

it, but not until I had ordered the pulley on its line shaft changed from a ten-inch to a forty-inch; or, in other words, I had the machine speeded up four to one, after looking into its properties on paper before I went near it in a material way.

The demonstrations I made, both of what could be done with that slide rule and with the tools as I found them in the yard, were so pleasing to the commandant that he expressed his hope that he might obtain permission to secure my services to respect all the tools, and to introduce our slide-rule methods of running them; but all that was lost in the general navy washout that soon followed, and the only permanent satisfaction I had of it was that the foreman of the shop in which the demonstration was made, of his own accord and in a similar manner, speeded up several lathes before I paid the last one of my five visits of a day each to the yard; and as I was told that this foreman was one who, while hard to convince, always stayed convinced, I also have reason to believe that he has since made great strides in the use of high-speed tools.

In still another shop the management had under consideration getting some one to help them improve matters; and sending for me, they agreed to engage me if I could convince their general shop foreman that I wasn't only one of "those theoretical fellows," but a man who also fully understood machines and shop work.

I agreed to try to do this, and a job was put up to me to improve on, one on which I afterward found out that every resource of that shop had been put to make the best of it. It was the turning up of certain cast-iron cylinders, sixty inches in diameter and seventy-two inches in length, when finished. These were cast with large sinking heads and were provided with inside flanges for heads.

I first investigated the only lathe in which this work could be done and found it in every way a good one, except that it was not running as fast as it might be run, though the class of work under consideration was of the kind that calls for the slowest legitimate speeding—namely, cast iron requiring the full swing of the machine.

All I could do was fifty per cent, which meant a thirty-inch pulley on one line shaft instead of a twenty-inch. When I had the change made, the foreman said that he, too, could have done better if he had speeded the lathe up, and the manager

and I both said that that was so, the manager adding: "And you have had six years to do that in, but you have not done it."

I also designed a new tool holder to get at the inside flanges in a better way and made a slide rule for the lathe, and, besides, brought high-speed tools of my own that I knew were all right, for the case was such that I could not afford to take any avoidable chances.

When everything was ready and I set the slide rule for the average depth of cut that the foremen told me they usually ran into in truing up the cylinder, the diameter, the hardness (as usual, I had to guess at that), and the life of the tool as one hour; the most economical combination shown by the rule was the slowest available spindle speed and a feed of one-fourth inch.

When I announced this, considerable surprise was evinced, for the best they had been able to do was one-eighth inch feed at the original slowest speed, so that I proposed to do the roughing at, all told, three times their rate; and as the tool stood up one hour and fifteen minutes, while I had aimed at one hour, my first point was gained. The second tool finished the cylinder in forty-five minutes; and even greater gains were made in turning up the inside flanges by taking substantial cuts with power feeds, whereas they had been picking away at them with fine hand feeds, for fear of breaking out the flanges, which I at once recognized as strong enough to stand the cuts proposed.

Even in the final finishing on the cylinder, which was a delicate piece of work, I made great gains, so that the total time, including a lot of awkward handling, proved to be just about one-half of their best time, according to the statement of the foreman himself, who, while conservative and skeptical, was perfectly honest.

This is again a good example of the triumph of scientific methods as against mere practical experience.

Again, I was requested to look into an old shop to see whether or not any improvements could be made in the running of the machines; and again I asked for diagrams of two of their best lathes, with a view of making slide rules for them before going near the place. As expected, the lathes were greatly underspeeded. I determined the pulleys wanted for the line shaft and requested that these be put up before my arrival, but they wrote back

that there was not head room enough on the line for the pulleys specified. As I could not request that the whole line shaft be speeded up only for my demonstration, I made two slide rules for one of the lathes, one corresponding to its old speeds and the other corresponding to the speeds that would be obtained by the largest pulley we could get onto the line shaft.

This done, I wrote the company to be prepared to have me make a demonstration with the former slide rule in the morning of the day of my arrival, and with the latter rule in the afternoon, and for this purpose to have some suitable material ready.

The lathe, though an old one, was in fair condition and was still operated by the man that had first started it off. He had been informed by his foreman that I was coming and told to do his best in competition with my slide rule, and no doubt only because of this put on a screw-cutting feed of eleven threads to the inch; for where a machine has belt feeds besides screw feeds, I have never found a workman do any better on his own initiative than to use the coarsest belt feed. He also threw the back gear in and put the drive belt on the fastest cone speed, and with this combination he did so well that I hardly thought the slide rule could indicate anything better, for it was evident that the slowest speed without the back gear would not have power enough to pull the cut, though the material was a very soft steel shaft, for efficient work on which the lathe was greatly underspeeded.

However, when I set the slide rule, in the presence of several witnesses it indicated a feed of nine threads to the inch and the same speed, thus showing that the man, even in his unusual efforts to have the lathe do the most he dared to risk, only got eighty-two per cent of its normal capacity, as meas-

ured by our standard.

As this operator was exceptionally handy at cutting threads, the backing belt had not been in position for years, whereas I had taken advantage of the two countershaft pulleys to get two forward speeds in making the second slide rule which we set for the same job after putting up the new pulleys during the noon hour.

The rule then indicated the same feed of nine threads in combination with the new fastest speed of the spindle with the back gear in, as I already knew it would, because of the extreme softness of the material that was being cut.

The new speed being about 2.2 times faster than the old, we now turned the shaft 2.7 times more rapidly than the operator had started out to do, or nine times as fast as he would have done if left to his own initiative; for being a good, honest fellow, he subsequently admitted that he would not have changed to a screw-cutting feed when ordinarily doing the work.

He also admitted that he had often thought it might be a nice thing to put up another forward belt on the pulleys originally provided for backing but that he had never gotten even so far as to suggest this to his foreman.

I believe that some of the cases cited above show pretty definitely that it is not wise to leave metal-cutting machines to the initiative of the average good, honest workman, and that our methods of handling such machines are mighty agencies in setting him to thinking in a manner profitable both to himself and the world's production; for surely it is true that we all learn principally by imitating others, and also that we cannot successfully imitate without thinking and reflection.

(To be continued in the next issue)

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