

year than I am doing this year." He said, "I suppose you know who I am?"

"No."

"I am 'Old Man Sharpe,' at the head of the Brown & Sharpe Company of Providence, R. I."

Now this simple idea has been enough to build up and keep through two generations the great Brown and Sharpe Company at the head of all the companies in this country who are doing accurate work, and probably no finer work, on the whole, is done in any company throughout the world.

Remember that the kind of engineering that is most wanted is that which saves money; that your employer is first of all in business to make money, not to do great and brilliant things, and he wants you to help him in making money, rather than in doing great and brilliant things.

In a large establishment which had enlarged very rapidly, but without a plan which was originally carefully laid out, it became a matter of the greatest difficulty to lay out tracks which were capable of taking care of the traffic, incoming and outgoing, and also between the various departments. The problem of locating these tracks was given in succession to the three best engineers in the establishment, men who were finely educated and experienced engineers. Now laying out tracks is a distinctly monotonous and uninteresting piece of work, with no glory in it whatever, and whether each of these men did their best or not, at any rate they one after another gave up the problem, and said that the buildings were so located that it was practically impossible to make a proper lay-out of the tracks.

In the drafting room was a young man who had merely an ordinary school education, in fact, very little of that even, who was working making cheap drawings, tracings, etc. He saw these men try the problem one after another and give it up, and after they were through he applied to the superintendent for permission to tackle the track problem. The superintendent said, "Why certainly, my boy, go right ahead. Do what you can." In about three months this young man had laid out the tracks so as to solve the traction problem in a complete and satisfactory way. And this is the incident that started a man on his upward career who I am sure you would all recognize as certainly the combined engineer and machinist who has made the largest pecuniary success of anyone in this country.

In another establishment it became necessary, to

add a number of additional furnaces to the melting department. The flues leading to the chimney of this department were so located that it was very difficult to build a new chimney which should have sufficient capacity to run the old plus the new furnaces without tearing down the old chimney and locating the new one in its place. This would necessarily involve a loss of at least one or two months in time. It appeared to be impossible to add to the height of the present chimney, because, years before, its foundation had sunk unevenly, and the chimney was leaning over so far to one side that its centre of gravity was barely within its base.

There was one young engineer, however, who realizing the seriousness of a stoppage of two months, proposed to build another chimney, on top of the first one, leaning back in the other direction, thus bringing the centre of gravity of the new chimney raised to twice its height back over the centre of the foundation. He carried out this work without even stopping the furnaces for a day. He raised a false sheet iron chimney above where the workmen were building all the time, so that they could build the new chimney with the smoke continually coming out of the top of the old one.

Now, neither laying out tracks nor adding to the top of an old chimney are very brilliant or original feats of engineering, and yet they marked the important events which led to the success of two great engineers.

There is one rock upon which many a bright and ingenious man has stranded, and perhaps the greatest temptation to the engineer who loves his profession is that of indulging his inventive faculty. Many of our brightest men practically spend their lives in worrying over the great improvements and inventions which they have in their minds, and they squander all of their own and their friends' money in trying to make them successful in a moneyed way after they have been perfected. Now for the average man no invention can be looked upon as a legitimate invention which is not an improvement on mechanism or processes or appliances which are already in existence, and which are successful. It is thoroughly illegitimate for the average man to start out to make a radically new machine, or method, or process, new from the bottom up, to do things which have already been done in the past. Legitimate invention should always be preceded by a complete study of the field to see what other people have already done. Then

some one or more defects should be clearly recognized and analyzed, and it is entirely legitimate for an engineer to use his ingenuity and his inventive faculty in remedying these defects, and in adding his remedy to the existing elements of the machine or the process which have already been found to work well. Any other invention than this should be looked upon as illegitimate, since it is almost sure to waste the money of your employer, as well as your own, and to result in partial, if not complete, disaster. Throughout the manufacturing world there exists a proper and legitimate suspicion and dislike for the man who is forever coming forward with new and radical improvements and inventions. Let me give you one illustration of legitimate invention.

There was a machine, a large number of which were in common use, and of which there were many designs and types used all over the world. This machine was of such a nature that it battered itself to pieces. Almost all of its parts broke. There was a young engineer who had many of these machines to use in his manufacturing department, and who decided to try to build a machine that would not batter itself to pieces. He spent one or two years in collecting, from all over the world, data about the various machines that had been designed, until he found instances in which some one of the parts of each of the various machines of different designs had never broken. He then copied the design of each of the parts which had not broken, collecting one element from one machine, another from another, another from a third, etc. There was, however, one portion of the machine of which he could find no single instance of a design which had not, at some time or other, broken. He devoted his special energy and ingenuity to the study of this element, and finally evolved what he believed to be a principle which would prevent it from breaking. He then constructed a machine containing all of the parts already existing which had not broken, plus the one of his own design, and patent, which he believed would not break, and as a result obtained a machine which lasted for many years without a single break-down—the first instance of its kind in the history of that art. And this furnishes an illustration of what may be called thoroughly legitimate invention.

Don't kick, certainly don't kick unless you are sure of accomplishing your result. Your kick, in perhaps nine cases out of ten, will result merely in aggravating your employer, whether it is just or unjust, and your

common-sense should tell you that it is foolish to aggravate him unless some good is to come of it.

William Sellers ranked undoubtedly in his time as the most noted engineer in this country. It was my good fortune to work under him for several years. During this time I was badly treated by one of the superintendents who was over me. I stood it for a long time, and then decided to go to Mr. Sellers about it. He listened and agreed with what I told him, and then turned to me, almost laughing, and said, "Do you know that all of this impresses me with the fact that you are still a very young man? Long before you reach my age you will have found that you have to eat a bushel of dirt, and you will go right ahead and eat your dirt until it really seriously interferes with your digestion."

Does all of this sound humdrum and commonplace? Yes, it does, but remember that I have been trying to point out the implements and methods which are to be used in obtaining success, and that implements and methods are almost always commonplace. But back of this each engineer should have, at all times, the hope, the ambition, the determination, to do great things; to do things which shall leave the world the better for his having lived in it; to do things which shall bring him into the front rank of his profession; and then to take at least one or two forward steps in his chosen line of work. It is the pleasure, the joy and the delight in doing this, more than anything else, that leads us to become engineers and that keeps us cheerfully at work, in spite of repeated disappointments.

In your desire to do great things, however, do not try for the impossible. Let your common-sense guide and control your ambition. Don't try for perpetual motion; don't look for a diamond mine in the coal fields of Indiana; don't make a machine to fly to the moon; but keep your eyes wide open all the time to see and clearly recognize defects in the machines, apparatus and methods that are immediately around you, and in the line of your regular duties; in those machines and processes which you understand best, not in someone's else field that you don't understand.

Next, clearly define this defect and if possible describe it in words. Then use your ingenuity to find the simplest possible remedy for it.

And lastly, your common-sense to see how, under existing conditions, the remedy can be applied with profit to your employer.