveted up the galvanized sheets the rivets would not be galvanized and would rust. If he riveted the whole thing black the galvanizing heat would probably start some seams, and the necessary calking would not help the galvanizing. So it was decided to weld up the tank. This not only made a good job, but saved money into the bargain. The tank was tested to 300 lb. per sq.in. and then galvanized. The use of flame welding in such cases takes it out of the repair-job class, and would seem to indicate an even wider field in supplanting the use of riveted joints in many places.

A New Use for Thread Gages

By B. F. Daniels

In laying out drawings of machinery it often happens that the draftsman desires to space off a part of the work into a number of small divisions, such as, for example, the threads of a screw, the teeth of a rack or a series of equidistant lines upon which to plot a curve. If his scale happens to be in divisions corresponding to those desired, it may be used; otherwise, the method below is useful:

Take an ordinary thread gage and draw it lightly over the point of a soft-lead pencil until the teeth become slightly coated with graphite. Then press it firmly upon the drawing at the place where the divisions are desired. It will be found upon lifting the gage that each tooth has left its imprint on the drawing. This series of little black dots may then be used as the desired spacings.

A Small Shop that had Indigestion

SYNOPSIS—A shop owner obtains a large part of his schooling through making and correcting mistakes. Sometimes his education is expensive. In the case here described it came near putting the Clevedelphia Iron Works out of business. Some of the errors of its proprietor, J. Algernon Smith, are duplicated in other small shops where those in charge do not thoroughly understand the how and why of things and make incorrect application of otherwise sound principles.

John A. Smith, Sr., was a practical, hard-headed, tight-fisted, old-school shop owner who had made money as proprietor of the Star Machine Shop. Although comparatively few mistakes in judgment could be charged against him, he did make a bad one when he sent Algie to college instead of keeping him under his thumb in the shop, for Algie was the kind that needed old-school and not new-school training.

During Algie's last year at school, John A. Smith, Sr., had the misfortune to be caught between a planer table and a pile of castings. He lived only long enough to fire the planer hand—an act which was quite characteristic and which no doubt insured him as contented an exit from activities as could be had under the circumstances.

Algie's devoted Mama made no change in the Star Machine Shop until her boy graduated, after which he was placed in sole charge. Within a month or two, the Star Machine Shop, John Smith, proprietor, became the Clevedelphia Iron Works, J. Algernon Smith, President. The old name was not quite polished enough to suit Algie. This was his first mistake. Not only did this deprive the shop of the influence of his father's former connection, but it was also hard to find in the directory or telephone book. There were 50 or 60 firms beginning with the word Clevedelphia, varying from the Clevedelphia Adding Machine Co. to the Clevedelphia Zither School. The Iron Works was well concealed in the middle of the list, where people got tired of looking before they came to it.

If Algie had stopped with this mistake, he would have been comparatively well off, but it was only the beginning of a series of them.

The foreman of the shop, Bill Thompson, had been a man after Jim Smith's own heart, practical, bluff and outspoken. When the Old Man was wrong he told him so in no uncertain language and the two of them thereupon indulged in a thunderstorm that cleared the air and left no bad feelings afterward.

Algie did not bother Thompson much for a few days. He was busy arranging the new furniture in his new office, getting the rug down and seeing that the fumed-oak filing cases properly received the contents of the old cardboard letter files. A good bit of his time was occupied in studying a correspondence course in the principles of efficiency with a view to bringing the shop up to date.

The first encounter between the new boss and his foreman will go down in history among the employees of the shop. It was brought about by J. Algernon's desire to make his "début" forceful and convincing. An idea of how this could be effected had come to him while reading the efficiency literature: "The average shop mechanic has no idea of the length of time that a job should take. This can only be determined by time studies made by an intelligent and trained observer." This struck Algie as just the thing. "Average shop mechanic," that was Thompson; "Intelligent and trained observer," that surely was J. Algernon Smith.

After hastily reviewing the chapter on time study, he walked out into the shop. The fact that he stubbed his toe forcibly against a bar lying across the passageway did not sweeten his temper.

He stopped at an old 20-in. lathe near the office. In this, the lathe hand had placed a 1¾-in. turned bar between the centers and was getting ready to chase a thread upon it with a single-pointed tool.

"How many of those have you to do?" Algie inquired of the operator.

"Two in all," said he, pointing to another turned bar on the floor.

"Go ahead," commanded Algie, pulling out his watch and adding to himself, "Here's where I show this fellow Thompson something."

The man at the machine did the best he could, but it took many repeated cuts to finish the thread, and with each one Algie's spirits rose.

"Thirty-two minutes!" he exclaimed, as the piece was finished.

As the lathe hand started to place the second bar between centers Algie stopped him. "Haven't we got a die for 1¾-in. five threads?" he inquired.

The lathe hand hesitated. "Yes, but I don't think—"

"I'll do the thinking for you," interrupted Algie stiffly. "Go and get it."

The job was finished by Algie's method in just six minutes, and armed with this comparison, he sought Thompson. But he had to wait until that busy gentleman finished giving instructions to an assembler before he turned with an inquiring glance from under bushy eyebrows.

"Mr. Thompson," said J. Algernon, "you are not looking after things very carefully. I have just shown a man how to do a job in six minutes that required thirty-two minutes to do the way you told him."

Bill's reply was a grunt.

Algie led him to the evidence. All of the men and boys in the vicinity struggled to conceal strange and violent exhibitions of joy. Suddenly, Bill opened up his 14-in. batteries and directed them point blank at Algie, riddling him, so to speak, from stem to stern with explosive words.

"Give a calf enough rope and he'll hang himself," he roared, "that's why I let you alone when I saw you butting in on this job. Why you blankety-blank-blanket, couldn't you see that the man was cutting a *left-hand* thread? Do you think I'd be fool enough to buy a die for a job that won't happen again in 10 years?"

It would take too long and require type that does not exist to print all of Thompson's remarks. It is sufficient to say that at the conclusion he told Algie the shop wasn't big enough to hold both of them, but for his father's sake he would give him a week to find a new man.

So Thompson left and a new man came to take his place—a man that could get along with Algie finely be-

cause he would agree with every opinion offered by him—a professional trouble-dodger of the type that is quickly spotted by the men under him, but manages to put it over on the proprietor for a longer or shorter time, depending on the latter's stock of native shrewdness and practical experience.

In Algie's case, with these two qualities dormant, this period of time might have extended itself almost indefinitely, had it not been for the shortcomings of the efficiency correspondence course. In spite of his diligent study of its pages and his unopposed efforts in the shop, things seemed to grow worse instead of to improve, and the work took longer and cost more.

Finally, a light dawned on Algie. He didn't know it all himself. And immediately he made another big mistake, which is often made by one who appreciates this deficiency for the first time—he swung from one extreme of unjustified self-confidence to the other of unlimited credulity.

He didn't know the principles of efficiency himself, but at least he could hire someone who professed to know them all, including No. 13—"Get it while the getting's good."

This efficiency expert had assurance enough for several and an imposing voice—a deceptive voice that effectually disguised the triteness of his remarks. An owlish air of wisdom was further conveyed by an enormous pair of horn-rimmed spectacles, intended possibly to magnify the 22-caliber brain behind them into 42-centimeter proportions. Add to this a mustache resembling a fair-sized eyebrow, from beneath which ornament proceeded conversation consisting chiefly of "I did this" or "I have done that" or "I can do something else," and you have a picture of the individual who hypnotized Algie.

Then began the vivisection of the Clevedelphia Iron Works. The first move was to put in an efficiency system so that Algie would be able to tell the good workers from the indifferent ones. Thompson had had his own way of doing this, but it was so simple that he kept it in his head—quite different from the one that was now installed, which consisted of hanging up a big blackboard and posting each man's weekly percentage on it. This was supposed to show just how efficient he had been, but there was a hitch in its operating machinery somewhere. Bill Burns of the cutting-off machine had been overlooked somehow in the distribution of work and had managed to soldier quite intelligently for the week without the new management getting wise. He was a surprised man when the blackboard gave him a 100-per cent. rating. But his boy who was studying algebra in the high school explained the reason to him: "You see, Dad, you had nothing to do and you did it perfectly, so they had to give you a 100 per cent."

It was evident that Old Man Smith had been a very ignorant person who did not know much about efficiency and whose knowledge in fact was limited to making money. For one thing he called everything by its common shop name, which was quite wrong from the efficiency expert's viewpoint—possibly because everybody could understand it. This was soon officially remedied, and a ¾-in. pipe tap became CMG-49X; a 2-in. hand reamer was christened HLQ-173P, while the old 20-in. engine lathe that had started all the trouble labored under the new title of NMO20-L10. All of the parts commonly made in the shop were similarly titled, and operations to be done were indicated by numbers. No more verbal orders were allowed, so that when it was desired to have the laborer take a pile of castings over to the drilling machine, the foreman, with the aid of a code book, was compelled to send him the following cipher message on an official blank:

"Man No. 16. Operation 149. Quantity 140. Part ZLX25. Location From BF16 to SLT24R."

On receipt of this, Pat, the laborer, by dint of consulting his code book and scratching his head, would arrive at the following translation:

"Pat O'Rourke git yer wheelbarrer and carry 140 three inch pipe flanges from the rattle box to Bill Donovan's drillin' machine." At which Pat would exclaim disgustedly, "Why in 'ell do they kape it so saycrit?"

If the shop had lacked system in the past, it surely made up for it now. The pile of stationery in the office was proof of that. There were printed forms for everything that a man could imagine, and some that only an efficiency expert could. It began to look as if the office itself would not be large enough to hold the people necessary to file and record and keep going such a stupendous system. Probably it would not have been, had not the total volume of business seemed to shrink in direct proportion to the length of stay of the system expert.

This gentleman had carefully sized up the shop, Algie and the general financial situation, and estimated that he could make his job last for three months, which was a long while for him to stay in one place. But he had not figured on Algie's education. Not the one that his father had paid for, but the one that Algie himself was paying for day by day. Being after all a son of Old Man Smith, he couldn't go through three months of actual schooling without having a few glimmers of intelligence. During one of them he saw himself and the efficiency expert in a new and more correct light, and the vision was far from being a pleasant one.

This was three years ago, and today Algie has Thompson back at the helm. He has also a very fair practical education, and the shop has nearly made up its cost. Pasted up on the office wall, Algie has some precepts which he says cost him $2500 apiece, but which he is willing to give to the readers of the AMERICAN MACHINIST without charge. They are as follows:

1. Mystery and big words are out of place in the shop. You wouldn't hire a draftsman who could not make a readable drawing or a bookkeeper who kept your records in Arabic.

2. Time studies are valuable, but only when the man who makes them has some value. At least he should know the difference between right- and left-hand threads.

3. Practical mechanics and fake shop systematizers are both *paying* propositions, but in different senses.

4. Strive for efficiency by all means, but first find out what it is.

What has become of the efficiency expert? Oh, he is busy working the 13th principle on somebody else!

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A resumé of etching reagents presented before the Institute of Metals points out that nitric acid is used sometimes for etching copper alloys, and is found useful for the rapid etching of 70:30 brass for commercial purposes when crystal size is to be judged. Probably the best way to use it for this purpose is to dip the specimen momentarily in strong acid and wash it at once under the tap. Gwyer also finds that the concentrated acid gives excellent results with the copper-rich aluminum-copper alloys.

Wasted Intervals in the Small Shop

SYNOPSIS—Some manufacturers have unfortunate experiences with time study, but these should not condemn it. In most cases of this kind it is not correctly understood or applied. As a matter of fact, nearly all successful managers make use of it, though perhaps unconsciously. This article deals with the analysis of a simple lathe job and indicates the value of time study.

When a workman comes to the superintendent with the complaint that the time allowed on a job is too small, what is to be done? One manager will accede to the demand or request—he is either quick-on-his-feet or lazy. Another will say, "Nothing doing"—he is bull-headed or ignorant. The third will say, "Let's investigate the matter"—he is right.

This third man does not say to the lathe hand who is making the complaint: "Run along, Bill, and put one of those pieces in the machine. It's just half-past ten now. Do the best you can and come back as soon as the piece is finished, so I can time you." Neither, if he is wise, will he stand at a distance and judge the rate at which work is being done by the physical activity of the worker, who, under these conditions, will rival a clog dancer for energetic and useless contortions.

Taking Precautions

He will take nothing for granted. His first move will be to look at the belt, for a slack belt has raised many a piece price without warrant, as a bit of grease upon a cone step has distorted many another. He will also take pains to examine the cutting tools for sharpness, hardness and angle, having had experiences resulting from both intentional and unintentional carelessness. Where the cutting is to be at all heavy, he will likewise look to the chucking and driving of the piece, so that excuses for less than can properly be done can have no foundation on this cause.

Now, even assuming that he has taken all of these precautions, he will still be largely at the mercy of the man who is doing the job on account of the presence of "intervals." Take the case of boring and facing a flanged cylinder. How many chances has a man to soldier on a job of this kind and get away with it? More than most people imagine. Let me put myself, for your benefit, in the place of the lathe hand who wishes to boost the price on this job.

Detailing the "Intervals"

First I must read the blueprint and see what is to be done, and next secure a sling to put about the casting. Both of these actions are favorable to the intentional losing of a little time, but the interval that occurs between them is what will cost you money. There are twice as many opportunities to soldier as there are individual actions in the complete operation, because there is an interval between each two, which, by a slight and undetectable lengthening, may be made to increase the total very perceptibly.

Proceeding to actual details of the work, my next steps are to lower the chain hoist (interval), attach the rope sling (interval), hoist away (interval), get clamps and bolts (interval), attach the clamps and bolts to the faceplate (interval), secure the casting temporarily to the faceplate (interval), take off the sling (interval), true up with chalk (several intervals), tighten the clamps permanently (interval).

Rough-Boring, with Intervals

So much for the chucking. Now comes the rough-boring. Selecting a tool is a critical operation (interval); I must grind it (interval); it must be stoned a bit (interval), placed in the toolpost (interval), shims put under it (interval), and finally tightened (interval). I have forgotten the bore, so I must look at the print (interval), next set my calipers to scale for the roughing cut (several intervals). I throw the shifter for starting (interval), but see that the speed is too fast on open belt (interval), so the back gears must be thrown in (interval), and as the speed is still too fast, the belt must be shoved up to the third step on the lower cone (interval); since the belt is tight I must get the belt pole (interval), and throw the belt on the upper cone (interval), then run it up by hand on the lower one (interval), before putting the pole away (interval). The next step is to select the proper feed and set the tumbler gears in the feed box (interval), after which I walk back to the carriage (interval), rack the carriage into position (interval), run in the cross-slide (interval), set the tool roughly to its cut (interval), then test the cut for size and caliper it (several intervals). After securing the proper rough diameter I throw in the power feed and no more intervals occur for a while, unless I strike a hard spot and have to change tools or regrind.

After the cut runs through and I have cut as much wind as conditions will permit, I throw out the power feed (interval), retract the carriage (interval), throw the shifter to stop (interval), take a careful look inside (interval), then remove the roughing tool and put it away (interval).

Finish-Boring, with Intervals

Next I select a tool for finish-boring (interval), examine it critically (interval), go and grind it (interval), come back and stone it (interval), place it in the tool post (interval), take out some shims (interval), and tighten the toolpost (interval). Next I must reassure myself of the dimensions of the finished bore by looking at the blueprint (interval), set my calipers (interval), throw the belt up a step (interval), get the stick for the upper cone (interval), change the feed tumbler for the finishing cut (interval), rack the carriage ahead (interval), advance the cross-slide (interval), and then test the cut for size by calipering (several intervals).

Throwing the power feed for the finishing cut gives some relief from intervals, but I must stop once or twice and caliper to see that the hole is not tapered. Each time this means throwing the shifter twice (four intervals).

Looking to See if the Hole Is Still There

After the cut is finished I must throw out the power feed (interval), throw the shifter (interval), advance the

cross-slide so the tool will clear the hole (interval), rack back the carriage (interval), swab out the dust and chips with a piece of waste (interval), look carefully inside to see if the hole is still there (interval). This may be lengthened by the discovery of sand-spots or blow-holes, which will necessitate searching for the boss to have him pass judgment before the facing cut is attempted. If all goes well, I next loosen the tool-post screw (interval), then remove the tool and put it carefully away (interval).

Rough-Facing, with Several Intervals

The next step is to face the outer flange. This means selecting a round-nose bent roughing tool (interval), grinding it (interval), returning to the machine and stoning it (interval), putting it in the tool post (interval), setting it for height (interval), tightening the tool (interval), throwing the belt down one step (interval), measuring the length of casting for the roughing out (interval), racking the carriage (interval), advancing the cross-slide (interval), starting the cut with hand feed (interval), measuring the length again (interval), clamping the carriage (interval), and throwing in the power cross-feed, if there is one. If there is no power cross-feed, so much the better for me, for I can introduce an interval after every twist of the cross-feed screw handle.

After the rough-facing cut is finished, comes a turn or two at cutting wind before I throw out the cross-feed (interval), then I loosen the carriage clamping screw (interval), rack the carriage away from the work (interval), retract the cross-slide (interval), loosen the tool-post clamping screw (interval), and take out the roughing tool and place it carefully away (interval). I next select a left-hand bent finishing tool (interval), feel of its edge (interval), stone it a bit (interval), place it in the tool post (interval), set it for height (interval), and clamp it (interval). I then rack back the carriage (interval), advance the cross-slide (interval), set the cut (interval), measure for length with a scale (interval), clamp the carriage (interval), and throw in the power feed.

Testing the Accuracy, with Intervals

When this cut runs out, after throwing out the cross-feed (interval), and stopping the machine (interval), I test the flange face for square with a straight-edge used in conjunction with another interval; if the test proves satisfactory, I can next proceed to the second chucking. At the risk of tiring your patience, having started this job, I am going to finish it, for I do not believe that anyone of you has ever realized how many intervals and how few cuts compose most machine jobs.

The Second Chucking and Some More Intervals

I loosen the carriage clamp screw (interval), rack the carriage out of the way (interval), reach out for the jib crane and pull it over (interval), get the rope sling (interval), pass it around the cylinder and make a hitch (interval), take out the slack of the hoist (interval), loosen the faceplate clamps (with an interval for each), sling the casting free (interval), turn it end for end (interval), swing it back into place (interval), secure it temporarily (interval), throw out the back gears (interval), lock the cone to the spindle (interval), remove the rope sling (interval), pick up a piece of chalk (interval), throw the belt shifter (interval), then mark and true up the casting (several intervals).

Then I secure the clamps (interval), throw in the back gears (interval), select a roughing tool (interval), grind it (interval), stone it (interval), place it in the tool post (interval), set it for height (interval), tighten the tool-post screw (interval), throw the shifter (interval), rack the carriage (interval), run in the cross-slide (interval), set a trial cut (interval), measure for length with the scale (interval), reset to leave 1/32 in. for finish cut (interval), clamp the carriage (interval), and throw in the power cross-feed. The roughing cut being finished, I loosen the carriage clamp screw (interval), rack the carriage (interval), back up the cross-slide (interval), loosen the tool-post screw (interval), remove the roughing tool (interval), put it carefully away (interval), pick up the finishing tool (interval), stone it a bit (interval), place it in the tool post (interval), set it for height (interval), clamp it (interval), rack the carriage (interval), run in the cross-slide (interval), set a test cut (interval), throw the shifter (interval), scale the casting for length (interval), reset the cut (interval), throw shifter to start (interval), take a test cut (interval), throw the shift to stop (interval), measure again (interval), throw the shifter to start if it is satisfactory (interval), clamp the carriage (interval), throw in the power cross-feed and take the finishing cut.

Closing Up on the Intervals

Then I loosen the carriage clamp screw (interval), rack the carriage (interval), throw the shifter (interval), try the casting again with a scale for length (interval), try it with a straight-edge for square (interval), throw away the old chew and take a fresh one (interval), reach over and get the hook (interval), put the rope sling around the cylinder (interval), put the hook in the sling (interval), take up the slack (interval), loosen the clamps on the faceplate (interval), swing the work free of the machine (interval), lower away (interval), remove the sling (interval), swing the jib crane out of the way (interval), dust off the carriage and ways with a brush (interval), then finally remove the finishing tool and put it away (several intervals).

I feel that I have omitted something, probably it is an interval, but let it go for as it is there are enough intervals to go around. In fact, we have over 175 intervals in this simple lathe job that takes but six cuts!

The Real Meat of It All

Keeping in mind the great preponderance of intervals and how much more they can affect the total time on a job than the speed or feed, or the make of steel used, is it not worth while to study them? This is what is known as "time study." It isn't so much the timing of these intervals that counts as it is the brains and reasoning that is employed to reduce them.

If you think that there is something in this, don't jump right in and buy a stop watch; there are other things that must be had at the start. One of them is a pair of spectacles that will enable you to look at things differently—to see the individual actions, and the intervals, instead of seeing the job as a whole. I can't refer you to anyone who has such spectacles for sale, but you can make a pair for yourself—try it and see. Look for the intervals on a job or two each day, and what you will see and learn, and what it will lead to, will repay you for the trouble many times over.

Small-Shop Time Studies

SYNOPSIS—No matter how well acquainted a man thinks he is with the details of his business, it is surprising how much he doesn't know about it. That is why time study is being applied successfully in many large shops. There is no reason why the small shop should not make use of this valuable method of cutting costs. This article tells how it is done, both in the small specialty shops where the closest analysis is profitable and in the small jobbing and repair shops where a broader grouping will bring best results.

Shortly after the Civil War, in one of the states where the supervision of medical practice was absolutely lacking, an old darky whose knowledge of therapeutics was limited to the immediate effects of castor oil and quinine hung out his sign as "Doctor Johnson." One of the white folks, with a sense of humor, called him in one day and asked to be treated for a recurrent pain in the vermiform appendix.

"For de Lawd's sake, Boss," exclaimed the dismayed darky. "I'se just a general practishuner an' not acquainted wid all dem organic species."

"But how do you know what to prescribe for patients, Sam?"

"Oh, I sizes dem up in a general way, sah. If dey is shaky and shivery, I jes gives dem some kuneen. If they ain't, I gives dem kastor royal. If one don't help I gives dem de oder wun, an twixt bode of dem I does pretty well."

Don't laugh at the dusky doctor, Mr. Small-Shop Owner, for it's dollars to doughnuts that you are in the same boat!

Asking Pertinent Questions

Do you know how long a job ought to take? Don't you "size it up in a general way"? Do you look any further beneath the surface than Doctor Johnson did? Do you in your mind's eye see into its structure, so that all of it lies open before you, any more than the chocolate-tinted physic dispenser saw in his mind's eye the complete anatomy of his unfortunate patient?

Oh, you do, eh? Well, let me ask a question or two. How long should it take a good man to clamp this casting on a miller table? Three minutes? All right, I suppose he can take it off again in the same time. Now what feed do you use for the roughing cut? Four inches per minute? That's good, and the finishing cut is 2 inches per minute? Well, I see that you *do* know the details of this job. Let me see; the piece is 12 in. long. That's 3 minutes for the roughing and 6 minutes for the finishing cut. Now what would you say was a fair allowance for setting the cut and throwing in the feed, returning the table, etc.? Yes, I should say myself that 2 minutes was enough. That makes 17 minutes altogether. Now, if you don't mind, let me see the time card of the last lot of these that went through. Thank you. This says 16 pieces in 9 hours. Let's see—60 times 9 equals 450, divided by 15—why, that's about 34 minutes each. Evidently, there is something wrong here. Yes, I know, setting-up time and unavoidable delays enter into this, but an hour a day ought to cover them, especially as this was the last day's run and the machine was already set up. Allowing for this still makes 30 minutes each instead of 17. I am afraid that you are as bad as the Doctor, after all!

Which Is Right?

The trouble is that you have not trained yourself to see and eliminate unnecessary intervals. It must start with you, not with the men. At present, your established time records and your detailed estimate are far apart. One of them is wrong. But you are not sure which one it is. Time study is for the purpose of showing conclusively how fast a job can be done. Whether you reach that standard after knowing it, is another thing, depending on yourself largely. But the knowledge enables you to measure your own efficiency as an executive, as well as that of your men as operators—measurements that are both of them worth while.

Do not consider time study as anything mysterious or out of reach. It is nothing more than a useful tool—a microscope if you will, that magnifies and reveals the hidden structure of your work. You can regulate its magnifying power to suit yourself and the job—in fact, you should, for if you stop to enlarge everything to the extreme limit of a thousand diameters, it will take too long to cover the ground. Here is an instrument that will measure more accurately than the finest micrometer; that will give you a more intimate knowledge of your work than a shelf of textbooks; that will effect more saving, if properly used, than a shop full of new equipment. Its cost to you will be the expenditure of a slight amount of time and energy. Can you afford not to install this useful tool?

In the specialty shop or small manufacturing plant, where the same operations are to be repeated thousands of times, not to make detailed time studies is to overlook a golden opportunity. Men are hired to make the time studies in the big shops, and the management thereby loses a large part of their value. The small-shop owner has the great advantage of being able to make these himself, and in the making he will see opportunities for improvements both in method and equipment that would not appear as vividly from the study of reports made by someone else. The process is not a hard one, and it becomes easier with every attempt. You will probably make a fizzle of the first two or three, but if you have the good "poker face" necessary for a successful small-shop owner, nobody need know about it but yourself.

Analyzing the Job

The first step is to analyze the job into its elements, using judgment in not carrying this to an extreme. At the start, for example, ten division would be better than one hundred and much easier to time. Later on, the finer divisions can be made if it appears necessary.

In arranging individual elements into a unit or group for timing purposes, make the divisions clear-cut and logical. Don't run actions relating to chucking in with

those which relate to cutting or calipering. Also, make a sharp division between *handling time* and *machine time.* Whatever the machine does itself without the help of the operator comes under the latter heading. You will find that this distinction is necessary and helpful later on if you make piece, premium or bonus prices based on your records. You can expect more efficiency from a machine than from the man who runs it. For one thing, it does not get into political arguments, nor does it violate its neutrality, nor require a drink of water occasionally, nor feel the bad effects of a spree.

Often, the closest time study will not disclose whether or not an interval is longer than it should be. Timing a thing does not automatically pass judgment upon it. This is why it helps to study several men on the same operation when possible; for the difference which shows up will throw light on the possibilities of eliminating intervals. The Taylor system of time study advocates timing only the most expert operators and using only the best elements for each one, throwing out all delays and lost time, and finally adding a varying percentage to cover these intervals. Unfortunately for the suitability of this particular plan in a small shop, there are seldom many experts in one line to pick and choose from, and the human material at hand must serve the purpose, however faulty it may be.

Blank for Time Study

A blank should be prepared containing the list of groups or units selected for timing. Several records must be made of each one if the study is to be of value. Space should be allowed for noting faulty conditions or unnecessary delays; in other words, prepare to list such intervals as you can "spot" that appear to be unnecessary.

Armed with the prepared outline blank and a split-second watch, the observer takes his place at the machine. An ordinary stop-watch will do, although one that registers in decimals of a minute is more convenient. The watch should be fastened upon a board which holds the record blank and is operated with the left hand, the board resting in the left arm of the observer.

There are two ways to time the units. One is to keep the stop-watch running all through the operation and, starting with 0, simply note the time at the end of each unit by glancing at the watch. After the recording is finished, by subtracting each time record from the one following it, the actual elapsed time is obtained. Thus, supposing there were five units in the operation; using a common 60-second stop-watch, we might get a record as follows:

Unit	Finished Min.	Finished Sec.	Elapsed Time Min.	Elapsed Time Sec.
1	0	18	0	18
2	0	43	0	25
3	1	10	0	27
4	2	43	1	33
5	3	18	0	35

Where the operation to be timed contains some units that are very short in duration, it may be necessary to time these separately, using the stop. This will not be required except on frequently repeated operations, so that the necessity for this and the opportunity go hand in hand in such cases.

In the jobbing and repair shop it will not pay to do much stop-watch work or to carry the timing down to a fine degree, for the job won't happen again frequently enough to make it worth the cost. What you are after is *results in the future,* not *reminiscences of the past.* Study operations in detail by all means, but time only such groups as will serve your future use.

To illustrate this, let me refer again to the flanged cylinder, the boring and facing of which were analyzed in detail on page 60. Here we found over 175 individual actions which in turn could have been elaborated into many times that number of physical and mental motions if we had time, space and inclination to do so. In other words, the simple record, "boring and facing a 10x10 flanged cylinder, 2½ hr.," could be expanded so that the study of its details would fill a good-sized book. But what good would such a book do the owner of a jobbing and repair shop? If he had a library of these big enough to cover all of his work, it would mean moving the machinery outdoors in order to make room for the books, and he wouldn't live long enough to read them all. On the other hand, give a book of this kind to a man who is manufacturing 1000 of these pieces every day, and let him know that it tells how to make a saving of 10 cents on each one, and he will sit up all night with a cold towel on his head in order to get at the facts.

In the jobbing and repair shop the purpose of time study is not so much to work out the best possible process for a certain few parts as it is to give the owner or manager an idea of the length of time that *any* job should require. Obviously, it would be impossible for one to time in this way all of the jobs that are likely to occur in such a shop; but if you analyze any machine job, you will find that it contains elements similar to some other job, although as a whole it may be quite different. In other words, two or three hundred well-selected time studies will give the jobbing-shop owner a working basis of great value, just as two or three hundred words of a foreign language will enable one to get along in the country where it is spoken.

Two or three observations, for example, will cover the entire range of sizes within them, provided they are used with good judgment. If it should require one-quarter of an hour for rigging up a steadyrest and hold-back dog on a 1½-in. shaft for the purpose of centering it, there is no reason why this same operation on the same machine would take a different time for a 2½-in. or a ¾-in. bar, as long as the piece comes within the weight limit of what a man can handle without using a hoist.

A Simplified Analysis

With this in mind, returning to the case of the flanged cylinder mentioned on page 60, instead of 175 or more subdivisions, the following eight groups will give the small-shop man something for further use: (1) First chucking, (2) rough-boring, (3) finish-boring, (4) rough-facing, (5) finish-facing, (6) second chucking, (7) rough-facing, (8) finish-facing.

While he may not have the same cylinder to bore and face for some time, he will have similar pieces to chuck—the first item will give him a line on this. He will have holes of similar diameter to bore—(2) and (3) will, if his records are reliable, give him a line on this. He will have other flanges to face—(4), (5), (7) and (8) will help him out there. In other words, he can use accurately timed parts of one operation as a guide in knowing how long another one should take. And if he does not go into the detail of timing the intervals, he can watch them carefully so that he may know the record established is not filled with unduly long ones.

Reducing the Intervals in the Small Shop

SYNOPSIS—After making time studies and finding the intervals, the next step is to reduce them. The problem is treated in this article from several points of view, and the relative importance of speed and feed increases, with other kinds of time savings, is discussed.

There is an outdoor sport far more exciting than golf, that has the added advantage of requiring little room. It can be played in the back yard after business hours, and the ones who play it have something besides merely the score to show for their efforts.

I refer to hunting for angle worms with a night light. That it is also the scientific and labor-saving way in which to prepare for a fishing-trip is merely a coincidence. The fisherman who practices it is quite likely to give up fishing as being too tame by comparison.

First you get a small pocket lamp—a bicycle lamp or a Ford headlight* will do. Then, as the shades of night creep over the dewy grass, you do the same, holding your lamp so that its rays fall just ahead to illumine the unsuspecting worm. It will take considerable practice before you can see the worm even after he is illuminated. And it will also be a considerable while before your score will be better than one grab to five sights. But you will have acquired new respect for the worm and will wonder why some university does not offer him a free scholarship and thereby cinch its hold on the world's hundred-yard dash record.

You go after the worms for a purpose, and you look for intervals in the shop for a purpose also. You wish to reduce them, to shrink them into insignificant proportions, or to annihilate them altogether. And naturally, in your enthusiasm for an immediate showing, you turn to the time-worn battle ground of speeds and feeds.

Spending a Dime to Save a Nickel

The influence of speeds and feeds on the length of time required for the average machine-shop job is something that has been vastly overrated.

Preparation time, or time required to get ready to do a piece of work, averages four-fifths of the total time required. In other words, the average job is four parts preparation and one part operation. This one part is not all cutting metal, as it includes all of the machine manipulation and tool changes following the chucking. Realization of this is brought home by the description of the lathe job on page 60. Raising feeds and speeds does not eliminate intervals. The actual cutting is the least important part as far as time or physical or mental effort is concerned. This is true of the average machine job. And yet more energy is spent hitting at this one sore spot than at all the other 99 things that need hammering. Is it any wonder that mechanics are aggrieved at the presence of a "speed boss" who, they feel, is to get his results by unintelligently screwing them up a notch?

* Ford joke No. 1,785,683.

Taking our figures of four-fifths preparation time to one-fifth operation time as representative of average shop work, a 50-per cent. increase in cutting feed or speed means but a 10-per cent. betterment in the total time on the job and does not save as much money as a 15-per cent. reduction in the preparation time. In addition to this, the latter kind of a saving does not shorten the life of a machine or sour the temper of its operator.

Prove It Yourself

If you wish a forcible object lesson on this subject, make it a point to keep track of some one machine in your shop for a day, and note what percentage of the time it is actually cutting metal. You will have a different opinion of the importance of speeds and feeds after this. Mind you, I am not advocating going back to the old days of carbon steel and ½-in. cuts, but I do claim that if half the fuss that had been made about speed had been made about other things that need improving, machine shops would be further advanced than they are today. The reason why speeds and feeds have been the object of attack is because they are in the path of least effort, although by no means of least resistance. In other words, it is easier to think of increasing somebody else's speed than it is to exert yourself in scheming out less palpable and more effective improvements.

What Jigs Do to Intervals

Jigs are among the most ferocious interval eaters that were ever invented. A well-designed drill jig slaughters the intervals without mercy. Consider the case of a cast lever-arm having a boss through which a hole is to be drilled and reamed. Neglecting the actions necessary to prepare the drilling machine itself for this work, here is a list of actions, broadly grouped, which must be followed when a jig is not used: Get clamps and bolts and equip the latter with sufficient washers for the proper height; chalk the casting, and after striking the center, lay out the hole and center-punch it; place the casting upon the drill table, and secure it temporarily; insert the drill into the drill-spindle socket, and square up the face of the boss with the drill; shim up where necessary, and secure the clamps; move the drill table so that the center-punch hole falls under the drill point; spot the center, retracting the spindle and examining the work, shifting the center with the drift if necessary; throw in the power feed, and drill the hole; take out the drill, insert the reamer, and ream; take off the clamps and remove the casting. Here are ten actions, each two having an interval between them. Now, using a jig, let us see what happens. Insert the casting in the jig, and clamp it (the jig being already in place on the drill table); insert the drill in the drill-spindle socket; throw in the feed and drill; take out the drill, insert the reamer, and ream; remove the casting from the jig. Here are five actions and four intervals against ten actions and nine intervals, or a saving of over 50 per cent. in number. It is really a saving of much more, for both intervals and actions that

remain have been shortened materially, excepting the actual machine cuts which are presumably made at the same speed and feed.

A New Way of Judging Things

Looking at things from the interval point of view gives one a new way of checking up the efficiency of a new scheme or process. You cannot always do this by judging it from its actual money saving, as the most efficient process may be employed in the least efficient manner and therefore show up the poorest results. But it is obvious that in an operation in which the intervals and actions are fewest and shortest there is opportunity for the maximum efficiency. One reason why automatic machines do such economical work is that they almost entirely eliminate the human interval element, and while there is lost time on all automatic machines and always will be, it is a small percentage of the whole and it is fixed, not being affected by fatigue or personal feelings.

A great many shop managers are contented with spasmodic savings. They hit a head when they see it, but it has to stick up a good way before it is visible. This haphazard, hit-or-miss sort of business sometimes does very well, especially where things in general are so bad that you can hit any one of them to advantage. But the real savings come as the result of systematic effort and are aided by time studies. In fact, this is what they are for. As a mechanical man, you cannot intelligently go through the time study of an operation without seeing its weak points. After you see them, it is not a difficult matter to fix them up.

Developing "Two-Handed Mechanics"

One result of your studies will be the development of "two-handed mechanics." You will insist that if a man has two hands given him, it is not, as some people think, so that he can use one if the other should be cut off, but so he can use them both at the same time.

While your personal efforts and training will do a whole lot toward bracing up the organization as a result of your refusing to let Tom, Dick and Harry set the time records for you and establishing the time allowances yourself, this must be followed by something else in order to attain its full value. You must have a method of paying your men for the extra efficiency that they develop if there is to be any tendency on their part to maintain it. This is not only fair, but it is good business.

The man who bases his time standards on this kind of a foundation and clinches them with a method of paying his men that is just to both parties will profit by it, not only because of what he learns while so doing, which in itself will lead to many cost-reducing improvements, but because it enables him to lead the shop instead of following it; to be a real boss instead of merely a nominal one.

Studying the Intervals Themselves

You should study, not only operations in detail, but intervals as a class. One small-shop owner spent a week in watching the tool-grinding wheel in his shop. He was not studying the wheel itself, but he was keeping tabs on a class of intervals that is quite common in all shops where men grind their own tools. He had found by observation that the tool grinder was the most continually worked machine in the shop. It was seldom shut down, whereas each of the other machine tools were stopped from 5 to 10 minutes seven or eight times a day, while their operators were at the wheel burning up money three ways at once.

Not only was the time spent at the grinding wheel a dead loss, but it was not alone this time that disappeared unprofitably, for in getting back and forth and in starting and stopping there were more actions and intervals that limited the output.

He figured that his loss was easily an equivalent of $4 per day in wages and profits for a shop of ten men. Looking at things in this light, he saw that it would be the best possible investment to install small motor-driven grinding wheels so that the men could put the tools in shape without having to stop the machines. To this end one wheel was provided to each two machines and an extra set of cutting tools supplied, so that one tool might be always in reserve. The saving from this was more than he expected, for it not only eliminated these intervals bodily, but also resulted in the tools' being kept in a better average cutting condition.

A Fly Trap for Intervals

The grinding wheel is a sort of fly trap where you can catch and examine intervals. There are many that cannot be caught so easily, however, and are harder to get together for examination. In one shop the clamp bolts are thrown into kegs and boxes so carelessly that the threads become damaged, and when a job is being set up with clamps it is necessary to waste time screwing the nut all the way down with a wrench instead of spinning it on with the fingers. In another shop (and in the majority of foundries) time is wasted through giving and receiving "lifts" that should be made mechanically. I will not try to enumerate them, as this would be an impossible task. There are so many of these special classes of intervals that you probably have a few in your own shop.

Congress and the Interval Question

Some people make the mistake of looking upon time study as a thing which is mysterious. A good dog sometimes gets a bad name unjustly. Time study must be a good thing, else why indeed did they abolish it from our navy-yard shops and arsenals—for Congress generally does the wrong thing in such matters. Bills have been passed to prevent the timing of any part of an operation performed in these shops. In other words, no attention must be paid to the hundreds of intervals that make up any one job. "Go ahead boys, take as long as you like, for it's only Uncle Sam that you're sticking." But some day when we need the guns and haven't them, there will be handwriting on the wall for a number of puffy politicians and misrepresentatives who bleat about patriotism and their beloved country and would sell the efficiency of its means of defense for a few hundred votes.

Let us be thankful, at least, that there is no law yet on the books to prevent small-shop owners from looking into the interval question. So get your detail spectacles on and begin to look at things from this new point of view. You will be surprised at what you see, and wonder why you never saw it before.

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In 1913 the production in this country of galvanized iron and steel sheets and of formed products galvanized after forming approached one million net tons, the exact figures being 808,818 gross tons of the former and 66,664 tons of the latter, making a total of 875,482 gross tons.

Inspection in the Small Shop

SYNOPSIS—Definite inspection methods distinguish the progressive from the ordinary shops. An elaborate inspection system, such as is used in the large machine shops, is of course out of the question for small specialty or jobbing shops. There are inspection methods for these shops, however, as well as for the large ones. In this article, methods of inspection for small specialty, jobbing and repair shops are described.

There was, and is, a large shop that does a big variety of work—almost enough to make it come under the head of a jobbing shop. There is no inspection of work in this shop, for the foremen have too much to do as it is, and an inspector, being a nonproducer, is not wanted by the president, who prides himself on the low overhead expense and intends to keep it low. Naturally, much work is spoiled, for almost every job is in a "rush." Quite naturally, also, nothing is said about these spoiled jobs by the foremen, who have enough trouble fighting the boss without fighting the men too. The cost system in that shop is another thing that the president is proud of, for it is cheap and he invented it. That is as much as you can say for it. Fortunately for the peace of mind of both the president and his foremen, it does not reveal when a job has to be done over two or three times to make it right. I wish I had half of what it is costing that shop annually for made-over jobs. I wouldn't lie awake nights trying to decide between a limousine and a seven-passenger touring car. I'd get them both!

Different Methods for Different Shops

The small specialty or manufacturing shop is so distantly related to the small jobbing or repair shop that methods that are suitable for one are far from suitable for the other. This has been noted by the reader of previous articles dealing with the small shop, and it is particularly true when we come to inspection methods. The specialty shop can afford, or rather, must have, a comprehensive inspection system in order to make its maximum profits. It is a case where adding to the overhead obviously pays. But in the jobbing shop, where similar parts do not come through in large quantities and the variety is great, inspection takes on a quite different aspect. In a specialty shop employing a dozen men on small parts in repetition work, it would undoubtedly pay to have one man whose sole duties were to act as an inspector. In the small jobbing shop of the same size, this would rarely pay. The answer resolves itself in the long run, as do most other questions, into that of "Will it pay?"

What Constitutes Inspection

Inspection is the determination of values. This is its broad meaning, but in the average shop, it is restricted to finding out whether a piece is *good enough*. Therefore, to inspect you must have certain standards. Sometimes, these are kept in the mind of the inspector and the results are very peculiar. In one large well-known automobile plant, inspection for size is a very definite thing, being determined by limit gages. But inspection for finish is left entirely to the judgment of the man examining the piece. The result of this naturally is that different inspectors have very different views in the matter, and not only that, but the views of the same man will vary from day to day. Therefore, those who have work rejected in this shop make a practice of saving it up until their inspector comes around in a good humor, when they can usually work it off on him.

Inspection should relate not only to material and workmanship, but also to design. In order to make the most out of inspection, it must suggest and recommend—not merely pass or condemn. In other words, it must act as an investigating commission rather than simply as a board of judges. This view of inspection, I am sorry to say, is one that seldom obtains in most large shops, but it will pay the small-shop owner to regard it in this light before his ideas become set. An inspector, through the nature of his work, bumps up forcibly against the difficult things in the shop. That part of each operation which is most difficult is emphasized by an increased difficulty of "getting it by" and often by a high percentage of loss. The average large-shop inspector does not regard the why of this as any of his business, but if he did he would be a more valuable man.

Making Inspection Pay

A slight change in design often overcomes obstacles that are difficult to get around otherwise, and at the same time does not in any way interfere with the original purpose of the piece. Sometimes, when rejections amount to more than they should, it is found that the limits which have been established are unreasonably high and unnecessarily so. In one case the plus end of a limit gage had become slightly closed, owing to an accidental blow, so that instead of 0.006-in. tolerance there was really but 0.002-in. The inspector rejected many pieces that should have passed before the thing was checked up by the foreman of the department, who was led to investigate by the complaint of the lathe hand and tested the piece with his "mikes." The inspector might have been going on to this day with the higher-accuracy standard if it had not been for the shop foreman.

The recommendations of the small-shop inspector should also extend to the chucking and tooling of the piece. Quite often, the accuracy of a piece of work is determined by these matters, which in the large shop are beyond the jurisdiction of the inspector, who might get himself into hot water if he should suggest a change in the methods in force.

How to Tell If Inspection Pays

There is a simple way in the specialty shop, and in the jobbing shop as well, to determine whether an inspector would be a paying proposition. This consists of keeping track of the spoiled work and of what it costs to make it right. If you figure that it comes out exactly even either way, then by all means install the inspector, for if he is the right kind of a man and you are the right kind of a manager, you will get much more out of him than you figure on.

Even in the specialty shop it is not always advisable to inspect each piece. Parts coming from the screw machines and automatics are generally handled by what is known as selective inspection. In plain language, the inspector will choose 10, 20 or some other number of pieces at random from a keg or box containing 100 to 1000 pieces. If these pass inspection, the chances are that the rest will. But if some of them do not, it will pay to look further.

Linking Inspection with the Method of Pay

In the small specialty shop when the work is paid for by piecework, bonus, premium or any system other than daywork, inspection of the goods before paying for them is an absolutely necessity. It is not a question of "Will it pay?" in such cases, but it must be done if the shop is to be kept from becoming a "get-rich-quick" institution at the expense of its proprietor.

In the small jobbing or repair shop, where the help remains the same for long periods, inspection on jobs which require a number of special fits may be let go until the machine is assembled. Even if the work has been done by the mechanic at a fixed price, he can be called upon to rectify at his own expense an error that develops when the machine goes together and that is shown to be up to him. Time cards, if saved up, will settle many a dispute, for desertion of one's own children, especially when imperfect, is not unknown in the shop.

First-Piece Inspection

In the jobbing shop a small lot of from six to ten pieces is quite often put through. It will pay to inspect the first piece very closely, after each operation. This lets the man at the machine know what will be required of the others that follow. At this point is the proper time for directions to be given the operator about the amount of finish required, so that too much time is not eaten up by unnecessary refinements. Inspection in the small jobbing shop is somewhat similar to the money you give to charity. You haven't enough to go around, so put it where it will do the most good.

Standards for Finish

In order to inspect intelligently, there must be some limit of quality, both as to size and finish, whereby the inspector can know definitely if a piece is good enough to use or not. The standards of size are usually very clearly established. In the specialty shop there should be limit gages showing the largest and smallest allowable dimensions for each inspected size. As far as quality is concerned, the setting of standards is more difficult, but it can be accomplished, and when it is, it will save a lot of money. A man is likely to make the job too good in the matter of finish, rather than just good enough. Every minute that is spent filing and polishing up a piece where filing and polishing are not required is a minute wasted and a fraction of a cent, or more likely the whole cent itself, deducted from your profit account. This is avoided by having a scale of finishes, which are represented by samples, varying from a coarse roughing cut to a fine high polish. You will find that six to eight of these graduations are sufficient to cover the line of work in the ordinary shop, and they may very well be designated by numbers. These save money, particularly when a new man is given a job that he has never seen before.

Putting One Over

Inspection doesn't stop in the machine shop, nor does it begin there. There was a small jobbing shop in Ohio that bought brass castings by the pound. Those patterns that were used most frequently were kept with the brass foundry that supplied these goods. Costs in this shop were made up by using a standard list of material containing the weights of various pieces, revising their values from time to time according to fluctuations in the material market. The cost clerk had an inspiration at one time to check up the weights of the various pieces entering into the machine and in so doing found that the weight of a brass casting required had in some unaccountable way increased very materially during the year. This gave rise to an investigation, which resulted in disclosing a very neat trick on the part of the brass founders, but one which resulted disastrously to their reputation and future business. They had lagged the castings with cardboard jackets, being careful not to increase the stock on the surfaces that were finished. This precaution insured that the extra metal would not easily be discovered in machining the piece, and they got by with it for almost a year. Now, in that same shop, the owner makes it a point to check the weight of individual brass castings against a standard instead of checking up total receipts from the brass foundry without regard to individual pieces, as was his former custom. It is the face value of the coins that you have that makes you rich or poor, and not their total number.

Saving and Spending

Another illustration showing the necessity of inspecting purchased material was very forcibly impressed on the owner of a small shop in Illinois. Finding a slight difference in the price of machine bolts in favor of a local concern, he changed his order over to that plant. There were no limits specified on the screw threads, either for diameter or lead. Such a thing had not entered his head, since all that had been received from the old plant had been satisfactory. He was much surprised in receiving these bolts to find that the nuts which he was tapping in his own shop failed to go on as they should, and the result was that the whole consignment had to be sized by hand with a die before they could be used. Today, he not only has a specified limit for these things, but also inspection gages, which he uses on receipt of the goods.

It pays the small-shop owner to purchase his materials on specifications and to reject them very promptly when they fall below the requirements. Those who do this are respected and get better treatment. Some unscrupulous dealers will try to shove second-class material upon the small shops, which they believe do not take the precautions that the big ones do in these matters. This is especially true where differences from specification can be found only by chemical analysis. While the small shop cannot afford to maintain a chemist for the purpose of checking these things up, it can at least have occasional analyses made by practicing chemists and act according to the results thus found.

Jokers in the Specifications

There was one shop owner, and by the way, not a small-shop owner either, who carried the specification idea to an

extreme. He would include in his requirements one or two little inconspicuous items that would doubtless be overlooked by the anxious salesman, and yet that would give him almost unlimited opportunity to reject the goods. When these arrived, he would immediately make a kick, expecting and usually receiving an increased discount for retaining the shipment. I suppose that he made several hundred dollars in one year by this practice. It is costing him three or four times that much now, for those who continue to deal with him always tack on a good fat percentage for such contingencies before they accept his order. He is now really buying most of his material at 2½ per cent. over the regular market price and doesn't realize that it is a penalty for his petty tactics.

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A Simple Follow-Up System for a Small Shop

By S. E. Charles

For a small shop which has not an elaborate system for dispatching work, the accompanying form will be found convenient for rush and express orders. In fact, where there is a small department and orders have a tendency to pile up, it will also show the superintendent where the trouble is located.

This form is used as a daily report and may be compiled either the first thing in the morning or else just before noon. The latter seems to be the better time, as a foreman usually has plenty to do early in the morning, while by noon things are running at their best. The form is self-explanatory, with perhaps the exception of the expression "time limit." Where this form is used the date on which the goods are promised for shipment is known as the "time limit" and is plainly stamped on the ticket bearing the order number.

The third time that an order is reported in a department, some reason must be given for the delay, which may

DEPT. _____ DATE _____

REPORT OF UNFINISHED ORDERS.

_____ FOREMAN

AFTER REPORTING AN ORDER THREE A REASON MUST BE GIVEN FOR DELAY

ORDER NO.	TIME LIMIT	TIMES REPORTED	REASON FOR DELAY

Simple Follow-Up System for a Small Shop

or may not be the foreman's fault. Perhaps the stock for the order was special and had to be ordered; perhaps the bushings in the drill jig were broken in the midst of the job, or perhaps there was more work ahead of the machine on which this particular job was to be done than the machine could handle.

By having these daily reports on the superintendent's desk, the cause for delay can be looked up quickly, and where action for any reason is necessary, the matter can be given prompt attention. Thus delays can be avoided, which might not otherwise come to light until it is found that the order cannot be shipped on time.

This report has a good effect in automatically pushing the work into the next department, as the foreman or his clerk is not anxious to spend time in writing explanations nor to have a long list of delays forwarded to the superintendent's desk. This may give rise to controversy unless a "dead line" is established; that is, no work can be forwarded to other departments during the listing time, which would be perhaps from 11:30 to 11:45 a. m. in all departments.

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Driving Custom Away from the Small Shop

By G. W. Jager

We often hear the proprietor of the average small shop complain that business is bad and that he cannot compete with the large shop. Business would improve for some of the small shops if they did not turn away so much work by their methods. And after a customer is once driven away, it is a hard matter to get him to again believe in the average small shop. Customers are driven away in most cases by taking advantage of their position and needs. Most of the work that is sent to the small shops is repair and experimental work, and the policy seems to be to boost the price to the limit, depending on the urgency of the job and the financial condition of the customer. Price boosting always reacts on the booster.

I was at one time employed in the repair department of a large manufacturing plant that had no means of cutting gears, so the blanks were turned up and sent to a small shop having a good reputation. On one occasion the gears were to be rushed through, but they were kept 5 days. The man who delivered them told our foreman that there must be lots of money in the small shop, as they were charging $22 for the gears. He said they had sent the blanks to G's to be cut, and were only charged $9.50 for the job. The foreman told the "Old Man," who promptly gave orders that future work be sent to G's.

Recently, I had another case of price boosting. A young fellow who had spent considerable money experimenting in different kinds of machinery had all his pattern work done in a small shop and had always received fair treatment. The work he was experimenting with when I was with him was not a commercial product but a special line, and was to be used in his own shop. That meant one set of patterns with very little chance of more later. He took the pattern maker through the laboratory, explaining the work and the use of the machinery. The latter surmised that if my employer was successful in his present venture, it would require all of his time and attention and that there was small chance of his starting at something else. The pattern maker evidently thought he had better make all he could out of the present job, as it might be the last, so he charged almost double that we had figured on. While my employer was wealthy, he was too good an engineer and shopman not to see the game, and the pattern maker was told so, in emphatic language. The small-shop owner in any line makes a mistake in trying to get as much out of the customer as he thinks he will stand for. This kind of business tends to drive customers away from the shop, and make them stay away too!

Paying the Small-Shop Workman—I

SYNOPSIS—It is difficult to make daily results equal the records established by time study, unless special incentives are offered. These are usually worked into the methods of paying employees. Piecework, premium and bonus plans are used for this purpose, although the daywork method can be made to offer an incentive when properly handled. This article treats of the two most common compensation plans—daywork and straight piecework.

If you were in the grocery or hardware business, you would weigh or count or otherwise check all of the things that you bought in order to be sure that you were getting what you paid for, and if you did not do this, but accepted goods and paid for them without knowing their value, your friends and relatives would have every right to ask for the appointment of a lunacy commission. This seems like such an obvious statement that you may doubt my next one, which is that nine-tenths of the manufacturers of this and every other country are accepting blindly, without means of checking its actual value, a component averaging one-third of their manufacturing costs. A fair day's pay for a full day's work is something that will never be more than half understood, for while there is a definite way through the medium of time study to arrive at a full day's work, there is no method known to man for determining a fair day's pay. The best we can do is to base it on what someone else who does similar work is, or has been, getting for it.

Men are not, as a rule, rewarded in proportion to their skill or its results. We will all agree with this unanimously, realizing how far short of our just deserts each one of us has individually come.

But, setting egotism aside by leaving ourselves out of the question and regarding the other fellows only, what a discrepancy there is between the real value of services and their market price! Not that all service is underpaid, by any means. There is considerable of it floating about that would cost too much if you got it for nothing, but the relation between the extremes of service and the extremes of reward are quite out of proportion. In the mechanical field, for instance, the ratio of $1.50 to $6 covers the pay extremes from crude labor to the highest grade of skill, including within its upper limits not only highly skilled operating mechanics and tool makers, but the majority of shop foremen, whose services are, without dispute, much more than four times as valuable as those of the sweeper or truckman. Even between two mechanics in your shop whose rate of pay is within 25 per cent. of equal, you easily note a difference of service value amounting to 100 per cent.

A Complicated Problem

There is no use wasting time wondering about the reasons underlying all of this. It is all parts of the tangled scheme of artificial human relationships and natural economic conditions, of supply and demand, of capital and labor mixed up with the requirements of civilization and the purchasing power of a dollar—almost as complicated a problem and as hard to solve as some that the small-shop owner faces when he starts out to make his weekly or monthly collections.

While it is impossible to measure the value of labor correctly or definitely, it will do the shop owner no good to worry about this point. What he wishes to do, if possible, is to establish a system of pay that will induce the men in the shop to deliver what he has determined to be a full day's work for the sum which custom has established to be a fair day's pay.

Making the Compensation Plan Work for You

In the shop all of the activities that are capable of accomplishing results must be directed toward reducing costs without sacrificing quality. You have seen how the shop inspector may "do his bit" toward this end; you have seen how the principles of time study are welded into a useful tool for this purpose; you have noted how the selection and care of equipment and small tools is made to work to this effect; and you have observed that, even going back to the fundamental choice of work for the shop, this, if correctly done, takes the initial step toward a low cost. These factors, however, do not approach the workman directly. While they influence his work and so help or hinder the final results, they do not touch him in that most sensitive spot—the pocket.

The Vital Spot

In the method of pay employed, you have a most powerful instrument to devote to the cause of low costs. Here is something that comes directly in contact with the man who does the work. You may be working for something besides profits; for instance, a reputation and an established trade. But your men are not; nine-tenths of them are working solely and exclusively for their week's pay. Out of the dozen or more in your shop, there may be one or two who are ambitious for advancement, but the prospect of this, without the actual presence of the familiar envelope, will not cement their services to you. Putting it broadly, your men are not working for you, but for your dollars. This is the stimulus that keeps them going. It corresponds to the electric current which galvanizes a frog's leg into activity, and you will be overlooking something important if you do not arrange your stimulus so that you will get the most "kick" per unit of current, or in other words, the greatest value of work for your dollar.

Sit Down, You're Rocking the Boat!

If you are inclined to be a philanthropist, forget it while you are installing your pay system. It is nice to have the feeling of universal brotherhood swelling out your vest and to think that there is something stronger than money that binds your employees to you—that you are going to be an ideal employer and lay aside the sordid considerations that degrade capital and shackle the feet of labor. All well and good, brother, but the small-shop man is not the one to demonstrate this truth—his money won't last long enough. And remember that it is also a sordid business to *buy* the regard of your employees instead of *earning* it, which is virtually what an employer does who permits sentimental considerations to run away with common sense.

Daywork With an Incentive

A friend of mine has a shop in which he employs between 15 and 20 men in making a line of machines in lots that are fairly small, so that it cannot be called manufacturing; and yet repeated frequently enough so that it can hardly be called jobbing. He does not believe in piece-work, neither does he believe in losing the powerful incentive that may be offered to workmen through a system of pay. So he has worked out a plan which in his case gives the good results of both. He keeps a careful and complete record of each man's performances. These records are compared with a standard time record that he is convinced is fair to both parties. Those who equal or exceed these time records habitually are raised substantially. Their rate of pay is probably as good as that of the average pieceworker. Those who habitually fall below this standard, thereby demonstrating themselves unfitted for the work, are given a chance at something else. If there is nothing at which they can excel, they are asked to look for other jobs. Those whose rates are high know that keeping them so depends entirely upon themselves. There is all of the stimulus of piecework in this plan without any of its drawbacks. But it requires a watchful and exacting management in order to make it successful. The key to its success is that as soon as a man demonstrates he is worth more money, he gets it. This is what all incentive systems attempt to do automatically, so to speak, and which my friend is doing "by hand."

Ordinary daywork, as it is applied in most shops, does not give either the proprietor or his men their dollar's worth. It is from 35 to 40 per cent. below the efficiency corresponding to straight piecework of even ordinary quality, as has been demonstrated time and time again when the installation of piece-price methods produced a drop of fully this amount in the records as established under daywork. In many shops the records kept are so poor and incomplete that no just comparison can be made by them. Where this is so the men know even better than the management that raises do not go to the ones who earn them, so much as to those who kick the most. As a result, in such shops there are low wages that cause the men to grumble and small profits that awaken lamentations from the proprietor. Low wages and small profits usually go hand in hand, and in this country the mechanical industry that today is paying the highest scale of wages is also making the most returns upon its capital investments in the face of exceedingly strict competition.

Piecework has a bad name, and it is no wonder. If anything else had been treated in the way that this has, it would have lost its reputation long ago. As far as the workman is concerned, piecework is the most liberal system ever invented, for all of the savings that are made in the labor costs go to the ones who make them. The firm simply gets the advantage of a reduced overhead expense and an increased output, also of knowing what the goods are going to cost in advance. That is, that is all that a firm would get provided it did not cut prices, which it almost invariably does in order to get its share of cost saving. It is an ironclad rule for the successful operation of the piecework system that while low prices must be raised, high prices cannot be reduced except when a change in methods is made. This may seem a little unfair to the shop owner, but is nevertheless true, and one who cannot see his way clear to agree to this principle had better pass up the thought of piecework and adopt some other system that will give him the desired share of time savings in another way.

When Two Times Two Is Five

The argument in favor of piecework—that a manufacturer knows what his cost will be in advance—is not always based on sound reasoning. One manufacturer who employed an expert rate-setter to put his plant on a piecework basis was delighted at the result, inasmuch as his labor costs were reduced almost 40 per cent. In extending this reduction to his total cost, he found that it would be possible to lower the selling prices 10 per cent. and still make more money than he had ever done in the past, to say nothing of the larger volume of business that would come through the price reduction. Fortunately, he decided to maintain his prices until the new system had had a six-months' trial, at the end of which time he was richer by considerable experience. He found that his toolroom expense chargeable to the repair of machines had practicably doubled; that his belting expense had arisen in alarming fashion; that the consumption and breakage of tools was greater than it had been before; that the depreciation rates on equipment would have to be raised; that the power bill was much higher; and that while all of these things together did not offset the saving effected by the change in compensation methods, at the same time they reduced his total cost saving to much less than he had figured.

Piecework Problems

One of the most bothersome things about piecework is caused by the variation in the conditions under which it is applied. The man who has a piece price on a certain job raises an emphatic howl if a lot of hard castings are received. His price has not been established on this kind of material and he cannot see why he should be held financially liable for poor work from the foundry. As a result, if there is to be peace in the family, a discount or allowance must be made, and as soon as this policy begins there is trouble. In England they devised a scheme to take care of these things by guaranteeing the pieceworker a certain day-rate. This has become known as the Manchester Piecework System. What it really does is to provide a soft landing place for those who fall down.

"When I used piecework in the shop," complained a Massachusetts small-shop owner, "I tried to make the prices fair to both parties. But no matter how hard I tried, I was continually getting into hot water. My shop was not large enough so that I could always do the same work on the same machines, for I was compelled, like most small-shop managers, to distribute the jobs among the machines that happened to be available at the time. Some of the tools were old and some were new, the rest of them averaging half-way between. The piece prices were set on the capacity of these average machines, which I considered a fair way of doing. The result was, that the fellows who had the good machines didn't kick at all, the ones on the average tools kicked occasionally on general principles, while the fellows on the old machines kicked all the time. Finally, I got disgusted with things and threw out piecework altogether, figuring that, while I'd make less money the chances were that I'd live longer."

These heartfelt remarks illustrated forcibly the existence of "good" and "bad" jobs, so common in the majority of piecework shops. Their existence is not so much a

reflection on piecework as it is on piece price-making, which is quite another thing.

In most shops when a change is made from daywork to piecework, the immediate result is a remarkable reduction in time records. Professional price setters have been known to take advantage of this fact when hired to put a "day shop" on "piece basis." Trading on the lack of information on the part of the management, they have made prices which were 10 to 15 per cent. above what they should be; the men quickly enough "catching on" and doing their part not to spoil a good thing. When you hear of a piece-price system that does not cause complaint, be suspicious of it. When both parties to a bargain are pleased, one of them very likely is getting stuck without knowing it!

Daywork can be made to produce an incentive in the small shop if it is properly applied. Piecework can be made to operate satisfactorily in spite of its unsavory reputation provided it is intelligently installed and administered. The secret of success in operating either of these systems is to know how long the job should take with the facilities with which it is to be done and then make the reward in proportion to the results obtained.

Paying for Consultation Time

By W. D. Forbes

The fact that Mr. Jennings had been running a jobbing shop for many years and was neither a nervous wreck nor a lunatic nor had he gone into bankruptcy, coupled with his initials being O. B., had gained for him among his friends the name of "Oh, be joyful" Jennings. The morning's mail included this letter:

Dear Sir—Your bill for work done for me some ten days ago is herewith returned for correction. I came to your shop by the 11:30 train, explained to your tool maker what I wanted done and left on the 1:48 train. I returned at a few minutes before 6 o'clock and the machinist had almost finished the work, and he completed it in time for me to take a trolley at about 6:18. As you have only five hours to work in the afternoon and as your machinist told me that he did all the work on the job, you cannot have possibly employed seven hours on my work. Please make correction on your bill and return to me. Yours truly,

O. B. called in the tool maker, talked over the matter, got his time cards and then wrote his customer:

Dear Sir—If you will kindly drop in to see me I can explain the charges made for your work under date of August ——. Yours truly, O. B. Jennings.

This letter came back in a day or two with a footnote in pencil, reading:

"Time is money" and I cannot waste time accommodating you when an overcharge is so apparent. I want a corrected bill. Yours truly.

O. B. J. never turned a hair. Calling in his stenographer, he dictated the following letter:

Dear Sir—You are correct in saying that time is money and, wishing your money for my time, I make the following explanation: You came to my shop, as you say, at 11:30. I put my tool maker at your disposal at that time and you talked to him, made sketches and gave directions until quarter to one. The tool maker ate his lunch in a quarter of an hour and began work for you at 1 o'clock, working until 6:15. By your own admission, this all added together makes six and a half hours. Three of the pieces you had made had to be hardened, for which a charge of half an hour was made, which added to previous time charges, made up the seven hours. I am returning the original bill and believe the explanation will make it satisfactory to you. Yours truly,

O. B. JENNINGS.

Two days later the bill came back again with a check pinned to it for its full amount, together with a little slip of paper on which was written: "Blease oxcuse me for being an ass;" then some initials which could not be deciphered.

Using Compound Rest in Cutting Multiple Threads

By B. H. Alwin

While building an experimental machine we had to cut a triple-thread screw and nut with 3 threads per inch, and after looking over all the lathes in the shop, found only one that would cut this pitch of thread. On examination we found that it required a 50-tooth gear on the spindle and a 30-tooth gear on the lead screw, but as the 50-tooth gear on the spindle was not divisible by three, we could not advance the spindle by thirds in the usual way, so we could not use that method. Looking at the lead screw we found it to be 5 threads per inch, which made it impracticable to open the nut and move the carriage to cut the second and third thread. As we wished to do the job as cheaply as possible, we did not want to make a special faceplate divided to three parts and so figured out another method.

After setting up the lathe to cut 3 threads per inch in the regular way we set the compound rest parallel with the work, and after setting the thread tool we took the first cut. The finished depth had to be 0.096 in., but we only cut 0.090 in. deep. Advancing the compound rest 0.1111 in. by means of the micrometer adjustment (estimating the 0.0001 in.), we cut the second thread to the same depth. We then moved the compound rest as before and cut the third thread. This gave us a roughed-out thread.

After roughing out all the threads we reground the tool, and as we used a threading tool with a removable cutter it did not disturb the set-up for the finishing cut. We then proceeded to take the finishing cuts 0.006 in. deeper, to finish the screw, and by using the compound rest, just as we did for roughing out, this gave us a practically perfect triple thread with a very smooth finish.

This method can be used for cutting double, triple or any multiple of any number of threads per inch. It consists in multiplying the number of threads per inch to be cut by the multiple thread wanted, which gives the number of threads to be used in finding the proper tool depth. After each thread is cut the compound rest is advanced a distance equal to the pitch used in finding the tool depth. If, for example, you wished to cut a quadruple-thread screw, 3 threads per inch, the calculations are as follows:

After gearing the lathe to cut 3 threads per inch, set the slide of compound rest parallel with the work. Find cut depth by multiplying the threads per inch to be cut by the multiple thread to be cut, as $3 \times 4 = 12$. The depth of cut for 12 threads per in. $= 0.0722$ in. After cutting the first thread, by using the feed screw advance the compound rest 0.0833 in., which equals the pitch of 12 threads per inch; then cut the second thread. Advance the compound rest another 0.0833 in. and cut the third thread; repeat for the fourth thread.

With this method any screw-cutting lathe with a compound rest can be used for cutting any multiple thread with any given pitch, without any other attachments or special lead screw.

Paying the Small-Shop Workman—II

SYNOPSIS—Those who are not satisfied with the straight daywork system of paying help and are also prejudiced against the piecework system still have left the choice of several other plans. The two most common of these are the premium and the bonus schemes, both of which are here described. A comparison is made showing how a saving effected by a workman is divided up under each of these four systems.

Two men were talking together in the assembly room of a lodge. One was a train dispatcher and the other a machine-shop foreman. "Do you realize," asked the train dispatcher, "that men in our profession have a useful life of only five or six years? Why, at times there are as many as eight trains in my division for whose safe arrival and departure at various stations I am responsible!"

"As many as all that?" interrogated the foreman. "I think that when I get tired of working for a living I'll take up train dispatching. In my department I have 20 men to look after and 25 different machines. There are from 30 to 40 varieties of pieces that go through this department every day, varying in number from 100 to 2000 individual pieces. These pieces correspond in a small way to your trains, for they must arrive and depart without delay, and even under the best of conditions the boss wants me to get twice as much as possible through this department. They say that a man can think of but one thing at a time, but we foremen know this isn't so, and if I, myself, had but eight things to think of at once, I should consider myself lucky."

The Efficiency of a Foreman

The small shop has an advantage over the large shop in the matter of supervision. Did you ever stop to consider what a low percentage of efficiency, as far as supervision is concerned, is possessed by the average shop foreman? Not through any particular fault of his, but as a result of existing general conditions.

The efficiency of a foreman is ordinarily better in the small shop than in the large, because of the greater number of men to be looked after in the larger plant. In some of these one man has to take care of a department containing 30 or 40 workmen, but assuming that one man directs the efforts of only 12 others, let us see how this supervising efficiency figures out. We may assume that he is an average foreman and not an exception, and also that the shop is an average shop, in which case out of a nine-hour day our foreman would probably spend two hours of his time in chasing work, conferring with the boss and looking up drawings. He would spend at least an hour a day in scheming new ways of doing things, arranging for tools, keeping the shop cleaned up and material moving. Not being a man who can work continuously, we must allow him one hour out of his day for lost time, resting, and other things not relating directly to the work. He has five hours left for the actual supervision of work. Now, assuming that he has 12 men, each of whom puts in 9 hours a day, making a total of 108 hours, these 5 hours which he has available must be spent over 108 hours of labor, which is to be supervised. It is evident that but 4⅝ per cent. of this labor can be under the actual supervision of this foreman, even assuming, which is by no means the case, that he supervises "to beat the band." If a shop foreman could concentrate for five hours continuously, he would no longer be a shop foreman, but president of a bank or a steel corporation or something similar. He would be an exceptional man if he could effectively use *half* of these five hours in this way, in which case his actual supervision efficiency would more probably be 2.3 per cent. when in charge of 12 men. In the case of the larger shops where it is not unusual to have 24 or more men to one foreman, the efficiency would drop a little over 1 per cent. Evidently, so far as any stimulation from the foreman is concerned, it cannot come from his actual supervision, but must be brought about indirectly, either through the pay system or by means of records that are brought to his attention daily.

The Premium Plan

You have seen that the objection to piecework on the part of the employee is the fact that it is a general practice for firms employing it to cut prices. And the reason for this lies in the fact that the entire direct labor-cost saving made under a piecework system goes to the man and not any of it to the company.

The premium plan was devised to get around these objections. It may be called an automatic price-cutting device. In other words, a record is taken as a standard, and if the work is completed in less time than this, part of the saving goes to the man and part to the firm.

Until time study came to be known and used, the standard records used in paying for work on the premium plan were obtained from records of past performance. And here is where a critical weakness came in. Those who worked under a system administered on these lines, knowing that new jobs would be tested a few times at daywork before the price was made, were naturally careful to have these daywork records sufficiently liberal to make a very comfortable premium standard. This objection has been removed in those plants where time study is used to establish the standard time, in which case the premium plan loses most of its objections as far as the employer is concerned.

An advantage of premium pay as compared with piecework lies in the fact that the shop manager is able to manipulate it more flexibly. If a man who has a piecework job finds that his work is costing too much he has no other remedy than to cut the price if he wishes to continue making the article, and he thus adds another straw to the overloaded camel's back. With the premium plan he can give the work to a man at a lower rate.

In your shop there are often men whose value you do not measure strictly by their output. A man, for instance, even with a good high output may have a disturbing influence that makes you value him much less than someone else who is not quite as efficient a worker. There are men who set good examples, and a good example, while it is not rated commercially, is still a valuable

thing to have around. Under the premium plan the individual workman's rate enables you to make allowance for such factors in a way that would be impossible under any system other than daywork.

Rate-Setting

No matter which system of compensation is used, it is necessary to set rates or make standard time records, and the process of doing this is known as "rate-setting." Briefly, there are four ways of going about it: First, setting the rates according to "experience" which really means guessing at them; second, basing them on former cost records; third, basing them on an actual demonstration; and fourth, on time study.

Beware of the arbitrary piece-price or standard-time setter. He is as dangerous as a firecracker in a gunpowder factory. I have worked in shops where an individual of this kind, after scratching his head thoughtfully, would announce a piece price that was always much too high or too low. The resulting diplomacy necessary to keep the force satisfied, on the part of the man giving out the work, would pull many a state through an international crisis.

So far as past performances are concerned, you don't want this, either. You are looking ahead and not backward, and more than likely your past records, being in the control of those who do the work, are not a criterion by which it would be to your advantage to be guided.

Demonstration would seem to be a better plan than either of those mentioned, and it is, provided the one who makes it is competent and yet not too expert. The demonstrator who is a circus performer on a certain class of work will set records that the average man will fall far short of attaining. No matter which system is employed, you must have a capable and representative man to make the standards.

There are other things necessary also. Even if the price setter is a capable and faithful man and his records are based on thorough analysis instead of guesswork, there will still be trouble unless one of two courses is followed. Either the capacity of machines doing similar work must be equalized or differing prices or time allowances must be made for the same piece on different machines of the same type.

The Alternative

Equalizing machine capacity is possible in the large plant, being accomplished by standardized feeds, speeds and driving power. But it is out of the question for the small plant, which must turn to the alternative and make the prices to suit the machines. There must be a higher price, for instance, for rough-turning this shaft when it is done on the old belt-feed lathe over there in the corner—the one that looks as if its 3-in.-driving belt was all that was keeping it from collapsing into a pile of junk on the floor—than that which is paid for this same shaft when it is turned on the new geared-head lathe with the 6-in. driving belt. It is strange that those who do not accept this principle will nevertheless make differing prices for work done with and without jigs, not realizing that the underlying theory is exactly the same—that a just piece price or time allowance must be in accordance with the facilities for doing the work.

For a graphical comparison of the four systems, consider the case of a certain product in which the daily 10-hr. output is increased from 30 to 40 pieces. I will assume that the operator has been getting 30c. per hour and that the overhead has been equal to the direct labor at this rate, or 30c. per hour also. Naturally, with the increased output the percentage of expense has increased, let us say 15 per cent., making it 34½c. per hour for the 40 per day output.

How do the various incentive plans divide up the cost saving made by increasing this output? This is the question that is of vital interest to all concerned.

With ordinary daywork, the old labor cost was 10c. per piece, and the burden cost 10c. each also. With the increased output the labor cost has dropped to 7½c. each and the burden to $8^{63}/_{100}$c. per piece. The total labor and burden saving is $1.548 per day *and it all goes to the firm.*

Daywork with an Incentive

When you examine daywork with an incentive, we find that the man's rate is presumably increased as a reward of his higher output. Suppose that he maintains this output and is raised to 35c. per hour; this makes the labor cost, at 40 pieces per day, $8^{75}/_{100}$c. each. The burden remains proportionate to the output, at $8^{64}/_{100}$c. The saving is the same, but 50c. of it goes to the man.

Now take the case of straight piecework with similar conditions, which means a piece price of 10c. each, an output of 30 per day and an overhead of 10c. per piece. If this output is raised to 40 pieces, all the firm gets out of it is the reduction in the total overhead which comes with the increased output and which is the same as before, amounting to $0.548 for 40 pices per day. The workman carries home the balance of one dollar. This is a great reason why piece prices are so frequently cut.

Coming to the 50 per cent. premium plan, basing the standard performance on 30 pieces in 10 hours, the allowance for 40 pieces will be 13.33 hours. These being completed in 10 hours effect a saving of 3.33 hours. The man gets his $3 a day plus a premium of half the time saved at his day rate, this amounting to 50c. The firm takes an equal amount and also all of the overhead saving, and puts away $1.048.

The Bonus Plan

Finally, we get to the bonus system, which is a sort of automatic combination of daywork and piecework. The standard performance is, as before, 30 pieces in 10 hours. The time allowed for the 40 pieces is therefore 13.33 hours. Completing the job in 10 hours, the workman is paid for 13.33 hours at his day rate, plus the bonus, which is equivalent to a raise in his hourly rate for these hours. Figuring that overhead expense per piece is similarly reduced by the increased quantity and that the total cost saving is as in the other cases, the man gets all of the direct labor savings and the firm gets simply the reduction in overhead. It will be realized that the results are similar to straight piecework. The difference is that the bonus system is based on a very accurate determination of standard time and that the requirements to earn a bonus are high.

[For a more detailed description of various wage systems, see "Review of Existing Wage Systems," by C. B. Auel, American Machinist, Vol. 36, page 945; "Principles of Industrial Organization," by Dexter S. Kimball; "Handbook of Machine Shop Management," by John H. Van Deventer.—Editor.]

The One-Man Machine Shop

SYNOPSIS—Much is to be learned by studying extreme cases, not only in scientific fields but in those covering industrial activities. The "one-man shop" is the machine shop reduced to its lowest terms. Of the total number of manufacturing plants in the United States 10 per cent. are "one-man plants." Many interesting characters are found in these "hermit" shops.

Mathematicians and scientists study physical laws by applying them to extreme cases, for if a law of nature, either mathematical, physical or chemical, fits both extremes as well as the middle, it may be accepted as general; but if not, it must be used with caution until its limitations are discovered.

The "one-man shop" is the extreme minimum limit in manufacturing. Make it smaller and it would cease to exist. It is a limiting case that one can put his finger upon with certainty, unlike the other extreme of the largest possible shop.

The mathematician is permitted to use imagination and finds it helpful in solving his problem. With magical ease he can reduce the size of the object in question until it is nothing more than an imaginary point, or he can increase it with equal ease to a size infinitely large. We who deal with machine shops do not have this convenient ability. We have the fixed minimum, below which it is impossible to go; the general average, which is fairly well-known; and an indeterminate maximum, which may never be known.

All studies of industrial conditions resolve themselves finally into looking for the condition of maximum profit and minimum cost, which means the possibility of maximum welfare for all concerned. One rarely finds this condition of maximum profit existing in a one-man shop, and also it is seldom, if ever, found in those shops which at present represent our maximum size. The possibility of most economical operation lies somewhere in between the one-man shop and the present great corporation plant and differs for different lines of activity. A satisfaction to the one-man shop owner may be the knowledge that he is safely within the limit of conservative bigness.

A Boob, a Crank or a Genius

In the one-man shop you will find either a boob, a crank or a genius. Sometimes you will find a combination of all three of them rolled into one, but just as the one-man shop is the extreme case of the problem, so you will find the one-man shop owner to be an extreme case himself.

The boob is found not infrequently in such shops. Possibly he is one who has not had sufficient speed and initiative about him to go the pace as an employee in a larger plant and is quite contented to receive less urging and fewer complaints in return for a smaller income. A shop of this kind stays one-man size, not because of any fixed attention of its owner, but from his inability to make it anything else. Here you will find locks and keys, sewing machines and lawn mowers indiscriminately scattered about, but seldom, if ever will you find anything that is a real machine-shop job—not only because proper equipment is lacking, but also because of a lack of skill.

The Crank and His Surroundings

The crank is found in the minimum-sized shop for quite a different reason. A crank is usually a person of ability who thinks a little differently from the rest of us. Owing to this difference in his way of thinking, it is hard for such a person to be constantly associated with ordinary mortals, and thus you find him adopting the hermit life of the one-man shop. But you will notice a difference in the kind of work that is visible here. Lawn mowers and sewing machines are no longer present; their place has been taken with something of a higher grade, such as guns, revolvers, typewriters, or other apparatus requiring a fair degree of skill. You will rarely find the boob engaged in manufacturing; but you often find that the crank, while devoting some of his time to repair work as a means of "keeping the pot boiling," has a side line in the shape of some ingenious mechanical article which would make his fortune if he were not so cranky in his views of how to dispose of his product.

The genius in the one-man shop is, of course, the rarest of the three species of inhabitants. He is there not because he has to be, but from choice. He likes the solitude and likes to do his own work in his own way, and in addition he enjoys the freedom from restraint which enables him to spend long periods in thinking about problems that you or I could not begin to understand. He is usually a man of considerable skill and thus is able to pick up as good a living as if he worked for someone else, and at the same time he has more time for his hobbies. His shop stays small because he does not wish it to grow, for as long as he makes his living and has time to work at his problems the thought of money does not trouble him greatly nor does he wish anyone around to bother him. Most of us know how irritating it is to see a shop mechanic tackle a job the wrong way about, and so we cannot blame the genius for having a desire to seclude himself from this annoyance, particularly irritating to a man of his disposition.

The Successful One-Man Shop

The owner of the markedly successful one-man shop must have skill in an exceptional degree. If his skill is average, he will find himself bound by the iron-clad law of averages, which says that the average small-shop man will annually produce goods of the selling value of $1950 and in so doing will annually add $1270 to the value of the raw materials. After he does this and takes out the price of power, supplies and oils, and the rent, he will be quite lucky if he finds enough left to buy three square meals a day.

Where there is exceptional skill it is a different matter. A die maker in a large factory in New England received for a number of years the top-notch wages, which at that time were 60c. per hour. Being rather observing it did not take him long to see that the most difficult work was coming his way. Finally he decided to go into business

for himself, broke away from the concern and let it be known in that shop and those of the surrounding towns that he was prepared to execute fine die work. His first customer was the plant at which he originally worked and which found difficulty in getting anyone to produce the results of its former employee. In this shop they figured their overhead at 125 per cent., and thus thought that when paying him an equivalent of $1.20 per hour, they were getting their work as cheap as formerly; although Jones, who had no overhead expense to speak of, figured that he was making the equivalent of twice his previous wages. I do not intend to enter into a discussion here as to which party was in error, especially as both of them were well satisfied. Let it go at that. But the point to be impressed is that with exceptional skill such as is necessary for the class of work mentioned, a one-man shop may be made quite a profitable institution when measured by the prevailing rate of pay for the same grade of skill in other plants.

The Itinerant Yankee Tinker

There were days long ago, when one-man shops were traveling institutions and roamed up and down on wheels through the New England States, stopping at various towns and settlements as long as sufficient work was found to hold them there. Those were the happy days for the mechanical bachelor of roving disposition. He could mend anything except hearts, and it is quite possible that he left a number of these behind him in a broken condition, possibly to be repaired and put in good shape again by the next traveling tinker who came that way.

We all have the idea that overhead expense fluctuates considerably from moment to moment and from hour to hour in any machine shop, but the way to realize this most forcibly is to study its chameleon-like actions in the one-man shop. It is evident that, having but one worker, this solitary individual cannot be both productive and nonproductive at the same moment, also that when he is not altogether one he must be altogether the other. To record the various activities of this many-sided individual would take a great deal of paper, and it would require several expert mathematicians to figure out the overhead expense rate from one day to another, especially as a drill-press repair job which lasts for the greater part of a day is likely to run the overhead for that day up to several thousand per cent.!

Similarly, in the matter of idle machines the one-man shop is at a disadvantage. It is rare indeed that you find all machines running when there are more than one.

A Case of Double Personality

Sandy Andy Thompson was a Westerner who somehow or other had gotten into business for himself in New England. He was a queer mixture of boldness and timidity, of short-sightedness and perspicacity; in fact, somewhat of a "boob, a crank and a genius rolled into one." I had heard about him long before making his acquaintance and thus knew some of his peculiarities, one of the strangest of which was his distinction between the personality of Mr. Thompson who owned the shop, and of mere Sandy Andy who did the work. They were physically one and the same, but entirely different people to talk to, and I believe that they lived as differently in Sandy's mind as it is possible for two distinct personalities to exist in the mind of one person. That there was good sound business logic behind this method of thought I suspected from a conversation with "Mr. Thompson" after hours one evening. "It is a good thing for a man to have a boss," he confided, "because otherwise you will find him getting sloppy with his work. I have to follow up that fellow Sandy pretty close, and once in a while I give him a good calling down for slipping up on some little point that he thinks I will not notice. But I have got my eye on him and he can't get away with it!"

Mr. Thompson Pays Sandy a Bonus

Did you ever hear of a man paying himself a bonus? I learned that Mr. Thompson did this at one time with Sandy. It seems that Sandy was getting discouraged with his pay and asked Mr. Thompson for more. The boss could not see it that way unless Sandy made better time on his work. It was arranged between them that if he finished the job in a certain time he should get a bonus. Sandy earned a bonus quite regularly, and Mr. Thompson paid it. The actual money transaction took place between Sandy Andy Thompson's right- and left-hand trousers pockets!

One day I was talking with Sandy Andy himself during working hours in the little shop. He was quite free with criticisms of the boss, Mr. Thompson. "If you don't think you are being treated fairly," said I, "why don't you go on a strike?" "Well," said Andy, "I tried that a year ago. I got sort of tired of working and sort of disgusted with things in general, and told the boss I was going to quit. I did, too; was out for three weeks, and just about the time my money gave out and I thought I would have to beg for my job back again, Mr. Thompson sent for me and said, 'Get back to work, you old fool,' and I did!"

The Danger of Depreciation

There is danger of depreciation in the one-man shop. It is not that sort of depreciation that runs down the value of equipment and buildings, but *self-depreciation*. One of the evidences of it is the willingness to work long hours for a very small return. It is a danger that may be said to go hand in hand with industrial individualism. In Oriental countries it is far more pronounced, possibly for the reason that there are so very, very few large shops and that most of the manufacturing is done and cared for in private homes by the head of the family and its members. In Japan, for instance, the ingenious wooden toys that you find on sale in our 5- and 10-cent stores are made under this plan, and whole families, from the aged to the very young, work long hours for a return that is merely sufficient to keep them alive. We do not wish this kind of thing in our own country, although we do nowadays have to compete with these products more or less directly.

Advice to One-Man Shop Owners

My advice to the one-man shop owner is to keep climbing until he has reached the five- or six-man size; unless he is a genius, in which case let him stay where he is by all means, for he would not be as happy under other conditions. But remember that one of the first maxims of manufacturing is to multiply profits by profitably employing others, and that while it is not altogether impossible, it is difficult indeed for the one-man shop owner to become a captain of industry.

Drafting in the Small Shop

SYNOPSIS—The small-shop owner does not as a rule trouble himself much about a drafting department. This article tells when it is profitable to employ a draftsman and how to start this department on the right lines.

Out West they tell a story of a small-shop owner who was densely ignorant on every imaginable subject. Everyone said that he should have failed years ago and no one could see any reason why he had not done so. If he had known as little about drawing his breath as he did about drawing a machine, he would have died of suffocation. He thought that "cross-hatching" had something to do with raising fancy chickens and that "shade lines" were used to pull window shades down. I honestly believe that he regarded "safety first" as a baseball term!

This man, in connection with some work that he undertook, had need for quite a number of drawings. Not having a draftsman of his own, he called on an engineer in a neighboring city and asked him to name a price on the job. There were several sheets of details and quite a bit of designing necessary, and the price asked was $250. The sum was modest considering what was to be done, but it took the shop owner completely off his feet. "If you had said $2.50 you would have got the job," he exclaimed. "You fellows ain't going to get rich quick off of me! I am going to spend $50 for one of them universal drafting machines I have seen advertised and set it up in the corner of my shop. I reckon it don't take much power, leastwise it don't appear to have a very big pulley onto it. The kid that runs the millin' machine kin tend it 'tween chuckin's."

Machine to Produce High (Speed) Art

It is not related whether this shop owner carried out his threat, but it would be interesting to see what kind of product could be gotten from a universal drafting machine if it was properly oiled up and run at 250 revolutions. The result would undoubtedly be a drawing that would have many points of superiority over the present futurist and cubist examples on exhibition in our art galleries.

The title I have given this article is "Drafting *in* the Small Shop," for in most small shops that is where it is done. And although in these cases this is often a matter of necessity, because the man who makes the drawings is the man who looks after everything else, there are advantages in having it done in the shop instead of in a secluded department. These advantages should appeal to large shops as well as to small ones. Many draftsmen call for details of construction that are sometimes ignored completely by the shop and are often happily unconscious of the fact that not the least attention is paid to their minute instructions. In the majority of shops the foreman, from his experience, knows a great deal more about the details of construction than the cub draftsman who attempts to say what shall be done. The remedy, of course, is to get a foreman that knows less or a draftsman that knows more, for knowledge and authority must eventually go together; or in the small shop, to place the draftsman out in the shop where he is both in touch with, and under the direction of, the practical man.

Wasted Effort in the Drafting Room

I am familiar with a shop that builds apparatus in connection with which there is a great deal of special piping. Piping diagrams are laid out in minute detail in the drawing room, showing the length of each piece of straight pipe, the angles, elbows, tees, valves, etc. When the pipe fitter comes to take the job, he disregards everything except the center lines. He works from both ends toward the middle, and when he comes to the last piece he measures it up for length, thus getting it right. Anyone acquainted with the peculiarities of pipe and fitting threads will know that this practice has cost the firm in question many hours of useless work in the drawing room, but it was in vogue for six or seven years and probably continues today.

When I see a draftsman laying out and inking in the individual teeth on a standard-pitch gear, I always feel like slapping him on the wrist! It is true that draftsmen are not so bad as they used to be in this respect, for instead of showing them all, they show three or four or possibly a quarter of the full number at most. But why show any? The mechanic doesn't count them, he looks for the written number. He doesn't grind his cutter to suit the shape on the blueprint—if he did the result would be disastrous. Possibly the draftsman puts them in to make the gear seem real, but there is no more sense in doing so than there would be in sprinkling a roast chicken with feathers and serving it on a dish of gravel to add to its reality.

Harder to Draw Checks Than Pictures

The average repair shop needs a man who can draw, but more often one who can draw checks than one who can draw pictures. Usually the boss himself can make sufficiently intelligible marks on a board or paper or the sides of the wall or on a big casting, to convey what is needed. Pattern drawings do not bother him much for he has the broken piece to use either as a pattern itself or as a model for one.

Speaking of patterns, most pattern makers can give the average draftsman "cards and spades" on laying out work. In the ordinary shop, in both drafting room and pattern department all of the cast work is laid out twice—first to small scale in the drawing room and then full size by the pattern makers. One manufacturer in Maine used to have his pattern makers lay the work out first and then have the draftsman copy it as a matter of record. He claimed that he saved time in this way in getting started, got designs that the molder could make, avoided sections so thin that they would not run and others that could not shrink without pulling apart.

There is a whole lot to be said on both sides, of course, but in the small shop, if there is a good pattern maker handy, half of the drafting problem is solved. One great fault of the pattern maker-designer is that he favors the foundry somewhat in the matter of metal, but between

the pattern maker-designer and the draftsman-designer such as is likely to be found in the small shop, I will take my chances with the former every time.

In western New York was a shop in which the superintendent was always in a hurry for jigs and fixtures. He was no hand at making sketches of any kind himself, either with instruments, or freehand, and being averse to losing time in explaining things to a draftsman, as soon as he got the idea, he would go directly to the boss pattern maker, who was of German descent. An amusing dialogue would usually follow.

Superintendent: "Philip, I want you to make me a pattern for a drill jig for the A65 side pieces."

Pattern boss (knowing the "super's" lack of artistic ability): "Yah, vare iss der drawing?"

Superintendent: "Oh, forget the drawing, Phil! You are too good a pattern maker to need anything like that. Just make me a box about so long, so wide, so high (drawing imaginary lines in the air), and put a hinge here, a couple of bosses there and a lug over on this side."

Pattern boss: "Py golly, you don't vant a pattern maker, you vant a mind reader!"

Superintendent: "Well, send down after one of the pieces and make the jig for it to suit yourself."

Pattern boss: "Yah, vy didn't you say so in der fust place?"

Room in the Small Shop for a Draftsman

While the draftsman is in most cases a "fish out of water" in the average small repair shop, when you get to the jobbing or experimental shop you come to a field holding out more promise for him. The shop of this kind, which perfects other people's ideas, usually has as a first task to perfect their drawings. The owner or superintendent of such a shop is often a first-rate all-around draftsman and designer himself. He has need to be a first-rate tool designer if his shop is to make a profit!

One of the most useful duties of a draftsman in a plant of this kind is to effect some sort of a standardization of the product. It is quite possible, although making machines of many different kinds, to keep some small and often used parts standard, thus saving money on small tools, saving storage space and avoiding loss of time in purchasing special parts. The draftsman should pick out certain sizes of key steel, machine screws, studs, tap-bolts, eye-bolts, cotter pins, taper pins, washers, rivets, spring wire, springs, flanges, thumb-screws, setscrews and the like, and then persist very strongly in the determination not to use other sizes unless absolutely necessary. The saving in material cost by a standardization of this kind is surprising, and it will avoid much of the litter that lies about the ordinary shop, never again to be used, but that is saved as religiously as if it were worth its weight in gold.

Manufacturing not being the immediate purpose in the jobbing and experimental shop, drawings, when made, are rarely finished up as tracings and blueprinted, but are left penciled in on manila paper. These sheets, in being handled by the boys in the shop, change color materially; in fact, the various thumb prints adorning them might lead to an accurate way of identifying those who have done the work. There is a creditable story that a notorious criminal was finally tracked and captured in an Indiana shop, his identification being made certain by means of thumb prints upon just such a manila drawing.

As long as he can convey what he wishes to the men, the small-shop owner who is his own designer does not need to be a highly finished draftsman. I have in mind one successful small-shop owner who, although nearly blind, works out the detailed designs of his machines in addition to looking after the operation of his shop. His memory has been cultivated to a marvelous extent, and his method of representing mechanical parts is to tear paper roughly into the shape he wishes to convey, marking the desired dimensions upon different parts of this. When a man can work under such handicaps and be successful, it makes the rest of us ashamed to think that we ever complain!

Letting George Work the Formulas

In developing new designs, the shop owner who has not had a technical education sometimes finds himself up against the solution of quite difficult formulas. However, one who is resourceful enough to successfully run a small shop will not let himself be stumped by such a simple proposition as this. I have in mind friend Smith, of Philadelphia, who knows as much about mathematics as a billy goat, yet whose machines exhibit a perfection of design that is quite remarkable. He told me the secret one day, and I will pass it along to you in confidence. He lets his big competitors work out the design and worry over the mathematics, and after they have solved all the hard equations, he takes a rule and a pair of calipers and investigates the machine. Then when he builds a machine of the same capacity, his mathematics are restricted to addition and subtraction.

When mistakes begin to be made by the workmen, by reason of lack of information, or when the boss himself finds that too much of his time is being taken up on the drawing board, then is the time to hire a draftsman and start a drafting department. Start it in the shop by all means! Let it rub its nose against actual conditions, and grub around in the realm of practical facts, no matter if this process results in grimy looking drawings.

Nice lettering is the last thing to be looked for, although apparently the most prominent thing in most textbooks of mechanical drawing. The matter of dimensions is important also. Shop drawings are not intended as a drill in lightning calculations in the addition of fractions.

A small-shop man who can make a free-hand drawing, either perspective or mechanical, is possessed of a very fortunate knack that he will do well to develop. Ability to do this kind of thing will forestall the day when expense must be added for drafting and will be of the utmost service for personal mechanical notes.

In the specialty shop a good design for the product is the first essential. This means a good commercial design as well as a good mechanical one. Each part must be studied so as to make it come as near being the best possible piece to machine that can be obtained for the purpose.

In the specialty shop manufacturing one product, there is a peculiar condition arising from the fact that very careful designing is necessary at the start, after which, except for changes from time to time, there is none at all. This, however, is offset by the frequent improvement in jigs and special tools in the case of any considerable demand for the article. Here is one of the most vital fields for the shop draftsman and where he can be essentially a profit-making individual.

Cutting the Material Investment in the Small Shop

SYNOPSIS—Comparatively few realize that there is an enormous amount of money tied up in "work in progress" and in "stock." How much the total figure amounts to no one knows, but we do know that the small shop ties up more capital in this way in proportion to its total than does the large shop. Means are described in this article for reducing the "dead" investment in the small shop, chiefly through standardization.

It is hard to realize the amount of money tied up in the materials that lie about most shops. One sees this stock as so much iron or steel, so many castings, so much brass, tin, nickel and lead; or so many kegs of bolts, nuts and washers; not as so many greenbacks and gold coins lying scattered about.

It is quite difficult to cultivate the habit of seeing these things as money. In fact, it is hard to realize the meaning of money itself when not in the familiar nickels, dimes, quarters, dollars, tens and twenties that we come in contact with daily, or try to. For example, if I offer you your choice between 383 Turkish altilikas, or 663 Japanese boos, or 373 Siamese bats, or 50,000 Arabian gasrangs, or 360,000 floos of Morocco, which would you take?

Probably you would choose the flock of floos for the same reason that the three-year-old takes two pennies in preference to a nickel and a nickel in preference to a dime. One is sure of street-car fare as long as he has a nickel, but not at all certain of it with the equivalent of 40 Egyptian foddas in his pocket. Is it any wonder that in the shop where we have thousands of equivalents instead of only a few, the chance of saving money by conserving materials is not fully realized because their real value is often as vague as boos, bats, floos and foddas?

Between the Devil and the Deep Sea

If a man doesn't order stock soon enough he experiences a delay; if he orders it too soon he is paying interest on idle material; if he doesn't order enough there is trouble; if he orders too much there is expense. He is between the devil and the deep sea in these matters most of the time.

No human ingenuity can completely remove this dilemma, and certainly no system can solve the problem. Perpetual inventories are all right. They are helpful, but they cannot foresee that Jones, Smith and Greene will each hand in a smashing big order next week for much quicker delivery than customary. Let some efficiency expert invent a perpetual inventory and stock system that has power to predict the future, and his fortune is made. I will buy one myself and try it on the stock market.

One way to reduce this trouble is to reduce the number of varieties of things that are used. At first glance this looks like the half-inch pill did to the small boy—an impossible remedy. But if you will go carefully over your shop looking for things that are nearly, but not quite, alike, you will be surprised at what you find.

Take gears for example. The average shop in the course of its average life collects enough varieties of gear patterns to make Brown & Sharpe's assortment look like a mere left-over. I worked in such a shop at one time. They used a considerable number of cast gears that were neither diametrical nor circular pitch—that is, twice in succession from the same pattern. Some of the boys said that you couldn't even depend upon the number of teeth staying the same, but I guess they exaggerated a bit. At any rate, the firm put numbers on the gears so they could be identified after they were out of the sand. The pattern carrier got in a scrap with the foundry boss one time and threw up his job, but before leaving took pains to swap a good many of the gear numbers on the patterns. Talk about confusion! The shop foreman who had ordered pinion 163 and gear 245 for completing a machine which, assembled, weighed a total of 40 lb., rubbed his eyes at the sight of the rolling-mill pinion and planer bull-gear sent to fill his order. But the worst trouble came with the ones that were nearly alike, where the difference would correspond to that, say, between $^{13}/_{64}$- and $^{7}/_{32}$-in. circumferential pitch. When one of the former meshed with one of the latter, the gear fitter would indeed earn his bread by the sweat of his brow. When a gear and pinion of $^{13}/_{64}$-in. pitch were placed on centers designed for the $^{7}/_{32}$-in. pitch, they would go together with surprising ease, but the noise made by them when running resembled a young boiler shop. These troubles were finally all ironed out and the pattern numbers put back in their proper places again, but in the interim several cases of nervous prostration were narrowly averted.

A Graveyard with Few Resurrections

The average shop as it grows accumulates many different styles and designs. There is little, if any, thought of standardizing product parts, and if there was the Boss would hesitate to sanction any changes on account of the confusion that might arise in filling repair orders. So the shop gets bigger and different designers come and go, each taking a whack at increasing the variety according to his own ideas. Nothing is ever thrown out or discarded. Patterns and tools and junk accumulate until the greater part of the plant is a graveyard, boasting at infrequent intervals of single resurrections.

This same shop owner will look complacently upon conditions of this kind, but will get up at sunrise to weed his garden, in order that useless plants may not interfere with the growth of useful ones.

Manufacturing on Repair-Shop Lines

If you are running a repair shop, one job of a kind at a time is all that you can expect, but you plan for this and charge accordingly. When you sell machinery at competitive prices and build it on repair-shop lines, one machine this week and another next month perhaps—give thanks that you haven't a cost system that will tell you how much you are losing! When you have work of this kind that is nine-tenths dead, it will be charity (to yourself) to put it out of its misery. If fond recollections of

bygone days make it too hard for you to do this, give it at least a semblance of life in the shop by building enough in one lot to last you for the next five years. Either plan will save money over present methods and will be a step toward standardization. Standardization really means the elimination of unnecessary variety. It is a process of pruning that has as helpful an effect on most shops as it has on most fruit trees.

I remember when, as a boy, I had my first experience with a planing mill. Three blocks before I reached this mysterious place, my ears were assailed by a hum that sounded like all the bees in the world gathered in political convention. As I came near it, this sound became louder and more terrifying, intermingled with the shrieks of battle and the groans of the dying. My childish imagination pictured the destiny of nations being settled within this shack. What a horrible disappointment to peek in at the door and see a couple of darkeys shoving pine boards through a harmless looking machine!

A very near-sighted individual looked out of his window as a procession was going past. It comprised a large number of similarly clad men, and when the old gentleman looked out again half an hour later, he saw, as he thought, the same forms and faces. "Henry," he called, "why are those fellers walking round and round our block? Tell them to run along and tend to their business."

Unless you are used to sizing up shop activities, the big quantities of similar pieces going through a manufacturing plant will fool you, just as the slow-moving similarly clad marchers fooled the near-sighted old gentleman and the noisy planing mill fooled the little boy. You are apt to think that because there isn't much fuss, little is being accomplished. Don't fool yourself! Watch the door of the shipping department and count the boxes!

Webster, who has a small shop in New Jersey, thought that materials were lying about much longer than they should, and determined to find out. When inventory time came, he marked everything that he could with yellow paint. The year following he was surprised to find his inventory 80 per cent. yellow, although he had suspected that there would be considerable color to it. Ten years from now he will still find a yellow streak in it unless the paint wears off or he makes up his mind to scrap this material.

When you consign material to the scrap heap it will average you a cost of a cent a pound if you run your own foundry, or a cent-and-a-half a pound, perhaps, if it goes to the junk man. Labor of the class required to wheel this material about averages you 17½c. per hour. Put a fifty-pound casting on a truck and have one of these cheese consumers trundle it up and down for three hours and then figure out where you are at. You will find that it would have put you 3½c. to the good to have shoved this casting into your cupola, to say nothing of the wear and tear on your truck and the shop floor.

After the idle stock in the average shop has been moved back and forth for a few years, it has accumulated enough expense for storage, handling and general nuisance to convert it into bronze instead of cast iron. Perhaps the shop owner is trying to discover the philosopher's secret of transmuting base metal into gold. Let him keep this process up long enough and he will get there with this idle material, in cost value at least.

Look for the material deadheads more closely than for the human ones, for they are harder to detect. The Leland-Gifford Co., of Worcester, Mass., have detention rooms in which they place all material that stands still more than 24 hours. They segregate it so that it will not contaminate the morals of the rest of the work in process. It's a mighty good scheme and incidentally helps to make their shop an example of neatness.

Start in on the elimination of dead material, Mr. Small-Shop Man, extend your efforts to the elimination of unnecessary parts by standardization, and I promise you that your efforts, if faithfully applied, will result in a handsome dividend on your total capital valuation.

One Way Reading Helped a Machinist

By William H. Kellogg

It is perhaps hard to say to what extent the use of books and literature is of benefit to a man in acquiring proficiency in a trade. In my early experiences as a machinist I did considerable traveling from one job to another and, as is often the case, the first four years' apprenticeship did not give me quite enough knowledge to start on a strange job with a full confidence in my ability to do the work.

In "The Modern Machinist," by Usler, is a description of how to chip a hole in a boiler, using a pair of dividers and a round-nose chisel. The operation is to chip around and around in a circle until the piece in the center falls out and then to follow with a drift. Of course, anyone who has had experience in a boiler shop or any shop where boilers are made and repaired would naturally know about this operation.

It happened that all of my previous experience had been in an establishment where gas engines and transmission machinery had been built, and while there were some jobs I could not do as well as the most experienced, I had never been in a place where steam-engine and boiler work was done.

A Chance to Try It Out

However, I had read the description mentioned above, and one day had a chance to try it out. The foreman had put me to work that morning, saying that he would give me a trial, and the first job I had was to locate and chip a hole in a boiler. So I got busy, and when I had the piece knocked out of the center, I went over and asked him for the drift for that particular size of hole, just as though it was a very ordinary thing to do, although I had never seen such a drift before. Well, I made good on that job, and also did several other jobs on which I did not have any previous experience. I think my success was due to the fact that I combined the practice of all of the fundamental manual operations with knowledge gained from books.

As this happened about 20 years ago, it might be said that things are much different now from what they were then, as nearly every young man has the advantage of manual training or other school work, and there is a greater disposition on the part of foremen to show a young fellow how to get started on a strange job. But the man who keeps himself posted and brightened up by the newest literature is likely to be the one who turns out to be the best in his line.

Small-Shop Orders and Disorders

SYNOPSIS—Few realize that the chief function of written orders is to relieve overloaded memories. Memoranda would be a better name for them. This article treats of the use and abuse of orders and order numbers. Their application and use in the small shop is discussed.

A brain with memory developed at the expense of reasoning power is a mind gone to seed. It may be a handy thing to have if you cannot afford an encyclopedia, but it won't help you to find a pound in the engine.

The foreman of the assembling room in a certain shop had just such a memory. It helped him to hold his job, for they had no lists of parts or drawings of the old-style machines and this individual ordered them "out of his head"—so many feet of 1-in. cold-rolled cut into 2-ft. lengths; so many 1-in. collars; so many half-inch square-head setscrews; so many castings of this and that pattern. These latter he picked out himself in the pattern loft, rummaging about in dark corners in search of these unnumbered pieces. His memory was so excellent that the machine-shop methods of 40 years ago were indelibly engraved upon it and he used no others. Like most of those who are exceptionally developed in one small particular, he was loud-voiced and bombastic and took pleasure in overawing his fellow foremen with his vast knowledge of facts and figures.

Second-Rate Memory but Lots of "Pep"

The owner of the shop had put up with this fellow for a long while—at first because it seemed that such a memory was invaluable, and in later years in a spirit of tolerance. Whenever he suggested a change in product or a new method of working, the owner would receive a lecture on "My Experience of 40 Years, or Why it Can't be Done." Getting tired of this eventually, he retired the marvelous memory on a pension and put in charge an active young chap with a second-rate memory but lots of good sense and ambition.

In less than a month that shop was transformed. The handicap of not knowing how they did things forty years ago turned out to be a blessing, for the young foreman put in present-day methods and insisted on their being followed. Lists were made out for the most common machines, patterns were numbered to correspond, and the uncommon, infrequently ordered old-style machines were dropped completely, being found guilty of costing more than they sold for. After this was accomplished the marvelous memory was no longer missed, and a boy with his head full of woodchucks, catfish and baseball did all the ordering by following the written lists.

The Value of a Written Order

The word "order" is an unfortunate one and only partly discloses the function of the slip of paper thus termed. Nine-tenths of the value of a written order is that it serves as a memorandum, and but one-tenth lies in its mandatory "do this" or "do that."

Orders are not issued for the benefit of the man who gets them so much as for the man who issues them. The average workman would have no trouble remembering his few daily orders if they were not in writing. But the man who issues orders is in a different boat. He is quite likely to forget some of the many he gives or get them twisted. Try making 40 or 50 oral statements of facts and then repeating them without notes, and you will realize what the orderless orderer is up against.

Bill Griggs and His Weakness

Bill Griggs has a weakness—he won't lie and he can't bluff. His men, who are free from such failings, take advantage of him. Among many other orders verbally given by Griggs is one to Hopkins to bore four rod ends to 3 7/16 in. Hopkins sets up on the job, bulls it and gets the first one almost 3 1/2 in. Seeing this, he makes this hole 3 11/16 in. and does the same with the three others. A day or two later when the pins are finished and fall through the rod holes, the botch comes to light. "Why didn't you do as I told you and make those holes 3 7/16 in.?" demands Griggs. "You told me 3 11/16, and that's what I made them," states Hopkins positively.

Griggs is pretty certain he did not, but the order was given last week and he has nothing but his recollection to back him. Seven sixteenths and 'leven sixteenths sound pretty much alike anyway, and the man may have misunderstood. So Hopkins gets away with it, and Griggs has to foot the bill for bushings. A written order on a slip of paper would have been much cheaper, but Griggs can't be bothered with such things.

I knew one shop owner who thought it beneath him to make written notes and who prided himself on his memory, but he was the last man in the world to remember that he had promised an employee a raise of pay!

Afflicted with Bulletinitis

To the usefulness of written orders there is one big exception which may explain why so many practical men hold them in distrust and contempt. If you worked in a large shop before you became connected with a small one, it may be that you have seen some high official smitten with "bulletinitis," and the experience is enough to make you steer clear of pencil and paper for a long while. Those who have witnessed the painful symptoms fear to catch this disease, which so often proves fatal.

The chief symptom is an uncontrollable desire to issue general bulletins on every subject. One who suffers from this complaint experiences acute atrophy of the judgment and an inflation of the ego so that his mandate "Let it be done," seems to him sufficient to accomplish miracles. When in the last stages one would not be surprised at something such as this:

Bulletin 1765 July 21, 1915.
To All Departments:
Beginning at noon of the above date and until further notice, Limburger cheese will smell like attar of roses.
By order of
THE BLANK MANUFACTURING CO.,
J. W. JONES, Works Manager.

Fortunately, the disease usually proves fatal before reaching this stage, for which let us give thanks.

A "tickler" is one of the conveniences that comes with written memoranda. It is an automatic memory packed in a little box. This box contains data cards arranged in proper order by days, weeks and months, with today at the front. Place a memorandum behind next Tuesday's card, and when Tuesday comes, if you follow your tickler it will remind you to look up an order or to inquire about the delivery of the nails you purchased, or to pay your gas bill. The tickler is not a specialist in one narrow line, but will remind you of anything under the sun, and it is infallible if you treat it properly.

If you would realize the good points of something, work in a shop where it is lacking. If you would find its defects, go where they have too much of it.

Overdone order numbers bear heavily upon a shop's digestion. A shop in which I witnessed a system spasm had an order-number scheme as ramified as the bony structure of a shad, but with this difference—the shad's framework is connected in a logical manner while the order numbers were not. There was the customer's-order number, to start with, followed by the shop-order number, which was restricted to the shop office. Then came the drawing-order number and the fabrication-order number, which chaperoned the parts through the shop. The foundry-order number and the pattern number were "also present." Finally came the assembling order number and the shipping-order number. Overlooked in the scuffle but doing their best were, in addition: Forged-order numbers, purchase-order numbers, stock-order numbers, stores-order numbers, jig-order numbers, tool-order numbers, standing-order numbers and sitting-order numbers. Not one of these had the least logical connection with any of the others.

Disorder Numbers in a Big Shop

When Browning & Smith sent a wire asking why their order of June 19 hadn't been shipped two weeks before, the fun began. The sales department fished among the "B's" until it found Browning & Smith and then hunted for June 19 which revealed customers order AA652. The order clerk in the front office, by searching in index ledger *A* found that this was shop order No. Z7654, wherewith he secured the ear of the chief production clerk, who tackled ledger *B*. After the pattern clerk had perused the pages of ledger *C*, the forge clerk had conned the columns of ledger *D*, the stores clerk had scrutinized the sheets of ledger *E*, the foundry clerk had lamped the leaves of ledger *F*, the machine-shop clerk had inspected the inscriptions of ledger *G*, and the assembly clerk had asked the advice of ledger *H*, it was found that all was well with the exception of one bearing cap which had been broken on the floor and which had been ordered replaced on replace order No. 56785. While the bookkeeping department was searching among the ledgers again for trace of the missing piece, the dirty-faced apprentice Dick, in defiance of system, crawled under a bench and fished out a cap that had lain there unnoticed for a year or more!

Order System in the Small Shop

Order numbers are simply short names to save work in writing and to help identify work quickly. It is easier to write the number 432 ten times than it is the words Browning & Smith ten times. When your order-number system becomes too complicated, all the saving from it vanishes and the value of it disappears. Use order numbers, Mr. Small-Shop man, but make them relate so that you won't need ledger A, B, C, D, E, F, G, and so forth to tell them apart!

An order system for a small shop is something that will save its owner money, if he will forget to look upon it as an order system and will regard it as a collection of useful memoranda. "System" is too rigid a name for it and would limit its helpfulness. If a man brings you a bag of money, don't insist on his taking two short steps to the left and one long one to the right before entering the front door. Let him come in head-first through the pantry window if he wishes, as long as he fetches the bag along! Too much rigidity and system will scare away the profits of common-sense economies.

Don't ask me for a set of rules for the small-shop order system, for I won't give them to you. But I will make this suggestion: Write down what *you* are likely to forget, or what *your man* is likely to misunderstand. Keep a copy so that you can lay your hand upon it until the work is done. Then throw it away or file it, as you please, for it will have served its purpose.

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Storing Pattern Plates

By Fred West

A safe place to store patterns and a handy method of placing them are problems that have always given considerable concern to the superintendents of shops and foundries. The universal use of the molding machine has greatly multiplied the stock of patterns now mounted on plates. Generally, no special arrangement for the care of these plates has been made in advance of their making.

The storage of the pattern plates is in most places the same as the ordinary pattern storage; shelves and bins in the pattern building are utilized for the plates in one way or another. The general complaint against this kind of storage for plates is that it is unhandy, as considerable lifting and moving are often necessary in order to find the plates that are wanted.

A novel scheme for storing plate patterns is as follows: The patterns are placed vertically on racks or frames hinged to the side walls. These frames are made up of castings bolted together. A heavy upright piece is pivoted to the wall at the top and bottom, to which six grooved castings are bolted at one end, projecting horizontally. A wooden shoe fits into each groove, and the pattern plates—two placed end to end—stand on the shoe. The grooves are in duplicate so that the plates are stored back to back, with four plates in each section. Also two leaves of plates are supported from the same pivots, giving storage for 20 plates in each unit. The scheme makes it possible to inspect all the plates instantly and to take away any plate either directly or by having to move only one other plate to get at it.

A service track along the wall makes it possible to take the plates to storage or to withdraw the needed ones with a minimum of labor and time. The castings making up the frames are very simple forms which can be made and erected cheaply.

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The Antidotes for Muriatic, Sulphuric and Nitric Acids are soapsuds, magnesia and lime water. The antidotes for the alkalines—potash, lye and ammonia—are vinegar and lemon in water.

Safety in the Small Shop

SYNOPSIS—The application and extension of safety devices have not been as thorough in the small shop as in the large one. In spite of this fact, fewer accidents per hundred men employed occur in the small shops than in the large ones. This is because the average small-shop workman is obliged to think about his work more than the one-operation large-shop machine hand. This article treats of safety in the small shop and how its cause may be advanced.

An acquaintance of mine is rather finicky about some things. He has a country house on Long Island which he wishes to sell. He says that this is not because of the acquisition of the new pest house, or because the colored orphan asylum has picked out a nearby spot for its summer home, or because the reformatory has a large and prosperous branch in this village. But now the last straw has been added and it has broken the camel's back. Adjoining his grounds is Long Island Sound, and this being a place where conditions are ideal for that purpose, the Government is about to establish a testing ground for submarines—as you might say, in "his backyard." He is afraid one of the pesky things will explode and blow him off his veranda! So, from a belief in the principle of "safety first," he is desirous of going away from there.

Accidents are best prevented by keeping one's mind on what one is doing. That is why there are fewer of them per hundred men employed in small shops than in large ones. It is very seldom that you find a small-shop mechanic who is not thinking about what he is doing, and it must be said that in the large shop the reverse is often true, especially where handy men are engaged in performing one operation over and over. There is nothing like deadly monotony for lulling the brain to sleep, or at least that part of it that would otherwise be engaged in looking after the safety of limbs and fingers.

An Unlooked-For Reduction in Accidents

A stamping concern in New England had a very bad accident record, in spite of the fact that the doctrine of "safety first" was preached extensively. A new superintendent inaugurated a change in the firm's labor policy, not because of the number of accidents but for altogether other reasons. The grade of labor employed had been far below the average, the policy of the former superintendent, which had resulted in this condition, having been to economize in wages. A large amount of spoiled work, ruined punches and dies, and considerable labor trouble had resulted from this policy. With an increased rate of pay and a strict preference for American labor, the spoilage and defectives were reduced remarkably. But there was another and entirely unforeseen effect which made its mark upon the accident records. No sooner had this new condition of affairs been established, than a great falling off in the number of accidents was noticed. It was rightly attributed to the higher grade of intelligence possessed by the workers, and the fact that most of them were thinking about what they were doing. Even had this change resulted in a higher cost of product—which of course it did not—the firm would not have sacrificed this gain in safety to go back to its original policy, with its heavy accident record.

"Safety First" versus "Watch Your Step"

The "safety-first" movement, which has swept from one end of the country to the other, is open to criticism, not as to the end it has in view but as to the means employed. Putting up "safety-first" signs on all the telegraph poles is all right, and relieves the unpleasant and inartistic monotony of an otherwise plain pole, but it is questionable as to the effect which it produces. Too frequent repetition of generalities becomes so monotonous as to make them disregarded. If, as you stepped from a train to the station platform, the railway guard would shout "Safety first!" he would not create the definite caution in your mind as he does with the words "Watch your step!"

"Watch your step!" is concrete—it calls for action. On hearing those words you immediately look down to see where you are going. The French have a street sign much more expressive than our "safety first." It is "Prenez Garde," meaning "Watch out!" How much more conducive to action to have someone tell you to "Watch out!" than to be greeted with the generality "Safety first!"

The subject of machine safeguards, due to the activity of state inspectors, has been so thoroughly impressed upon shop owners that I shall not say very much about it. The thing of importance to the small-shop man is to know what to do when "the belt runs off the boiler" or something equally unexpected occurs. He must be ready for emergencies. He must look ahead and anticipate what is going to happen, and must figure out how to avoid the catastrophe.

Thinking Ahead and What It Accomplished

There was a foreman of a gang in a Western loft building who gave much thought to the subject of fire in the shop. The structure was far from fireproof, and he occupied one of the upper floors. There were no fire-escapes and it seemed to him that things would be pretty serious in case a fire should start on one of the floors below. In looking about, his eye chanced to fall on a roll of 2-in. leather belting which was kept on hand for manufacturing machine belts for one of the product machines. "That would make a first-rate fire-escape," he thought to himself as he mentally estimated the length of the roll. Not long after this he had an opportunity of putting his plan to actual test, and his foresight probably saved the lives of a number of men who might otherwise have perished.

Organization for emergency is possible when the emergency can be forecast. The most common one is probably that of fire, and the shop owner whose men are instructed in what to do under such conditions is likely to escape with less loss of property—to say nothing of lives—than he who has no plan for such a contingency. One shop had an excellent equipment of fire pails which were always kept full. They had a select equipment of fire hose and nozzles which were always neatly coiled and ready for business.

They had a beautiful little red painted fire pump that looked quite capable of reducing any conflagration which might occur. But when the fire did break out all of the boys grabbed for the same fire pail. After spilling the water, they all grabbed for the same fire hose. By the time they had this straightened out and had telephoned to the engineer, the fire had secured a good start and was much encouraged by the fact that the engineer himself was wrestling with a rusted valve which had become stuck and refused to open.

Outside Conditions Affect Inside Risk

What a man does and eats at home affect his shop risk most strongly. If a microscope could be invented which would analyze the condition of a man's brain at the time of an accident it would undoubtedly show that in 99 per cent. of the cases there is a befogged or befuddled or an otherwise thick mental condition. Seven beers the night before are as bad as an unguarded elevator opening! An indigestible meal produces worse effects than the absence of lights at the top of a stairway.

Playfulness is quite out of place in the shop, and often results in serious accidents. I remember the case of a good-natured electrician who had the habit of drawing sparks from belts and playfully directing them against the back of the neck of an unsuspecting victim. He was an exceptionally large electrician and due to this fact had an unusual "condenser capacity," which resulted in his being able to draw and transmit large and wicked sparks. One day, while standing on a stepladder, he played this trick on a shopmate who happened to be passing. He did not notice that the man carried a jar of strong acid until after the shock had been administered and the acid spilled. Fortunately the damage was confined to the victim's hands and clothing. It taught the fat electrician a much-needed lesson, and I doubt if he ever sees a spark without thinking of the corrosive power of sulphuric acid!

A Forcible Hint on Decreased Belt Tension

Sometimes a consideration of safety helps to increase profits. One instance of this was in a little shop where the owner had suffered the rather unpleasant experience of having his hand carried around a motor pulley between the pulley and the belt. The tension was pretty stiff—and the hand was too, for several months! If there had been a shaft extending through this pulley on the shop-owner's side he would have broken an arm or been whirled about and have lost his life. These things made him reflect on the subject of tight and loose belts, and on studying the matter he found that by keeping his belts in proper condition he could run them with much less tension than formerly, with the result that they lasted much longer. Such a forcible hint toward economy would not be wished for by most shop owners!

Some of the people who spend their time scheming up machine guards need a little mixture of common sense and shop experience to make their work effective. They are likely in their enthusiasm—which I would be the last one to discourage—to overdo it. Such a thing as this leads them to extremes—something like the idea of putting life preservers on a bathtub!

Landscape Gardening in the Small Shop

Machine guards drawn up by some "safety-first" draftsmen give the tools a queer, foreign appearance that makes the small-shop owner hold his breath—that is if it is not too strong to hold. I have before me a picture of a drill press with an iron smokestack surrounding the spindle, a sheet-iron clothes locker inclosing the drive belt and a most ornamental squirrel cage over the back gears. It is all right in principle, and it is what we will have to come to, but it looks as if it would be more in style at the zoo than in the machine shop. There is another illustration of a drill press in which the draftsman has overlooked something important. This is a blacksmith drill, one of the combination hand-power and belt-driven affairs that you bolt on a post. The illustration shows it belted up with copious guards surrounding the belt, feed screw and bevel gears. Unfortunately, the artist has left the handcrank in place on the driveshaft and has not provided a guard for it. I am afraid when he throws the belt and starts up this machine the crank will hit him a whack on the chin.

Seriously speaking, however, we must all, in small shops as well as in large ones, look forward to the day when our machines will be so guarded that instead of each having six or a dozen dangerous parts that need to be watched by the operator there will be but one. Thus, instead of having six or a dozen enemies, as it were, watching their chance to hurt him, he will have but one, and this one as far from formidable as we can make it!

Points of Danger on Machine Tools

The following extracts, which will be of help to small-shop owners in properly guarding machines, are taken from "Universal Safety Standards," by Carl M. Hansen. It is compiled under the direction of the Workmen's Compensation Service Bureau of New York and is one of the very few practical books on the subject of safeguarding:

Boring and Turning Mill (Vertical Belt Driven)—Tight and loose pulley belt shifter to be equipped with automatic locking device; cone-pulley belt shifter to be applied; all power driven gears to be completely inclosed; driving belt to be guarded to height of 6 ft. from floor; universal couplings and shafts to be guarded; revolving table to be inclosed on edge by stationary bandguard, with provision for adjusting stock; all counterweights to be guarded for entire travel. Guard to have bottom sealed to prevent weight from dropping.

Bulldozer—Driving clutch and all power-driven gears to be completely inclosed; clutch lever to extend through guard and to be provided with automatic locking device; exposed shafting to be protected with shaft guard; eccentric to be completely inclosed; connecting rod and head to be guarded by railing extending entire length of travel; railing to have opening to admit stock.

Cutting-Off Machine (Motor-Driven)—All openings in motor exposing rotating or live parts to be guarded; motor to be controlled by switch and starting box of approved safe type, with control located convenient to operator; all power-driven gears to be completely inclosed; clutch to be completely guarded to within 1 in. of maximum aperture; feed belt to be completely inclosed.

Drill (Belt-Driven)—Driving belts to be guarded to height of six feet from floor; tight and loose pulley belt shifter to extend through guard and to be equipped with automatic locking device; cone-pulley belt shifter to be applied; all power-driven gears to be completely inclosed; spindle shaft to be guarded; safety drill sockets to be used; table to be equipped with drill-press vise, or clamps, or other provisions to be made to properly secure stock when drilling.

Sensitive Drilling Machine (Belt-Driven)—Tight- and loose-pulley belt-shifter pedal to be equipped with locking device; main-drive belt and all other belts and pulleys to be guarded to a height of 6 ft. from floor; all power-driven gears to be completely inclosed; spindle to be guarded; safety drill socket to be used; table to be equipped with drill-press vise, or clamps, or other provisions to be made to properly secure stock when drilling.

Tool Grinders, Center Grinders, All Other Emery and Abrasive Wheels (Belt- and Motor-Driven)—Tight- and loose-pulley belt shifter or clutch lever to be equipped with auto-

matic locking device; belt to be inclosed to height of 6 ft. from floor; if motor-driven, all openings in motor exposing rotating or live parts to be covered and motor is to be controlled by switch and starting box of approved safe type, with control located convenient to operator; wheels 8 in. or more in diameter, whether used wet or dry, to be mounted with safety flanges, provided that operation for which wheels are used and shape of wheels do not make this impractical; wheel to be provided with substantial retaining hoods (or, when such would interfere with operation, with bandguards), covering as much of the wheel as possible and of sufficient strength to retain fragments in case of explosion; plate-glass shield to be attached above point of grinding contact; arbor ends to be protected; dry wheels to be provided with efficient exhaust system, capable of drawing off all dust particles; all wheels to be operated at a speed not to exceed that recommended by the manufacturer; speed limit stops to be applied.

Steam Hammer—Operating levers to be equipped with automatic locking devices; scale guard to be applied at point of operation; locking device for ram to be provided and used when changing dies. If steam pipe leading to or from cylinder is within 7 ft. of floor level, it is to be effectively insulated by nonconducting material.

Engine Lathe (Belt-Driven)—Tight- and loose-pulley belt shifter or clutch lever to be equipped with automatic locking device; cone pulley, belt and back gears to be inclosed to a height of 6 ft. from floor; back gear-shifting lever to extend through guard; cone-pulley belt shifter to be applied; all other power-driven gears to be completely inclosed; chuck to be preferably of a safety type and to be inclosed on edges by stationary bandguard, with provision for adjusting stock; lathe dogs to be of a safety type or inclosed; tool to be guarded at point of contact.

Plain Milling Machine (Belt-Driven)—Tight- and loose-pulley belt shifter or clutch lever to be equipped with automatic locking device; driving and feed belts to be guarded to height of 6 ft. from floor; cone-pulley belt shifter to be applied; all power-driven gears to be guarded; telescoping universal coupling shaft to be completely inclosed; cutter head to be guarded.

Planer (Belt-Driven)—Driving belt to be guarded to height of 6 ft. from floor; tight- and loose-pulley belt shifter or clutch lever to be equipped with automatic locking device; feed eccentric to be guarded; all power-driven gears to be completely inclosed; openings in planer bed to be covered by substantial perforated metal guard securely fastened; table to have 18 in. clearance from all stationary objects when in extreme positions, otherwise space to be permanently and effectively barred against passage; tool to be guarded at point of contact.

Straight-Sided Press (Double-Geared, Belt-Driven)—Driving belt and pulley to be guarded to height of 6 ft. from floor; tight- and loose-pulley belt shifter to extend through guard and to be equipped with automatic locking device; all power-driven gears to be completely inclosed; connecting rod to be guarded; ram crank to be guarded; counterweight to be guarded from floor to top of weight when in extreme upward position; press to be equipped with approved automatic device at point of operation, preventing operator's hands from coming within danger zone.

Plate-Bending Rolls (Motor-Driven)—All openings in motor exposing rotating or live parts to be covered; motor to be controlled by switch and starting box of approved safe type, with control located convenient to operator; all exposed shafting to be covered with shaft guard; all power-driven gears to be completely inclosed; rolls to be completely covered with a heavy plate, leaving small slot for feed.

Shaper (Belt-Driven)—Tight- and loose-pulley belt shifter or clutch lever to be equipped with automatic locking device; driving belt and pulley to be guarded to height of 6 ft. from floor; cone-pulley belt shifter to be applied; feed crank to be guarded; tool to be guarded; ram to have 18 in. clearance from all stationary objects when in extreme position; otherwise space to be permanently and effectively barred against passage in similar way to a belt-driven planer.

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Plugging Holes in Dies

The liability of dies cracking when hardening is lessened by packing asbestos into any small dowel holes which may be in the dies, before putting them in the fire. When the die has small holes tapped in it the asbestos is difficult to remove, and a mixture of 1 part graphite to 3 of asbestos is better. Putty has been used for a similar purpose with good results.

Care of Cutting-Off Sawteeth

By H. C. Atkins

In the operation of circular saws for cutting off bar stock difficulty with chips is often experienced. This is particularly true where a heavy feed is used. The chips adhere to the front of the tooth and prevent the tooth as it enters the cut from doing its work.

A tooth is often jerked out of the saw because the tooth does not do its share of the cutting, and either the machine, saw or tooth has to break. In trying to overcome this difficulty we have found a simple but very satisfactory remedy. It consists in attaching to the machine an ordinary foundryman's wire brush in such a position and in such a manner as to brush the chips out of the gulets of the teeth just after the saw leaves the cut. This takes the chips out of the way while they are hot and before they have time to become "sweated" on the front of the tooth.

In applying the wire brush it is necessary to rig up a guard to prevent the oil used in lubricating the saw in the cut from splashing on the floor and on the operator. Where a very fast feed is used there is enough heat in the chip itself to affect the cutting edge of the saw. This removes the heated chip and saves the saws.

Another hint which may be of service is in the sharpening of saws. Be careful in grinding or sharpening the teeth of these saws that the wheel cuts free and that it does not draw the temper of the points of the teeth to a blue, or even a straw, color. It is quite frequently the case that a saw will cut very satisfactorily after the first grinding, but seems softer after being ground again. Heavy grinding and bluing of the teeth in grinding are sure to reduce the temper of the saw at the very point where it should be the highest. This often reduces the temper to such an extent that the saw will not do satisfactory work.

Careful attention to these details will give added satisfaction in using cut-off saws on any type of machine.

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Humoring a Small Lathe

By A. S. Day

I once had an opportunity of observing several operators of a small lathe who always had trouble when cutting off round stock. One was a Frenchman, who was considered a first-class mechanic, and he could do anything on that lathe but cut off. The minute he tried it, the air was full of French "cuss" words and flying parts of broken tools, and the hacksaw always finished the job.

Other operators had about the same luck until a Dane came along and solved the problem. When he found that the lathe wouldn't behave with ordinary treatment, he reversed the order of work by turning the tool upside down and running the lathe backward. The machine then behaved beautifully, there were no more broken tools and the work was turned out as per schedule. When questioned about it, he said: "If the tam t'ing don't vant to work going the right vay, it vill haf to be humored."

[The best remedy for this disease is to take the slack out of the spindle bearings.—Editor.]

Small-Shop Shafting*

SYNOPSIS—This article takes up an important small-shop subject which is too frequently neglected. Practical hints on selecting and caring for shafting are given. A simple chart gives a quick solution for shaft diameters and the maximum allowable distance between hangers.

There is one redeeming feature about the game of poker—someone gets the money. In this respect it is quite unlike the horsepower which goes to waste in the small shop. This does not increase the profits of the boss or raise the wages of Mike on the machine or of Billy, on the bench. In fact, it is one of the many little wastes which go up in heat (and sometimes in smoke) without doing anyone any good.

The loss from these causes is more serious in the small shop than in the large one, for the reason that proportionately much more power per man employed is

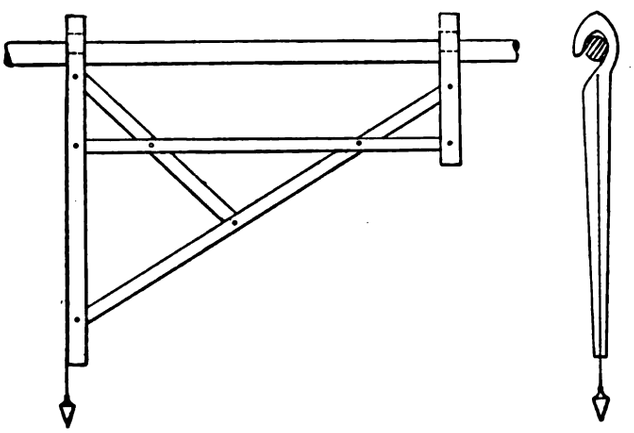


FIG. 2. LEVELING SHAFTS WITH BRACKET AND PLUMB-BOB

used. And if these wastes are considered worthy of study in the large shop, how much more so is it necessary to attack them here, where their importance is greater?

Sleight-of-Hand Mathematics

In presenting the data bearing upon this subject I will try to combine science with simplicity so as to strike an average which will be understandable without too much wear and tear upon the gray matter. To this end, more or less of the material in this and the three succeeding articles will be presented in the form of charts, and a word about them here will not be out of place. An alignment chart is a kind of sleight-of-hand mathematics that will enable a man who cannot or will not add, subtract, multiply or divide to solve quite complicated mathematical problems in a very short time. If you believe that two times two is five, or that three and two are six, well and good—it does not make any difference to the chart or in the final results. In fact, anyone who has the ability to follow simple directions can give a gray-whiskered college professor thirty yards in the hundred and beat him to the answer, and will have the satisfaction of *knowing* that his answer is right, which will be more than you can say for the professor, unless he figures it out twice.

The chart given in this issue on page 86, for example, tells you how to determine the proper diameter of

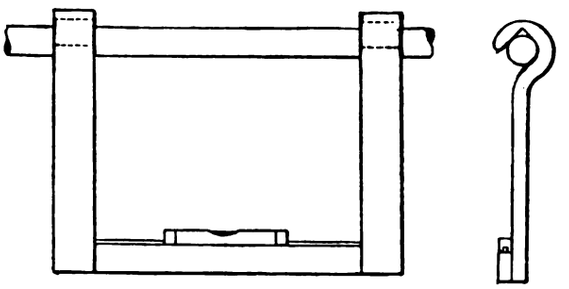


FIG. 3. LINING SHAFTS WITH A LEVEL

a line shaft to transmit a given horsepower at a certain number of revolutions, and also what the maximum distance between bearings should be, allowing for average shafts of cold rolled steel weakened by keyseats, and taking into account average belt pull, weight of pulleys, etc. The small inserted key charts are simply to illustrate the method of using the large one, and if you will follow these examples through you will agree with me that there is still hope for a man who has not a college education!

Bill Jones writes in about his line shaft and wants to know how to tell when she is out of line. Throw off the belts, Bill, and try to spin her by hand. If you can, she ain't! That is the simplest test that I know of. In fact, if it isn't to make a shaft turn easy, what reason would there be for lining it up?

Wisconsin Pete's Method of Lining

Line shafts have a very annoying way of getting out of line, no matter how straight you start them. Sometimes it isn't so much the fault of the shaft as of the

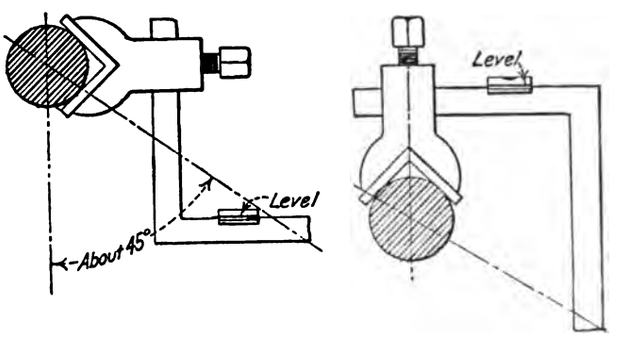


FIG. 4. LINING BOTH WAYS WITH ONE WIRE

building. They tell of an old Wisconsin shop man, whose first name was Pete, who found it cheaper to jack up the building than to adjust his shaft hangers. He would get three or four jacks under his shop and a couple of

* This is the first of a series of articles dealing with power distribution in the small shop. Succeeding articles will treat of pulleys, belts and various transmission problems.

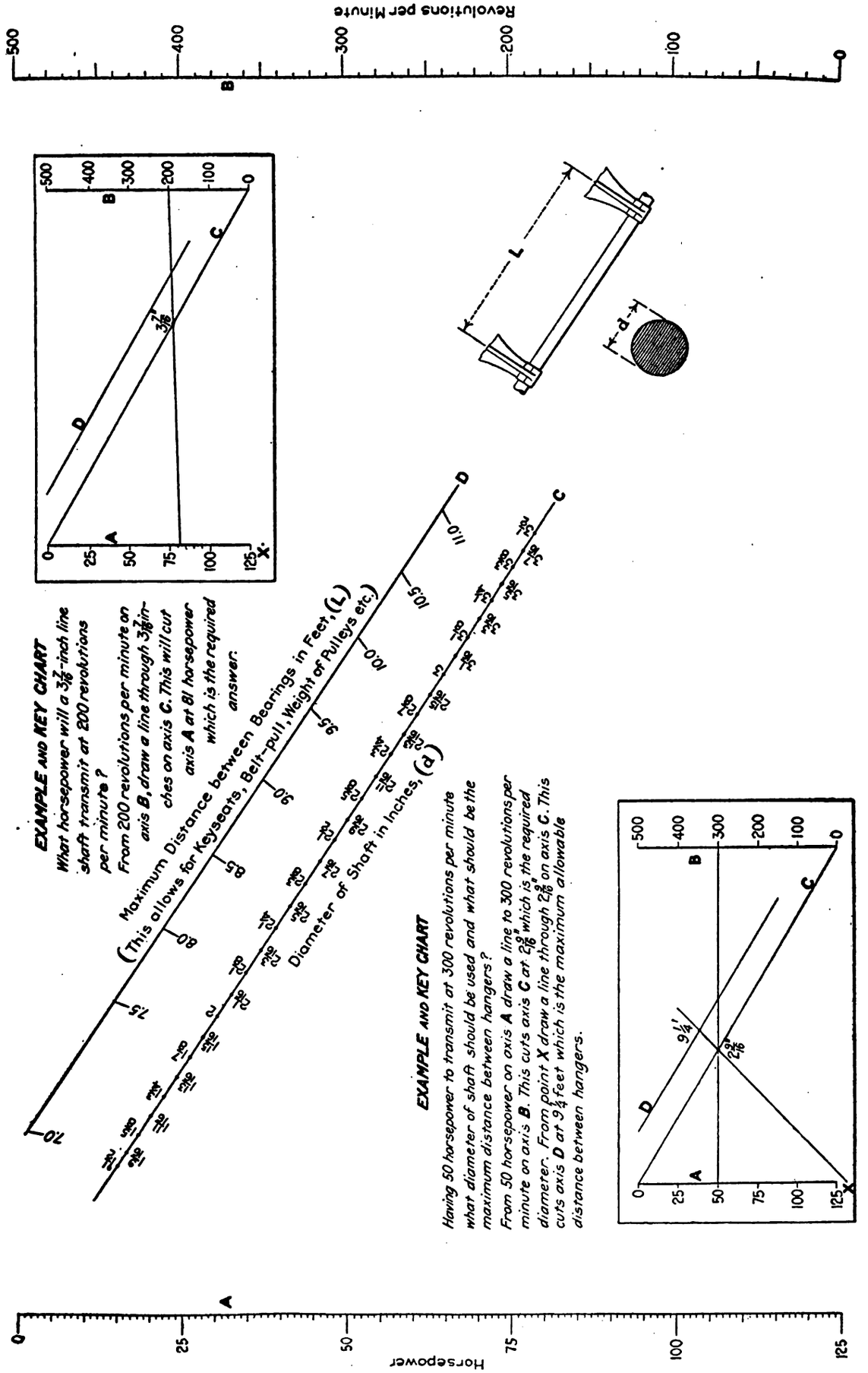


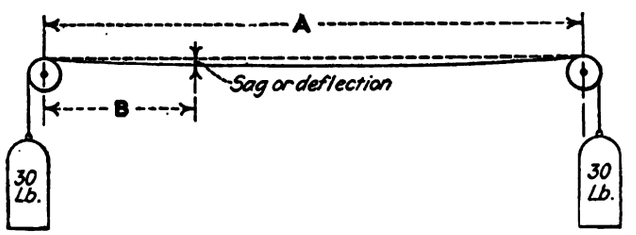
FIG. 1. ALIGNMENT CHART FOR DETERMINING LINE-SHAFT DIAMETERS AND DISTANCES BETWEEN HANGERS

men underneath to operate them, and then telephone directions to them through a knothole. While most shops are not as bad as Pete's, there are a good many shafts which go out of line for the same reason. Hangers have a habit of shifting and bearings of wearing, so that with all of these conditions surrounding the line shaft it is no wonder that the average shaft eats up from 40 to 75 per cent. of the total power even when not doing a tap of work.

Too much belt pull on a pulley in the middle of a long span will often make a shaft crooked. When it comes to lining up crooked shafting you have a real job. The best way to do it is to first straighten the crooked lengths; but don't do it the "regular" way. This consists of sticking the shaft in a long lathe between centers, shoving a pry under the middle, with its fulcrum on the compound, then having a couple of huskies jump up and down on the end of a crowbar, while a boy holds a fuller on top of the shaft and a brawny blacksmith with a 16-lb. sledge smites the fuller. "Altogether now, boys!" Bang! "Once more!" Bang! "Once again!" Bang! Of course you wouldn't hit your lathe with a sledge hammer; oh, no—you are only hitting the bar. I wonder what absorbs that 16-lb. sledge blow with 160 lb. of human energy behind it after it leaves the bar? If I could find out I'd get a pair of them for shock absorbers.

Four Different Ways of Leveling the Line Shafting

The best and quickest way, without doubt, to align shafting is to use a surveyor's level and the shaft-sighting targets that are furnished for shop use. It will pay



(To nearest 64th of an inch)

Distance A, Between Supports, feet	Distance B, from either point of support, feet						
	10	20	30	40	50	60	70
150	1/8	13/64	5/16	3/8	27/64	7/16	29/64
140	7/64	7/32	19/64	23/64	25/64	15/32	15/32
130	3/32	11/64	1/4	19/64	5/16	21/64	
120	3/32	5/32	7/32	17/64	9/32	9/32	
110	3/32	9/64	9/32	7/32	15/64		
100	5/64	1/8	5/32	11/64	11/64		
90	1/16	7/64	1/8	9/64			
80	5/64	5/32	7/64	7/64			
70	1/32	1/16	1/16				
60	1/32	5/64	5/64				
50	1/64	1/32					
40	1/64	1/64					

FIG. 5. SAG OF A STEEL ALIGNING WIRE FOR SHAFTING

a number of small-shop owners to club together and buy an outfit of this kind, using it in common and lining up their shafts once or twice a year. If this cannot be done, there are other very good ways, one being to use a bracket and plum-bob as shown in Fig. 2. Care must be taken with this apparatus that the two ends of the hanger are always on the same diameter shaft.

The line shaft in the small shop should be of one diameter from start to finish, its extra material cost being more than offset by absence of the bother of bushing or reboring pulleys. In one shop they saved $28 worth of cold-rolled by decreasing the sizes of the line shaft every few lengths, beginning at the motor end. It was found convenient a few years later to shift the motor to the other end of the shaft, when, instead of merely moving the wooden split drive-pulley, they found that the decreasing diameters made it necessary to turn the shaft end for end and relocate the pulleys. This little job cost in the neighborhood of $280, and is an apt illustration of how some people save money.

If you have a grudge against the plumb-bob you can use the spirit-level method shown in Fig. 3 with the same caution about unequal shaft diameters.

The last two methods have to do with leveling only, but there is in my estimation one method by which a shaft may be aligned both ways which is superior to

FIG. 6. AUTOMATIC SHAFT POLISHERS

these two, in fact coming close to the surveyor's level method. This consists of stretching a wire or fishline approximately parallel with the shaft, and as near to it as the pulleys and other obstructions will allow, locating it on about a 45-deg. line, as shown in Fig. 1. By using the combination square and level shown in the illustration it is possible to get a very good job of truing up, and a variation in the diameter of the shaft does not make any difference, unlike the other methods. If you are a real particular cuss use a No. 17 Birmingham gage piano wire, loaded with 30 lb. at each end and correct for the sag by means of the figures given in the accompanying table. The method of doing this is clearly shown in Fig. 5, while the table makes it easy to get just the right figure to fit any case.

For the small shop the length of which is limited, a fishline will answer perfectly well and the sag on this will be so little that no corrections need be made.

Automatic Shaft Polishers and Pointers About Shaft Bearings

Self-aligning shaft bearings are a good investment and will save their cost in power very quickly. So also will bearings equipped with oil reservoirs having wick or ring self-oiling devices; that is, if the reservoirs are cleaned out every six months or so to make room for the oil. The wick oilers must be kept from getting glazed over with lead acetate which is a component of most lubricating oils. A bearing that needs to be oiled daily is a nuisance as well as an expense and a source of danger. If you have one of this kind, tap out the oil holes and screw grease cups in them.

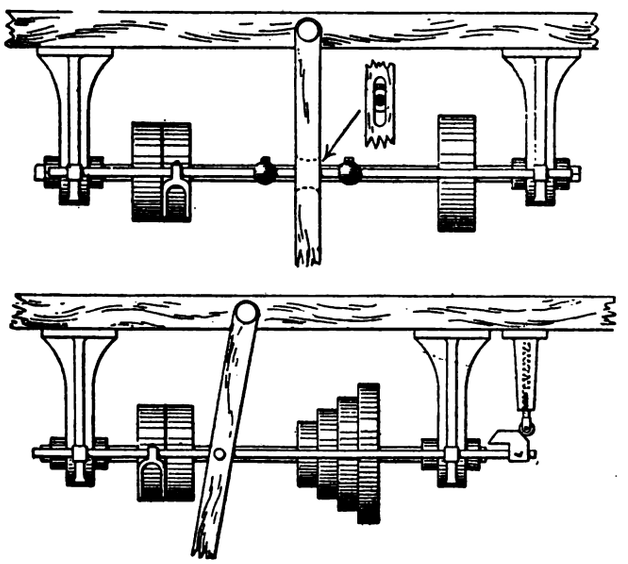
The little trick shown in Fig. 6 may be known to you. It represents an automatic shaft polisher. The holes in the disks, which are made of leather or stiff cardboard, are a little larger than the shaft, and each disk is split to allow its being placed over the shaft between pulleys or couplings. Three or four of these on a length will chase one another back and forth at a lively clip, and in so doing will keep the shaft brightly polished at no expense. It is not often that the small-shop owner has a chance to get something for nothing, as he has with these little automatic polishers.

Small-Shop Pull and Pulleys

SYNOPSIS—This article deals with the choice of dimensions of pulleys, the arrangement of countershafts to reduce friction losses and the construction of belt shifters. A chart is included, which will enable the small-shop man to obtain pulley speeds and diameters without the necessity of figuring.

Solid pulleys on a line shaft are like the new-style shoes that lace up the back—all right until you have to take them off! The small-shop owner makes no mistake in committing himself to a "split-pulley-for-line-shaft" policy. That shop in which the machine locations never change is a dead one. The time lost in taking down a length of shafting, driving off four or five pulleys to change one which happens to be in the middle, will cost the difference between the price of solid and split pulleys every time. A man hesitates to tackle a solid pulley if it has been in place for any length of time, even if he knows that the machine it drives is not correctly speeded. Perhaps this is a sort of benevolent instinct, for he hates to murder the pulley, and knows that, in nine cases out of ten, he will have to smash it in order to get it off at all.

While the choice between solid and split pulleys is easily made, that between wood, steel and cast-iron pulleys



FIGS. 2 AND 3. TWO WAYS OF OVERCOMING SHIFTER TROUBLES

allows of argument. There is little difference between the driving power of pressed-steel and cast-iron pulleys, but there is an advantage for steel over cast iron in the matter of weight. Wood pulleys take hold of the belt better than either steel or cast iron, but depreciate more quickly. The wood-rimmed pulley with steel hub stands at the head of the list in both price and service. While they are more or less of a "luxury" for small shops, it will pay to consider them for main drives.

Jim Anderson was up against a stiff proposition last week with one of his shop pulleys. The case was one in which he could not make the belt any wider nor the pulleys larger in diameter in order to increase the belt speed, nor could he increase the belt tension without having trouble with his bearings. He got around the difficulty by facing his pulleys with leather, which increased their driving power considerably. He made an endless belt for each pulley ⅛ in. to the foot shorter than the pulley's circumference. After cleaning the pulley surface with gasoline to remove the grease, he applied glue both to the pulley and to the inside surface of the belt, and then drove the belt on by bumping it evenly against the shop floor. After it was in place he secured it with a few copper rivets.

The subject of windage, or loss of power through the fan effect of pulleys, has been overdone. It is the chief

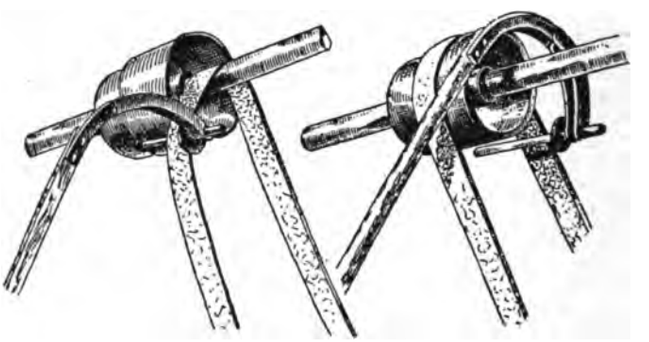


FIG. 4. A GERMAN SAFETY BELT-POLE

argument used against wood pulleys in favor of iron or steel. At ordinary speeds up to 300 r.p.m. and diameters up to 24 in. I doubt very much if the finest power-measuring instrument would be able to detect any difference in a line shaft fitted with wood pulleys and a similar one equipped with cast-iron or steel pulleys of the same size.

A Hair Restorer for Small-Shop Heads

The alignment chart shown in Fig. 1 will be found to save many hairs which would otherwise be scratched out of heads puzzled over pulley problems. When you receive a new machine and want to find the countershaft and line-shaft pulley diameters and speeds, get out your rule or straight-edge, lay it across this chart, and you have the answer. There is no guesswork about it and no wondering whether you carried eight or nine when you last divided. These charts will make the small-shop straight-edge or rule as useful as a carpenter's square.

Before you put up a pulley make sure that it is properly balanced. The faster it runs and the larger it is in diameter, the more necessary it is to be particular about this. It should not be necessary to mention this point, but conclusive evidence that it is neglected in most shops can be had by standing upon the upper floors and feeling the vibration due to unbalanced pulleys. Unfortunately, machinery manufacturers are not always careful in balancing countershaft pulleys, and when you receive a countershaft with a new machine it is well to make sure that the large pulleys are in balance before putting it up.

Pulley-balancing becomes of great importance when the belt speeds get up between 3900 and 4800 ft. per min., or in round figures between ¾ and ⅞ of a mile a minute.

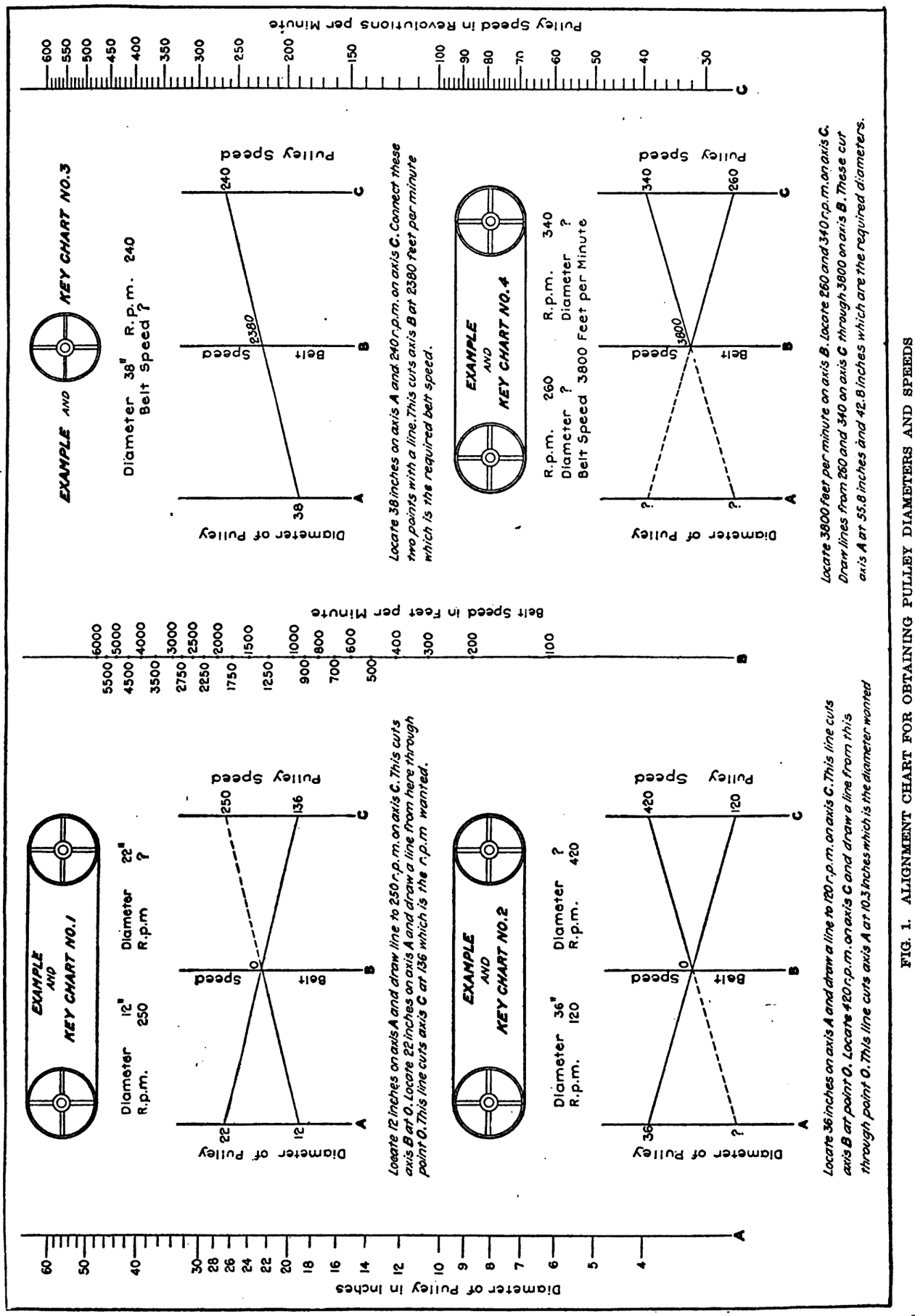


FIG. 1. ALIGNMENT CHART FOR OBTAINING PULLEY DIAMETERS AND SPEEDS

That is going some; but nevertheless it is between these limits that you get the most efficiency out of leather-belt drives. Try to get the overhead belts within these speed limits and choose the pulleys accordingly with the help of the chart. You will notice that the belt speeds may be read directly from the middle line.

Dangerous Belt Shifters

When I go into a shop where the belt shifters are hog-tied with pieces of rawhide belt lacing to keep them from running away I feel glad to get out again with a whole skin. They should hang a skull and crossbones in front of such a shop, for the spirit of negligence is stalking about within it and the ambulance will sooner or later call at its portals. The ordinary belt shifter is a mechanical abomination, aside from its dangerous habit of taking the function of starting and stopping into its own hands. The shop manager who is a real mechanic cannot abide it, and will arrange something on the lines of the shifters shown in Fig. 2 or 3 which will "stay put" and yet enable one to "put" them without trouble. These devices will save time, money, cuss-words and human lives.

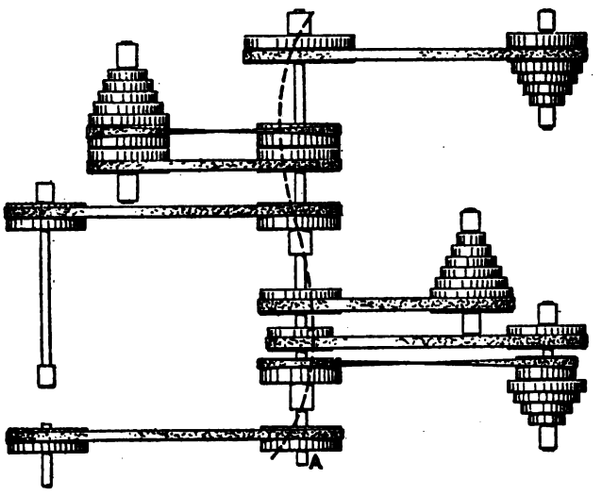
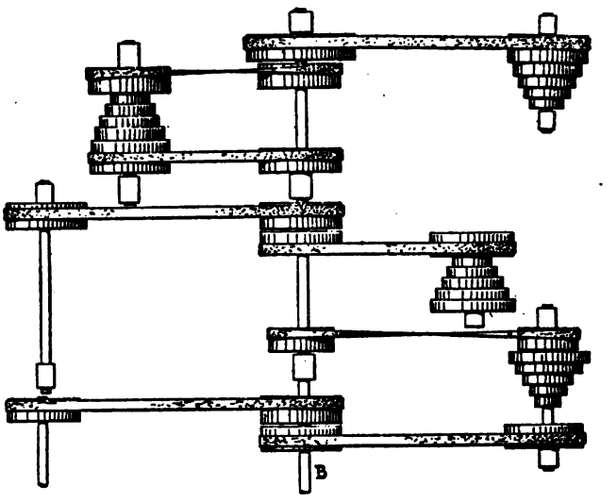


FIG. 5. AN OVERHEAD LAYOUT THAT WILL EAT UP POWER. (DOTTED LINE SHOWS THE TENDENCY TO BEND THE LINESHAFT)



SAME COUNTERSHAFT ARRANGEMENT WITH PULLEYS PLACED TO EQUALIZE BELT PULL

A Safety-First Belt Pole Taken from German Practice

In connection with the line shafts and countershafts, it will not be amiss to speak of belt poles. One is shown in Fig. 4 of a design taken from German practice. It has some very good points, the chief of which is the goose-neck that enables it to reach over a shaft.

A great deal of power can be wasted or saved, according to the arrangement of line shaft and countershaft pulleys. In Fig. 5 an arrangement is shown at *A* that will eat up power. The dotted line indicates the tendency of the belts to pull the shaft out of line. By simply rearranging the driving pulley, keeping the countershafts in the original locations, this tendency has been overcome at *B*. A good way to look at such things is to imagine that the shaft is quite flexible and figure what the belts will do to it. This will help you to arrange pulleys and hangers to offset tendencies to deflect, and as a result you cut down your power bill considerably. If you don't believe it, try it!

Being Jarred Out *of Your* Rut

By W. D. Forbes

That all human beings get into a rut is indisputable; the strange thing about it is that few recognize the condition without a tremendous jolt being given them. O. B. Jennings got a jolt.

Dow came into the office one morning and handed him a check of pretty good size and a bill which was at once receipted and handed back without a word. Dow seated himself in a chair and holding the receipted bill in his hand and looking at the serene face of O. B., said: "I am going to surprise you, make you indignant and perhaps very angry. I am going to do this for two reasons—first on my own account and second on yours. I have had work done by you for three years off and on, I have just paid you a pretty good-sized amount and have your receipted bill. You hold, and I have often heard you assert, that you should not and would not thank anybody for money you have earned, but you would thank them for the work which enabled you to earn the money. Now, O. B., you are not treating your customers honestly and you are not earning the money that your customers are paying you. As the countryman said, 'them is hard words,' but I am going to prove to you right here that they are true, and you are man enough I believe, after you get over the shock, to acknowledge that I am right."

Mr. Jennings had flushed and straightened up at what Dow had said, but he made no reply and Dow continued: "You have a lot of good workmen, a first-class foreman and you are yourself a king among mechanics, but here is where you are making a mistake and being unfair. You take your customer's drawing or sample, give it to your foreman, who hands it over to the machinist or tool maker without any instructions except 'make that,' and he proceeds to work his own sweet will as to how to get out the job. Now we will get right down to the concrete.

"Here is a charge on this bill of some $6 for cutting 30 strips of No. 16 sheet steel 20 in. long. It is not a large charge for the job, but this 2-in. wide stock could be bought in the city, and it could have been cut off to length in a very few minutes, thus sav-

ing much of this $6 charge. In other words, you are not using your ability or even ordinary supervision, especially when you will find that the blueprint showing these strips is marked for strip steel. This is entirely overlooked.

"Here is a charge of $17 for a jig for the rack-stock holes—they have to be exact. Now you could have laid these two racks together and a simple inexpensive jig would have located these holes accurately. The jig would not have cost more than a dollar. I learned this dodge from you some three years ago when I first came here.

"Your men are perfectly aware that all your work is done by the hour, and any extra time put on the job they consider really helps you. You have too few sizes of merchant bar steel in your storeroom. The six 1⅜-in. shafts in my machine were turned up from 1¾-in. stock, as the weight you charge me for clearly shows. The sixteen keys for the gears on these shafts you planed up and ground, and they cost me exactly 4½ times as much as they would have cost me from a supply house.

"Your overhead charge you tell me is 125 per cent.—none too much for a shop like this. But with that overhead charge it is not fair for you to charge me for the time of truing up the faceplate of your 28-in. swing lathe or for truing up the angle plate that had to be swung up on it. It took the lathe hand over a half-hour to find bolts to bolt up this faceplate, and then they were a mass of old nuts, pieces of pipe and collars, as no bolts of the proper length could be found with good threads.

"You charged me $11.50 for that fine-thread pilot tap, and it cut so hard that it took two men to use it. Here is an offer from a tap-making concern to make the same tap for $3.60. When the man was ready to cut the thread, instead of being provided with a regular threading tool, he ground up a parting tool he had on the board and then had to have the tool rehardened. He spent twenty minutes or more running around the shop trying to find an oil pan, and there was a wordy war and almost a fist fight before he could get a dauber brush from the storekeeper. The man that cut the thread went out and stood by the blacksmith while the tap was being hardened and drawn, just to see if it was going to crack.

"Your laying-out table has been so gouged up that the boys won't use it for a nice job, but they get the planer hand to let them do such work on the planer platen. On your bill are a number of charges for drill rod. Now this is expensive stuff, and the men are so careless that they rarely return a piece to the storeroom if there is any left over. If you will look over the tool chests of the boys in the shop and about the benches, you will find enough drill rod of all sizes to stock you up for a year.

"One thing more: There were 60 fillister-head screws used and the proper length was not in stock, so a longer screw was taken and hacksawed off. The counterbore for sinking these heads was a little too small, so the 60 screws were all taken to the speed lathe and the heads filed down to fit easy in the counterbore.

"I do not consider that a single one of these overcharges was intentional so far as making work was concerned, but it was purely and absolutely because you had got into a rut and did not know it. It affects me by making my work cost too much, and unless there is a change and you take a brace I must go somewhere else to have my work done and that I do not want to do. If I have to take my work elsewhere it will affect you, of course. Now think over what I have said, O. B., and when you get over being mad, straighten things out."

After Dow left, O. B. sat for an hour thinking. He was angry and mortified, and the more he thought of what had been said to him the more mortified he became, because the truth of it all was borne in on him. Three weeks afterward the shop took on an entirely different aspect and O. B. was out of his rut.

✦

The Old and the New in Small Shops

The engine lathe probably holds undisputed sway as the backbone of machine-shop equipment, except, perhaps, in highly specialized manufacture of duplicate parts. This is particularly true of the smaller shops, where the lathe is often the only machine except a small drill of some kind.

Even in the making of shrapnel and similar ammunition, the engine lathe is in great demand in these strenuous times. If this be considered as out of the usual, a visit to the shops of any sparsely settled community where manufacturing in large quantities is unknown will soon convince one that it is still a staple machine which can be manufactured safely in fair quantities at all times. This is also a factor which can well be considered in equipping school shops.

The recent development of the autogenous welding apparatus has also made this a necessary part of even small-shop equipment, so that we often find the old and the new side by side in shops that have little else with which to handle their work. Not only are broken parts repaired, but worn places are built up with new metal by the "putting-on" tool, which was so often needed in years gone by. The striking feature is that the old and the new should so often be found together in the smaller shops.

✦

Safety-First in Operating Levers

By F. E. Potter

In this age of "safety-first" it appears to me that one point in the design of special machinery is often overlooked. I have noticed a number of machines with the starting and stopping lever operating, in my opinion, wrongly.

I believe that the lever and its connections should be so designed that a push, instead of a pull, will stop the machine. In case of accident, the time required to reach forward and pull the lever back might permit more serious damage to either the operator or the machine than if it were necessary merely to push the lever in. This small difference in time might save a finger or even a life.

✦

As an example of the way the parcel post is being utilized in the machine industry, it is interesting to note a recent shipment into Los Angeles, Calif., of 22 tons of antimony in 50-lb. pigs. This was found to be the cheapest and quickest method of shipment.

Selection of Belts in the Small Shop

SYNOPSIS—The average efficiency of belts in the small shop is low, largely due to incorrect selection. This article deals with the principles underlying the selection of belts for transmitting various loads and gives a graphical chart whereby the figures are arrived at easily. Quality specifications for first-class leather belting are also given.

Official War Bulletin (Somewhere in the United States)—The war between the electric wire and the leather belt goes on as fiercely as ever. At present the electric forces seem to be the aggressors and have obtained considerable territory in the larger shops. In the small shop the leather belt brigade is strongly entrenched and is making a notable resistance. From present indications it will be a number of years before it is compelled to capitulate.

One very effective reason for the comparative slowness of the small shop to extend electric-power transmission beyond its main drive motor is that few small-shop owners

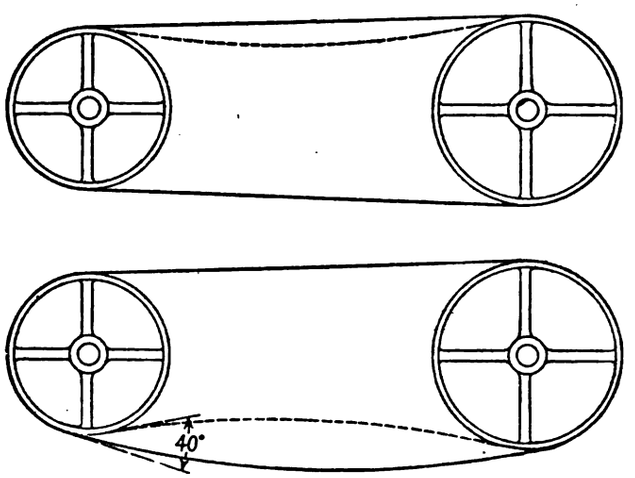


FIG. 2. GAINING POWER BY PROPER ARRANGEMENT OF BELT SAG

consider themselves competent to act as electricians. Whether this opinion is justified or not must be discussed in another chapter. The small-shop man likes to deal with something that he understands, and he looks upon the leather belt as a simple and understandable thing.

This view may be the result of long association. One may, however, live with a person for many years and still not know him. And the same thing applies to leather belts, judging by the fact that belt efficiencies in the small shop are low when measured by what they do against what they should do.

This is not to say that the small shop is a hotbed of belt troubles. Inefficiency does not always show up in the form of trouble, although it always makes its tooth marks eventually in the expense ledger. Put a 30-hp. drive on a job that requires a maximum of 5 hp. and you will not notice much belt trouble. Reverse the conditions and you will have the trouble as well as the expense. Most of these cases result from a wrong selection and have nothing to do with the quality of belt or the pulley surface.

The chart shown in Fig. 1 will help in the proper selection of belts. With this you can find the proper belt width for single, double, or triple oak-tanned belts, provided you know the horsepower to be transmitted and the belt speed in feet per minute. This latter can be obtained from the chart shown on page 89, if you know the pulley diameter and its revolutions per minute. As for the horsepower, if you do not know how much should be provided for a certain tool, you will have to wait for the chapter on "Individual Motor Drive," which will tell you.

Choosing Belts of the Proper Quality

It pays to get the best in the matter of belting. The quality is judged largely by the location from which it is cut in the hide. This should be within 18 in. of the center of back. Laps should not exceed 4 ft. 6 in. in length. If they do, it is an indication that poor quality of belting is used. The weight of single belts per square foot before they are filled or treated should be as follows: 1 to 2 in. wide, 14 oz. per sq.ft.; 2¼ to 5½ in. wide, 15 oz. per sq.ft.; 6 in. wide and over, 16 oz. per sq.ft. For double belts the weights should be as follows: From 1 to 2 in. wide, 28 oz. per sq.ft.; from 2¼ to 5½ in. wide, 30 oz. per sq.ft.; 6 in. wide and over, 32 oz. per sq.ft.

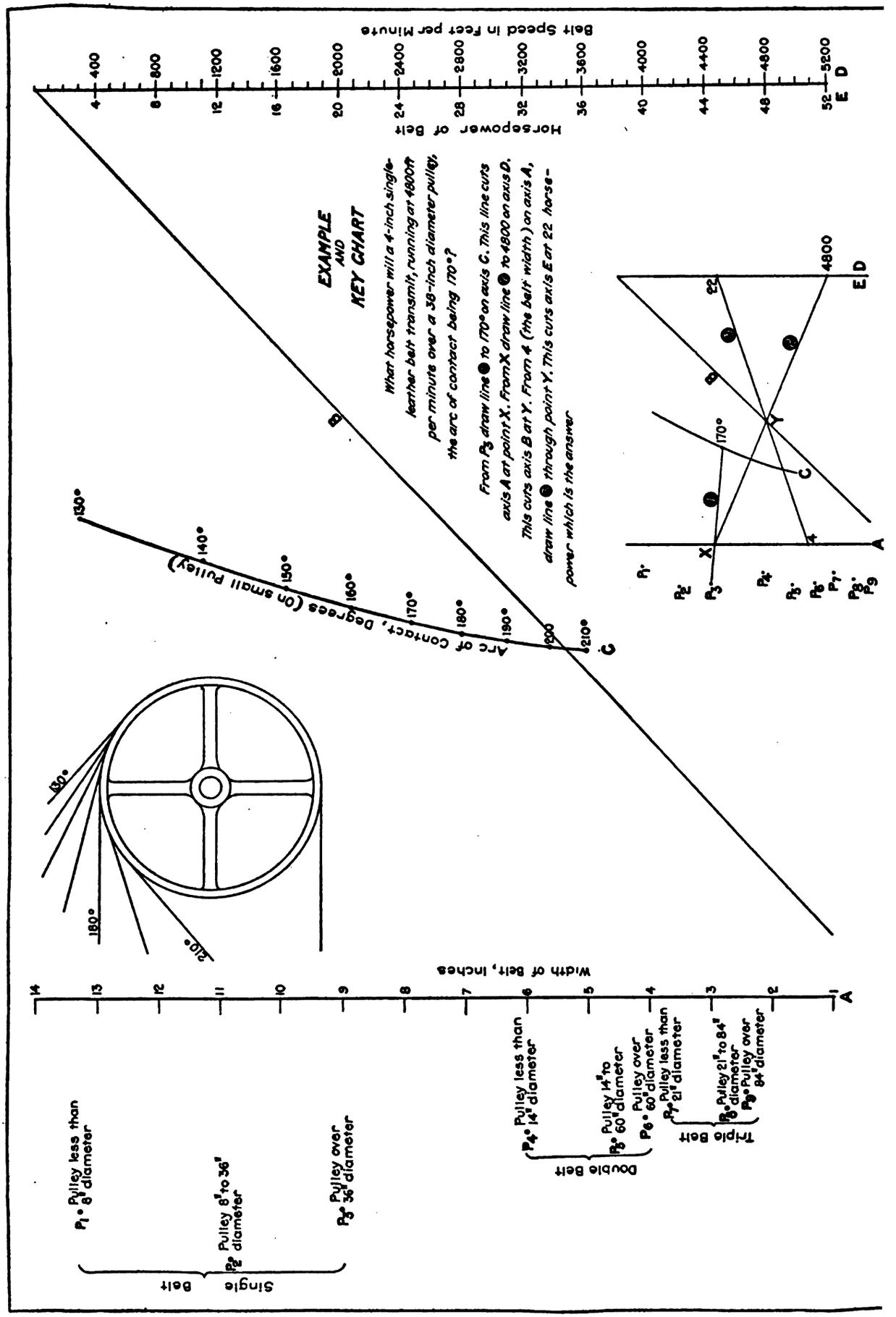
Single belts subjected to a test pull of 1500 lb. per sq.in. should show an elongation of not more than 15 per cent. Double belts subjected to the same test should not exceed an elongation of 13 per cent. It is not always possible for the small-shop owner to carry out these tests in order to check up the quality of his belting, but by making his specifications call for these conditions, he shows the belt manufacturer that he knows a good belt from a poor one, and incidentally places himself in a position to protect himself on belt purchases.

As mentioned on page 88, oak-tanned belts deliver a maximum efficiency when running between 3900 and 4800 ft. per min. There are limiting speeds for single, double and triple belts beyond which it is inadvisable to go, on account of centrifugal force, which tends to make the belt leave the surface of the pulley. For single belts this limit is 5000 ft. per min. For double belts it is 4600, and for triple belts 4400 ft. per min.

Relation of Pulley Diameter to Thickness of Belt

For a certain thickness of belt there is a pulley diameter under which you cannot go except at the sacrifice of belt service. The table gives the minimum pulley diameters for various thicknesses of belts, ranging from 5/16 to ¾ in. It will be noted that chrome-tanned belts, on account of their flexibility, may run on much smaller pulleys than oak tanned. This is a good thing to keep in mind when up against a drive where one of the pulleys is under the proper limit for oak-tanned belts.

Chrome-tanned belting due to its flexibility and strength has another advantage, which is that it can run to a maximum speed of 5800 ft. per min, without causing trouble. This and the flexibility which allows it to run about a small pulley make it an ideal belt for driving wood-working machinery.


Belt Speed in Feet per Minute
400
800
1200
1600
2000
2400
2800
3200
3600
4000
4400
4800
5200
Horsepower of Belt
4
8
12
16
20
24
28
32
36
40
44
48
52
E
D
EXAMPLE AND KEY CHART
What horsepower will a 4-inch single-leather belt transmit, running at 4800ft per minute over a 36-inch diameter pulley, the arc of contact being 170°?
From P8 draw line ❶ to 170° on axis C. This line cuts axis A at point X. From X draw line ❷ to 4800 on axis D. This cuts axis B at Y. From 4 (the belt width) on axis A, draw line ❸ through point Y. This cuts axis E at 22 horsepower which is the answer
Arc of Contact, Degrees (On small Pulley)
130°
140°
150°
160°
170°
180°
190°
200°
210°
C
B
A
X
Y
22
4
P1
P2
P3
P4
P5
P6
P7
P8
P9
Width of Belt, Inches
14
13
12
11
10
9
8
7
6
5
4
3
2
1
Single Belt
P1 • Pulley less than 8" diameter
P2 Pulley 8" to 36" diameter
P3 • Pulley over 36" diameter
Double Belt
P4 • Pulley less than 14" diameter
P5 • Pulley 14" to 60" diameter
P6 • Pulley over 60" diameter
Triple Belt
P7 • Pulley less than 21" diameter
P8 • Pulley 21" to 84" diameter
P9 • Pulley over 84" diameter

It is a good thing to keep in mind when arranging belt drives that the slack side of the belt, whenever possible, should be on top, as shown in Fig. 2. In this case there is a difference of 40 deg. in the wrap or contact of the belt with the driving pulley, which makes a difference of 15 per cent. in the driving power of the belt, which is simply due to having the sag on top. When belts are inclined at an angle the same principle holds good, but to a less degree. Arrange them when possible so as to increase the belt wrap on the smaller pulley.

SMALLEST DIAMETERS OF PULLEYS THAT SHOULD BE USED WITH BELTS OF GIVEN THICKNESS

		Thickness of Belt, In.	Smallest Pulley for Oak-Tanned Belt, In.	Smallest Pulley for Chrome-Tanned Belt, In.
Single belts	Light	3/16	7½	5½
		¼	10	7½
	Heavy	5/16	12½	9½
Double belts	Light	5/16	15	11¼
		½	20	15
	Heavy	5/8	25	18¾
Triple belts	Light	9/16	22½	17
	Heavy	¾	30	22½

Belt splices, so far as strength is concerned, range in the following order: Endless cemented; machine wired; belts laced with chrome leather; belts laced with calf-

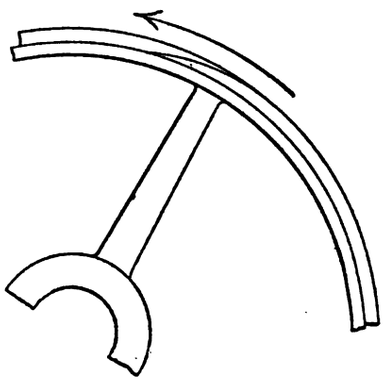


FIG. 3. THIS IS THE WAY BELT LAPS SHOULD RUN

skin rawhide. A cement joint is preferable where there are idlers to take up the belt slack, but is an item of considerable expense where belts are kept tight by shortening them from time to time. The machine-wired belt splice with rawhide pins makes a joint nearly equal to the strength of the belt itself and may be made so quickly that it reduces the expense of joints to a minimum. This is the ideal joint for overhead belts, which are not likely to be shifted by hand. Wherever belts are shifted by hand the matter of safety demands leather-laced joints unless the belt is made endless.

For endless belts the proper length of splices are as follows, depending on the width of belt: From 1 to 2 in. wide, 5 in.; 3 to 4 in. wide, 6 in.; 5 in. wide, 7 in.; 6 to 7 in. wide, 8 in.; 8 in. wide, 9 in. From 9 to 18 in. wide the splice is usually made the same as the belt width, and over 18 in. it remains constant at 18 in. long.

Some Practical Pointers on Belts

In putting belts on pulleys be sure that the belt-lap splices run in the direction shown in Fig. 3. If this is not done, the splices will have a tendency to open up, and the result will be trouble and expense, both of which commodities the small-shop man has plenty of as it is.

If you have a case where belt-lacing will not hold when made of calfskin rawhide, try some chrome-leather belt lace. This stuff will tether a bull elephant and will make a joint about 50 per cent. stronger than the ordinary rawhide lace. The following table shows the proper length of lace to use for a belt of given width:

Width of Belt, In.	Length of Lace, In.	Width of Belt, In.	Length of Lace, In.
1	10	3	25
1½	14	4	34
2	17	6	50

Short centers on belt drives are one of the most frequent cases of inefficiency. Fifteen feet between centers is a good average for small pulleys and narrow belts up to 4 in., when running with a sag on the slack side, ranging from 1½ to 2 in. For wide belts the ideal short center is not less than 25 ft. with a sag of 2 to 3½ in. In many shops these distances are out of the question, and then it will pay the small-shop owner to look into the subject of idler pulleys.

Remember that it is easier to keep a double belt flat on its pulleys than it is a wide single belt. In fact, when the width exceeds 4 in. it is best in all cases to use double belts. Thick, narrow belts are preferable in almost all cases to wide, thin ones of the same power. While on this subject it may not be amiss to give a simple rule for finding the length of belts. The best one that I know of for the small shop is this: Use a steel tape line!

The Cost of Home-Made Machinery

Every mechanic admires the ingenuity displayed in many shops in designing and building machines to meet their special requirements, and many useful machines have been developed from them. But we hardly realize how many machines are built in shops to do the work of standard machines, just because the management is too short-sighted to buy a machine already on the market.

The small shop, with scarcely capital enough to get along and pay necessary running expenses, is often justified in fudging up machines for its work. This is often done when work is slack and a few hours' time does not pull down the bank balance as much as a corresponding number of dollars.

But this practice of making machines to perform standard shop operations is all too prevalent in some shops which do not or should not have the excuse of not having sufficient capital. This is particularly true of railway shops, both the trunk lines and the street-railway systems in various cities. True the large railway shops are usually well equipped, but the smaller shops are too often denied necessary tools and have to tinker up substitutes from the scrap pile. These are fondly supposed to be cheap because they do not appear in a lump sum on the books, but the real cost is usually higher than if they had been bought in the open market.

To a smaller extent this holds true in the case of supplies such as milling cutters and drills. Unless there is time which would otherwise be wasted, it is seldom advisable to make any standard equipment or supplies which can be bought in the open market. The time when it was economical to make standard bolts, nuts and screws for regular work has long since passed and the list is being extended rather than reduced. If the railways would spend less money on rosewood desks in the offices and more in some of their smaller shops, it would be a step in the direction of real economy.

Maintenance of Small-Shop Belts

SYNOPSIS—Next in importance to the correct selection of a belt is its proper maintenance. The tension to which it is stretched is an item that has a great effect on driving power and on the total length of service that may be expected. Idler pulleys and the advantages to be had from their use are discussed and a number of practical points relating to the care of belts are given.

A man returned from the South recently and related a yarn which while it punctures the boundaries of truth in a few places is worth passing along. Hank Perkins, a New England mechanic, moved down to the Louisiana sugar country and started up a machine shop. This does not mean that he commenced operations in a new shop, for what Hank did was to start an old one going again that had been standing idle for a number of years. One of his first acts was to speed the main-line shaft up from its former rate of 75 revolutions a minute to something near 250 turns, which necessitated equipping it from one end to the other with new drive pulleys.

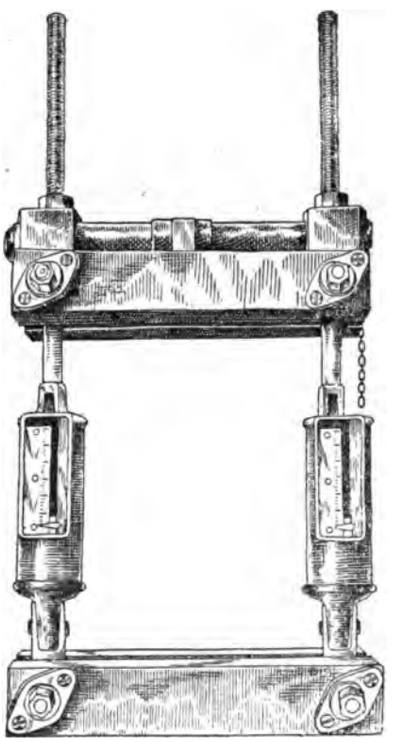


FIG. 1. TENSION SCALES

Hank found that sulphur was running pretty high in the neighboring foundries, and that the best pulleys he could get had their faces plentifully besprinkled with blow-holes. As long as a group of these did not go clean across the face of the pulley and cut it in two, he considered it policy as a stranger to say nothing and make the best of it.

Hank hired a husky, flat-footed, chocolate-visaged coon who applied for the job of engineer and millwright, and who said he had held down this combination when "Massa Brown" ran the shop. Great was Hank's surprise one day about noon to spy the dusky millwright pouring molasses out of a stone jug upon the overhead belts.

"Sambo," exclaimed Hank, "what are you putting that dog-gone stuff on the belts for?"

"Why, Massa Hanks, that's sure nuff de mos' pow'ful belt dressin' ever was. You wait 'til after dinnah, boss, and see foh yo'self."

At dinner time Hank saw about 10,000 flies light upon the belt in anticipation of a feast and end up by sticking fast to it. When the darky blew the whistle and started up the engine he saw the possibilities of molasses as a belt dressing, for the flies which stuck fast to the belt fitted into the blow-holes on the pulleys and made the belt pull like the dickens—sort of a chain-drive! There were plenty of flies available, plenty of molasses and plenty of blow-holes; so, with these three sources of supply, Hank saw that he would have no trouble with his belts.

Starting with the Belt at the Proper Tension

Most small-shop owners are not as fortunate as Hank was in having a simple remedy for belts which will not pull; for even belts which are properly selected for their work get lazy and stretch and lay down on the job. The great problem in the shop is to keep belts in an average

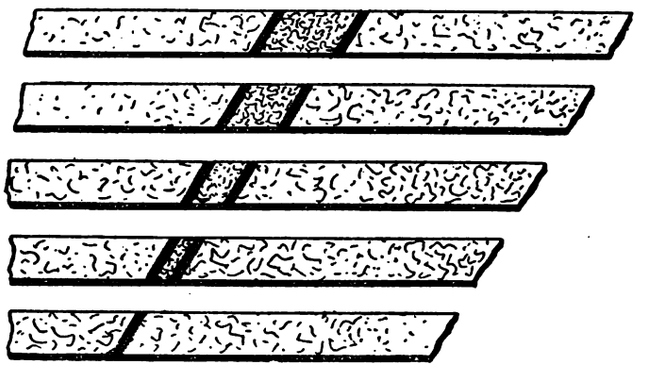


FIG. 2. STRETCHING A NEW BELT WITH TAKE-UP PIECES OF VARIOUS LENGTHS

condition of tightness which will make them deliver a maximum of pull divided by a minimum of trouble, and to accomplish this is worth some study and effort on the part of the shop owner.

There is as much harm done in getting a belt too tight as not tight enough, for this results in wear and tear on the countershaft and line shaft bearings and, what is even worse, wear and tear on the belts themselves. When you have too much tension there is also an unusual stretch, and before you know it the belt is literally "down and out."

It does not cost much to know what tension a belt is under when it is first put up. The device shown in Fig. 1 is a simple belt tension scales which can be built at odd times in any small shop, and will pave the way for belt economies to follow. The idea is to cut new belts short enough to start with, so that a tension is secured at which they will transmit the power calculated and not pull themselves to pieces. The belt clamp and tension scales

combination is brought into play, being tightened until the proper tension is reached, which is 60 lb. per in. width for a single oak-tanned leather belt, 105 lb. per in. width for a double belt, and 150 lb. per in. width for a triple belt.

In other words, if you had a double belt 4 in. wide you would set it so that the scales read 420 lb. tension, taking care first to slap the lower part of the belt to equalize the pull in both sides before weighing it. Some people increase these tensions 20 per cent. in a new belt to allow for first stretch. Having obtained the proper tension it is a simple matter to cut the belt off to length and make a joint. If it is a new belt, it would be waste of time to make a cemented joint, and in fact in such cases it is almost a waste of time to make a lace joint. The machine-wired joint which is held together by a rawhide pin is much better for overhead belts and is made in a few moments. Cut a new belt 6 in. short of the measured length as indicated on the belt scales and set in a 6-in. distance piece. If you have on hand a number of these pieces for each width and thickness of belt you can save a good deal of new belting by using these pieces instead of cutting off the leather as it stretches. The idea is clearly shown in Fig. 2.

Although belt tensions will not stay where you put them, because of stretch due to service and changes that come with fluctuations in humidity, if you start right and at regular intervals go over your belts and set them at the proper tension you will be doing something positive about it instead of trusting to luck and the dope pot. In this connection, where possible, head off the tendency to stretch by relieving the tension at night and throwing off the overhead belt when a machine is shut down for some days.

Substitutes for Proper Belt Tension

I may be doing belt dressings an injustice by calling them substitutes for proper tension. Some few of them, it is true, are rather an aid to the full use of proper tension than a substitute. The shop superintendent, however, sometimes looks upon the dope pot as a substitute for more intelligent work, and this may help to account for the alarmingly high belt mortality rates in some shops. The original steer would not recognize his own hide by smell, sight or feeling if his ghost should walk through a shop where it was whirling about overhead covered with compounds.

The real and effective substitute for belt scales in the large or small shop is the intelligent use of idler pulleys. When one of these, properly designed, is installed it not only insures a constantly maintained tension, but, if it is correctly located, will increase the wrap of the belt about both pulleys, which is a big help in itself. The *American Machinist,* Vol. 33, p. 1003, described a remarkable drive at the F. E. Reed plant, where a 5-in. and a 7-in. belt transmitted 136 hp. at 3100 ft. per min., averaging 11⅛ hp. per in. of width. Light double belting was used, and each drive had an idler so placed that the belts made nearly three-quarter full contact. This drive ran 11 years without a dollar for repairs. This speaks well for the use of idler pulleys, especially as the belts in question were much more heavily loaded than any which the small-shop owner will have if he selects them according to the chart on page 446. In locating idler pulleys place them on the slack side of the belt, about one-quarter ways from the driving pulley, to get the best results. Arrange them with a lever or direct weight, so that the tension is kept constant, and then forget that you have any overhead belts until the regular cleaning and dressing day comes around.

Cleaning and Dressing Belts

All belts should be cleaned and dressed every five or six months. If they are coated with caked dirt, a rag soaked in kerosene rubbed over them and followed with a scraper will take it off. If they are oil-soaked, leaving them in naphtha over night will bring the oil to the surface, after which they should be packed in sawdust and left for a week.

Here is a belt dressing which will not injure a belt. It is one which is used by belt manufacturers. It is made of two parts of beef tallow and one part of codliver oil, the

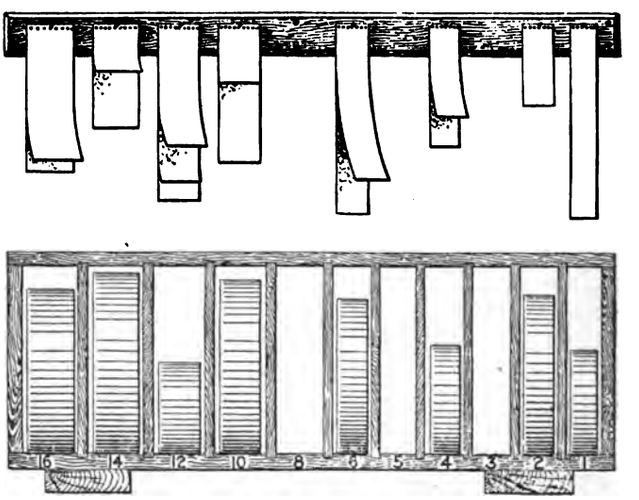


FIG. 3. STORAGE OF NEW BELTS AND OLD PIECES

proportions being by weight. The tallow is melted and allowed to cool until the finger can be inserted without burning it. (Let George try it first!) Then the codliver oil is added and stirred until the mixture is cooled, after which it is ready to apply in light coats to the driving side of clean belts.

While twice a year is enough to dress ordinary belts, there are some which require this more often. For example, belts which run in hot and dusty places become smooth and shiny and should be looked after every three of four months. Neat's-foot oil applied to the *outside* of such belts will help.

Belts should be allowed to wear out only in one way, and that is by transmitting power through their contact with the *faces* of pulleys. Unfortunately, many belts are ruined through rubbing against shift fingers and the side flanges of cone-stepped pulleys. This is in truth burning the candle at both ends, for not only is the belt ruined but power is wasted in doing it. The remedy is to provide plenty of room between shift fingers or to put rollers upon them, and in the case of cone-stepped pulleys to use a belt at least ⅜ in. narrower than the face of the pulley.

A method of storing rolls and odd lengths of belt, which combines neatness with convenience, is shown in

Fig. 3. The short lengths are hung on spikes directly over the bins which contain the rolls of new belting. It is just as easy to put the odd pieces here as it is to throw them into a box, and much more easy to get at the size piece that is wanted.

Checking Up the Cost of Maintenance

To keep belts in A1 condition will cost each year between 14 and 40 per cent. of the first cost of the belting. This will include labor, supplies and renewals. If it is costing you less than 14 per cent. at present, it is a safe bet that your belts are not being kept in A1 condition and that they will fail in much less time than belts which are so maintained. If the small-shop owner has $300 worth of belts in a shop, he must expect to spend at the very least $42 a year in looking after them; and in fact if he gets away with a maintenance cost of 25

BELT RECORD CARD

Location _____

Kind of Belt _____

Make _____

Date Installed _____ Date Removed _____

Length _____ Width _____ Thickness _____

Date		Cost	

FIG. 4. A SIMPLE RECORD FORM FOR THE MAINTENANCE OF SMALL-SHOP BELTS

per cent., or $75 for this quantity of belts, he is doing well, provided, of course, that he keeps them in A1 condition.

Some will argue that it is much cheaper at this rate to let a belt wear out as fast as possible. This might be true if the cost of the belt were the only matter concerned. The thing that costs you the most money when a belt goes to pieces or fails is not the leather or time required to fix it, but it is the time lost on the machine that is shut down. When belts are kept in proper condition, the stoppages per month should not average over 3 per cent. of the number of belts in use. In other words, if there are 100 belts in the shop, there should not be more than three cases per month where a machine is shut down on account of belt troubles.

There is probably not one small shop in forty that knows what its percentage cost of belt maintenance is. The exceptional ones are those who know how much the total belt expense amounts to. It is far better to have an individual record of the belt, for a total record of this kind is simply a matter of history.

Machines in the Repair Shop

It is a mistaken idea that any old machine tool, no matter what its vintage or how obsolete its type, will answer the purposes of the repair shop.

Today it seems quite as important that fairly uptodate tools be installed for repairing as for manufacturing, particularly where the repair shop is connected with a large plant having many parts to be replaced at frequent intervals. In a somewhat less degree, this is true where the parts to be replaced are in small quantities and of a varied character, but are, nevertheless, required in a hurry.

Most of us in thinking of the repair shop are apt to recall the old-time establishment equipped with slow, half-wornout lathes, planers, boring mills, and the like, where it took just about so many hours to put a job through—not because the workmen were unnecessarily slow, but because they were hampered by their equipment. Only too frequently are similar conditions encountered today.

Of course, in the smaller shops doing repairs, especially in out-of-the-way localities where work comes along rather irregularly and it is often a difficult matter to keep the force of men and the equipment fairly busy under the conditions prevailing even in reasonably good times, there is a logical reason for using many tools that have seen better days in manufacturing service. Such repair shops and numerous small shops of other kinds form a natural outlet for the large numbers of tools which are sold from the equipment of manufacturers who are constantly replacing certain of their tools, even when in good condition, with later and more effective ones. These tools, now "second hand," find a ready market, and without them it would sometimes be next to impossible for the smaller shops to get underway.

But along with these really effective tools there is a tendency in many places to hang onto equipment that has long since outlived any particular degree of usefulness.

Railroad shops present an illustration of a class of establishment doing repairs where modern tools should be of prime importance in getting out work quickly. These shops often put through fairly large lots of parts and while in many cases the equipment for such work is far from what it should be to be most effective, in other instances it is interesting to note that tools are kept uptodate and whether the work coming to a machine is a single pair of boxes or a lot of fifty or more, the job can be put through with dispatch.

✣

Straightening Cast Iron

By Samuel Applin

Gray-iron castings often come from the foundry so warped as to render them unfit for use. Such castings may be straightened by the following method:

Arrange a pair of strips on a heavy iron plate and have at hand a C-clamp large enough to span the plate, castings and strips. Heat the casting at the point to be straightened to a red heat, lay it across the strips and span the whole with the C-clamp. Then bring the screw down very slowly until the required results are obtained or the red color has left the iron. To bend the casting reheat it and repeat the squeezing.

Sparks from Small-Shop Motors

SYNOPSIS—There are widely differing views on the subject of motor drive in the small shop. Some hold that the complete abolition of overhead shafting is desirable; and others, that the small-shop owner has enough mechanical troubles without adding electrical ones. The various viewpoints are here presented with the purpose of throwing light on a desirable average plan to be discussed in the succeeding article.

In approaching Bill Nevins' shop I was much surprised to hear the irregular Bang!—bang!—chug—chug—chug of his old gas engine. On my last visit the previous year he had declared the intention of consigning his noisy and somewhat odoriferous power plant to the scrap heap and of fitting out the shop with electric motors. Evidently something had made him change his mind and I determined to find out what it was, for Bill's opinions and reasons are always worth hearing. He is a canny old codger and has made his ten-man shop pile him up a very respectable bank account, although he publicly expresses the conviction that it is easier for barnyard fowl to scratch up gold nuggets than for small-shop owners to make money.

Bill invited me into his office, put the cigar I handed him into his pocket and pulled out a well stained corncob. He filled this with cigar clippings from a paper package, and deposited a generous wad of the clippings in a remote recess of his capacious mouth. A lighted match, and a few strong puffs completed the process of "winding up" that always preceded one of Bill's conversations.

Sam Hodges of the Enterprise Shop

"Yep, the old engine is still there," said he between puffs, "an' what's more, I calc'late that's where she'll stay for some time. Some fellers won't use anythin' that's second-hand but when it comes to *experience,* I always figger that this policy costs 'em money.

"Take Sam Hodges, who owns the Enterprise Shop up the street; he's one of them kind of fellers. If it wasn't for Sam, an' the second-hand experience that I've got off of him right along, I'd have been a bankrupt long ago. Sam kin afford to pay for brand new experience because he married rich, whereas a feller like me has to put up with somebody else's cast off goods in this line, so to speak.

"'Bout the time you was 'round here last year, there was a dern smart chap from the power house up to Nashua, had me nearly talked into scrappin' my engine an' puttin' in 'lectricity. If it hadn't of been that Sam Hodges walked past the window jest as the agent shoved a contract under my nose and said, 'Sign here,' I swan to Pete I'd have tied myself up for a big order of brand new experience. That little glimpse of Sam walkin' past sort of fetched me out of my trance an' back to earth so to speak. 'Hold on,' I says to the drummer, 'I've changed my mind. But come back this afternoon an' we'll go see a feller that I know.'

"He started in on Sam same as he had on me—told him that the reason he'd just missed bankruptcy last year an' was headin' plumb for it now was because he didn't have motor drive; all the big up-to-date plants had it, an' if the little ones didn't get in line pretty quick they'd be left as far behind as the Noah Boat Co. left the rest of the trade in the days of the big rain!

"He showed him seventeen different ways that 'lectricity would cut costs an' painted such a pitcher of the new and enlarged Enterprise Works that Sam made a note to try and get an option on the next-door lot.

"Sam cert'nly was ignorant on 'lectricity an' motors. Why, when the agent began to tell 'bout the big power house an' how they turned out 60 cycles a second, Sam busted in on him. 'Hold on, stranger,' says he, 'do I onderstand you to say 60 cycles a second?' 'You sure do,' says the drummer. 'For the love of Mike,' says Sam, 'Old Hank Ford ain't a patch on your fellers. Why the best he can do is two Fords a minute!'

"Well, the upshot of it was that the agent talked Sam into throwin' out his steam engine an' into puttin' a separate motor on most every blame tool he had in the shop, 'cept the bench vises and such like odds an' ends that he couldn't scheme no way to hitch a motor to.

Current That Had to Be Tamed

"Seems that the ord'nary current that the power company furnished wasn't refined an' religious enough for Sam's consumpshun—needed to be transformed an' converted, or words to that effect, which meant a right smart bit of machinery in the enjine room at the start-off—convertors or motor-generators I think they call 'em. Sam had an idee that all you did was to slap a motor onto a machine an' run a wire to it an' call it square, 'stead of which he had to have fuses an' circle-breakers an' rheostats an' comptrollers fer every blamed one no matter if it wasn't no bigger than a musk melon. On top of this there was a marble tombstone in the enjine room covered with switches an' lightnin' arresters an' voltmeters an' ammeters and wattmeters, an' all manner of fancy ornimints.

"Fust complaint I heard out of Sam concerned the ammeter. He said the dern thing was no good an' couldn't be relied on because the pesky needle kept flopping back an' forth, an' didn't regulate worth a cuss. Said he'd tried tyin' the needle fast so it couldn't flop, but that it didn't seem to make no difference in the flickerin' of the lights.

"From that time on I got consignments of second hand 'lectrical experience pretty regular.

One Hundred and Fourteen Kinds of Trouble

"I learnt that motor drive ain't as simple as it looks to be when you see a pitcher of it, 'specially when the current is of the heathenish variety and has to be converted before it's fit to associate with respectable motors. Take a gas engine an' there's only half a dozen things at most that can ail it, whereas Sam showed me a book that tells of 65 different things that can be the matter with direct-current motors, and 49 kinds of diseases that alternating-current motors are liable to, not to mention all the things that can happen to transformers and the convertors and switchboards and all of them contraptions.

"Sam tried to get along without a 'lectrician at first, but got burnt a couple of times after which he wouldn't touch a wire or a motor if you gave him a gold watch. I could see it worried him right smart to have the feller 'round, for he couldn't tell whether he was workin' or soldierin' or getting out gov'nment contracts. When Sam'd ask him what he was doin' he'd tell him he was makin' a bridge for the air gap, or alterin' a phase relation or some such talk that would leave Sam just as wise as he was before.

"One of the things the agent told Sam was that the use of motors would give him more head room. I reckon this didn't help him much, for his head was 'bout as big as it could be long before he bought the motors. Said that Sam would have plenty of room to run a traveler over his machines, but forgot to mention that the shop walls would cave in if anybody hung the weight of a crane onto 'em. Sam had better ferget the crane anyway, long as the heaviest piece he's got to hist is under thirty pound. He's better off to stick to the two-legged dutch crane that's doin' the liftin' now!

A Much-Needed Electrical Invention

"The agent told Sam that he'd get more work out of his machines because with all of them different motor speeds the fellers could come nearer to hittin' the right one, but Sam says it works out just the opposite—gives 'em that many more opportunities to run too slow. He says that if them smart Alecks who figure the comptrollers would work up a riggin' that you could hitch onto the feller that runs a machine so that he'd get a 'lectric shock if he didn't run up to speed, that they *would* be doin' somethin'. I calculate myself that a good stiff piece price'll come nearer to doin' it than anythin' in the 'lectrical line that's on the market today.

"I got a good chunk of second-hand experience when it comes to fittin' up machines with motors. The 'lectrical expert had some job with the tools over at Sam's before he got 'em hitched up right. He laid out a draft of the connections so as to be sure to get 'em elaborate enough, an' when the stuff arrived he started to tear down the shop an' everythin' within it and build 'em up different again. By the time he finished I reckon it would have been cheaper to have scrapped all of them machines and bought new ones with motors already on 'em.

"I can't see where Sam gets anythin' out of his motor drive 'cept trouble. Where it used to cost him $8.50 a week for gasoline an' nothin' for runnin' the enjine, he has to pay $8.25 for current and $22 a week for the 'lectrician. As fer gettin' more work out, he couldn't get no more out than what comes in anyway.

"No, sir, I'm going to keep right on operatin' my gas enjine, an' gettin' second-hand 'lectrical experience. Some day you may see a motor in this shop, but there'll only be one of them an' it'll have to be of the proper religion to take the current that comes to it without transformin' or convertin'."

I Find a Motor Enthusiast

Before leaving Bill Nevins' town, I stopped at two more small machine shops. The first was one that specialized in screw machine work. Here I found six automatic machines, each provided with its own variable-speed motor.

"Nothing but motor drive for me!" exclaimed the owner, who was an enthusiast. "By having a speed control on these machines I can knock out 20 per cent. more output. Previously, I could get two speeds only, unless I took the trouble to change the driving pulleys to suit the job. Half of the time I was running from 30 to 50 per cent. too slow, which meant a loss of profits; and the other half of the time over speed, which meant frequent shutdowns to sharpen and replace tools. Now I can hit a proper gait no matter what size of stock is being worked.

"At first I hesitated to put in motors," he continued, "because I knew so little about them. But I have always made it a point to understand everything connected with my business, and realizing that a machine-shop man must understand the uses of motors I determined to get posted. Books, periodicals and talks with those who knew did the rest. I can look after my equipment and make minor repairs. The more difficult repair work, which is not frequent, goes to people who are fitted to take care of it with the least trouble."

A Compromise Between Belts and Motors

In the second shop, I found a happy compromise between belts and motors. The shopowner had evidently found the secret of making them dwell together in peace and coöperation. Machines which were difficult to drive with belts were driven by motors. Among these I noticed grinding and polishing wheels, speed lathes and a buzz planer.

Each of these machines had its own direct-connected constant-speed motor and the absence of highly speeded, violently slapping belts was pleasantly noticeable. There was also in this shop a policy of saving power where possible, for one or two bulky tools that were used but part of the time were provided with individual motors driving direct on their countershafts. All of the motors were of the constant-speed type and used alternating current just as it came to the shop, making the electrical equipment very simple.

Three Different Points of View

Now here are three widely different points of view. One small shop owner "calculates he'll stick to his gas engine." Another swears by a variable speed motor for each machine. Still another favors a compromise between motors and belts, with the restriction of the motors to the constant-speed type.

Which is right? It depends on circumstances. Perhaps they all are!

✦

Detecting Impure Platinum—In the steel laboratories, as well as in others, unsatisfactory results have often been experienced on account of impure platinum crucibles. In order to remove the existing uncertainty in detecting fairly accurately the amount of such impurity the Bureau of Standards recently took up experimental study of the problem, with the result that it has developed a sensitive thermo-electric test for platinum purity which permits a rapid estimate to be made of the amount of included foreign matter such as iridium or iron, without affecting the articles tested, such as crucibles, wire gauze, dishes, etc. This thermo-electric test is being adopted generally by large buyers of platinum ware. From the results of the investigations it is now possible to predict very closely what will be the loss in weight of a "platinum" crucible when heated, thus eliminating a serious uncertainty. Ordinary grades of platinum are found to lose from 0.7 to 2.7 milligrams per hour per 100 sq. cm. of surface at 1,200 deg. C. Curiously enough the small amounts of iron always present in platinum are found to bear no simple relation to the magnetic properties. The Bureau of Standards devotes Scientific Paper No. 254 to a discussion of the subject.

Motor Drive in the Small Shop

SYNOPSIS—This article takes up the arguments in favor of individual-motor drive, and analyzes them with respect to small-shop conditions. The simplicity of constant-speed induction motors is compared with the complexity of direct-current variable-speed motors, suitable applications for each type being pointed out.

Those who look carefuly into the subject of individual-motor drive before they install it are not the ones who afterward voice complaints. Some definite lines may be laid down which will give the small-shop man the benefit of "second-hand experience" in this matter. While not attempting to go into the technical ins-and-outs concerning motor applications, I will try to indicate some viewpoints which may be of help to one who is considering the question from the small-shop angle.

In considering the purchase of new equipment one point must be clearly established before the investment can properly be made. It must be clear that the equipment is going to do some good. The large shop can afford to purchase equipment on the basis of a proposed return which the small shop could not consider. It can very properly make purchases that do not hold out the prospect of any momentary profit, just as the rich man may spend money in a manner that would be financial suicide for one in less affluent circumstances. The small-shop owner must see good evidence of a direct and sure financial return. He buys a tool because it will help him to make money, not in order to have his shop called an uptodate one. Equipment that is worth considering must show that it will help to get out more of the product, or that it will reduce its cost, or improve its quality and thus raise its value.

Indirect Benefits Sometimes Overlooked

Sometimes the benefit comes indirectly, and many shop owners make a mistake in overlooking these indirect advantages. You, Mr. Small-Shop Man, have a certain amount of energy in your makeup. This is the force that gets behind your little red wagon, so to speak, and pushes it up over the hill of prosperity. You cannot stop to pick daisies along the roadside and expect to reach the summit before the night comes. Too many side issues will detract from the sum-total of your money-making capacity. Whatever will help you to conserve your energy so that you can apply it to your real product is worth considering as a help.

The shop that consumes less than 50 hp. has no business maintaining and running a power plant. If you are within reach of central-station service, you can buy power in small quantities more cheaply than you can make it. If you figure that you can turn it out for less, your figures are wrong and you have left something out of your costs. The question of individual motors is a debatable one; but there is no doubt at all about the advantages of replacing your gas engine or steam engine by a large motor, not only because of the reduced expense an added convenience, but because you relieve yourself of a certain burden of care and attention, and can put this released energy into making goods that bring in money.

Splitting the Big Motor Into Little Ones

Please observe that I said a motor. When it comes to splitting the one motor up into several and sprinkling these promiscuously around the shop, that is another matter.

If your shop is small it will not stand the added expense of an electrician. This means that the electrical equipment which you buy must be extremely simple, or else you must become a fair electrician yourself. Make it a rule not to have anything in your shop that you do not understand—either in the line of motors, machines, or men.

A constant-speed, "squirrel-cage" type induction motor is a very simple machine, and it is of the accommodating kind which will run on the current delivered by most of the central power stations without the use of auxiliary converting apparatus. It has no brushes or commutator, and the care of such a motor limits itself to keeping oil in the bearings and cleaning them out occasionally. There are no sparks to contend with, and unless one attempts to start such a motor under heavy load, no electrical troubles are to be expected. A man does not need to know whether a volt is round or square in order to live on good terms with such a motor!

Motors of this simple type run only at constant speeds. Those practicable for small-shop use that allow various speeds to be obtained run on direct current. The alternating current furnished by most central stations may be changed into direct current, but it means additional apparatus in the way of converters or motor-generator sets. The brushes and commutator of the direct-current motor require attention. The use of variable-speed motors leads away from simplicity and toward the need of electrical knowledge. The advantages to be gained in the small shop through the use of these motors must be balanced against the time and attention required from the shop owner to make himself competent to handle this equipment.

Advantages of Individual Motors Analyzed

Now that we have distinguished between the simple and the more complicated types of motors, possibly the best way to find out whether it is desirable to put either of them in the small shop will be to take the arguments urged in favor of individual-motor drive and look at them one by one, with the sharp eye of a small-shop man.

Crocker & Arendt, in their book "Electric Motors," state the advantages of the use of motors to be as follows: (1) Saves power; (2) permits of large prime movers; (3) shop buildings may be made lighter in construction and cheaper; (4) the cost of equipment is not much, if any, greater than that of belting and shafting; (5) permits of flexible arrangement of machinery; (6) gives clear headroom; (7) promotes cleanliness; (8) is beneficial to health; (9) enables power to be easily supplied to detached buildings; (10) permits great freedom for growth of the shop; (11) reduces the extent of shutdowns; (12) gives

better and more flexible speed control; (13) is conducive to increased output; (14) overtime work may be carried on economically; (15) noise due to line shafts and belts is done away with.

The small-shop man is never at a loss to transmit all of the power generated by his engine through one belt; his problem is rather to make a 20-hp. engine deliver 50 hp. on occasions. As a rule also he is a pretty healthy specimen, able to stand shop dirt and shop noise. So with the foregoing as justification I will lay aside arguments 2, 7, 8 and 15 as not having very much bearing on a small-shop decision.

Individual-motor drive allows of cheaper building construction, it is true, since the overhead shafting and its supports are dispensed with. Where new tools are bought fitted with motors, the cost of the equipment is not likely to be more than that of the line shaft and belting necessary to drive the same tools without motors. While these arguments are of interest to a man building a *new* shop and buying *new* tools, they do not affect the case of the small-shop man who is figuring on rigging up with motors the present tool equipment of his existing shop building. So I will lay aside arguments 3 and 4 as reserved for close consideration by the builder of a new shop, but not affecting the ordinary small-shop motor problem. And for the same reason, inasmuch as they deal with new constructions and conditions, arguments 9 and 10 can be put on the same shelf.

Power Saved Not a Large Item

The small-shop man who installs one large motor to replace his gas or steam engine is certainly going to save money on the cost of power. But if he goes a step farther and puts individual motors on the various tools, will he save still more? Small motors are less efficient than big ones, and while they do away with the power-loss in line-shaft friction, it is a toss-up whether they save anything over the one big motor after all. Giving them the benefit of the doubt, and assuming that they save the equivalent of all overhead loss, which may amount to 40 per cent. of the total power in a shop where a 30-hp. motor fills the bill, this saving will be at the most 12 hp., which in itself would not be inducement enough to make the change.

Clear headroom is a strong argument when crane service to machines is necessary. It is not often a compelling reason in the small shop, but must be considered with the stronger arguments which remain—flexibility of machine arrangement, reliability, speed control, increased output, and overtime work.

One of the fundamenal laws of nature is that things when once started have a tendency to keep on traveling in a straight line. Possibly this is the reason why one has such a hard job making a line shaft turn around corners. The electric wire seems to be privileged with respect to this law, however, and will turn a corner as easily as it will run straight. Here is one of the big advantages of individual motor drive. Machines do not require to be grouped to suit a shop center line represented by the line shaft, but may be placed to suit the work in hand and the room or space available. A light machine having its individual motor may be moved about very easily to suit changing conditions without the nuisance of taking down and putting up cumbersome countershafts. But while flexibility of arrangement is a strong argument and gives the tool equipment a mobility that is of advantage, by itself it would hardly influence a small-shop owner to adopt individual drive.

Testing the Argument of Reliability

Whether the advantage of reliability is an argument in favor of individual motors depends on conditions that exist in the shop. Where there are few if any shutdowns caused by defects in the present power plant, this argument would count for little. It is something that can be calculated pretty closely in dollars and cents by estimating the total amount that has been lost for the past year from this cause. More than this amount individual motors would not have saved on this item.

Speed control and increased output are given as separate arguments, but should in reality go together, as one is the cause and the other the effect. Together they form the strongest of all the inducements held out to the small-shop man to adopt individual-motor drive. Yet the force of this double argument depends absolutely upon shop conditions. In the general repair shop it would have very little weight indeed, for the majority of machines in such a plant do not run up to their capacity, nor would very much be gained by having greater speed flexibility. But when we get to the shop which specializes or which goes into manufacturing work, these arguments make us sit up and take notice, especially on the classes of machine work where the cutting itself forms a considerable portion of the total operation. Thus, on automatic screw-machine work the output of a battery of machines may be increased from 15 to 25 per cent. by the addition of individual motors which will allow each cutting operation to take place at its proper speed.

Discourage Instead of Encourage Overtime

Sometimes I believe that the arguments which have to do with overtime work being made easy by individual motor drive should be censored for the reason that overtime work itself comes under a general ban. Why should we make it easier to transgress this economic law? Overtime is good neither for the man who does the work nor for his employer nor for the work itself; and when it is frequently necessary one should take steps to make it unnecessary rather than to make it easy.

Summing up on the subject of motors in the small shop, there are few small shops in which it will not pay to drive a line shaft by a motor in preference to any other form of motive power. There are few small shops in which conditions are such as to make the adoption of complete individual-motor drive a warrantable expense. In between these two limits are a large number of small shops in which compromises may profitably be effected. What these are will depend entirely on conditions and the decision will be helped by keeping in mind the considerations here outlined.

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Work of a Cartridge—It is pointed out that the cartridge used in the German infantry rifle, marked M 98, contains 3.2 grams, or about 0.112 oz. avoirdupois, of powder, which on explosion creates 2762 calories, or 10,960 B.t.u., corresponding to 1,170 kg.-m., or 8,463 ft.-lb. Of this one-third is utilized in creating the initial velocity of the bullet of 820 m., or about 2,690 ft. per second, and in imparting the rotative motion. One-quarter of the energy is lost in heat to the barrel and 45 per cent. passes away in sound energy and the escaping gases. The bullet passes out of the barrel in $\frac{1}{200}$ of a second, and during this time a pressure of 5,600 atmospheres, or 51,450 lb. per square inch is acting within the barrel.

Sizes of Motors for Machine Tools

The small-shop man will be interested in the following table of sizes of motors for machine tools which has been compiled to supplement the articles on "Motor Drive in the Small Shop" which appear on pages 98 and 100.

Vertical Boring Mills—24- to 30-in., 5-hp.; 36- to 42-in., 7½-hp.; 60- to 90-in., 10-hp.; 100-in., 15-hp.

Light Duty Engine Lathes—14-in. swing, 2-hp.; 16- to 20-in., 3-hp.; 22- to 24-in., 5 hp.; 27- to 48-in., 7½-hp.

Medium Duty Engine Lathes—14-in., 3-hp.; 16- to 20-in., 5-hp.; 22- to 24-in., 7½-hp.; 27- to 48-in., 10-hp.

Heavy Duty Engine Lathes—14- to 16-in., 5-hp.; 18- to 20-in., 7½-hp.; 22- to 24-in., 10-hp.; 27- to 30-in., 15-hp.; 36- to 48-in., 20-hp.

Radial Drilling Machines—4-ft., 3-hp.; 5- and 6-ft., 5-hp.; 10-ft., 7½-hp.

Vertical Drilling Machines—Sensitive drill, ¼-hp.; 15-in. swing, ½-hp.; 20- to 26-in., 1-hp.; 28- to 34-in., 2-hp.; 42- to 50-in., 3-hp.

Planers—24x24, 5-hp.; 30x30, 7½-hp.; 36x36, 10-hp.; 48x48 and 56x56, 15-hp.

Shapers—14- to 20-in., 3-hp.; 24-in., 5-hp.; 36-in., 7½-hp.

Horizontal Millers, Plain or Universal—24x8x18-feeds, 3-hp.; 30x10x18, 5- to 7½-hp.; 36x12x20, 7½- to 10-hp.; 50x12x20, 10- to 15-hp.

Vertical Millers—28-in. diam. table, 5-hp.; 32-in., 7½-hp.; 40-in., 10-hp.; 54-in., 15-hp.; 70-in., 20-hp.

Horizontal Boring Machines—3½-in. spindle diam., 3-hp.; 4-in. spindle diam., 5-hp.; 5-in., 7½-hp.; 6-in., 10-hp.

Crank Slotter, Light Duty—10-in., 3-hp.; 16-in., 5-hp.; 20-in., 7½-hp.; 30-in., 15-hp.

Crank Slotter, Medium Duty—10-in., 5-hp.; 16-in., 7½-hp.; 20-in., 10-hp.

Cold Saws—12- to 15-in. diam., 2-hp.; 18- to 20-in., 3 hp.; 24-in., 5-hp.; 32-in., 7½-hp.; 36-in., 10-hp.

Grinders, Plain Cylindrical, Medium Duty—10x50 to 10x120-in., 5-hp.; 14x72 to 18x168, 10-hp.

Grinders, Plain Cylindrical, Heavy Duty—10x50 to 10x120-in., 7½-hp.; 18x120 to 18x168, 15-hp.

Universal Millers—No. 1, 1- to 2-hp.; No. 2, 3 to 5-hp.; No. 3, 5- to 7½-hp.; No. 4, 7½- to 10-hp.; No. 5, 10- to 15-hp.

Single Bolt Cutters—1- to 1½-in., 1- to 2-hp.; 1¾- to 2-in., 2- to 3-hp.; 2¼ to 3½ in., 3- to 5-hp.

Double Spindle Bolt Cutters—1- to 1½-in., 2- to 3-hp.; 2- to 2½-in., 3- to 5-hp.

Punches and Shears—⅜-in. hole in ¼-in. plate, 1-hp.; ½x½, 2- to 3-hp.; ⅝x⅝, 2- to 3-hp.; ¾x¾, 3- to 5-hp.; ⅞x¾, 5-hp.; 1x½, 5-hp.

Squaring Shears for ⅛-In. Plate—42-in., 3-hp.; 60-in., 4-hp.; 96-in., 5-hp.

Squaring Shears for ¼-In. Plate—42-in., 5-hp.; 60-in., 7½-hp.; 96-in., 10-hp.

Hydraulic Wheel Press—100-tons, 5-hp.; 200-tons, 7½-hp.; 300-tons, 7½-hp.

Gear Cutters—36x9, 2- to 3-hp.; 48x10, 3- to 5-hp.; 60x12, 5- to 7½-hp.

Emery Wheels—6-in., ½- to 1-hp.; 10-in., 2-hp.; 12-in., 3-hp.; 18-in., 5- to 7½-hp.

Keyseaters—6-in. stroke, 3-hp.; 8-in., 3- to 5-hp.; 10- to 12-in., 5-hp.; 14- to 16-in., 5- to 7½-hp.; 18-in., 7½- to 10-hp.

Pipe Threading Machines—¼- to 2-in., 2-hp.; ½- to 3-in., 3-hp.; 1- to 4-in., 3-hp.; 1¼- to 6-in., 3- to 5-hp.

Buffing Wheels—6-in., ¼- to ½-hp.; 10-in., 1- to 2-hp.; 12-in., 2- to 3-hp.; 14-in., 3- to 5-hp.

Wet Tool Grinder—2- to 3-hp.

Twist Drill Grinder—1½- to 2-hp.

The data have been drawn from a number of sources representing the latest practice.

Munitions in the Small Shop

SYNOPSIS—The European nations in search of war material place their orders with large and well-known shops. These, in turn, are forced to sublet certain portions of their work to smaller shops. The machine shop employing 20 men or less, while it has not entered very widely into these activities, is interested in the subject of munition making. There are many such shops in the United States, and their combined capacity could not be overlooked in case of necessity. In this article the relation of the small machine shop to munition making is considered.

"This talk about war orders and big profits gets my goat!" exclaimed Jerry Finlay, of the Roxbury machine shop. "To read the newspapers you would think that all the kings, dukes and other noncombatants of Europe were hurrying over to this country with satchels crammed full of orders. You would think that if a man had a shop and machines and machinists to run them, all that he had to do was to put out his hand and take in a gilt-edged contract. Why, there are 25 small shops in this town, each one of them able and willing to handle a war order, and the closest they can get to it is the anteroom of some broker's office!"

Big Orders Go to the Big Shops

Friend Jerry was not quite right in his statement, although it was true about the shops in Roxbury; for there are small shops that are working on munition contracts. The small shop, however, is naturally the last to feel business of this kind, which starts with the big plants capable of turning out great quantities of material. Those that have munition orders to place are dealing with large concerns only, for they have not the time, nor can they take the trouble, to hunt out the smaller plants. They must leave this to those that take the original contracts, who may in turn sublet certain parts of their work to small shops in the neighborhood.

A cardinal principle in manufacturing for profit is to make the largest possible percentage of the purchase price find its way into the welcoming recesses of the strong-box. The canny firms that have made direct contracts are practicing this policy to the letter, and this, no doubt, is why newspaper reports of the amount of money to be made in munition manufacturing are sadly at variance with the balance sheets of some that take subcontracts.

Inflated Reports of War Profits

Another reason why the small munition-making shop is likely to fall short of its anticipated margin is because it tries to do something for which it is not fitted. Take for illustration a small shop that has a dozen lathes and that takes a subcontract for turning shrapnel cases. It must go through the same motions to do this work as a shop ten times as large; in other words, it must maintain similar kinds of indirect expense, such as shop inspectors and the like. Jigs and fixtures must be made, and while the first one in the small shop may cost no more than the first one in the large shop, the latter, using so many of these of a similar kind, is able to manufacture them, whereas the small shop must build one or two at a time. The expense of cartage and shipping is relatively greater, and altogether, the percentage of expense in the small shop that tackles a job of this kind is much higher, to say nothing of its labor costs.

Getting Out of Their Field

It was pointed out in the first article of the small-shop series that the field of the little shop is distinct from that of the big one. The small shop that attempts to do what the large shop can do better is certain to find that it will come out of the deal with less profit than the big shop, if it makes any at all. The immense-production war orders and even the subcontracts are most suitable for the large shops—that is as far as the actual production of the munitions themselves is concerned.

There is much profitable work, however, that goes hand in hand with the large orders, some of which may be done to advantage by a small shop. I was in a knife shop recently whose owners are experts on the handling of high-speed steel. They are making a nice profit and developing a new field in furnishing high-speed boring cutters for shell work, all hardened, ground and ready to use. This kind of work is something that this shop can do much better than nine large ones in ten, and the orders that they have received for these goods are proof that large shops appreciate this fact.

Going After a Subcontract

Another reason why some subcontracts have not been found profitable is because of the great variation in prices at which they are let. These prices range, so to speak, from the ridiculous to the sublime. There is a reason for this, and I will let Tom Peterson tell the story. Tom has a pretty good-sized shop; in fact, it can hardly be classed as a small one, for he works 50 men and has in his shop some 30 lathes. His experience, however, will serve to illustrate what the man that goes after a subcontract on this line of work is up against.

"Work was pretty slack in my shop the first part of this year," said Tom, "and I read so much about these shrapnel orders that I thought I'd go after one myself. I knew that it wouldn't be any use to try for an order direct, because the big fellows won't look at a man unless he has a shop capable of producing several million shells a year. But I knew that the Blank Machine Shops down the state had taken a big order and were subletting the machine work on 3-in. shells, so I went down to see their manager.

A Human Interrogation Point

"When it came to asking questions that fellow was the limit. I had to prove to him that I wasn't a speculator or promoter and that I had a shop of my own, and even then the questions that he fired at me would fill a good-sized book. After I told him how many machines I had and the class of work that I had been doing and proved

to him that I had worked to limits a good deal closer than were required in this case, I thought it about time to ask a couple of questions myself. 'Say, Mr. Brown,' I interrupted, 'I think I have proved to you that I am able to deliver 10,000 of these cases a month. Now I want to know what there is in it for me; in other words, at what price are you subletting them.' Say, the way that fellow acted, you'd have thought that I had insulted him. 'Price!' he exclaimed, 'we're not making any prices on subcontracts. You fellows are doing that. Give me a figure on what you will do them for, and I'll tell you pretty quick whether you get the contract or not.'

Blind Bidding for New Business

"I told him I would have to figure on it a bit and went home. The more I figured on the job, the madder I got. Here were these chaps, who were assured of their contract price, trying to get the little fellows to fight each other for subcontracts on a competitive basis. None of these little fellows had done this kind of work before or knew what they were up against, and some of them did not know how to estimate the cost properly.

"I made up my mind that I was not going to be one of the fellows to 'hold the bag,' so after I had figured a liberal cost and a good fat profit, I added 25% for good luck and submitted my figures. I did not get the contract, but as work in the regular line had picked up in good shape, I am quite pleased that I didn't."

It is quite a job to figure the proper percentage of overhead on a subcontract of this kind. First, there is an investment in tools, jigs and fixtures that will never be of use for anything else. The first cost of these must be absorbed by the business in sight. Then in the matter of machine-tool depreciation there is a point that often gets by the unsuspecting shop owner. When a man takes a contract of this kind it means jump in and dig. He gives his men prices that make them shove the machines for all they are worth. The ordinary machine tool put on shell work gets old while it is still young. There is going to be a large number of second-hand machine tools for sale after this war is over, but if it doesn't stop pretty quick there won't be any of them worth buying!

Bringing Home the Bacon and Choking on It

This competitive bidding on subcontracts extends all along the line on all kinds of munitions. In New England I heard of a man that had taken a contract for making a certain type of bayonet at 60c. each. He had gone out and brought home the contract, which reminds me of the city fellow that went hunting up in the woods and brought a bear back to camp—at least he showed the bear the way there and did it at a rate of speed that broke all existing foot-race records. The fellow that brought the 60c.-bayonet contract home with him when last reported was rushing around the state at a great rate trying to find somebody to take the job off his hands at 70c. each.

Small shops that are able to turn out accurate jig and tool work are reaping a rich harvest. The demand for such material is enormous, as those plants that have contracted to deliver large orders of rifles and like material are incapable of producing anywhere near the required amount of small tools, jigs and fixtures in their own toolrooms.

Some small shops have taken the overflow of the automobile shops and are turning transmission gears and other material that lies within their capacity. Of course they are not making 100% profit on this line of work, nor do they expect to, and if the truth were known about the munition game, one would read less about this 100% profit, at least in the shops that are doing the work. There are some that have simply taken big contracts and then turned them over and that anticipate enormous profits from so doing, but these people are not manufacturers but money jugglers.

As individual units small shops are not fitted to go into the munition game except on the special auxiliary lines that lie within their capacity. But there is one point worth considering and that is the relation between the small shop and our own needs for ammunition in case the mechanical sources of this country should be taxed through war. As independent units small shops would not be able to do very much. Properly organized and combined, however, their vast number would make them a factor to be dealt with.

Possibilities of Combined Efforts

The sum total of the munitions and materials that could be produced in our small machine shops if properly organized, would form a surprising figure. It would compel those in a certain district getting together in the matter of the distribution of work, the handling of shipments, and in arranging facilities for inspection. It would mean that each shop must perform the operation that it is best fitted to perform, and doing this would knit these small shops together into a producing organization that would run the large shops a close race in effectiveness.

While the need of small-shop facilities for American munitions may never arise, it is more or less a matter of duty for each small-shop owner to familiarize himself with the methods used in munition making, just as the *American Machinist* considers it a patriotic duty to publish the "how" of this art so that our defensive resources may be strengthened by the spread of the information. While battles nowadays are fought amid a veritable rain of shells, it is quite conceivable that in some cases *one more shell* might have won the victory. If in such an event it happened to be a shell made in a small shop, its value to the country would be surely as great as that of the ones made in our immense factories.

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Extrusion of Metal—In a paper presented at the International Engineering Congress at San Francisco dealing with forgings it is pointed out that by extrusion of metal is commonly meant the process of pressing metal, in hot or cold condition, through a die or opening of the size and shape desired. The metal is usually heated, but some of the softer ones are also worked cold. This, however, takes considerably more pressure compared with what is required when the metal is heated. On the other hand, the metal by being worked harder is improved in strength and structure. Even when extruded at high temperature the metal, being compressed, gets a finer grain with a higher tensile strength. Another advantage of this method is that intricate cross-sections can be given to the material, and the articles produced get a very neat finish and are so uniform in size that the variation is not more than one-thousandth part of an inch, or even less. For this reason the extruded metal is used without any machining. This method is used in the manufacture of pipes and wires of lead, miscellaneous shapes in brass, shrapnels of steel, valves for automobile engines of high-grade steel, rods, etc.

Small-Shop Rat's Soliloquy

SYNOPSIS—In a shop much goes on that its owner does not see and many things happen that none of the workmen imagine. But the small-shop rat is wise to all of it. His house of refuge is the dirty shop. In this article a small-shop rat expresses his dissatisfaction at having to seek new quarters and gives some reminiscences of life in the home he is leaving.

"Yea, bo, I'm on my way!"

The speaker was a large gray rat that had evidently seen better days, judging by the way in which his ribs outlined themselves through a skin plainly in need of interior filling. His whiskers drooped disconsolately and his tail hung limp and spiritless, as he stood upon a pair of trembling hind legs in order to express his sentiments.

"These progressive fellows make me sick," he complained: "always changing something for the worse, or reforming it, as they call it. Two months ago I was happy, healthy and fat—look at me now! And all because Bill Jones took the notion that he ought to improve his shop. Improve it! Why man alive, you couldn't improve a place like that; it was perfect to start with.

"Say, that shop was the softest boarding house that a rat ever had the good fortune to strike. And you can bank on it that we rats appreciated it and patronized it accordingly, for we are not the kind to hold our trade back from a fellow who puts up good accommodations, even though we may not approve of his morals or his face. That fellow Jones certainly had a hard face, and I always felt that some day he'd pull off a mean trick on us.

"Many's the family that I've seen raised in that shop, and all so fat and healthy that it would do your heart good to look at them. Why, up to a month and a half ago, I had some two hundred children and grandchildren of my own, all told, frisking innocently about there. And to think—to think—say, excuse these tears, Mister, I'll get over it in a minute.

Delicacies Under the Shop Benches

"Never again will I find such a house of refuge—never again such a practical floor or such hospitable workbenches filled with all manner of delicacies, ranging from succulent old shoes to palatable pasteboard file boxes.

"And how I will miss the good-hearted fellows that worked in Jones' shop! There was Heine Schmidt; one could not wish for a better judge of good cheese, nor one who would be more liberal with his crusts. Instead of throwing the leavings out in the yard or leaving them in the middle of the floor, this charitable man took pains to throw them under his bench in a most accommodating way.

"Then there was another fellow they called Pete, who worked at a machine that had a big iron table on it that traveled back and forth. He liked ham, but didn't care for the fat, and used to trim it from his sandwiches and flip the strips into the spaces underneath the table of his machine. It was a hard place to get at, but I found a way—I found a way!" And here the old rascal chuckled to think of his shrewdness, and licked his chops at the thought of the bygone feasts of ham fat.

Germs as an Epicurean Rat Relish

"What with the sewers and the hospital next door, that shop was as near to heaven as a rat could imagine. Such germs as they had in that hospital! I couldn't see any sense in the fellows in the shop taking pleasure in a pinch of snuff, but let me tell you, there's nothing like a good sniff of smallpox germs or a pinch of diphtheria bacilli to make an old rat like me feel spry and frisky. When I was young and my taste wasn't properly developed, I was satisfied with common ordinary germs like measles or bronchitis, but now that I know what's what, you couldn't tempt me with such trash. I want something that tickles all the way down. Yellow-fever germs are the tastiest of all, and they stick to the whiskers longest, but they're getting scarce nowadays, I'm sorry to say.

"The boys were certainly thoughtful in that shop. Every night they left their overalls on top of the benches where we could take a nap on them, and sometimes they would leave candy in their pockets or chewing tobacco flavored with molasses.

Solid Comfort and Perfect Happiness

"You human beings don't know what solid comfort and happiness are. Let me tell you something of the pleasures that a rat can enjoy in a shop such as Jones' used to be before it went to the bad. Just imagine getting real hungry playing tag in the sewer, then having a good meal of Swiss cheese and ham fat, followed by a run over to the hospital for a relish of sharp peppery typhoid or smallpox germs, and then a good long swig from the shop drinking-water bucket to wash the whole thing down. After this, imagine burrowing into a soft comfortable bed in a pair of overalls and going to sleep and dreaming of doing it all over again. If that isn't easy living, I'd like to meet it!

"I lived in that shop from the time that I was knee-high to a grasshopper, and I knew it from top to bottom. At first I was pretty green, I'll admit. They made blowers in that shop and used to test them out on the test block. Well do I remember the time that I ran in front of one of the deceiving things while it was being tested. I turned more somersaults in the next few seconds than most rats do in the course of their lives.

Rats Know All the Shop Secrets

"You human beings are not half so observing as you think yourselves. If Bill Jones had known as much about his shop as we rats did, he wouldn't have needed to make all these changes or reforms, as he calls them. I could have told him about the new reamers that rolled through a crack in the floor and got all rusted up in the dirt underneath. I could have told him where the brass chips went to and where the leak in the water pipe that ran his water bill away up each month was located. He didn't know, either, that among the big pile of stock castings out in the middle of the floor nobody bothered

to haul up the bottom ones, and that if what was wanted could not be found, another one was ordered and the old rusty one stayed underneath, where it had been for years.

"The men in the shop were not any smarter than was Bill Jones. When Hank Peters' little girl got the smallpox it made us rats laugh to hear him blame the school that she went to. Why, my little grandson, himself, brought those germs over from the hospital and took a nap that night in the pocket of Hank's overalls. Hank took them home with him that Saturday, and little Mary helped her mother with the washing.

What Happened in the Dark of Night

"You wouldn't believe some of the things that a rat sees in a shop. One night I came near being witness to a murder. Tom Johnson, who did the repair work, had a job fixing something on the third floor and worked overtime by the light of a couple of candles. There was a fellow called 'Red,' who fired the boiler at night and who used to run across to the saloon every little while to get a drink. The way that fellow would let the water run down in that boiler was scandalous. It's a wonder we weren't all blown up half a dozen times a night!

"This 'Red' was a tough customer and took pleasure in playing practical jokes on his shopmates. On the night that I am telling about, when Tom was working all alone on the third floor, 'Red' pulled off his shoes and sneaked upstairs in the dark. I knew there was a joke or some kind of a trick coming and followed along to see the fun. 'Red' picked up a couple of half-inch nuts, sneaked quietly along until he was within twenty feet of Tom and then let one drive at him. It hit him square in the forehead and Tom went down flat on his back.

"He lay there quiet and still just as if he were dead. I could see 'Red' getting scared, for he was the only other man in the shop that night and he wasn't on the best of terms with Tom.

Witnessing an Attempted Murder

"After a while 'Red' went over to Tom and felt of him. Then he took hold of his feet and began to pull him along the floor toward the elevator-shaft opening. I saw his game. *He was going to drop him down the shaft* so that it would look as if Tom had stumbled into it in the dark and had been killed by accident.

"When 'Red' got Tom's body to the shaft opening, he had to turn him around so that he would fall head first. His head and shoulders were over the edge when I saw 'Red' stop suddenly and look at Tom's face, for he had opened his eyes.

"That was a narrow escape for Tom. 'Red' held him there over the edge until he swore that he would never breathe a word about what had happened to anyone. 'Red' don't think anybody except Tom and he knows what happened that night in the dark, but he overlooked the wise old rat.

All Now Changed for the Worse

"But all of these good times have gone forever. Bill Jones' shop is a different place now. The floors are made of concrete and a rat couldn't dig through them to save his soul. The old wooden benches have been pulled down, and nothing is allowed to be placed under the cast-iron legs of the new ones that stand out from the wall, which to my way of thinking *is* a disgraceful waste of room. The men are *not* allowed to put their overalls on the benches at night, but must hang them up in metal cabinets that we can't break into. We can no longer quench our thirst from the shop water bucket, for this has been replaced by one of those new-fangled and useless fountains. Even the elevator openings have safety gates on them, and there is no chance for a rat to see anything exciting any more. Oh, that I should have lived to see the day!"

The old gray rat shrugged his shoulders and slowly dropped to all fours again.

"So long, bo," he remarked, "I've got a ways to go and must be going."

"May I ask whither?" I interrogated.

"Oh, to the nearest foundry. These places are not as stylish as machine shops, and the smoke is disagreeable at times, but they set a good table. And at least they never do anything in foundries to drive us poor rats away."

And with the exception of a gaunt stray foundry cat or two, I guess he was right.

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Unnecessary Handicaps

By F. C. Colvin

The small shop is frequently handicapped by the lack of handling facilities and machine equipment. Frequently, many of these handicaps are greater than necessary, for a little attention to details would reduce them.

Several examples showing the truth of this were seen recently in a railroad shop at a small division point. The most glaring was in connection with a large wheel-lathe. The wheels were lifted by an electric hoist suspended from an overhead trolley, and this was the source of the trouble.

The trolley tracks were so much out of shape that it was impossible for the machinist and his helper to swing the wheels into the lathe after they were hoisted clear of the floor. After vainly trying several times to force the trolley along the overhead track, only to have it roll back, two more men were called from other work to assist. Aside from the loss of time and the fatigue of four men, there was a loss in output, for the lathe was standing idle all of this time.

While the main trouble was that the trolley was out of line, the trolley-wheel bearings were also far from perfect. Ball or roller bearings for such purposes can be had very cheaply, and their use should be carefully considered. We would not suggest a power-trolley traverse in such a case, but a little attention to the track and trolley would prove to be a paying investment.

Other instances of poor equipment in this same shop were milling-cutter arbors out of true and bolt-cutters slides that did a tango all over the ways. Not much time or money is needed to fix these things, and it pays a big dividend to have a milling cutter use all its teeth, instead of only a few, and a bolt-cutter slide to stand up to its work.

✦

Russian Iron and Steel production has been advancing steadily, according to statistics presented in "Engineering." In 1914 the production of pig iron, semifinished and finished steel totaled 14,418,000 metric tons against 8,528,000 metric tons in 1909. The figures for the intermediate years show that the gain has been a steady one.

Buying for the Small Shop

SYNOPSIS—The purchasing of materials is the first step in manufacture and must precede actual work on the product. The important relationship of good purchasing to low labor cost is often misunderstood. The small-shop man, however, appreciates this better than the large-shop man, as he sees both sides of the question.

The tendency to hunt bargains is universal and is not confined to any one age, sex or condition. A shop owner was watching a struggling group of women elbowing and shoving each other in front of a bargain counter. "Give women the vote?" he asked, sarcastically. "Not while they have as little judgment as they display here. In order to lay hands on a last season's article, marked down from 43 to 39c., this array of athletic amazons are spoiling each other's hats, tearing expensive dresses and ruining admirable tempers."

It was only a week later that this same shop owner was in the market for lubricating oil. Somebody offered him a new and unknown brand a few cents under the market, and he gobbled a couple of barrels as avariciously as a toad licks up bluebottle flies. What this combination of rosin, aluminum soap and nitric acid did to $20,000 worth of expensive equipment was a caution and would have bought the shop owner's wife quite a number of $60 suits.

A Glue Proposition That Was Not Fishy

Some shop owners have been stuck so frequently that their purchasing disposition becomes soured and they dislike to spend a dollar unless they get a certified check for $1.50 attached to the purchase. They lose the willingness to "take a chance," which, if done with judgment and under certain restrictions, forms a large part of the basis of American prosperity. An exclusive "sure-thing" policy is likely to develop "dry rot."

It pays to "take a chance" where the loss, if any, is certain to be small, and where the gain, if any, is likely to be large. It does not pay to take a chance which, while holding out prospects of considerable saving, is at all likely to injure the quality of your product.

A man came to me one time offering to sell a formula for an elastic waterproof glue. He wanted $5 down and a similar amount in 60 days if the results were satisfactory. In addition to the formula and a convincing manner, he had some very good letters from those who had used this glue. We needed something of this sort for the pattern shop, ordinary glue loosening up on patterns which were kept in the sand over long periods, and so with the chances about 7 to 3 against ever shaking hands with the money again, I took a chance.

That glue formula turned out to be one of the best investments I ever made, figuring what it saved against what it cost. Patterns shed moisture like ducks and would apparently split anywhere else than on a glued joint. I am sorry that the purchase terms involved a promise not to give away this formula, or I would pass it along. But I wish the best of luck to the old gentleman of the formula if he is still alive, for there was nothing fishy about either his glue or his proposition!

When It Does Not Pay To Take a Chance

Now for the things on which it does not pay to take a chance. One of these is the quality of the materials used in the product. Saving on quality is the most reckless kind of extravagance. You don't hear all the complaints about your machines, because some people are too busy to spend time and money kicking when they get stuck. They swallow the dose, but next time they get another doctor.

A manufacturer that is now out of business made a line of small hand-power machines for punching and shearing metal, an assortment of punches and dies going with each tool. In order to insure all of the repair business coming back to him, he made the punch and die holders to his own special standard. This was short-sighted policy in itself, for customers dislike hoggishness and admire service. You can't fool a man into thinking that you are using 12 threads on ⅝-in. diameter stock for his benefit.

Some seller—you can't call him a salesman—induced this man to use a 6c. tool steel for punch and die stock. The average weight of a set of these punches and dies was 1½ lb., so that in dropping from 14 to 6c. stock he saved 12c. per machine.

This manufacturer would have fired any clerk who punched a customer's nose, on the grounds that such an action would be likely to discourage future business, and yet for a saving of a miserable 12c. per machine he delivered to each man who bought one a whole set of punches, each equally discouraging. After making a few dozen holes they would curl up and die, and what the autopsy revealed usually turned a good customer into a most vindictive knocker.

Borrowing To Take the 2-Per Cent. Discount

Purchased material averages from one-quarter to one-third of the total cost of most mechanical goods. In other words, 25 to 33⅓ per cent. of the expenses incurred by shop owners is for goods the most of which are billed at 2 per cent. for cash in ten days. A man should be well-pleased to net a profit of 20 per cent. on cost, and the 2 per cent. that may be saved by taking this cash discount, figuring on a selling price in which one-third of the cost goes for material, will increase this profit 3⅓ per cent., relative to the amount that it would be if bills were paid at 30 or 60 days.

Without Cash Discount		With Cash Discount	
Material	$10.00	Material	$9.80
Total cost	30.00	Total cost	29.80
Profit	6.00	Profit	6.20
Selling price	$36.00	Selling price	$36.00

Now, assuming that the cash capital is turned over four times a year and that in the event that the discount is not taken the bills are met in 60 days anyway, the question resolves itself into deciding whether there is anything gained by taking 20c. discount four times a year on each $10 worth of material, borrowing $10 from the bank for 60 days to do this if necessary. The saving on the discount per machine will be 20c., and the interest on the

money at 6% will be 10c. Thus on a total volume of business of $100,000 a year on the foregoing basis, $217.29 will be saved by borrowing the money to take the cash discount. Even on a yearly business as small as $10,000 this will mean $21.74, which represents a suit of clothes for the small-shop owner or a hat for his wife. Of course if sufficient bank balance is carried so that the money does not have to be borrowed, the relative saving is twice as much.

No matter how much aversion a small-shop man may have for written orders, he *must* have them for the goods that he purchases, for those who sell these goods require it. If he will make an additional copy of each order aside from the one retained on file, he has the entire makings of a follow-up system and price-record index. This copy is first placed in a "live" folder and followed up from time to time until the goods are received. Then it is placed in a "here" folder until the goods are inspected and the bill is paid. Then it is transferred to a filing box and filed alphabetically under the name of the commodity purchased. This automatically makes a price record of it, and before accepting a quotation one can look into this file and make sure just what he has paid for the goods when previously purchased.

Can the Big Shop Buy to Better Advantage?

The large-shop purchasing agent who is on to his job and alive to his company's interests has one object in mind above others. This is to obtain goods of the required quality at the lowest price. First he must be sure of the quality. This means definite specifications for the goods purchased and careful inspection and tests after they are received. Specification preparing, inspection and tests cost money if they are properly done, and while the big shop can well afford to maintain a capable department for this purpose, it is evident that the small shop cannot. The remedy in the small shop is to hold fast to what which is found good, regardless of the fact that an untried make of apparently similar goods can be had for a few cents less.

At that, the big shop hasn't the best of it by any means. It is in only comparatively few large plants that the purchasing is done with a noteworthy degree of intelligence, largely because most purchasing agents are unfamiliar with shop practice. They are well acquainted with one end of the street—the one at Price Avenue crossing—but they have never been as far as Shop Service Roadway, although some of it must be said have been found dodging about in Graft Alley!

Where the man who buys the goods is also the man who uses them, he is in position to note the exact effect of the pill that he prescribes. Reamers and files look alike to the purchasing agent that has never used one of either kind, but they get their proper rating when the shop man gets his fist on them. One of the great satisfactions of being a small-shop man is the ability to lay down a full house of shop facts against the salesman's bob-tailed flush!

Cash buying is one weapon of the small-shop man. Get the reputation of paying cash, and dealers and manufacturers will prefer to sell you a small order and get the money rather than to deliver a large order to someone else and wait for it.

On the whole the big shop hasn't much on the little one in the matter of buying. What it gains in size and shrewdness it loses in the lack of closeness of touch. The big shop gets stuck more frequently, but it hurts more when the little one gets it. And when small shops combine in an association and buy their most common materials in large quantities for cash, subject to specification, inspection and tests, then they will have a bulge on the big ones in this matter.

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Learning What an Order Means

By W. D. Forbes

Jimmie O'Connor was O. B. Joyful's foreman, and he had the worried expression usual on the face of a man in his position. He had expressed his mental condition one day by saying: "I wish to the Lord that I could feel that I was doing the right thing at the right time and in the right place; but I always feel that I am late, in the wrong place, and should be looking after something different. It's fierce!"

Jimmie brought in to O. B. one morning a piece of paper with a sketch on it and said: "Contractor White, who is building the big house up in the park for Meeks, was in and wants this made, and our tool-steel stock has nothing to make it of. Had we better make a forging or send downtown for a piece of the right size?"

"What is it?" asked O. B. Jimmie read from the paper: "One piece tool steel 1x2½ in., bore exactly in the center flat ways a ¾-in. hole; each side bore holes same diameter exactly 2 in. from center. Be particular to have all measurements exact and holes on center line."

O. B. took the paper and after looking at it a moment asked, "White is a carpenter, isn't he?" Jimmie assented and said, "The old man is in a hurry for it and is particular about it." O. B. replied, "All right, I will look after this," and immediately 'phoned to White's office, asking him to stop in on his way to dinner, which he did.

Then O. B. took a piece of paper and make a sketch and wrote under it, "Make of flat machinery steel, drill the ¾ holes and lay out to ordinary scale measurement, drill and countersink the two holes *A* and *B* for ¼-in. wood screws," and sent the sketch down to Jimmie, who came flying up stairs in a great state, insisting that the contractor had wanted the holes bored and the material cast steel and everything up to size.

O. B. said: "Yes, Jimmie, this is all right. You tell me just what he said, but you forget that he is a carpenter. When he said cast steel, he meant a steel casting. He knows no more what a steel casting is than a cat does of a holiday. When a carpenter makes a hole he bores it. When a machinist bores it he swings it up in a machine and tools it out. What a carpenter calls boring we call drilling, and exact to a carpenter is rough measurement to us. Yet I never saw a machinist that could saw a board off square or made a box to take anything that had to fit. Do you know, Jimmie, what Mr. White wanted that piece for?"

Jimmie did not know. "Well, it was to screw up between two posts in his cellar, and the holes were to guide three ½-in. rods that lead to the furnace drafts." "Well, then," said Jimmie, "he didn't know what he was talking about when he gave me the order." "No," said O. B., "I have found that a good many people who give orders do not know what they are talking about, and in my business it is a big factor to be able to find what is wanted without offending the man and losing the job."

The Field of the Engine Lathe in the Small Shop—I

SYNOPSIS—The engine lathe is indisputably the most useful appliance in the small shop. In addition to this it is the most common machine and one that receives much abuse. This and the following article deal with the field of the engine lathe in the small shop and give some practical points on its selection and use. The relation between the rigidity of tools and fixtures and profit making is also discussed.

Teacher (to new pupil in technical-training school): "Eddie, what is a lathe?"

Pupil (scratching his head in order to stir up its contents): "A lathe is a thing with a long body and four short legs, having a tail and a head that goes round and round."

Teacher: "That is quite an original definition, Eddie, and now you may tell us what a machine shop is."

Pupil (after some deliberation): "A machine shop is a room with a lathe in it."

Teacher: "Very good, Eddie. As you are the only pupil present today you may go to the head of your class."

Eddie's definition of a machine shop wasn't so bad after all, even if his description of a lathe would have fitted

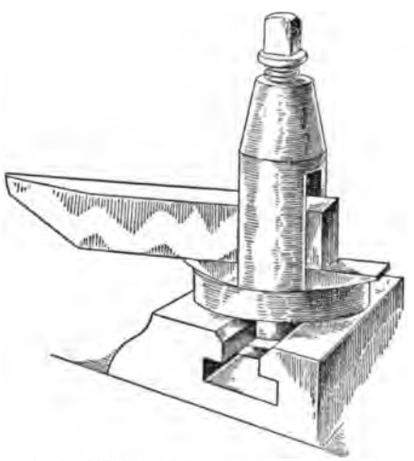


FIG. 1. A RAKISH APPEARANCE, BUT NO GOOD FOR WORK

an intoxicated dachshund equally well. One can hardly call any place a machine shop unless it contains at least one lathe. The small shop that possesses a grinding machine is in the favored class of the select few, many small shops are without millers, a number of them have neither shapers nor planers, and some few do not possess a drilling machine. But where indeed is the shop, however small, in which the "four short legs and a long body, with the head going round and round" is not a prominent part of the scenery?

A man wrote in the other day and wished me to recommend a book that told all about the lathe. I wrote him that there was only one book published that contained the necessary information and that, unfortunately, this book did not have this information in shape for practical use. The dictionary is the only volume that can adequately describe the possibilities of the common engine lathe, and it is too busy settling disputes about the pronunciation of European proper names to meddle very much just now in the machinery business. When you consider what is being done daily on lathes in the 15,000 small machine shops of this country, you will realize that this is no idle statement, and that every page of the *American Machinist* for the last ten years might have been filled with information about engine lathes and what they could do without by any means exhausting the subject.

The Engine Lathe Coming Back to Its Own

While it has always been a faithful stand-by in the small shop, the more fickle large shop has been somewhat weaned away from the simple engine lathe, but there are

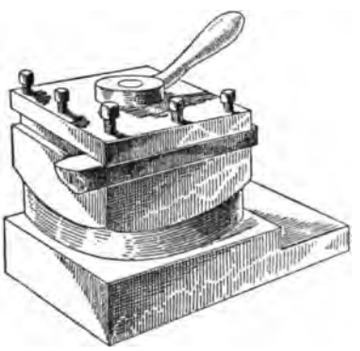


FIG. 2. GIVE A DOG TEETH IF YOU WANT HIM TO BITE

signs that it is beginning to feel the attraction of a first love and that this machine will shortly come back to its own. Shop superintendents are beginning to realize that the much-abused lathe, rigged up with simple rugged fixtures and running along as it does day after day, is something like the tortoise and will beat the fleeter and more fanciful hare, which gets a big start and then shuts down for repairs. Today the call for munition making in all countries is for simple engine lathes; not just because these can be delivered faster than other machines, but because they have been found to produce unheard-of results when measured by this most exacting and strenuous kind of production.

Various Epochs in the Cycle of a Lathe

There are distinct epochs in the cycle of a lathe, the most prominent being its selection, purchase, installation, use, repair and discarding. Oftentimes one of these machines has several lives, like a cat, being sold by its original purchaser and going through the whole cycle over again in one or more different shops—possibly through intelligent manipulation and tooling earning more money for its last owner than for the first. Sometimes, however, it goes from bad to worse, losing its air of dignity and

briskness and becoming shabby and dilapidated in some out-of-the-way shop that has woodchucks within it and skunks underneath it.

There is little excuse in the small shop for what sometimes happens in the big one; namely, the selection of the wrong machine. The small-shop man who buys a machine tool knows exactly to what use it is to be put, and if he keeps this and a few other simple principles in mind and does not become hypnotized by the voluble machinery salesman, he will make very few mistakes.

One of the essential things is to buy a lathe with a reputation. You can see the outside of any machine without trouble. You can devour the pages of any catalog or circular and read the specifications, but the one thing you cannot do is to see the workmanship within on the critical parts. To be sure, you will find out about this later on, but this is sometimes an expensive way to get experience. Make it a cardinal point, therefore, to buy a lathe from reputable makers, and do not take an unknown make with merely a machinery jobber's nameplate on it.

Choosing a Lathe According to Its Weight

One of the curious things about the machinery business is why so many people allow the weights of machines to influence their purchase. They do not usually apply this principle in selecting a wife, and they adopt quite an opposite policy in purchasing a loaf of bread, but the statement, "Our lathe weighs 100 lb. more than this one, Mr. Brown," has sold innumerable machines. And yet choosing a lathe by weight is as senseless as selecting a phonograph record by smell.

One of the most important things for the small-shop man to get with a lathe is long-wearing quality. When you hire a laborer from a bunch of applicants you pick a man with a big chest and husky biceps. When you pick out a lathe from a choice of reputable makes take the one which has the biggest spindle and the longest bearing of the carriage on the shears.

Lathes may be broadly classified into those which are suitable for manufacturing, general utility and toolroom work. The small shop as a general thing wants the general-utility lathe. The decision between belt and gear drive is not difficult to make and should be in favor of the belt, except in those rare small shops where work is finished on a grinder. There is still another choice between the solid-bed lathe and the ones with fixed and adjustable gaps; and getting to quite a different breed of cats, there is the two-spindle lathe, which has proved itself to be a small-shop friend in need.

I've heard it said that the small shop does not need such refinements as quick-change feed boxes. The small shop is the very place in which these things are needed. Lathes in the large shop are not put through the gymnastics that they undergo in the small one, for where large lots are machined without change there is little

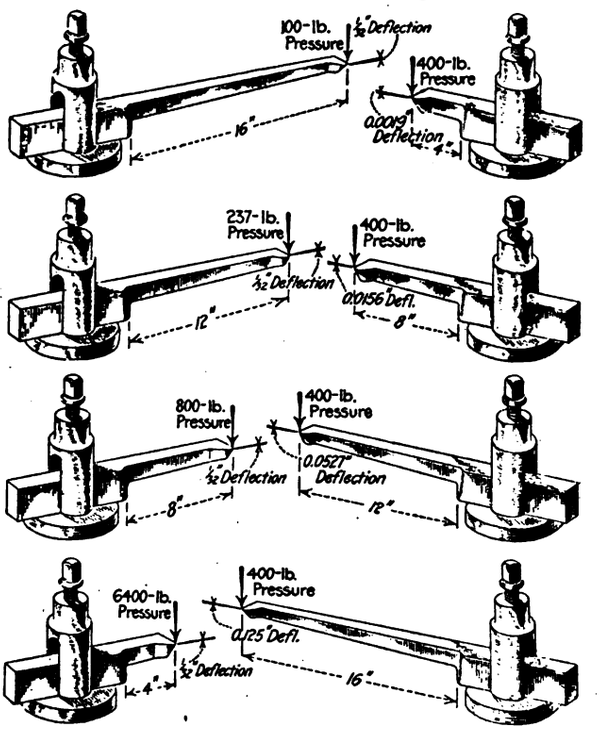


Fig. 3 Fig. 4

FIGS. 3 AND 4. EFFECT OF TOOL OVERHANG

Fig. 3. Effect on allowable cutting pressure. Fig. 4. Effect on spring under a given pressure

gained by the ability to make changes quickly. The small-shop man, however, with the variety of operations that he has to tackle, finds that quick-change features are all to the good.

Attachments That Increase Earning Power

One thing that has kept the engine lathe from coming into its own before this is the ordinary tool post shown in Fig. 1. If you wish to make hay while the sun shines,

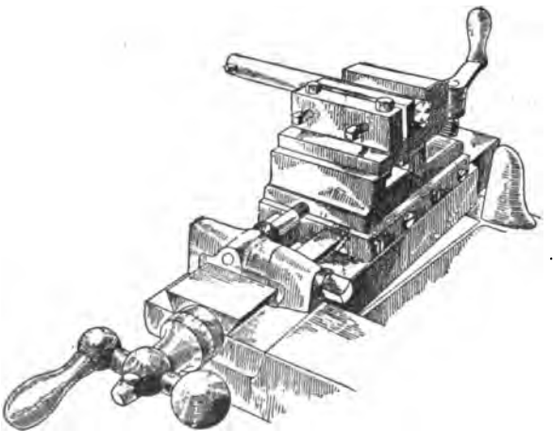


FIG. 5. A BORING BAR THAT WILL DO BUSINESS WITHOUT BEING COAXED

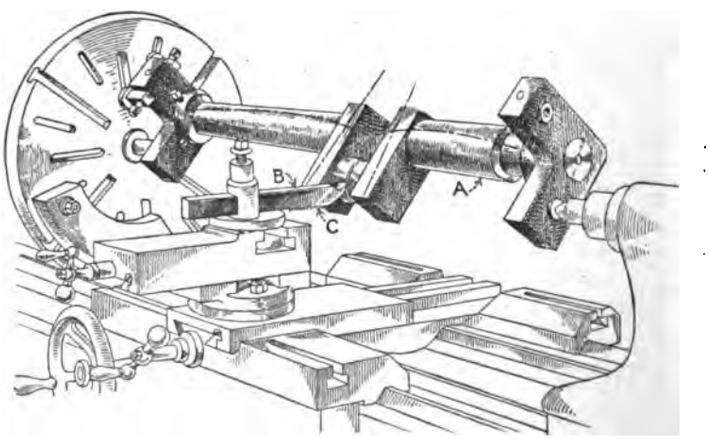


FIG. 6. ALL KINDS OF SPRING IN WORK FIXTURES AND CUTTING TOOL

don't grab the pitchfork by thumb and finger and hold it at arm's length in imitation of the way that tools are held in this tool post. Give a dog teeth if you want him to bite, and give the lathe a tool post such as is shown in Fig. 2 if you wish it to eat iron. Many thousands of engine lathes turning out shells at high speed have been equipped with these useful and thoroughly practical tool posts after the original tool-post arrangement fell down hard.

It will pay the small-shop man who cannot afford a chucking machine and who has chucking work to do in small lots of from six to twelve pieces to consider the purchase of a removable turret that will fit on the shears of his lathe and that will in reality convert it into an effective chucking lathe. In fact, the small-shop owner who studies the action of turret lathes and screw machines can steal a good deal of their effectiveness and apply it to his old reliable engine lathe. Roller backrests and box tools for turning are not necessarily restricted to use on screw machines, and the same gain in production time will be apparent on an engine lathe when these things are applied as would be noticeably absent on the screw machines if they were removed from them.

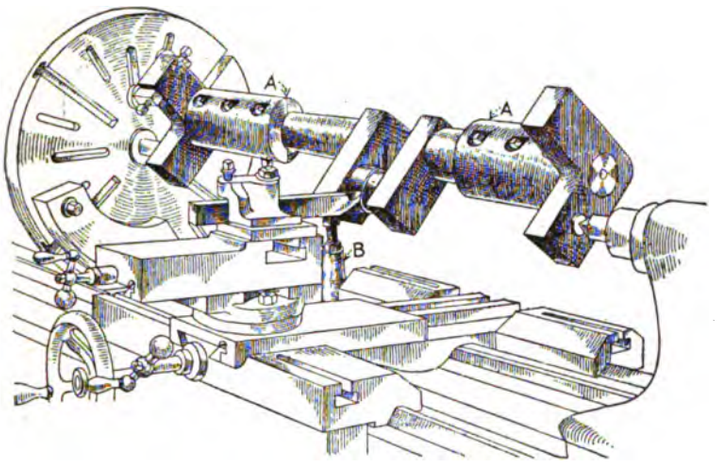


FIG. 7. CUTTING OUT THE SPRING CUTS DOWN THE COST OF TURNING WORK

Close Connection Between Rigidity and Profits

There is a remarkably close connection between rigidity and profit-making in work done on the lathe. That this is not fully realized, even by those who class themselves as A-No. 1 mechanics, is proved by an inspection of the lathe department of the average shop. The ordinary boring tool should not be called a boring tool at all, but a "profit cutter." One could hardly design a spring-board along better lines or a cutting tool along worse ones. The effect of the overhang of a tool of this kind on the allowable cutting pressure is shown in Fig. 3, in which it is assumed that enough cut is put on the machine to deflect the end of the bar of the cutting tool $\frac{1}{32}$ in. Notice how rapidly the allowable pressure decreases when the tool is lengthened. And then notice in Fig. 4 how the deflection of less than $\frac{2}{1000}$ of an inch with a 4-in. overhang and 400-lb. tool pressure multiplies itself under the same tool pressure into $\frac{1}{8}$-in. deflection when the overhang is 16 in. Instead of having an assortment of useless boring tools of different lengths, it is cheaper to make the boring bar shown in Fig. 5, which is one that will do business and that will not ask any favors of the piece in the chuck.

Fixtures That Increase Rigidity

A small shop that had to turn up the crankpins of a number of crankshafts used the rigging shown in Fig. 6, making cast-iron throws as shown at *A* for the bearings and using a tool overhung sufficiently to clear the cheeks of the crank throws. There was no money in this work, and no wonder! If they had kept in mind the relation between rigidity and profits they would have adopted fixtures something like those shown in Fig. 7. These may be made so that one set will accommodate a number of cranks. Reinforcing a springy job with such fixtures enables a much heavier cut to be taken without danger of deflection.

Equalizing the tool pressure on work is one way of securing rigidity and adding to profits. Boring a hole with a cutter head in which the tool is equalized between two or three equally spaced cutters is sometimes overlooked in the small shop. A simple boring bar is shown in Fig. 8. An arrangement of this kind will insure a true hole on lathes in which the shears are worn out of true, as the alignment depends only on the truth of the head and tail centers and of the spindle faceplate. In addition to this, as the outer end of the boring bar is supported, a much heavier cut may be taken. A set of these bars is a first-rate small-shop investment, and by tool adjustment a few of them may be made to cover a large range of work.

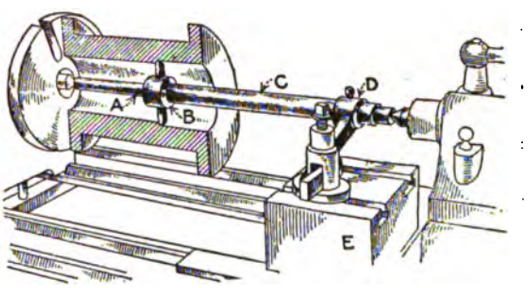


FIG. 8. BORING A TRUE HOLE INDEPENDENT OF THE CROSS-SLIDE AND SHEARS

Factors That Cause Accident

There are factors in the accident problem that seldom receive consideration, such as dull tools and bull-dozing foremen. The dull tool may be due to ignorance of the operator or the foreman's objection to the time lost in changing such tools as band-saws and planer knives. In either case there should be someone to see that the fault is remedied.

The workman's temperament should also be considered. A nervous man should not be asked to work on a dangerous machine nor under a bull-dozing foreman. Either combination is bad. In fact, this kind of a foreman is bad anyhow. Observation will show that such a foreman has a high percentage of accidents.

The Field of the Engine Lathe in the Small Shop—II

SYNOPSIS—There is some inconsistency in being extremely particular about buying a machine and then not properly caring for it afterward. This article deals with the question of the spring of lathe beds and illustrates methods by which they may be lined up and tested.

Providence permitting, if you ever get to Providence, R. I., you must visit the Brown & Sharpe plant and ask them to show you the accurate measuring machine. You will have your eyes opened on the subject of the flexibility of metal and will have new ideas about the difficulty of keeping machine-tool beds in proper shape.

This measuring machine is built on the most rigid lines. The frame is between 16 and 18 in. deep at the center and of exceedingly strong section; in fact, it was designed to eliminate spring and distortion as fully as possible. One of the tricks they do with this machine is to take an accurately ground plug gage and adjust the measuring spindles until this is just held suspended between them. Then they will ask you to place your hand under the bed of this machine and lift. As soon as you begin to pull the plug drops. The pressure exerted by your hand has been sufficient to spring the bed and draw apart the measuring spindles!

They repeat this experiment in a somewhat different way. Placing the same plug between the centers, you are asked to lay your hand upon the top of the bed. The expansion of the metal caused by the heat of your hand is sufficient in a moment or two to cause the plug to fall. If a rugged machine such as this is, built particularly for the purpose of withstanding deflection, is subject to such delicate stresses, what can we say about the ordinary machine-tool bed, and particularly the long bed of the common engine lathe?

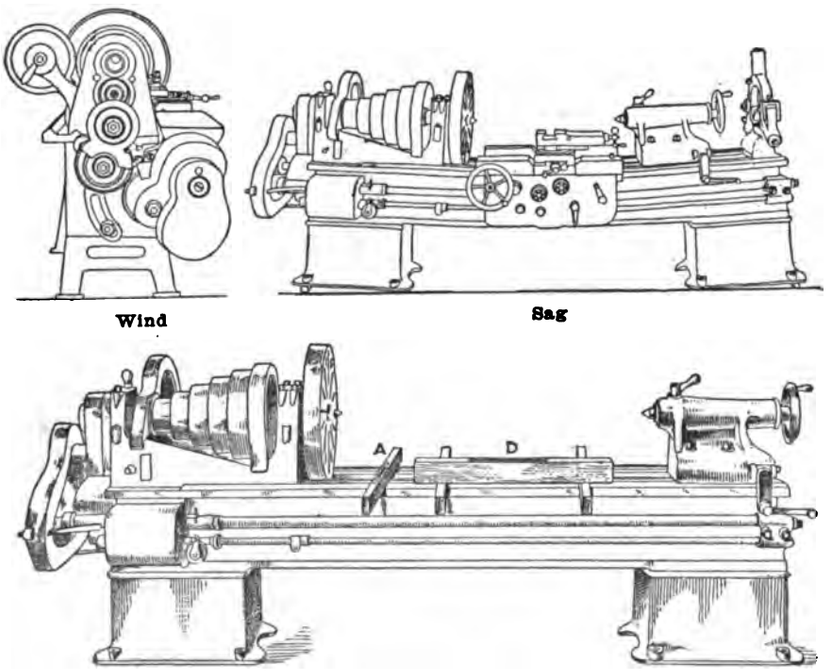


FIG. 1. TESTING THE LATHE BED FOR LEVEL
Exaggerated wind and sag shown in outline

Jim Hodges was a mighty particular machine-shop superintendent—about buying machines. When he wanted to buy a lathe he raked over all of his catalogs on this subject and sent for those that he did not have on hand. Next, he would draw up his specifications, calling for an accuracy of ½000 in. in 12 in. when boring and turning, and send out letters asking for quotations, requesting the weight of the machine, the size of the main bearings, length of carriage bearing on the shears, speed and feed ratios and the like. He kept a card index of all quotations of machine tools and of other data concerning them. In fact, he was right uptodate—in the matter of buying.

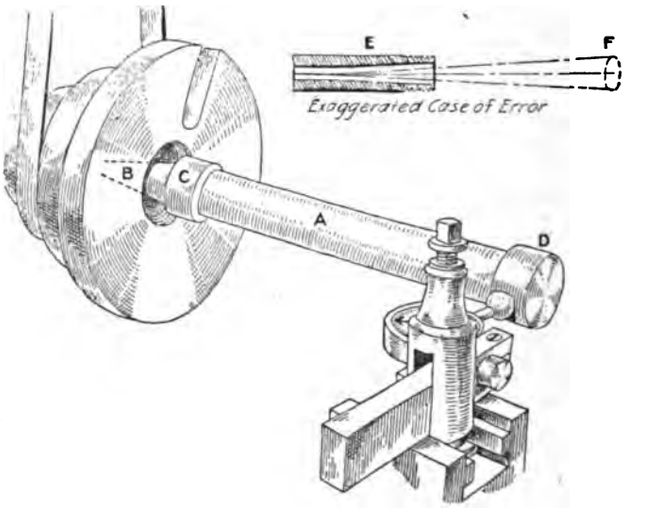


FIG. 2. TESTING ALIGNMENT OF CENTER BEARING WITH LATHE SPINDLE

When the lathe that had met all of his severe requirements was received in the shop, nine times out of ten it was set on a shaky wooden floor that would stay almost as level as the Atlantic Ocean. The machine would be carefully lined up and tested, the bed being brought into true by driving wedges under the legs. In a month or two the floor would take another sag, to which the lathe bed would accommodate itself, not having the power to keep all four of its legs suspended from the floor. Somebody would report to Jim that the new lathe wasn't boring true, and then there would be trouble for the machinery house that sold him the tool. Jim couldn't get it through his head that it takes sense and judgment to maintain

accuracy in a tool after it is bought, as well as to build accuracy into it in the shop where it is made.

The Simplest Possible Lathe Test

The simplest way to test a lathe is to bore and turn with it, but the fact that this test does not prove satisfactory

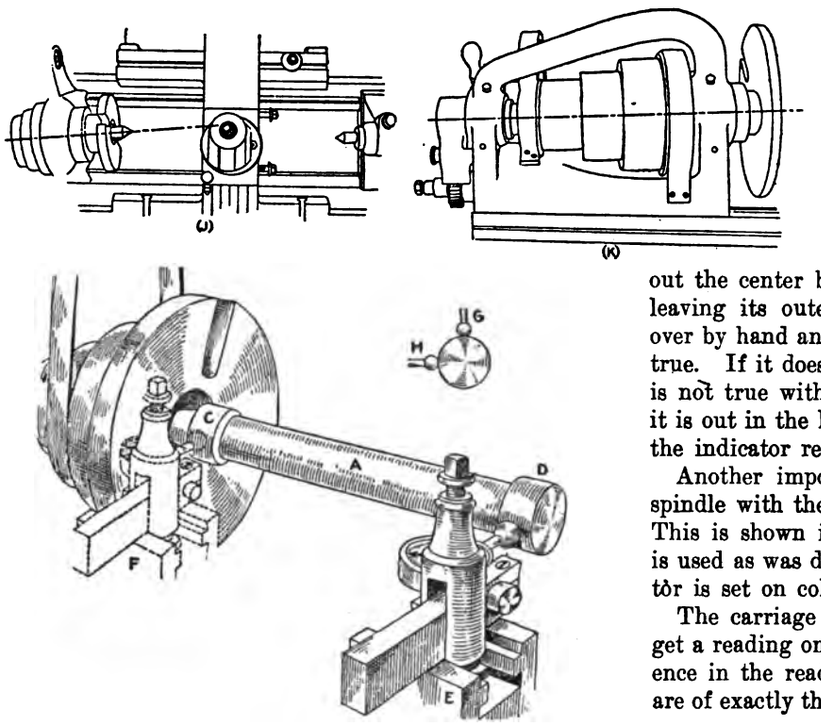


FIG. 3. TESTING ALIGNMENT OF SPINDLE WITH SHEARS
Exaggerated cases of error shown in outline

is not an indication that the lathe itself is to blame. When you consider the ease with which a lathe bed may be sprung you will realize the truth of this fact. To repeat the B. & S. experiment on a small scale, take any 16- or 18-in. lathe that you may have in your shop, put a bar between the centers and a test indicator in the tool post and bring this against the bar. Then put your hand under the lathe bed and lift, and see what happens to the indicator readings. After this illuminating test you will not be so quick to complain to the lathe builder or machinery dealer who sold you a machine that does not turn or bore straight.

A concrete foundation is almost an essential for a lathe that is to be kept in condition to do accurate work. If it is placed on a wooden floor it must be tested carefully from time to time to see that sag or deflection in the floor has not affected the machine.

One of the most important tests is to make sure that the lathe bed is free from wind and is level. The way of doing this is shown in Fig. 1. Accurate straight-edges and a sensitive level (not a carpenter's level) are the appliances used. The bed is first tested for wind, as shown at *A*, repeating every 2½- or 3-ft. length of the bed. Then it is tested for level in the direction of its length at several places, as shown at *D*. If a lathe is properly leveled up with wedges and then grouted in on a substantial concrete foundation, it will maintain its level for a long while, but if it is placed on a wooden floor, and particularly an upper floor, the wedges must be adjusted frequently. In setting up a lathe that has legs of the cabinet type, always wedge up on the inside edge of each cabinet leg first, before driving the wedges on the outside edges. Exaggerated cases of wind and out-of-level are shown in outline in Fig. 1.

The alignment of the center bearing must be true with the lathe spindle if it is to do accurate center work. This is tested as shown in Fig. 2. First, make a test bar *A* on an accurate lathe or grinder, this bar having a shank *B* to fit the head center bearing. Collars *C* and *D*, which are from 12 to 15 in. apart, should be turned to the same diameter. Before putting this bar in the lathe that is to be inspected, it should be carefully tested on accurately ground centers with an indicator to see that it runs true at *B*, *C* and *D*. If found accurate, wipe out the center bearing carefully and insert the test bar, leaving its outer end *B* unsupported. Turn the lathe over by hand and indicate the collar *D*, which should run true. If it does not, it is evident that the center bearing is not true with the lathe spindle, and the amount that it is out in the length of the test bar can be figured from the indicator reading.

Another important test is that for alignment of the spindle with the shears, both horizontally and vertically. This is shown in Fig. 3, in which the same test bar *A* is used as was described for preceding tests. The indicator is set on collar *D* in the horizontal plane, as shown.

The carriage is then moved from *E* to *F* in order to get a reading on the collar *C*. There should be no difference in the readings on the two collars, which of course are of exactly the same size. If this test is repeated in the

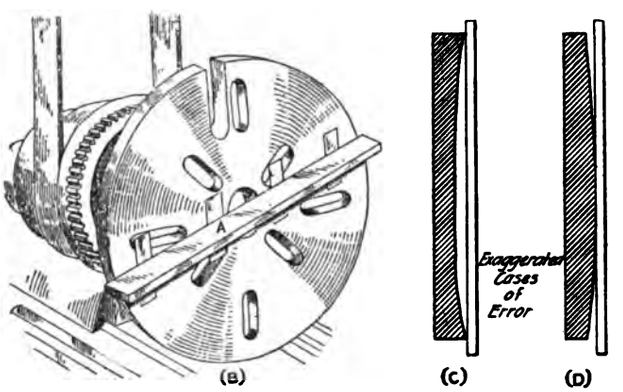
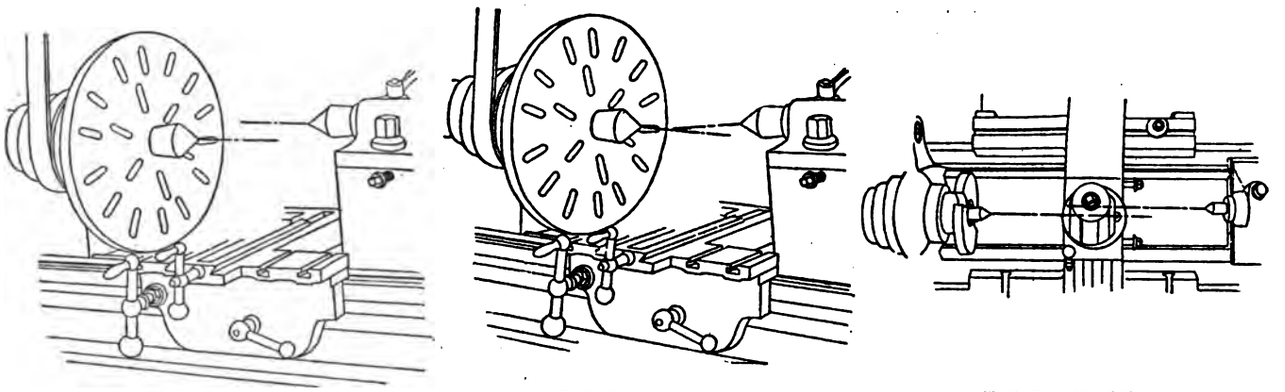


FIG. 4. TESTING ALIGNMENT OF CARRIAGE CROSS-SHEARS

vertical plane as shown at *G*, it will show whether the center line is also true in this position. A scriber may be used instead of a test gage for both first and second lathe tests if no indicator is at hand, but these tools are so cheap and so generally useful that few small shops can afford to be without them.

Alignment of the Carriage Cross-Slide

The alignment of the carriage cross-slide shears is tested as shown in Fig. 4. A light cut is first taken over the faceplate, and this is then tested with an accurate straight-edge *A*, using tissue-paper strips, as shown at *B*. At *C* and *D* are shown exaggerated cases of error. If the faceplate is at all convex the carriage cross-shears must be rescraped. If it is slightly concave there is no great harm done, as hollow work will bear on its outer



Head Low | Tail Center on Angle | Tail Spindle Offset

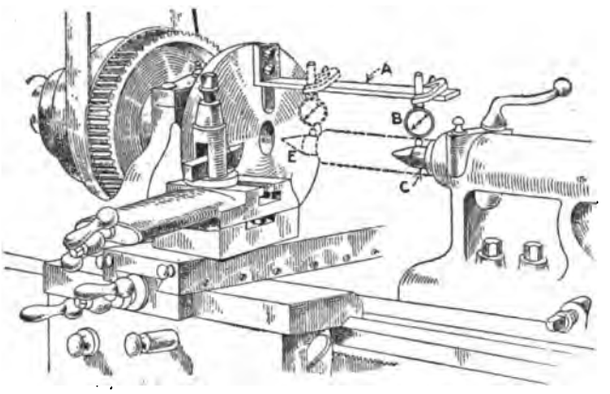
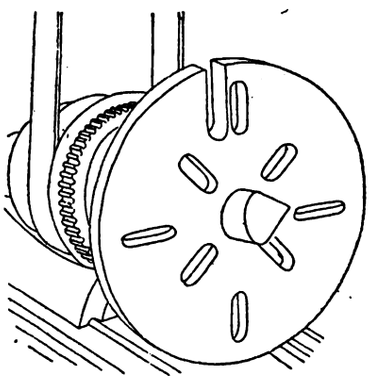


FIG. 5. TESTING ALIGNMENT OF TAIL SPINDLE
Exaggerated cases of error shown in outline



edge slightly, which is much better than having the high spot in the center so that the piece rocks.

The central position of the tail center and the alignment of the tailstock spindle are checked up as shown in Fig. 5. An angle piece *A* is first strapped to the faceplate, which has been demonstrated to be true. To this is attached the test indicator *B*, placed so as to bear against the tail center, after which the head is rotated by hand and the gage *B* is read on the four quarters.

This test gives merely the central position of the tail center and does not tell how the tailstock spindle travels. To check up this point the indicator *B* is moved to the position shown at *D*, and the tail-center spindle is advanced to its extreme travel and the test repeated at *E*. This will also show whether the head spindle, although still parallel with the shears, has worn low. All spindles will wear low in time, particularly if heavy chucking work is done. Lathe spindles are usually set from ½000 to ⅝000 in. high by their makers with this in view, and until they get from ½000 to ⅝000 low, it is not necessary to put shims under the headstock or to adjust the bearing boxes.

Testing the Truth of the Center Point

All of these other tests may prove satisfactory, and yet the lathe refuse to do accurate turning on center work. In this case it is due, very likely, to the fact that the live center is not truly ground. This is tested as shown in Fig. 6. A bar is placed between centers, and a spot is turned as shown at *A* as near as possible to the driving

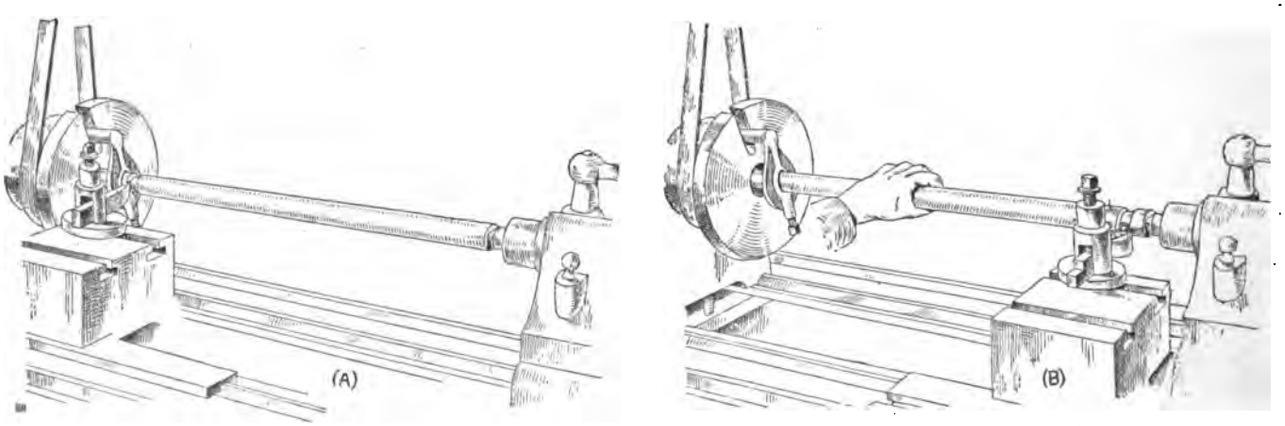


FIG. 6. METHOD OF TESTING THE TRUTH OF THE LIVE-CENTER POINT WITH TEST BAR AND INDICATOR
Exaggerated case of error shown in outline

dog. The bar is then reversed, and with the spot near the tail center it is indicated as shown at *B*. If this spot runs true this shows that the head center is ground accurately.

The space that may be devoted to the subject of the lathe in this small-shop series will not permit of even scratching the surface. When it comes down to the last analysis, however, the lathe is simply a machine to turn out money. The speed at which work is done is a measure of the money that a machine is capable of earning. Keep in mind that springy tools and fixtures do more to cut profits than any other inanimate small-shop enemies, and that rigidity and balanced cutting-tool pressures will do a good deal to increase them. And when you go over the *American Machinist* from week to week, keep your eye peeled for tools and fixtures that bear the earmarks of rigidity.

Machine-Shop Memories—How I Learned to Keep My Elbow Down

By T. E. White

I suppose that every man that ever worked in a shop has had at least one scrap, and I guess I have had as many encounters, bloodless and otherwise, as the next one.

The first real shop scrap in which I was a principal occurred when I was about 15 years old. I was a boy in a gang of five or six men, and we were presided over by a Scotchman named Archie, who had a quick temper, a scathing vocabulary and a ready hand (for a boy). He was one of those old-timers who had been brought up to think that a boy should be knocked about. I couldn't see it that way myself and made up my independent young American mind that I could get along without any knocking about.

I pulled pretty good with Archie for a while. He was a fine mechanic and a man with a fair education, and he did his best to teach me something. If I was filing (and I had a lot of it to do), when I began to tire my right elbow would gradually go up until my arm was extended like a chicken's wing when it is about to fly. Archie believed, and rightly too, that the right arm should be kept close to the body when filing, and to impress his idea firmly on me he used a hammer handle, applying it to my elbow.

Did anyone ever teach you to file by that method? When you are tired, and the men near-by are whistling "Rocked in the Cradle of the Deep," just because your file is "rocking" and it is a hot day, and you are 15, and there is a ball game in the vacant lot next to the shop, and you can see the pitcher "winding up," and then, bang! one strike! right on that tender spot between the bones in the elbow a good hickory hammer handle wallops you, and a raucous Scotch voice that sounds to you like a lathe tool that is set too high, "What in hell is wr-r-rong wie ye, can ye no keep your ar-r-r-m doan?"

I Didn't Like That Man

Well, I can remember to this day how I hated that man, but still, as mad as I used to get, I always had a glimmering of reason. I knew that he thought it was for my own good, and maybe it was good for me, but I don't think it is very good for anyone to be repeatedly angered, especially when that person is just a little bit afraid to show it, and I was.

One day the break came. I had a lot of steel letters and figures to be hardened, and we always heated them in bunches of 4, 8 or 16, according to their size; I was bundling them and wrapping iron binding wire around them. I had a spool of this wire weighing about 2 pounds in my hand, and some of the men were "kidding" me and I was laughing.

Archie came out of the office, where he had been getting a "call" from the super, and he saw me laughing. He came up behind me and hit me a good sound slap on the ear, and started to tell me to mind my work, but he never finished his discourse. All the accumulated venom in my system came to the top, all those raps with the hammer handle flashed into my mind, and Archie got that spool of wire, right in the middle of his forehead just as hard as I could throw it.

Good night! What a row there was!

A New Use for a Bastard File

When he came to (he was "out" for a couple of minutes), I thought he'd murder me. I had nothing to protect myself with but a 14-in. bastard file and the prestige of having floored him. He got up and shook his head and started toward me. I waved the file at him and warned him to keep away. Lord, how that man swore! He was a master of profanity, and he could swear the temper out of a tool in ordinary conversation, but that day he outdid himself. As I said before, he was a man of some education, but what he did was more than educated swearing; it was better than that; it was better than artistic swearing; I don't know what to call it. Perhaps sublime would be the word. Yes, it was sublime swearing. The rest of the men were spellbound, and they claimed afterward that the power nearly stopped, but the only thing that interested me was that he never took his eyes off that trusty 14-in. bastard file. He wound up his great effort with a solemn warning to me never to speak to him again. I never did, but I always think of him when I have a lot of filing to do, and I keep my right arm close to my body.

Use of Portland Cement in Foundry Work

By W. J. Dawson

We find that portland cement gives the best results when dusted on a finished mold. It has been used on all classes of work. One job was some heavy web wheels for blank gears, which had been "scabbing" so badly as to make them unfit for castings. The cement was applied on the molds the last thing before closing them, and a casting free from "scabs" was the result. We used cement right along after that.

One day we had to make a wheel that would take between 900 and 1,000 lb. of iron to pour, with risers and a runner box built up six inches on top of the cope, which was the heaviest part of the wheel. It was swung up, and the metal poured until the mold filled and forced up about two inches into the risers. The mold then started to run out, as the clamp had been put on it. It was a rush job, so three or four men stood on top of the cope, while some others clamped it up as best they could. The wheel was then filled again and cast. The cement held the mold together.

The Small-Shop Planer—I

SYNOPSIS—This article deals with the use and abuse of planers. These machines are often misunderstood, both as to their capabilities and the care needed. The small-shop planer is a relatively big investment, and this and the succeeding article tell how to make it a paying one.

In one part of Clevedelphia, near the elevator works, a narrow alley separates two rows of shop buildings. If you walk down this alley as far as the fire hydrant and then look through the window at your left, you will see the planers in Smith's shop. Cross the street and walk a few steps farther to the telegraph pole and you may peer through a door that will reveal the planer department in Jones' shop. If you are a man who knows planers, you will keep crossing and recrossing this alley for an hour or more in order to gaze your fill on the worst and best in planer practice.

In Smith's shop you will see planers that are seldom oiled until something sticks and must be pried loose. You notice that the feed and elevating screws are dry and covered with dust and that black dirt lies thick on the elevating gears and overhead rigging. Table slots are full of caked dirt and chips, which must be mined out with a chisel, and the vees are as fissured and creviced as the sides of a sandstone quarry.

The machine nearest the window is running on a long-stroke job that reaches the length of the table. It is cutting in the neighborhood of 20 ft. a minute with a two-notch feed and the table is returning at about 40 ft. The planer hand is sitting on a soap box with his back against a post, to all appearances asleep. The heads have reached a position in their travel on the cross-rail where the tools are directly over the planer vees and a rain of chips is falling over the edge of the overflowing platen pockets into the vees at the end of each cutting stroke.

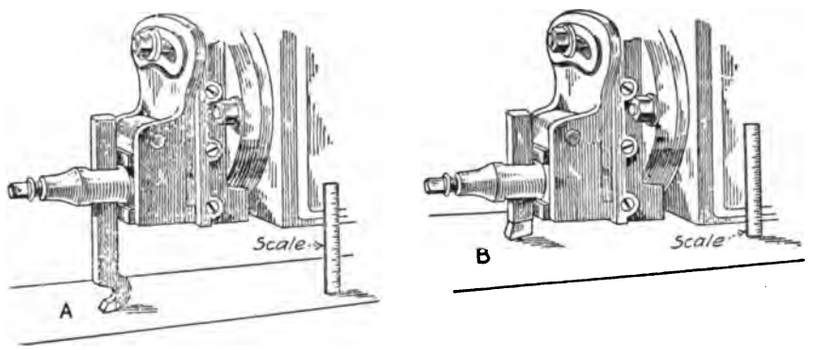


FIG. 1. SIMPLE WAY OF MEASURING RATE OF PLANER DIVIDENDS

Horrible Examples in Smith's Planer Department

Beyond this mutilated machine is another planer, and its table surface is marred and scratched in a horrible manner. If you watch the operator, who is swinging a rough engine base into position, you will see the reason. After the chain is unhooked and the wooden lintel is withdrawn, the sand-crusted casting bangs down on the planer platen and he shoves it into position with a pinch bar.

On the third machine the operator is setting his dogs after clamping a row of castings with C-clamps, gripped with bolts 8 in. away from the casting and 2 in. from the clamp blocks. He has pulled these up with a 4-ft. pipe extension on his wrench and they are so tight that the strain on the bolts almost lifts the planer table from the vees. You notice that he has a hard job trying to stop the table with the tumbler and that it dances back and forth hysterically, until he is forced in despair to grab the belt shifter.

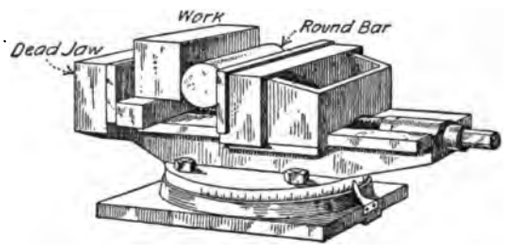


FIG. 2. GETTING TRUE WORK FROM THE PLANER OR SHAPER CHUCK

Tools Ground to Lift the Table

Now he is ready to cut, although the rail is a good 18 in. above the work, and the tool is ground with a lip so that you can hear the "bump," "bump" of the lifted platen as each fresh edge is cut, even above the snoring chatter of the overhanging tool. The machine is taking its feed at the end of the cutting stroke and the edge of the tool is being dragged back over foundry sand and scale instead of over clean metal.

The fourth machine is so far away and the shop is so dark that you cannot tell much about it, except that it is running on short stroke and that the work is directly in the middle of the platen. The belts are squeaking a bit. What is that stuff the planer hand is sprinkling on the pulleys? It looks like powdered rosin.

It is a pleasure to cross the street and see what is going on over at Jones'.

There is no dust on the planers and the oil on the feed screws has a golden color, which shows that they are cleaned so frequently that black sludge has no time to gather. Table slots and holes are protected with false pieces except those which are in actual use. Evidently care is being taken to keep the vital vees in good condition, for although there is long work being planed on one of Jones' planers, you notice that the table pocket is surrounded with a sheet-iron guard which keeps the chips from falling over the end.

Jones' tables are almost as smooth as the day he bought them, for he uses strips of belt leather under the rough castings when they are moved about. You notice

that the planer hand on the nearest machine is carefully filing down a burr which has been raised in some accidental manner.

Jones Wants Speed as Well as Carefulness

Look as hard as you can and you will not notice many C-clamps on these planers. They are too slow for Jones,

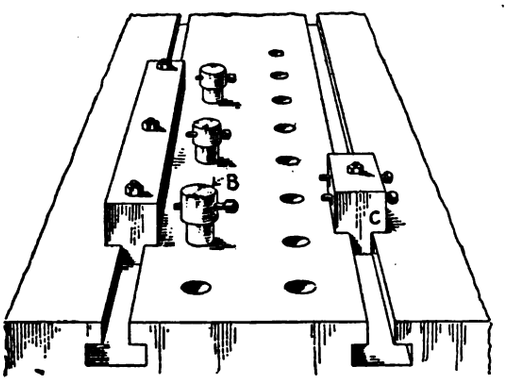


FIG. 3. SCREW STOPS AND A SQUARE STOP BAR FOR RAPID CHUCKING OF FLAT WORK

who wants speed as well as well-cared-for equipment. Instead of these, you notice that the work is held with ingenious clamping strips and screw stops which are applied in a jiffy. The tools are ground so that the castings do not lift, which is one of the reasons that such convenient devices may be used.

In this shop the planers that are running on short stroke have the work at one end of the table or the other, so that the wear will not all come at the center of the vees. There is no trouble with the belts, which

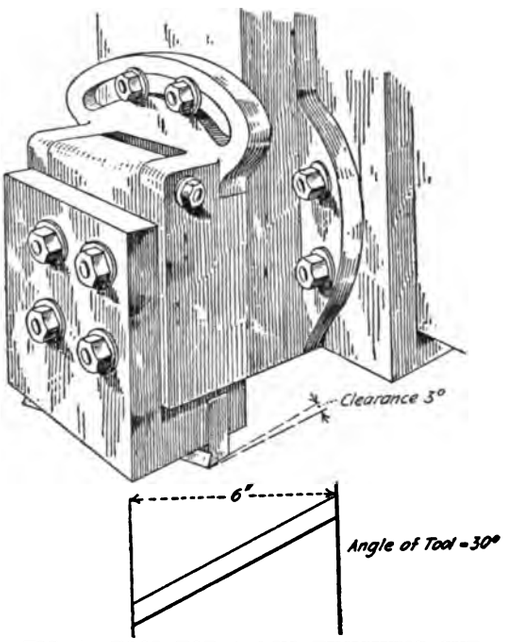


FIG. 4. TOOL FOR A 6-IN. FINISHING CUT

are endless and have the appearance of being cared for at frequent and regular intervals.

Making It Easy to Make Mistakes

There have been a number of expedients invented to enable men to do things easily in the wrong way. One of these is a goose-neck planer tool. There is some excuse for a goose-neck tool in a lathe tool-post, because the tool-post itself is not rigid, and the tool must in this case make up for the deficiencies of the post. Where you have such a massive, solid tool block as on the planer head, the only possibility of digging in comes through spring of the tool itself. A goose-neck tool, such as shown at *A*, Fig. 1, will enable you to scrape a casting fairly

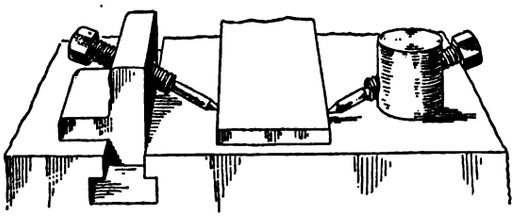


FIG. 5. PIN CLAMPS FOR THIN WORK

smooth. A finishing tool such as shown at *B*, in the same illustration, ground with not over 5-deg. clearance on the bottom, gripped close in the tool block, and with a rail as near to the work as it can be got, will never dig in, will give you as smooth a surface as the goose-neck, and in addition to this, one that will be as true as the planer vees.

You can pretty nearly figure planer profits by measuring between the top of the work and the bottom of the

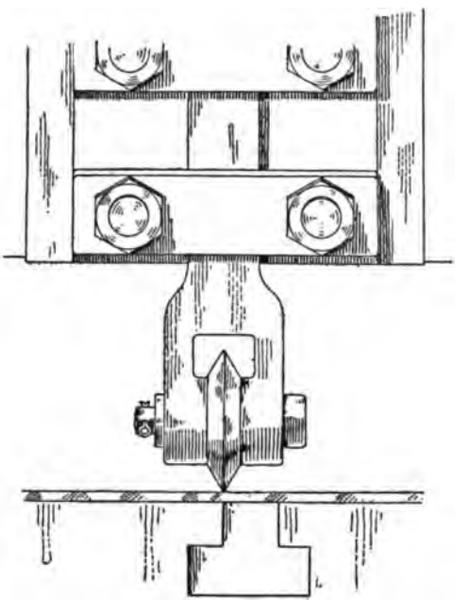


FIG. 6. SPLITTING SHEETS ON A PLANER

cross-rail, as shown in Fig. 1. The greater this distance, the less is the profit, because the rigidity will be reduced.

True Work from the Planer or Shaper Chuck

The kink shown in Fig. 2 is worth repeating in this article because it is overlooked in so many shops. When you work with a planer, shaper or miller chuck, you must always figure on the solid or "dead" jaw for the alignment of a piece which has to be squared up. The movable jaw of the average chuck is not to be relied upon. Placing a round bar between the live jaw and the work forces the latter against the true surface of the dead jaw and helps produce square results.

A great deal of time is lost on planers in putting on too many clamps with too little judgment. A properly ground planer tool will not tend to lift the work; the thrust will be down and against the motion of the platen. A piece properly stopped endwise does not need much clamping and can be held sidewise by means of such stops as are shown in Fig. 3, any one of which may be applied in much less time than the customary U-clamps. The square side-bar, in connection with the smaller screw-stops *B* and *C*, in reality takes the place of a planer chuck and will earn dividends on a large class of work.

A great deal of time can be saved on planer work on the finishing cuts, especially where extreme accuracy is not required. The tool shown in Fig. 4 is one capable of taking a 6-in. cut and of being fed at the rate of 4 in. per stroke. The cast-iron block which holds the cutting tool is bolted solidly to the clapper block and is very rigidly supported. A tool of this kind, if given a shearing cut, will do excellent work without any tendency to dig in, but it must be carefully set in its holder, to have the cutting edge dead level with the planer platen.

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Machine-Shop Memories—Circumstantial Evidence

By T. E. White

I was once in a shop that had some strict rules against fighting. The foreman was a big, quiet man and awfully strict, although I must say he was a just man. One of the men there was named Fritz. Fritz was big and he had the impression that if he ever died or quit, they would have to get the best man in the world and redesign him to bring him up to the requirements, and then maybe the shop would be able to stagger along for a year or two. Fritz and the superintendent came from the same town in the old country, and he was supposed to have a pull. As to that, I never found out whether he did or not, but I know he had no pull with me.

Butting in on the Job

I had worked about an hour one day, chucking a job in a lathe, and had gotten it just right. In going to the bench for my calipers, I turned my back to the lathe for possibly five minutes. In the meantime Mr. Fritz came along with a piece of shafting in one hand, a scraper in the other and laid the shaft on the shears of the lathe I was working on and proceeded to calmly loosen up the chuck jaws. I turned around just in time to see my job fall into the chip box.

I had left a tool in the tool post to hold the lathe, that being the shop rule, so I walked quickly over to the lathe and asked Fritz why he took my job out when he saw a tool in the tool post. His answer was not calculated to cool my rising wrath. He said he took the job out because he wanted to and asked me, "Vat you going to do about it?" I bounced around the end of that lathe and proceeded to demonstrate to him.

In going around the lathe I took hold of the tailstock to assist myself and in some way cut my wrist to the bone, I never found out what did it and in fact I was so mad I didn't notice it then, but I knocked Mr. Fritz head-over-heels over a pile of castings. He jumped up and came at me with the scraper, just as the foreman grabbed him. I thought I was fired *sure*, but by luck I got out of it. The foreman held an inquiry right there, and I told him what Fritz had done and said that when I protested to him in a mild way he had stabbed me with the scraper, and showed my wrist to prove it!

There was a man near-by who said he saw Fritz do it and another who was willing to swear that Fritz had made threats against me several times in his presence. That settled Fritz. He was so angry he couldn't make himself understood, and the foreman told me to go back to my work, and he had Fritz transferred to another department.

Put the Back Gears on Your Temper

I have had a lot of scraps in my life and every one of them could have been avoided if I had used a little common sense and had put the back gears on my tongue and temper. I'm nearly 40 now and I don't do those things any more, because I never got anything out of those escapades except a little fun and excitement. I never remember being called up to the main office after one of my scraps, and, while getting my pay raised, told that I would have to take charge of the shop because I was such a good fighter I would make a good boss.

No, boys, it don't pay to be a scrapper.

✤

A Miller Job on a Drill Press

By H. W. Johnson

During the fall of 1914 I had a hand, as toolroom foreman, in equipping a plow factory. The machinery was only partially set up, when one day the forge-department foreman said he wanted dowel holes in some drop-forging dies that had been made by an outside firm. The dowel was to keep the die from creeping in the hammer, and he wanted the hole elliptical, 1 3/16 x 2 1/16 in. and 1 in. deep, to allow some adjustment across the hammer when keying up. The dies were too heavy to swing in the lathe, we had no miller, and the only drilling machine that was set up for use was of 18-in. swing with no back gears.

We did the job on the drill, the first operation being to drill a 5/8-in. hole 1 in. deep, then to put a 1 1/4-in. drill down to the same depth. The speed was too high for the large drill on the hard metal, but by using fuel oil as a lubricant we got the hole down to the desired depth. Then we made a boring bar from 1-in. round cold-drawn steel, with a cutter set in the end at an angle, so it projected a little ahead of the bar.

This bar was guided by a heavy steel strap, in which a 1-in. hole had been drilled. Both bar and strap were cyanided.

With the strap bolted in place and the upper end of the bar in the drill chuck, we bored the hole in the die out to 1 3/16 in. The strap was then moved over so as to sweep the 1/4 in. from one side of the hole, so as to make it 1 3/16 x 2 1/16 in.

✤

By Far the Largest Copper Producer in the World is the United States; in fact, we produce more than all the rest of the world together. In 1845 the production was 224,000 lb.; in 1913 it was 1,224,484,098 lb. The total production of the United States from 1850 to 1913 was 18,857,476,910 lb.

The Small-Shop Planer—II

SYNOPSIS—In this article the foundation of the small-shop planer is described. Tests are given for leveling the bed, for setting the zero point of the saddle swivel and for the accuracy of crossrail. A reason is given for the difficulties sometimes met in speeding up old planers.

Planers may be divided into two classes—those that have legs and those that have not. It is an advantage to buy a planer that has no legs, because then you can use judgment in placing the points of support under the bed and keep these away from the extreme ends. Four-legged animals are given by nature an overhang at each end, unlike four-legged planers and lathes, on which the supports are almost invariably attached to the four corners.

The majority of shop owners do not balk at giving the planer a concrete foundation, but unfortunately make the mixture of sand, stone and cement and forget the most important element—brains. They think it sufficient to make a good level foundation, wedge the bed until the platen shows level and then grout in solid under the edges. **Here are two mistakes: A level platen does** not always mean level vees, and vees will wear low in the center, the result being hollow work. The center of a planer bed should be set one or two-thousandths higher than the ends.

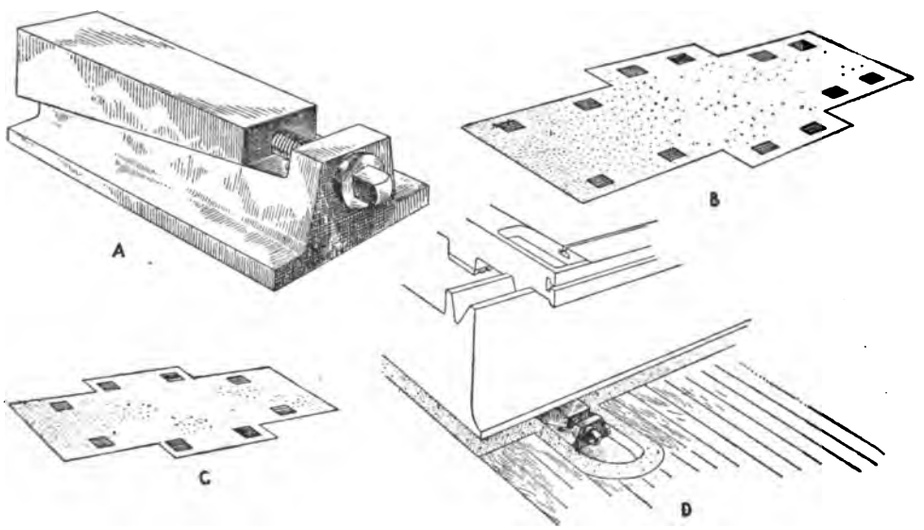


FIG. 1. PLANER WEDGES AND THEIR CORRECT SETTING

The best planer foundations are provided with cast-iron wedge blocks like those shown at *A*, Fig. 1. These are set into pockets in the concrete foundation and are spaced as shown at *B* and *C*, for large and small planers of the legless type. These pockets are carried out from the machine to admit the wrench and have cover plates as shown at *D*. A planer mounted in this way may be leveled in an hour or two and kept in shape to turn out A1 work.

After the adjustable wedges are set it is not difficult to level a planer bed. The necessary tools are two accurately sized cylindrical plugs like those at *A*, Fig. 2, the test bar *B* and the precision level. Planers, having end legs, are leveled crosswise only, except at one end. The legless breed are level both ways, as shown in Figs. 2 and 3, proceeding as indicated by the dotted lines in Fig. 4, working to both ends from the center.

The absence of a precision level does not need to keep the small-shop man from leveling his planer bed. A few gallons of kerosene oil and some odd lengths of pipe will do nearly as well. The vees are dammed at each end as shown at Fig. 5 and connected together with a pipe at one end to maintain the level. A surface gage on a block which fits the vees is moved along and carried from one side to the other, the wedges being adjusted until the liquid surface is at the same distance from the gage point at all places.

Capillary attraction makes the liquid surface rise to meet the needle as seen under the magnifying glass. This occurs when the needle point is about two-thousandths of an inch above the surface, and this fact can be used as a guide in leveling.

Very frequently even new planers refuse to plane square on the down feed when the saddle swivel scale is set at zero. When a real planer hand tackles a new machine his first act, after oiling it up, is to find its errors, and he goes after a new zero line for the saddle scale as shown in Fig. 6, using an accurate square and a test indicator held in the toolblock. It is deplorable that machines should be sent out in such condition, and possibly more so that the planer hand when he tackles his new job can depend for the accuracy of this point neither on the tool builder nor on the management of the shop.

Considering the backlash of the elevating screw gears, lost motion in the elevating nuts, wear on the threads of the screws, the short bearing that the crossrail has on the housings and the weight of the crossrail itself, it is a wonder that any planer can plane square with the table after the crossrail has once been moved. This rail alignment is maintained principally by the elevating screws, and a common practice is to take out any backlash by lowering the rail a bit farther than necessary and then raising it. When the elevating screws are kept free from grit, well oiled and are accurate to begin with, this practice will do for ordinary work. For close work it is best to test each rail setting with an indicator and test bar shown in Fig. 7.

The thing that wears out most quickly about a planer is the patience of its operator when the driving belts get cantankerous. The rest of the machine, due to its bulk, general laziness and the fact that it takes a breath-

ing spell at the end of every stroke, seems to render it more or less invulnerable against common diseases that attack smaller and frailer machines. When you buy a planer you buy it for a long while, especially if it is a large one. Lathes are given by shop appraisers an aver-

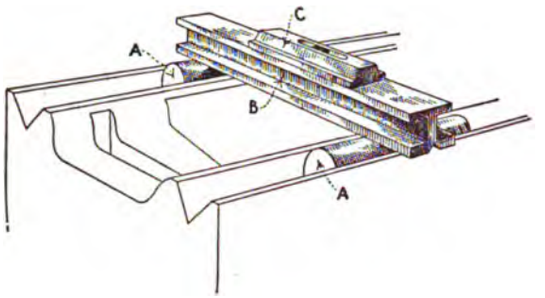


FIG. 2. CROSS LEVELING WITH PLUGS AND TEST BAR

age life of ten years, whereas a planer, if it is a large one, is allowed twenty-five years.

One can easily get apparatus with which to measure the accuracy of round work, but most shops are rather short on means to measure the flatness of work after it comes from the planer. Possibly if lathes were allowed to operate as long as they produced work which was as

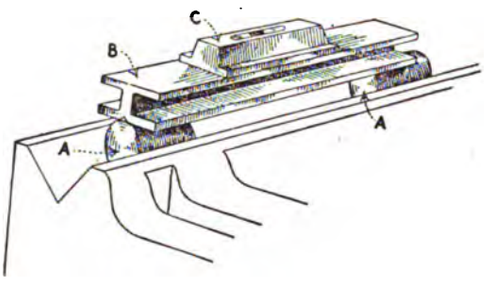


FIG. 3. LEVELING THE PLANER LONGITUDINALLY

nearly round as some planer work is nearly flat, their claim on existence might also be considerably lengthened.

In spite of this, when carefully cared for and properly operated the planer is the basis of the accuracy of all other machine tools. Upon it is produced the final shape of nearly all flat sliding surfaces, which, while they may be further smoothed up and rectified by hand scrap-

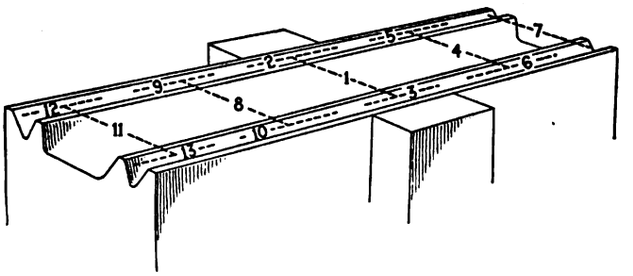


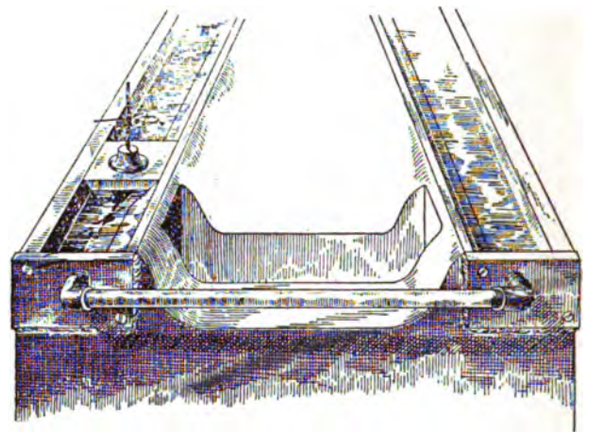
FIG. 4. SEQUENCE OF LEVELING OPERATIONS ON PLANER

ing or grinding, must owe their initial and a great part of the final measure of accuracy to the planer.

The fact that planers have a reputation for long life leads to some hard usage and abuse. One is likely to regard the planer as a heavy chunk of metal capable of standing most anything, while in reality an *accurate* planer is a delicate machine. There would be a much heavier mortality rate among human beings if they wore their vital organs outside of their ribs, in as exposed a position as are the planer vees.

It is a rare thing to find vees that have been used for any length of time that are not scratched, or more likely corrugated with deep gouges and crevices. If a planer table looked as bad as that at the end of its first year the shop owner would make a noise like a question mark and somebody would get "his" for abusing an expensive machine. As long as this damage is done in the vees, where it is much more harmful, no questions are asked.

One disadvantage about having in a shop such a long-lived machine as a planer is that it gets old-fashioned before you feel willing to discard it. Planers designed



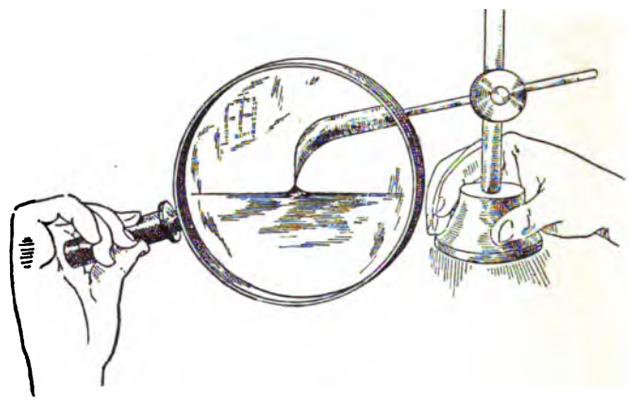


FIG. 5. LIQUID LEVEL FOR SETTING UP PLANER BED

and sold five years before the advent of high-speed steel are still in their prime, so to speak, and have five or six years more of useful work ahead of them. These hale and hearty old boys are slow movers, being geared to run between 15 and 20 ft. per min. on the cutting stroke. Nowadays planers are made to run between 40 and 60 ft. on the cutting stroke, and while it remains to be seen whether their lease of life would be as long as that of their predecessors, it is a sure thing that they are doing business at a much faster clip, which is really a matter of much more importance.

Respeeding an old planer is not an easy proposition. There are two things that you buck up against in inducing one of these old fellows to try and get a gait on. One of these obstacles is the inertia of the moving parts, and the other is belt troubles.

It is a quite common idea that the great amount of power required to reverse a planer is due to the weight of its heavy table. Speed is what counts with the inertia of planer parts as well as with a bullet, and I for one would much prefer to stop a trolley car by standing on the track than to get into the path of one of those little sharp-pointed quarter-inch high power rifle bullets, notwithstanding that the car weighs over 100,000 times as much as the bullet. The thing that makes it hard to reverse a planer is the inertia of the driving and overhead pulleys, which have to be brought to a dead stop and then reversed within such a short period of time. Some mathematical genius has figured out that it takes from eight to twelve times as much energy to bring these rotating parts to a stop and reverse them as it does to reverse the planer table. The same mathematical man has figured out that during the course of a busy day a pair of planer belts slips an average of 5 miles. I do not doubt this a bit, having known planers with such belt-slipping tendencies that could they have been applied to the transportation of the planer itself would have moved one of them from New York to San Francisco in record time! When you sense the odor of something burning near a respeeded planer, investigate before you pull the firebox. Scorched belts,

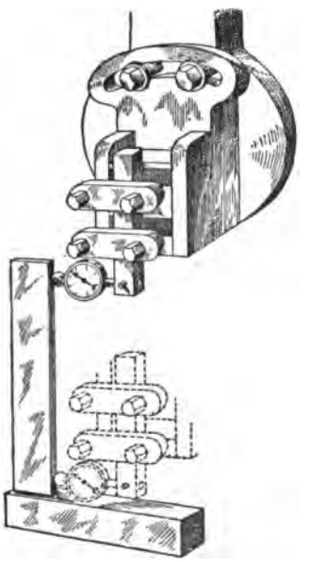


FIG. 6. TESTING THE SADDLE GRADUATIONS

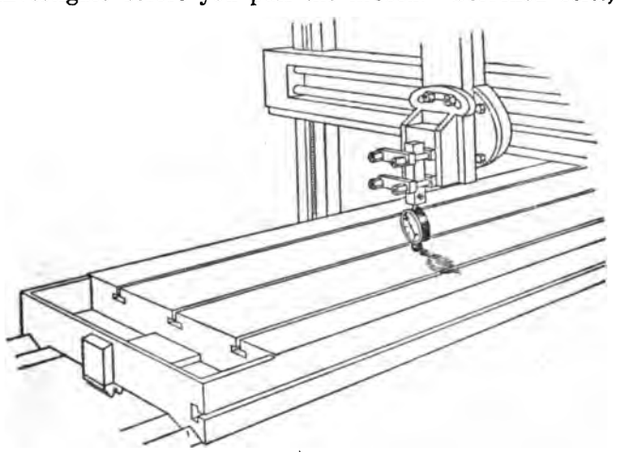


FIG. 7. TESTING ALIGNMENT ON PLANER CROSSRAIL

which have been heated to the burning point by the friction of slipping, are probably responsible.

Planer belts should be endless, as the constant shifting from tight to loose pulleys is destructive to all forms of laced joints.

Double belting is best, because it will not stretch as quickly as single belting, and therefore requires less cutting. Don't cuss the planer for being hard on belts, for it is the nature of the beast, and none of them are not. Rather accept this as a necessity and go over the belts once a week, cutting them and making glued joints where necessary.

The old-style planers did not encounter these troubles because they did not run fast enough. Belts might squeak once in a while, but did not often burn, and there was no necessity for making countershafts and driving pulleys of aluminum to lessen their inertia. It is when you come to urge upon these old-fashioned designs the necessity of running at modern speeds that planer troubles begin. That is why one shop owner who speeded up the drive in the planer department, although he maintained the same piece prices for planer work, received complaints from his planer hands that they were unable to earn as much as formerly. Modern planers are geared to take care of these troubles, and at proper cutting speeds and return speeds, without making much fuss about it. They are made to rough-cut cast iron at from 40 to 50 ft. per min., steel castings and machinery steel at from 30 to 35 ft. per min. The return speeds are from three to four times as great, 100 ft. per min. not being considered high.

On the whole, it is better to increase the feed on old planers than to try to get them up to a point where their speed compares with those of modern design.

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Unscrewing Cylinder Studs

By R. L. Albernathy

In 1898 I worked night shift in the repair shop of the Illinois Steel Co., at Joliet, Ill. Early one night word came that the engine running the rod mill was wrecked. The connecting-rod strap had broken and, among other damage, the piston had knocked off the cylinder head, breaking the studs flush with the face of the cylinder. There were 16 studs, 1¼in. diameter and 2½ deep. The foreman said: "Get those studs out; they are in good and tight, and as we have no portable drill you will have to get a ratchet, and drill them out."

While clamping the "old man" against the cylinder my helper, an Englishman, said: "Say, young fellow, if you want to get them out in a hurry screw them out with a screwdriver in the ratchet."

I asked him if he had ever seen it done, and he said he had, in the old country. The ratchet I had was well suited for the task, being of heavy construction and having a socket for square-shank drills. So I got the tools with which to fit a screwdriver to it, about ⅛in. thick at the point. I then chipped a slot across one stud, placed the ratchet in position, and screwed the feed screw out until there was no give to the "old man." Setting the pawl to work left hand, I told the helper to screw her out. Although he had a 20-in. handle, he could not budge it. We then put a 3-ft. length of pipe on the handle and came down with a steady pull, when the stud started.

The rest was easy. As he pumped the handle up and down I eased up on the feed screw. We got all but one out that way, and were drilling that one, along toward quitting time, when the foreman dropped in. Seeing the circle of empty holes, he said: "You are pretty handy with a ratchet drill." Then his eyes fell on the studs lying in a pile and he tumbled.

The Small-Shop Drilling Machine

SYNOPSIS—Pound for pound this is the small-shop machine that earns the money. It is the champion light-weight work producer, but often is kept in too poor condition to make a good showing. This article deals with the possibilities of the common drilling machine in the small shop.

Water seeks the lowest level and manufacturing operations seek the minimum rate of pay per unit of output. Hence the drilling machine. It is the "low-rate" tool, and 999 out of every 1,000 machinists shake hands with

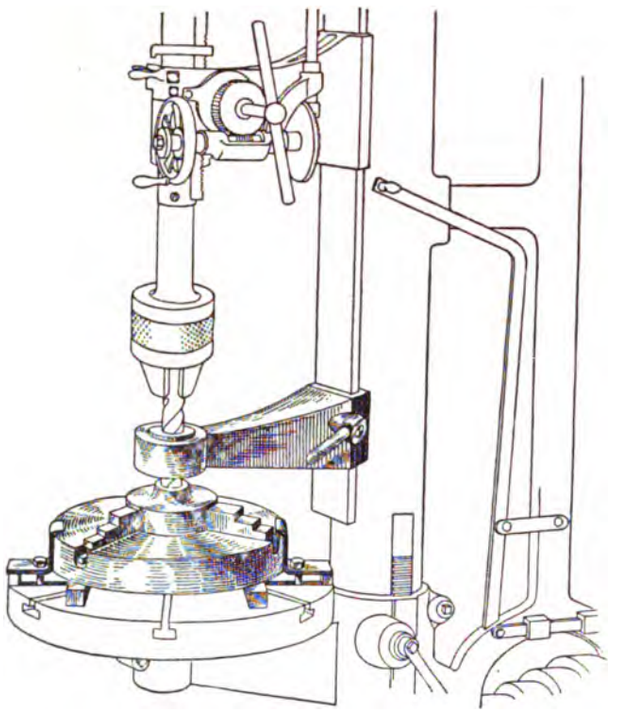


FIG. 1. AN ADJUSTABLE UNIVERSAL CENTERING JIG

a drill lever as soon as they graduate from the tool crib. A full-fledged "machinist" would as readily act as the chauffeur of a wheelbarrow as run a drilling machine continuously. It is the 'prentice boy's and the handyman's tool—one that is regarded with some disdain as too simple and easy for any one "out of his time."

All this is quite proper, for a machinist has no business running a drilling machine, any more than a Ford needs a locomotive engine to pilot it over the road. It is true that a high-priced mechanic can turn out a job on a lathe almost as well as a cheap boy can do it with jigs on a drilling machine, and the cost of his doing it won't be much over ten times what it costs for the boy to do it; but somehow this doesn't appeal to a shop owner. Six spindles with a two-dollar-a-day operator against one spindle with a four-dollar-a-day mechanic look good to most of them.

Don't take this as a slur on machinists, for there are few things on earth more worthy of respect than the skill of a real mechanic, and it should not be degraded by doing work that inferior skill can accomplish. If machinists realized this truth and the fact that there will always be plenty of high quality work for those able to do it, their trade would become an automatic self-ele-

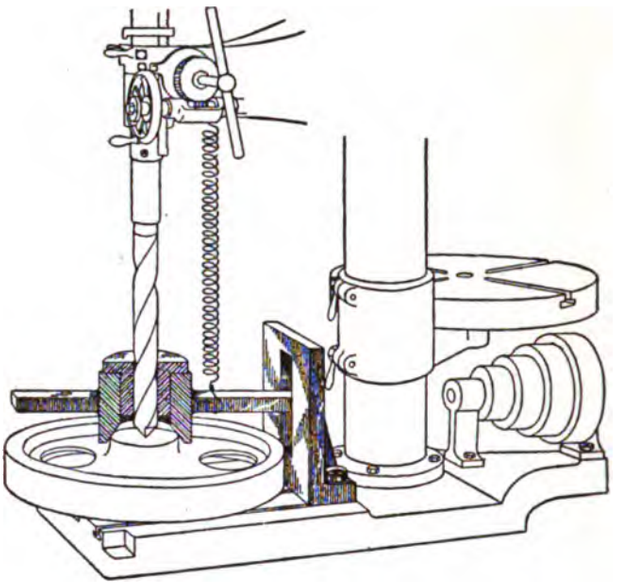


FIG. 2. MAKING THE DRILL ITSELF LOCATE THE WORK

vating one, and none of them would pin their faith to the restricted-output fallacy.

A restricted view of the possibilities of the drilling machine, especially in manufacturing, is a drawback that costs shop owners much money. You can hardly imagine an article more desirable to make, as far as cost is concerned, than one on which every operation could be

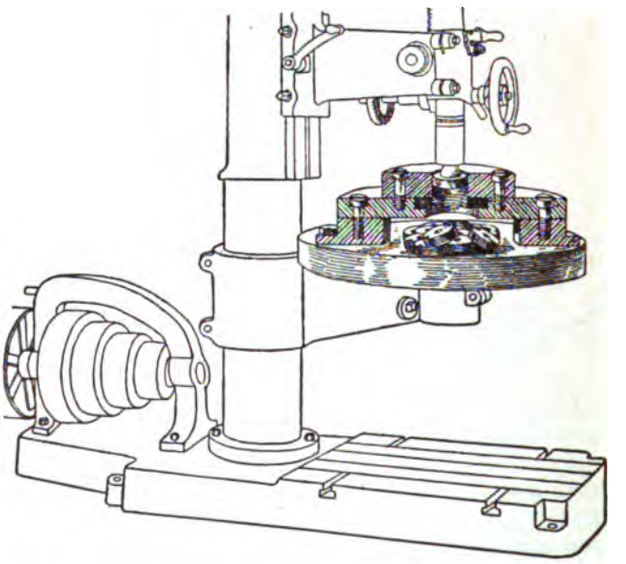


FIG. 3. THREADING PLUGS ON THE DRILLING MACHINE WITHOUT REVERSING THE SPINDLE

performed on drilling machines. There are signs that this fact is recognized in some progressive shops, as long rows of drill spindles will testify. When you plan to manufacture a new machine or other product, get as

much of it on the drilling machine as is possible, even if you must use a mallet on the head of the draftsman to accomplish this end.

Jigs and fixtures cluster around this machine tool as naturally as kids collect in front of circus posters. Take the jigs away from the machine and the kids away from the posters and the value of both is greatly reduced.

There is no reason why drills should monopolize nine-tenths of the existant jigs. The reason for their doing so is part and parcel of the necessity that has followed the classification of this machine as a low-rated tool. Some day you will see as many lathe jigs as drill jigs. The procession has already started so far as the miller is concerned.

Jigs will make a poor, old, decrepit machine that can't bore within ⅛ in. of true turn out work to the thousandth limit. It makes no difference if the table springs ¼ in. when the feed is on as long as the jig guides the

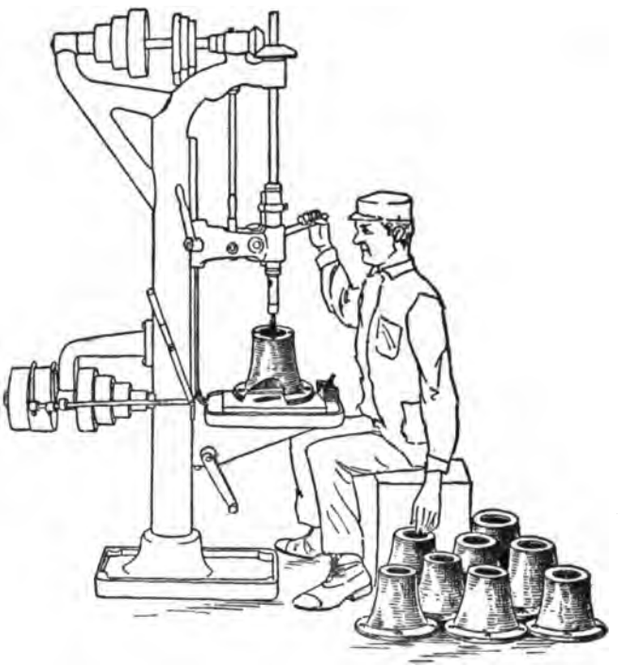


FIG. 4. QUICKER THAN BACKING THE TAP OUT OF THE WORK

tool and there is a flexible connection between it and the erratic spindle. Accuracy and brains are built into the jig; the cost of the piece is reduced before the first one is made; chucking becomes a matter of tightening a thumb-nut; calipering is abolished; squaring up and measuring are eliminated—all because the drilling machine has been delegated to the apprentice and the handyman.

Shops in which this machine is regarded as a thing with which to punch holes lose sight of its usefulness. Aside from drilling, reaming, tapping and facing, you can bore accurately and economically. With box tools you can turn a variety of short-end work; you can keyseat with it and cut keyways, and with the aid of a compound slide you can end- and face-mill. It has even been used for punching and forming thin metal, for broaching and as an arbor press.

Perhaps it is the inherent ability of the drill that makes it possible for the boy who has associated with one for a few months to get a job as a full-fledged machinist in somebody else's shop when business is good.

As a result of its being a "low-rate" machine, the brains must be furnished by the management in directing its usefulness. There are so many possibilities along these lines that I can merely point out a few for the guidance of small shops.

It takes more brains and ingenuity to make a cheap jig good enough for the job than it does to produce one

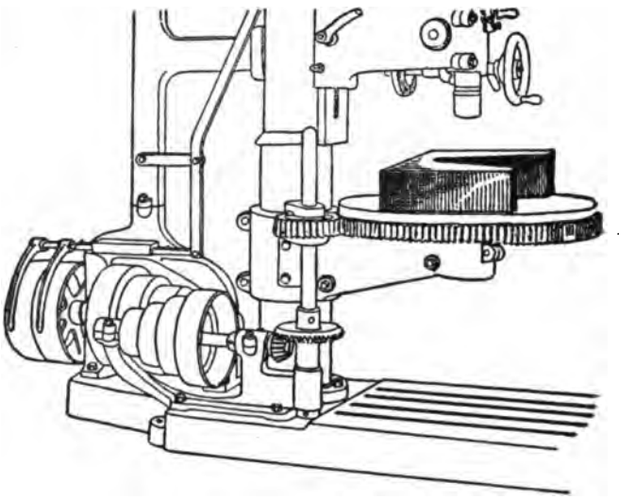


FIG. 5. DRILL BLOCKS PREVENT THE SPREAD OF SMALLPOX MARKS ON THE TABLE FACE

of the high-grade specimens of the toolmaker's art that is polished and star-spotted. Unfortunately, those who have these crude appliances are somewhat ashamed to show them, although they should feel just the other way about it. A jig built on the lines of 10,000-part production for a total output of 50 or 100 pieces is a case of

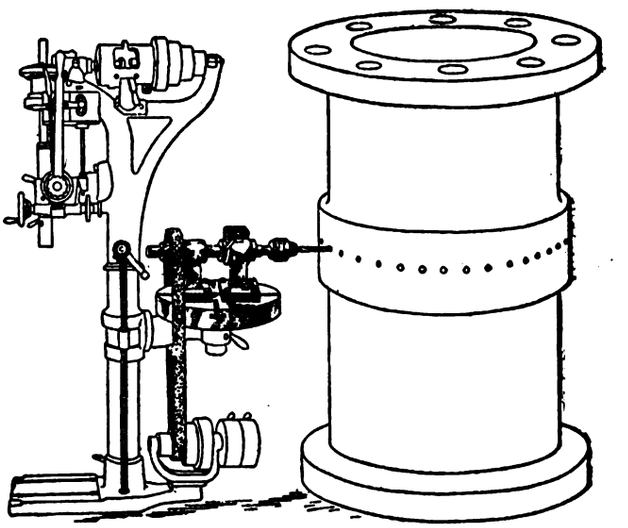


FIG. 6. THE CHAMPION QUICK-CHANGE ARTIST AMONG MACHINE TOOLS

the most foolish lack of judgment. Fitness for its work is the final test of a machine as it is of a man.

Wooden jigs are of great use on small lots; so also are sheet-iron contraptions that would be laughed at in the big plant. Keep a set of standard bushings and make the jig bodies of hardwood. They will do the trick as well as cast-iron ones and won't be as hard to lift.

A small chuck clamped to the table with a central bushing holder, adjustable in height by sliding on the column, forms a universal jig for round work bored centrally. It converts the drilling machine into a formidable chucking lathe, especially when quick-change sockets are employed. Above all, insist that the drilling machine be treated as a machine tool and be not abused. Once a year is not often enough to oil it, and a small-pox-marked table surface reflects more disgrace upon the shop owner than upon the careless boy who produced the blemishes.

Comfort for the Disconsolate

One word of encouragement before I finish. You, like myself, no doubt have seen the wonderful accounts of tests on high-speed drills, in which they pass through iron so rapidly that it makes you dizzy to think about it, and you wonder how the operator has time to throw out the feed in time to prevent the drill boring on into the cellar. You, like myself, no doubt, have tried to equal these results and failed and wondered why. Courage, my friend; the case is not hopeless after all. All that is lacking is the right kind of iron—the kind that you can whittle with a penknife and bite hunks out of with your teeth. If you want to equal or exceed those records, try drilling a piece of cheese—it will be as serviceable for use as some of the ones that these tests are made from.

✦

Machine-Shop Memories—Boiling Over

By T. E. White

Along toward spring one of the fellows got a nice big healthy boil on his neck. It was on the back of his neck, a favorite location for boils.

His names was Jones, and he was a great fellow for preaching. He was a red-hot Methodist and was opposed to drink and tobacco and never neglected an opportunity to air his views about the use of those commodities. One of his habits was to tell any young fellow that he saw taking a chew that a hog wouldn't eat tobacco. This may be an indisputable scientific fact, and no doubt it would interest anyone who was fond of natural history, but I never knew it to fail to produce an immediate and violent outburst from the one who was being informed. But Jonesey kept right on reforming (?) the bunch, and when he got a cold along with his boil, we were all secretly pleased.

A Bum Job for an Invalid

Jonesy was feeling miserable one night, and when he came in he got a rotten job. He had to take the job that was in the lathe when he came to work, and it was one that a well man detests, to say nothing of a sick one. There were about 100 fiber gaskets to cut out and they were, as near as I can remember, about 16 in. outside, 14 in. inside diameter and ⅛ in. thick. He had a board bolted to the faceplate, and he fastened the square pieces of fiber to this with wood screws, cut out the inside, and then cut out the gasket.

Along about 9 o'clock that evening my friend Frisco Jack says to me: "Jonesy's got a bum job there; I wonder if he'd swap with me *tonight; I feel* kinda sorry for him, he's sick; I guess I'll ask *him about it.*"

I was amazed. I had never *heard of* such a thing. Here was Jack, with about 10 big tool-steel plates to face off and and nothing to do but watch his cut run for about 30 minutes at a time, and yet he wanted to take that bum job off Jonesy's hands. I looked at him for a minute to see whether he was in earnest, but he seemed to think that there was nothing strange in his conduct, so I said, "Well, if you're chump enough to do that, go ahead and do it."

Over went Jack. "Jonesy," he says, "I'll swap jobs with you if you like tonight. You ain't feeling good and I got a snap, so you might as well be sitting down while you're standing up. It don't make any difference to me what I do."

I thought Jack was showing a good spirit and acting like a true shopmate. Not so Jonesy, however. He looked up and snapped at Jack: "No, I don't want no help from you or your friend (that was me). When I get so I can't do my work I'll stay home." "Well," Jack said, "don't get sore, Jonesy. I didn't mean any harm. I just thought I'd help you out."

Hogs and Tobacco

Jonesy didn't reply, and Jack came quietly back to his lathe and asked me what I ever did to Jonesy that made him refuse to have anything to do with my friends. I told him nothing that I knew of except that I had once taken a chew in his presence, and he had as usual told me that a hog wouldn't put tobacco in his mouth, and I had replied that neither would a certain two-legged hog of my acquaintance.

Jack laughed, and so did I. Jonesy happened to see us laughing and came over and bawled us out for making fun of an afflicted man. The foreman came along then, and we cut out the argument, and didn't renew it for a while.

After lunch Jonesy had to give in, and asked for a different job and the boss gave him some castings to lay out. I was downstairs after some stock, and Jonesy was leaning over a vise, setting his surface gage. Up over his head, on a ladder, one of the electricians was putting up a lamp connection.

Slippery Footing

The bottom of the ladder was provided with spikes, but the spikes were resting on some scrap sheet iron on the floor, and just as Jonesy was getting interested in his work the ladder slipped and down came a 170-pound man and a ladder on the back of his neck. It burst the boil, mashed his nose and broke his false teeth. Jonesy had just got his face washed and was beginning to find out how badly he was hurt when I came back upstairs and saw him. "Good Lord!" I said. "Did you hurt yourself, Jonesy?"

Jonesy roared like a lion and reached out and handed me the prettiest punch on the nose I had ever received, and I took it without a word; I couldn't say anything. I realized that he had to do it. He was too good a Methodist to swear, and he had to get the bile out of his system somehow, and I happened to be the goat. Well, I guess Jonesy got a lot of good out of that punch!

Around Small-Shop Babbitt Fires

SYNOPSIS—Babbitting is an important art in the small shop, and in the repair shop especially there is a great deal of this work to be done. This article takes up some of the practical points to be considered in babbitting and gives the composition and uses of lead-, zinc- and tin-base alloys.

The blacksmith's forge is the small shop's babbitt fire, just as it is frequently its brass- and aluminum-melting furnace, its shrink-fit producer and its coffee and sausage heater. As an all-around convenience it is hard to beat—sometimes comprising as well the principal part of the shop-heating apparatus.

When "Old Man Babbitt"—not the B. T. Babbitt of soap fame, by the way—produced his concoction of copper, antimony and tin he little dreamed of the array of mixtures to follow. His name has stuck to these as closely as a spattered drop of the metal itself sticks to a new suit of clothes. Every mixture that contains over 80 per cent. of tin is now known as "genuine babbitt."

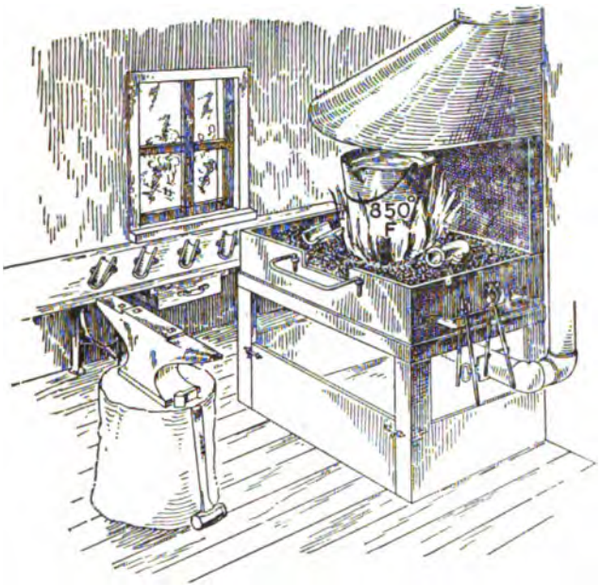


FIG. 1. THE BLACKSMITH'S FORGE IS THE SMALL-SHOP BABBITT FIRE

FIG. 2. INSURING A SMOOTH SURFACE WITH CLAY WASH DIP

While there are so many varieties of metal, there are really but three kinds—those that contain tin as the base or major part, those with zinc as the base and those with lead. If your present practice is to remelt scrap, type slugs and tin cans, call the result bearing metal, and wonder why you have poor results, you will do well to reform and use one or more of the following mixtures.

The tin-base metal is a high-grade bearing metal which is expensive because of the high percentage and high cost of tin. The composition is as follows: Tin, 77 parts; lead, 17 parts; antimony, 7 parts; copper, 6 parts. This is known as a "copper-hardened" metal and is the stuff to use in the bearings that you want "high grade." It will run thinner, wear better and cost more than the other two mixtures which follow.

It is not enough to chuck these metals into a melting pot and melt them together. The result would be more like the discard from a type foundry than good bearing metal. Get a crucible and melt the copper in it first, then add the lead and antimony. Use plenty of powdered sal-ammoniac as a flux and protect the surface of the molten metal with a layer of sawdust or powdered charcoal. Stir well and do not get hot enough to show red. Run this mixture into pigs in an iron mold and let it cool. If you want to sound like a metallurgist, call it the "hardener."

Next melt the tin, or "base" metal, all by itself. When this is accomplished and the dross has been skimmed, add the "hardener" a bit at a time until it also is melted. Use plenty of the powdered sal-ammoniac flux and stir well, so that the different elements can get thoroughly acquainted. Then pour into iron molds and you have a babbitt metal that will answer for your best work.

Cheaper Mixtures Based on Lead and Zinc

The second mixture is the zinc-base metal. It consists of 77 parts of zinc, 17 of tin, 7 of lead and 6 of copper. In this case the tin, lead and copper form the "hardener," and are first cast into pigs before adding to the zinc. Do not melt zinc by itself in an iron pot. The bearing metal made from this composition casts well, wears well and is of medium cost.

Finally comes the "lead-base" metal, which is good enough for slow-speed bearings under moderate loads. It consists of lead 77 parts, tin 6 parts and antimony 10 parts. The tin and antimony form the "hardener," which is added to the melted lead.

Most shops have need of at least two grades of bearing metals and can adopt them from the foregoing, unless they are buying satisfactory metals already mixed, in which case they will not experience much saving of money or increase in satisfaction by becoming their own metallurgists.

A Good Cook Doesn't Burn the Soup

There is no reason why as good bearings cannot be poured from babbitt heated on a forge as from that cooked scientifically on a thermostat-controlled gas furnace—if you don't burn it. Nine out of ten bad bearings—the spongy ones with metal spotty and varying—are due to overheating or too long cooking.

When you have a mixture of three or four different metals—and babbitt nowadays has four more often than three components—the more restless ones tend to boil away if cooked too long without stirring. So it is better to melt a small quantity and keep adding a bit frequently than to melt up enough to last for the day.

If you heat a pot of babbitt to more than 900 deg. F. your chances of getting a scaly job are doubled. The high limit is 850 deg. F., which is too high to be tested with the finger, but can be judged from a pine stick, being the point at which such a stick when thrust into the metal hesitates whether to burn or not and finally decides to do so. This is too hot for pouring, unless the shell to be run is less than ⅛ in. thick. For ordinary work the metal is right to pour when it will char the pine stick but not produce flames.

There are three kinds of hand ladles for pouring babbitt—the good kind, the bad and the indifferent. A good ladle is one with a lip designed to pour a heavy *solid* stream. The one shown at *A*, Fig. 3, is bad because it pinches the stream into a miserable trickle, and the one at *B* is not much better, as it pours a thin sheet and cools the metal quickly. That at *C* is good and the one at *D* is better, having a skimming bridge near the lip which holds back the dross. One of the secrets of making a good cast is to empty the ladle and fill the bearing as quickly as possible, exposing the metal to the air as little as may be and avoiding pouring babbitt against either mandrel or casting. An old cast-iron tea-kettle is not to be despised in pouring a large bearing.

Babbitt metals tend to shrink away from the cast-iron containing-shells in cooling. To counteract this, heat the shells and the mandrel to about 350 deg. F. One who keeps a plentiful supply of tobacco juice in stock can gage this temperature nicely after a little practice, but must be careful not to hit the pouring gate by mistake unless he is fond of fireworks. Old Bill Simmonds has a scar on the back of his neck that came from just such an oversight.

Sometimes a bearing is too large to take to the fire to give a preliminary heating, especially when work must be babbitted in place. Under these conditions a blow-torch is used to heat the shaft and cast-iron box. This is a slow-job, and time is money. A quicker way is to melt twice the amount of babbitt needed, make a run-out at the lowest level and heat things up by pouring the metal through the box, catching it in a clay or iron mold as it comes out. When things are hot, the run-out hole is plugged and the bearing poured. Any one who has tried to pick up a mandrel fresh from a cast will admit the quickness and efficiency of this method of heating.

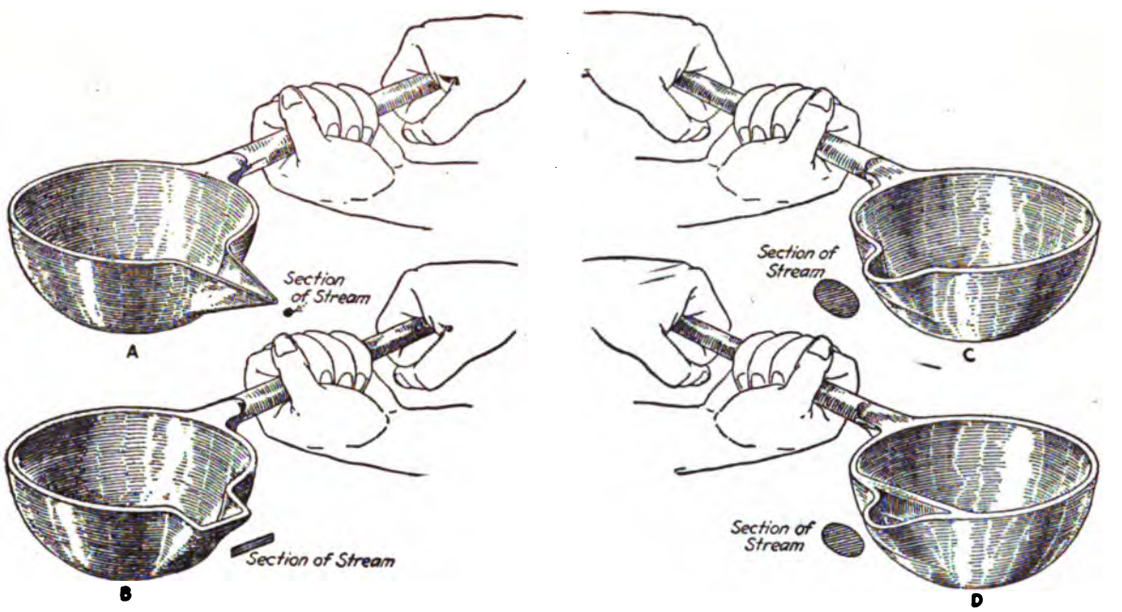


FIG. 3. GOOD AND BAD BABBITT LADLES

A smooth bearing surface is insured, other conditions being kept right, by dipping the heated mandrel in a clay wash solution consisting of 2 lb. of red Jersey clay in a bucket of water. Melted metal will lie upon this surface as quietly and as peacefully as a tramp on a feather bed. Sections as thin as 1/16 in. have been run with tin-base babbitts by using this scheme.

In Worcester, some months ago, I met an erecting man who does a lot of babbitting. He uses a kink that was published in the *American Machinist* a number of years ago, and recommends it highly. This relates to a mixture of ground asbestos and cylinder oil to replace fireclay as a lute. The stuff is mixed as stiff as thick putty and can be used repeatedly. It does not soften with heat or blow, and can be used over and over. Try it.

Sand, grit and the like float on the surface of melted babbitt, which is a good reason for casting half shells

and flat surfaces with the bearing side down. Sand and grit are desirable in a soldier but unsatisfactory in a bearing.

When there are many half boxes to pour, the method illustrated in Fig. 4 is desirable and quick. The mandrel, like a metal pattern, is plated and provided with end half-collars, which are far enough apart to admit the casting easily. The spaces between these half-collars and the casting are luted to prevent the escape of metal. A

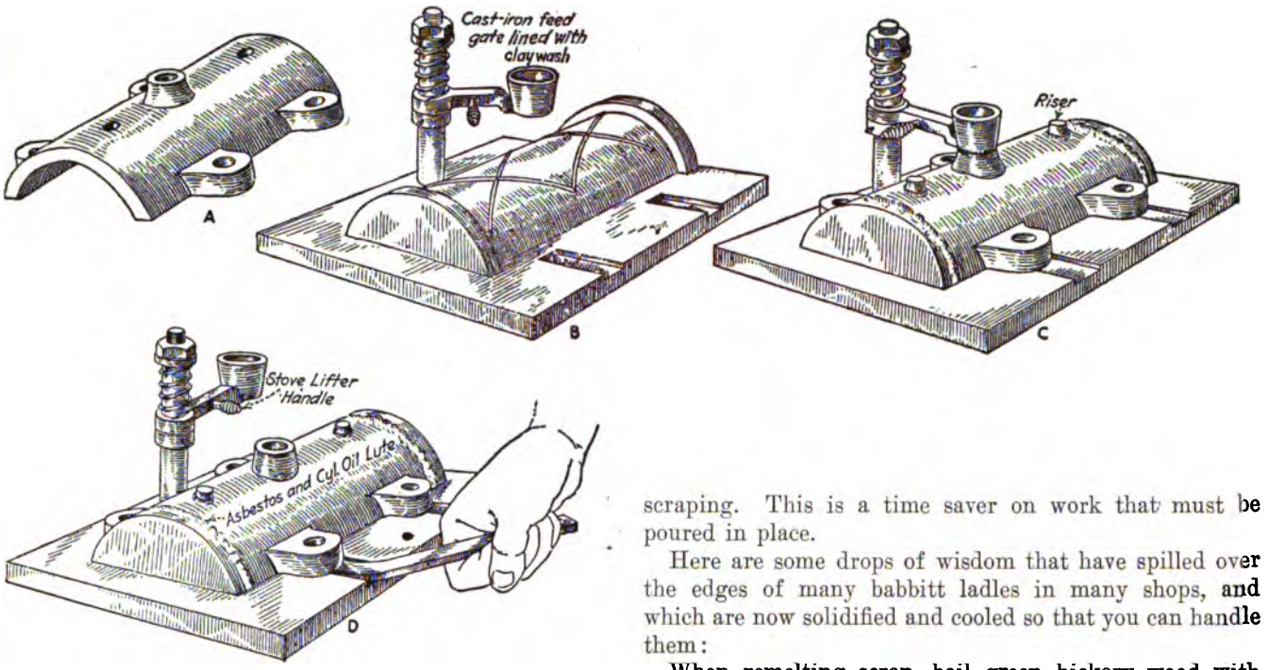


FIG. 4. MANDREL AND METHOD OF POURING HALF BOXES

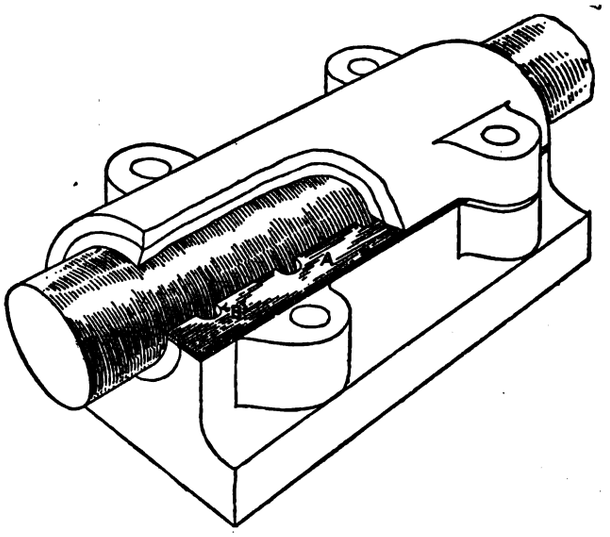


FIG. 5. POURING TWO HALVES AT ONCE

spring presser foot holds the casting down so that it will not float and in addition forms a pouring gate which is lined with clay. Slots are provided to admit a jimmy for loosening the finished work. Plate and mandrel are heated before starting, and after that the successive pourings keep them hot without any further attention. The two halves of a split box can be run at one pour by using the scheme shown in Fig. 5. A strip of tin dipped in clay wash is laid on each side of the joint as shown at *A*. These strips are placed against the mandrel and have gates *B* cut in them so the metal can run through. Fresh-cast babbitt after it becomes solid and is still hot is weak, and an endwise blow on the cap will shear off the sprues *B* and enable one to remove the cap. A sheet of rosined paper wrapped around the shaft will prevent the metal's pinching and reduce the amount of scraping. This is a time saver on work that must be poured in place.

Here are some drops of wisdom that have spilled over the edges of many babbitt ladles in many shops, and which are now solidified and cooled so that you can handle them:

When remelting scrap, boil green hickory wood with the metal to remove the dross.

Beware of blowing out a cast-iron shell with compressed air before babbitting. Air lines contain water, and this won't mix with babbitt. Hand bellows are safer.

A large casting too heavy to lift can be dried by burning gasoline in it.

Use sal-ammoniac in the melting pot if you want clear metal.

Remember that a thin section will cool quicker than a thick one, and must be poured hotter.

Remember that powdered rosin sprinkled and rubbed on a damp job will prevent explosions.

Smoking a mandrel with lamp black will do if rosin paper or clay wash is not available.

A heavy cord dipped in clay wash will act as core for an oil groove.

Slow cooling makes bearing metal coarse grained. Open up the box as soon as the babbitt is cold.

Dirt and dust rise to the highest point on the mold. Risers and a high pouring gate will get them outside of the bearing.

If you must pour a bearing cold, use a mixture that contains plenty of antimony. It won't shrink as much as other mixtures will.

Remember that air is lighter than babbitt and vent at the highest point. You cannot depend on air getting out where the babbitt goes in. Give it a private exit.

Overheated metal, lack of proper vent and slow pouring are back of most spoiled bearings.

Last and most important of all, *pour quickly.*

From a Small-Shop Note Book

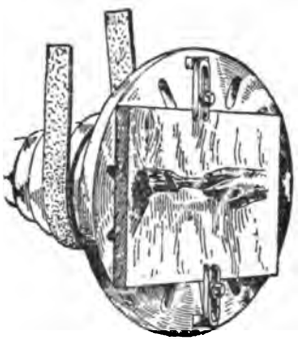
SYNOPSIS—Here are presented illustrations that speak for themselves. They represent what ingenuity and necessity are doing in small shops with limited equipment. When the big shop needs a machine one is ordered, but when the little shop needs one, nine times out of ten it gets along without it. Brains and resourcefulness take the place of an unlimited pocketbook, and do equally as well. If there is a way to do something the small-shop man will find it as these ideas contributed by the small-shop readers clearly demonstrate.

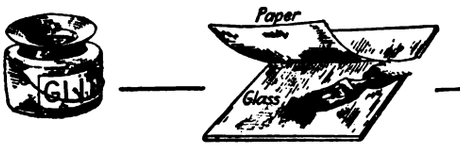
Diagonal Rivets for Plated Patterns

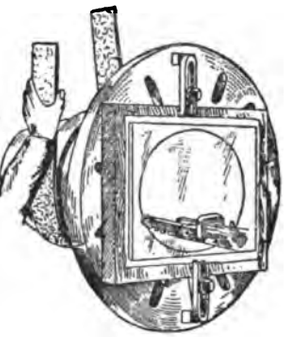
Diagonal rivets keep plated patterns from getting loose after they get into use. Why not try them out on the next plate that you make?

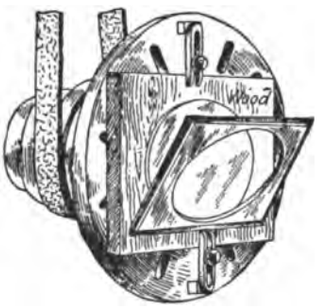
A. E. HOLADAY.

An Improvised Circular Glass Cutter







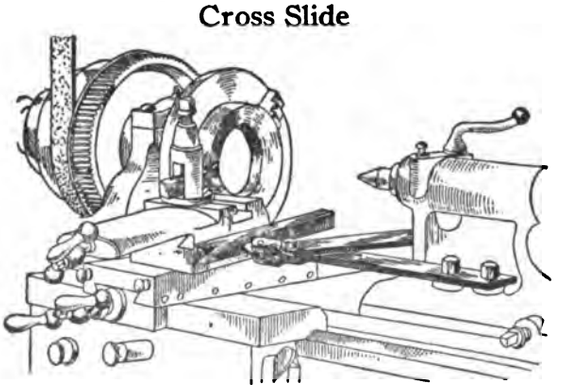


GLASS

A sheet of paper is placed between the wood block on the lathe face plate and the glass to be cut. Common glue is used and the glass is pulled from the block while the glue is soft.

IRA R. ALEXANDER.

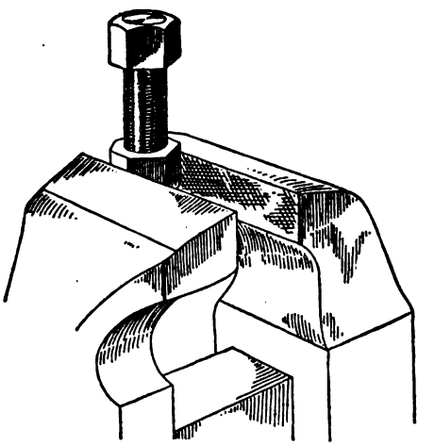
Taper Forming on Lathe Cross Slide



Taper feeding by hand is hard work. The cross feed does the trick here. A good scheme when there are a number of pieces to do, and one that prevents skinned knuckles.

C. E. MOBERG.

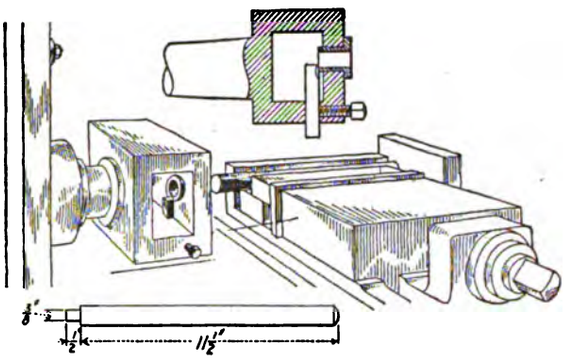
Improvised Sizing Tap for Brass Nuts



A cyanide-hardened machine bolt makes an emergency sizing tap.

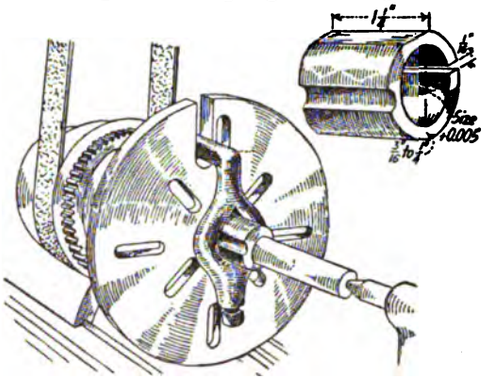
HAROLD E. GREENE.

Box Turning in the Miller



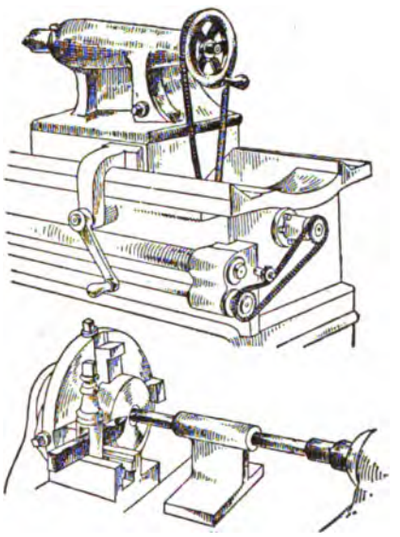
When you are crowded the miller will take some of the lathe work if you let it. PETER MEYER.

A Split Clamping Bushing



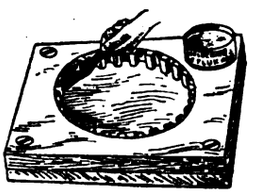
The clamping bushings of tool steel are hardened in oil and drawn soft at the groove. H. T. GREEN.

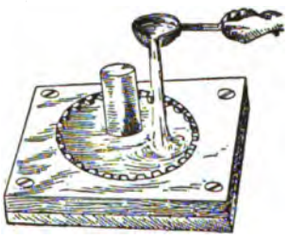
Making Use of Tailstocks



Tailstock and carriage feeds are the same, feed change affects each. D. O. BARRETT.

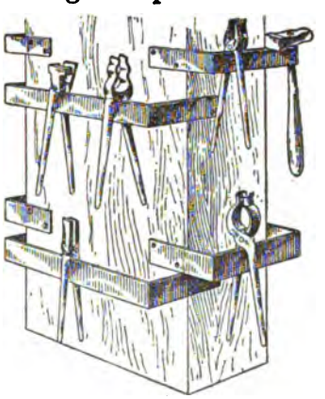
Pattern for a Babbitt Gear





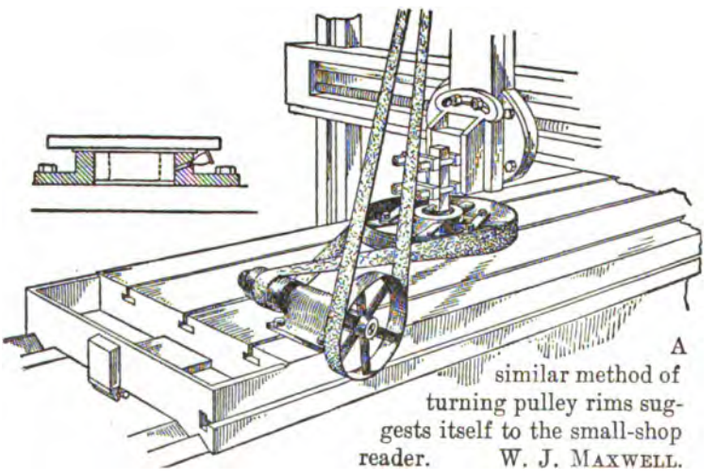
These three engravings show how one man made a model gear from a strip of tin, a board and some babbitt. A crude method but satisfactory, for the finished product served its purpose well in the experimental machine. IRA R. ALEXANDER.

Forge-Shop Post Racks



In addition to holding up the roof a post may be used as a means of holding tools. A. E. HOLADAY.

This Planer Used as a Boring Mill



A similar method of turning pulley rims suggests itself to the small-shop reader. W. J. MAXWELL.

Living up to a Reputation: the Small-Shop Miller

SYNOPSIS—The influence of environment is as strong within the shop as it is out of it. Billy Fyles tells how a certain small shop lived up to the prestige of its new universal miller, thereby transforming itself from a small shop to a large one. Undoubtedly other things had something to do with this evolution; still, there is more truth than fiction in this narrative.

"Yep, it all come about because they bought a universal milling machine," remarked Billy Fyles as he probed for a splinter in the back of his grimy hand. We were discussing the remarkable growth of the Conners Consolidated Corporation, which a year or two previous had reposed under the less pretentious name of Conners Brothers Machine Shop.

"If I didn't know the reason, who would?" queried Billy defensively, noting the skeptical look on my face. "There ain't a foot of shafting or a hanger or a piece of belt in that shop but what I put there, an' I laid the foundation and set that miller myself just two years come New Year's day.

"I don't claim that the machine itself did it all—not by no means. But it started the thing going. It's like the case of the biled shirt and silk hat that made a congressman out of Tom Gerraghty. Mebbe if I tell you about him it'll help you understand the other.

"Tom was driver of a coal truck over at East End. A well-set up fellow he was, too, for all that his face was like a bottle of ink eighteen hours out of the twenty-four. His old woman had advanced idees, and her ambition was that Tom should walk out with her of a Saturday night and Sunday afternoon rigged up in a biled shirt an' a stovepipe hat.

"I'll give Tom credit for not havin' no such notions himself. He managed to steer clear of the disgrace by holdin' out enough of his pay envelope for beer, so that after the rent and vittles were settled for there wasn't enough left to buy a postage stamp, let alone fancy togs.

"All would have gone well with Tom if his wife's uncle hadn't been unfeelin' enough to die and leave her fifty dollars. Next Saturday night, after things was settled an' Tom come home from work, there was a long-tailed coat and a biled shirt an' a stovepipe hat alayin' on the bed waitin' fer him. When he'd recovered from the shock, his wife led him to the kitchen and showed him a tub of hot water with a cake o' soap an' a scrubbin' brush settin' alongside.

" 'Twasn't long afore Tom got used to his new duds and began to look forward to the end of the week so's he could parade in 'em. He noticed that instead of havin' to take to the gutter to let people by, folks made way for him when he was all togged out.

"It got so that Tom was ashamed of lookin' like a lump of coal on weekdays an' of comin' home with a dirty face. His wife kept apickin' at him about makin' somethin' better of himself, and afore long he was trottin' off to night school three times a week reg'lar. He'd never have kept it up if it hadn't been for the thought of livin' up to his biled shirt and top hat.

"After he'd learned to spell an' to drive a pencil he joined a debatin' society. He wasn't much on argument, but he was strong on appearance in his Sunday togs, an' his voice was powerful enough to win most of the debates that he went into. Bein' an Irishman, he had a nat'ral gift of gab, and when he needed a ten strike to even the score he'd bring down his big ham of a fist on the table with a bang that would convince most anybody.

" 'Twasn't long before Tom Gerraghty was Democratic candidate for councilman, an' he carried the ward almost solid. Day after 'lection he bought himself a white velvet vest decorated with red trimmin's, an' a new top hat twice as shiny as the old one.

"Well, sir, Tom kept progressin' and alivin' up to his new clothes—sort of hitchin' himself along up a ladder of top hats and swallowtails, so to speak. In a couple of years he bought himself a big diamond sparkler, an' right afterward this got him 'lected to Congress. If the decorations had held out, an' Tom hadn't smashed himself into kindlin' wood along with his new 90-horsepower roadster, nothin' could have kept him from bein' Governor of this state!"

Billy Fyles paused a moment to let the significance of this story sink in before proceeding with the analogous case of the Conners Consolidated Corporation.

One Foot in the Grave and the Other Slipping

"Sometimes a man needs somethin' of that kind to jar him out of a rut," he continued. "And you know yourself that Conners' machine shop was in a rut two years ago, if ever one was. There wasn't a man or machine in that shop in them days but what had one foot in the grave and the other on a banana peel—that is as far as any real usefulness was concerned.

"Ed Conners bein' the older brother, had the best machine in the establishment, an' this was an 18-inch lathe that was new when Ed was a baby. In turning a straight piece of work, Ed used to watch when the carriage came opposite certain cracks in the wall back of the lathe, and favor the cut in or out as the case might be, to make up for the worn places in the shears. They do say that the tool chattered so bad that if a feller who didn't know the machine started to thread a bolt he'd be likely to turn out a grooved tap instead. Every time they tightened the belt they'd have to drive shims under the legs on the head end to bring the spindle back into contact with the bearings.

"Hennery Conners, the younger brother, pounded sand in their one-horse foundry and looked after the four other molders, who couldn't get work anywhere else. This department was as bad as the shop, and whenever they chucked a pig into the cupola everybody got ready to jump for fear it would knock the bottom out.

"Besides making stove grates and odd jobs they used to build a patent water lifter once in a while when there

was nothin' else to do. It was a good little machine, but nobody knew it, and the way they went at the making of them made them cost a lot more than they sold for.

"I can't imagine how they came to buy that miller; they must have got it for almost nothing at the bankrupt sale of the Fire Engine Co.'s plant. Anyway, it was a crackin' good machine, with feed handles and micrometer dials stickin' out all over it. I was mighty proud of the job when it was all set up, although it made the old relics around it look worse than ever.

"First Sunday after that I goes down to the shop to take out the slack of the belt. I must have come in rather quiet, for the first thing I see was Ed and Hennery asettin' on soap boxes a little ways off from the new miller an' lookin' at it as if they was hipnertized. I sneaked out of there on tiptoe, feeling as if I'd butted in on a Quaker meetin' or something else sort of sacred.

Obstacles to Starting the New Miller

"When Monday come the Conners wanted to do some work with the new machine right away. Come to find out, there wasn't any millin' cutters come with it an' there wasn't a tool in the shop good enough to handle such a job as makin' 'em. Hennery comes out with the opinion that it's time they had a real lathe anyway, 'stead of a poor imitation that you dassent lean against for fear of its fallin' apart. I was that surprised when Ed agreed with him that I swallowed my chew and come near chokin' to death!

"A week or two after this I had the job of beltin' up a first-class lathe that had taper and relievin' attachments an' a gear feed. Now that there was another new tool to help things along, the shop began to look a little different.

"Ed turned up some cutters and notched 'em on the old planer an' turned a relief on 'em with the new lathe attachment—everything as smooth as silk till he comes to harden 'em. 'Gosh dumb it!' he says to Hennery, 'you can't expect a man to harden cutters on that tumbled-down pile of bricks that you call a forge!'

"'Who's askin' you to?' says Hennery. 'Ain't it bad enuf that I have to melt iron in that rusty old stove-pipe standin' over there in the corner, wot you call a cupola?'

Billy Fyles Has a Difficult Millwright Job

"Well, sir, the upshot was that Ed got his new forge and Hennery got a new cupola, bein' as the foundry hadn't had a look in as yet on the sprucin' up business. Ed hardened the cutters and made a first-rate job on 'em. He was as pleased as a kid with a new squawker until he come to think of grindin' 'em. All they had in the shop for grinding was a 14x2 snaggin' wheel that traveled up an' down an' sidewise nearly as far an' as fast as it turned around.

"I had quite a job riggin' up the new universal grinder that come the followin' week, on account of gettin' up the overhead works wrong side foremost at first an' havin' to face the machine around the other way in consequence. It was easier to dig up a satisfactory reason why the machine had to set that way than it would have been to take out all of them lagscrews and put the counter up twice.

"That millin' machine was a dandy when it once got goin'. Ed got together all the pieces of the water lifter that could be finished by millin' and in a day an' a half was around lookin' for more work to keep it agoin'.

"'I tell you Hennery,' says Ed, 'you've got to make me them water lifter castin's in 200 lots, 'cause I can't bother with less. An' please tell that broken-down bum that molded the last batch not to rap his patterns with a sledge hammer. What we need for these millin' jobs is good soft gray iron an' one-sixteenth for finish—neither more or less.'

"'What we need is a couple of moldin' machines, if you're goin' to be so partic'lar,' says Hennery.

"I wish you could see the job I done linin' up the new air compressor that had to be installed to accommodate the moldin' machines. While they was about it they got one big enough to run a bunch of hammers an' drills as well an' still have some wind left for more moldin' machines in the future.

"Don't think that the Conners boys let all of them new machines an' tools stand idle in the meantime. They wasn't the kind to see everythin' goin' out an' nothin' comin' in without a struggle. Soon as they saw a hole in the shop they'd hustle around and dig up business to fill it. Somethin' like a vacuum·a shop is—the more you try to keep it empty by hustlin' the work out, the more new work seems to try to get in. An' besides, there was more money an' higher grade work to be done with good tools than the old junk that they'd had before.

"Things begun to get pretty crowded with all this new machinery, and it wasn't long before there was a new buildin' goin' up. All the old machines was discarded, and a man who had known the Conners place a year before wouldn't have believed it to be any relation—nor the Conners boys either, for that matter. They had a bunch of real machinists workin' for 'em an' had quit tryin' to use bums an' farm hands for molders.

New Designer and an Educated Foot Rule

"'Twasn't long after they got the new cost system workin' that Ed and Hennery found out some of the parts of the water lifter was costin' entirely too much account of the way they was made, and next thing they got up was a crackerjack designer with a college dipplomy an' a educated foot rule that could do all kinds of figurin'. He went over that water lifter from A to Z an' made several improvements, an' cut the cost down about half, and made it lift twice as much as it done before. On the strength of that they was able to shave the price about a third an' took a contract with one of the big Chicago mail-order houses to furnish 'em water lifters in carload lots. Ed begun to travel over the country a bit to get idees an' look up business; an' hooked up with a export house in New York for a couple of shiploads of water lifters for South Ameriky.

"What with these an' other orders that come pilin' in, the business grew so fast that things got serious even with night an' day shifts. There was only one thing fer 'em to do, an' they done it—that was to buy up the Climax Works across the street—a plant that two years before hadn't known whether Conners Brothers was the name of a circus or a plumber's shop.

"That's the story of the Conners Consolidated Corporation," said Billy Fyles. "An' if it wasn't all brought about by that millin' machine, I'd like to know what else done it?"

What, indeed!

ALPHABETICAL INDEX

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