

to the summit without halting, and without priming or difficulty of any kind. The steam gauge indicated, at starting, 120 lbs., and at stopping, 90 lbs. pressure of steam.

The time occupied in traversing 1,450 ft. was $3\frac{1}{2}$ min.; the speed being about $4\frac{1}{4}$ miles per hour. Returning to the foot of the hill, a third wagon was brought up and attached with the other two, to the same locomotive.

FOURTH TRIAL.

The total load in wagons was now 16,530 lbs., and the excess in weight of the rolling wheels of this engine was over the regular and, as already stated, the efficient traction driving-wheels of No. 1, brought up the figure to a total of 23,230 lbs.

This load was taken up the same heavy grade in 4 min.—a most precisely 4 miles an hour. The steam pressure varied from 105 to 120 lbs.

The action of the driving-wheels was carefully observed, but no evidence of slip was discovered, with even this heavy load.

The proprietor and agent both desired to try again, using the same engine, with a fourth wagon added to the train; but time was passing rapidly, and it was decided to change the ground, and to experiment with heavier loads on less exceptional grades.

FIFTH TRIAL.

The locomotives and wagons were taken across the railroad track to the other portion of the selected road, where the grade was 2.27 ft. rise in 100 of horizontal distance, or 225.46 ft. per mile. This did not approach, in steepness, that already described, but it was, nevertheless, a heavy grade.

Engine No. 1 was here attached to a train of six loaded wagons, weighing, all together, 30,080 lbs. Starting with 95 lbs. steam, it drew the train steadily, and with apparent ease, except when, as in the first trial, priming occasionally produced some annoyance.

SIXTH TRIAL.

The train was stopped, engine No. 2 was substituted for No. 1,

and, with the same load, on the same grade, a trial of speed was made. The mean speed, over the whole course, was 3.6 miles per hour, that figure being exceeded at times. The steam pressure varied between 90 and 105 lbs. The length of the course was 1,435 ft.

SEVENTH AND LAST TRIAL.

A train of 10 wagons was next

the steam that the engine would take was required to keep the piston moving. At starting, the engine exhibited a tendency to rise forward. It may be concluded from these two facts that this load was about a maximum for the engine when carrying 85 lbs. of steam, and that, while drawing it, nearly all the weight of the engine was brought upon the drivers.

assumed at 0.04.

Coal.—The amount of coal used on this engine during the day was 350 lbs.

Effect on the Road-bed.—During all trials, the effect produced by the locomotive upon the road surface was carefully observed and compared with that produced by the hoofs of the horses, which were at intervals climbing the

second grade with loaded wagons similar to those used with the traction engine. The hoofs of the horses, it was noticed, cut into the load somewhat, loosening the metalling and injuring the surface, thus increasing the resistance offered to the vehicles following them. The wheels of the traction engine, on the contrary very perceptibly compacted and improved the load, and thus, to some extent, reduced tractional resistances. There

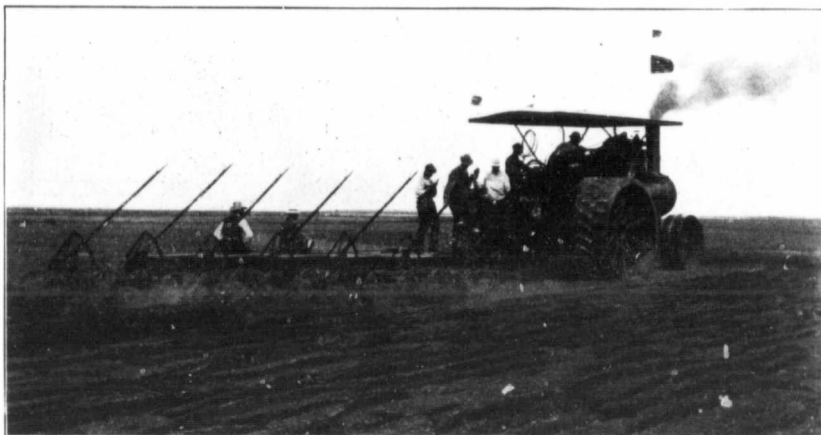
was a marked difference in the action of the two motors upon the surface, and it was evidently a matter of economical importance.

Horses vs. Steam.—Each wagon could usually be drawn to the top of the hill by two good horses, but only with great effort. Three were required to do the work as comfortably as it should be done, and this number could pull a single load steadily and with moderate exertion.

The locomotive on this grade therefore performed the work of between twenty and thirty horses. We may conclude that it can, with 85 lbs. of steam, draw a load which would require the severest exertion of twenty horses. The maximum steam pressure proposed by the builders of these engines is 130 lbs., at which pressure they are still far below the limit allowed by our own laws.

It was now late in the afternoon, and it was concluded to suspend work for lack of time to make up other trains.

The great steam road-roller was brought forward; its construction was examined by all present, and its effective action in compacting the road was observed. It moved backward and forward, on this grade of 225 ft. to the mile, rapidly and steadily, and was said by its owner to be able



The 'tumbley' 36 h.p. Steam Tractor, pulling a 14 bottom 14 in. John Deere Engine Gang

made up, and engine No. 2 was attached. The total load was now 63,400 lbs.; the course was the same as during the preceding trial. Several unsuccessful attempts were made to start this load, the connecting chains snapping as soon as the strain came fully upon them. Chains were finally obtained of sufficient

Even during this trial no slip of the driving wheels could be detected, notwithstanding the fact, already stated, that they were smooth on their wearing surfaces. The marks left, by the bolt holes in their rims, upon the surface of the road were perfectly distinct and undistorted. The engine gave no trouble by priming.



Goold Shapley & Muir 20 h.p. Gas Tractor in the contest. This engine pulled 3, 2 bottom 14 in. Imperial Gangs. The photographer miscalculated and mapped only the engine at work

strength, and a start was made. The load, increased by the weight of a large number of men and boys who clustered upon the wagons, was taken to the top of the hill without accident and without a halt. The steam pressure varied between 85 and 124 lbs per sq. in. At the lower pressure, the throttle was carried full open, and it was evident that all

It was noted, during the trials on this grade, that the wagons would just start backward down the hill when detached, and it is therefore to be concluded that the co-efficient of traction on a level, corresponding with the coefficient of rolling resistance, must have been very nearly represented by the tangent of the angle of the grade, or about 0.0427; it may be