ments were made on the motor doing 3425, it was found that this one was not working to its full capacity, but could have been used on other roads as well.

Comparison of the Work of Miners. When comparison is made between the number of men employed—both miners and laborers—on any one road and the number of cars mined from that road, and the respective numbers on any similar road, as itemized in the last two columns of the tabulation, one finds here discrepancies also. For instance M road and O road can be compared as they were in the same seam and had similar mining conditions. So while M produced 1.18 cars per man per day, O road produced over twice as much or 2.52 cars per man per day. The rate of pay was about $1.00 for all the roads. It was a two-ton car.

TABLE II

HALF MONTH OF BITUMINOUS MINE

Road	Pay, Cents Per Ton	No. of Men	Cars	Haulage
B	5962	2	42	2½-ton motor
B2	42	3	42	
B3	5962	4	88	1 mule, 1 driver to sidetrack
"	42	7	138	
A1	5962	4	84	2½-ton motor
A2	72	5	187	
A3	72	10	230	1 mule, 1 driver
A4	72	2	66	2 mules, 1 driver
"	42	8	204	
A5	72	12	348	1 mule, 1 driver
A6	42	16	420	1 mule, 1 driver
A7	5962	4	104	1 mule, 1 driver
A8	5962	4	79	
Main A	42	2	66	

2½-ton motors, 84 and 271 cars.
1 driver. 88, 230, 270, 348, 420, and 249 cars.

RECAPITULATION

	Pay	No. Men	Cars	Cars Should Have Had	Difference
Cut and load	5962	18	534	576	−42
Machine	42	36	870	1440	−570
Pick	72	31	838	745	+93
			2242	2761	

Second Tabulation. The second tabulation (Table II) is from a bituminous mine. Here only one seam was being mined and the conditions on all roads were practically the same. You will notice that one motor did over three times as much as the other and that there is no equality in performance between the various drivers and their mules. The boy who got out 420 cars had to travel ten miles a day to do it. In the recapitulation you will see that the men who had the lowest rates of pay got the smallest number of cars—that is got less than their proportion. The output of the mine would have been 27 per cent greater if these men had been given cars; if the work of transportation had been pushed better. The output per man for calculating the number of cars they should have had, was only seven tons a day.

As a side light on this mine and the floating from one mine to another, which is blamed so bitterly upon the workmen in the mines, I should say that this mine had only nineteen per cent of the men that it had had a year before.

Time Element. I do not need to call your attention to the need and uses of time measurements. You probably know more than I do on that subject. But you do not know how unappreciated in mining is the fact that the time element enters into all work. A mine is a friendly place. One can stop and have a chat with any one at any time. When you take up the matter of delays, you find the people about the mines so accustomed to them that they consider them unavoidable; such things as poor switching arrangements and bad frogs along the track and cars getting off the track. That is a part of mining to them. In measuring the work of a shaft, it was found that the engineer took ten seconds to respond to the signal to hoist. This repeated three hundred times a day meant a loss of fifty minutes a day and that loss of tonnage to the company and that loss of tonnage to the miners.

Mining Same as Other Work. Although mining considers itself a thing apart and quite different from any other line of work, the principles laid down for manufacturing can be adapted to it. Curves indicating the progress of work can be easily used.

Curves of a Shaft. As an example of such curves, some plotted from the work of one shaft are presented (Fig. 1). The data on which they are based are taken from the record kept by the hoisting engineer, who put down each hour the delays inside the mine and the delays outside and the number of cars hoisted. At the end of the month totals were made for each hour of the day and for the total working time. Percentages were then calculated for each hour, percentages being taken as one basis for the

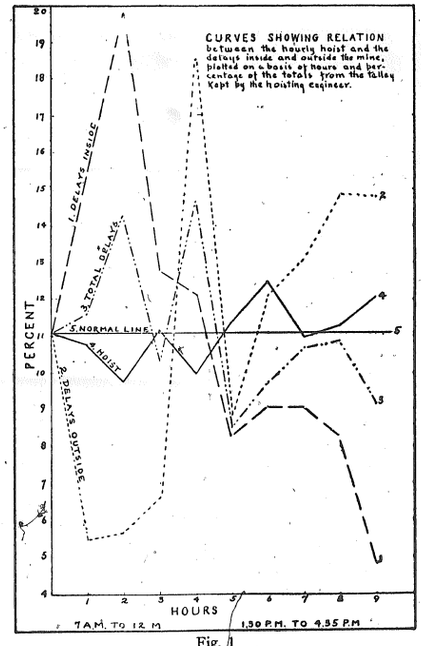

Fig. 1

curves in order to be able to compare different months. The other basis for plotting the curves is the hour of the working day.

Interpretation of Curves. The interpretation to be made from these particular curves is that the biggest percentage of the output was obtained in the second half of the day. For if the mine had been working at an even gait, 11.1 per cent of the output would have been hoisted each hour, whereas all the morning hours are below this line and the afternoon above. If delays had been eliminated, the capacity of the shaft would have been twenty per cent greater, although the record was made during the month of its greatest hoist.

The curve for the inside of the mine shows that the delays are greatest during the first two hours of the day. This was due to a slow start inside the mine. The curve for the outside, on the other hand, shows that delays are least in the morning hours (except for a peak at the fourth hour due to three breakdowns) and increase during the day, indicating that as the work inside increased, the outside became crowded. The curve for total delays has peaks opposite to the hoist and indicates that the mine did not get thoroughly going until the fourth hour.

Too Much Coal. The mine from which this curve is taken had one fault which is often found. So much emphasis is laid upon getting out coal, that often those in charge of work forget that coal cannot be obtained without empty cars. At this mine every mine car was loaded with coal at the beginning of the day; there were no empties for the miners—not until coal had been dumped and the mine cars transported to the working places could the miners begin to work. There was even a night shift so that it would be certain that every car was filled. Of course the day men got a slow start. And the mine got a slow start because the roadways were so filled with loaded cars—cars all traveling in the same direction—that the motors could not manipulate them. It was an unbalanced way of doing things.

Measurements Coarse. Measurement work can be done in mining. The units do not need to be refined. They can be crude and large. An Ingersoll will do as well as a stop watch, and the use of the Ingersoll is indefinitely better than the usual nothing.

Unrelated Incidents. As there is so little attention paid to organization of work underground, unrelated incidents will show up the manner of doing things.

No Mine Office. At one mine they would not let the mine foreman have an office underground for fear that he would sit down. A mine is a cold place; the average temperature is about 60 degrees F. It is also a damp place, and a mine foreman cannot always be in motion. He has to stand still when men are reporting and when he is giving orders about work.

Sergeant Who Had Been a Tracklayer. I was talking about the mines one wet night in France, with one of my sergeants who had been a tracklayer, and he remarked: "I used to get many a nine hours for a night shift and be out at quitting time with the day shift. We would be told to change a rail. So after lunch we would get the rail and put in the new ties and pull all the spikes except those at the end of the rail. The last trip would go out half an hour before quitting time. Then we would yank out the last couple of spikes and change the rail and spike it in place in a hurry and catch up with the day shift going home."

Mine Foreman Cannot Follow-up Details. You see a mine foreman cannot follow-up details of