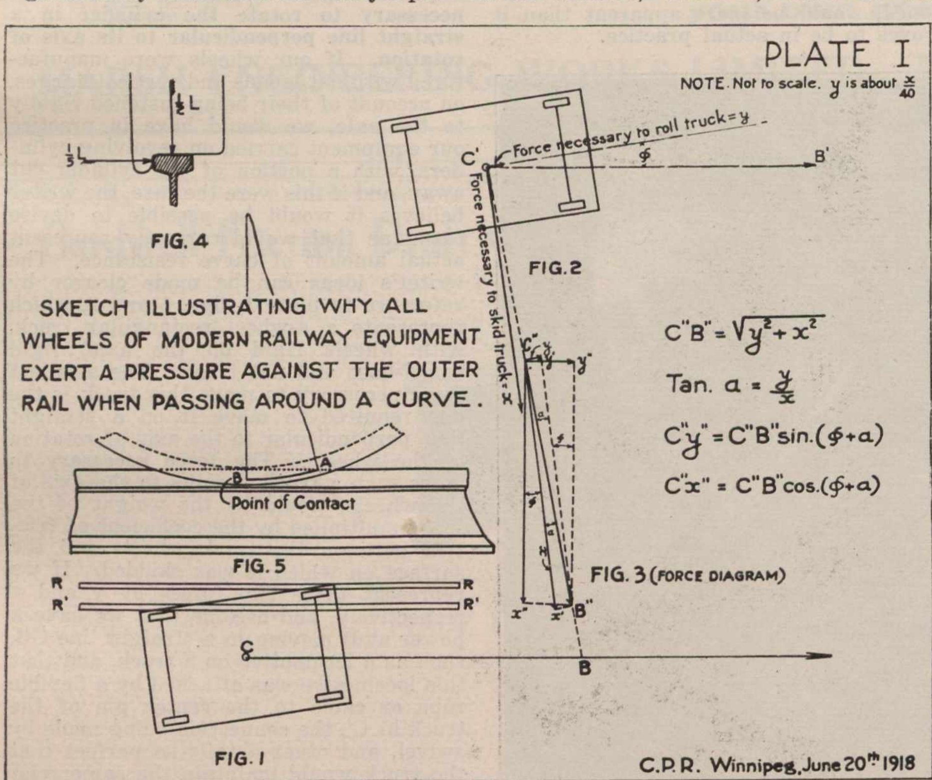
by a curved rail and have almost identical conditions. If we then had a flat tread wheel and vertical flange, as shown in fig. 4, with correct elevation, half the axle load would be on the outer rail and the horizontal pressure against the outer rail would be the total load on the axle, multiplied by the coefficient of friction necessary to skid the wheels. This force, acting against the flange of the rail, something in the position of the line AB, shown in fig. 5, might be susceptible of a mathematical solution, and we could no doubt get formulae which would correctly represent curve resistance as we know it to exist. Now, everything that has been said in regard to the truck in fig. 1 and fig. 2 would be actually true if applied to a single set of wheels.

It is generally conceded that curve resistance amounts to approximately 0.8 lb. per ton of load per degree of curvature. A great many believe that the major portion of this resistance consists in the skidding of the wheels in a longitudinal direction, on account of the difference in length of the inner and outer rails. If this skidding actually took place, the difference in length between the inner and outer rails, on a one degree curve for a distance of 100 ft. being approximately 1 in., one half the load on the wheels would have to be skidded 1 in., or if the skidding backward and forward were equal, the entire load would have to be skidded ½ in.; and even assuming a large coefficient of friction for a moving body, say, 22%, a little calculation will prove that the work done in this skidding would only account for ¼ of the 0.8 lb. mentioned above.



In order to check the writer's ideas that the greater portion of curve resistance was caused by the pressure of the wheels against the outer rail, caused by the tendency of a cylinder to rotate in a line perpendicular to its axis, as mentioned before, the writer had a long 8° 10′ curve, leading off the yards in Winnipeg, carefully measured up. He then calculated what diameter the inner and outer wheels should be, so that in passing around this curve, if the theory of coning proved correct, there would be no flange pressure on either rail; in other words, the diameter of the wheels was made directly proportional to the length of the two rails on an 8° 10′ curve. These wheels were turned with a standard flange, but with a flat tread; they were put under C.P.R. steel flat car 311,074, 36 ft. 10 in. long, 5 x 9 in. journals, a simplex truck frame, center to center of axles 5 ft. 4 in., center to center of trucks 26 ft. 7 in., Susemihl side bearings. The tare of this car was 31,200 lb., live load 99,000 lb. of steel rails. The first experiments made with this car were with the idea of testing the tractive force necessary to move the same.

The writer asked the C.P.R. Mechanical Department officials to rig up a system of levers with a spring balance, that would be capable of measuring the tension necessary to pull the car on a level, straight track. The Mechanical Department officials, however, were of the opinion that we could get better results by using the dynamometer car with some alterations. This car has a piston, free to move in a 16 in. diameter cylinder filled with oil; the piston is connected with a draw bar by a shaft 4 in. in diameter, and the shaft is so packed that no oil will leak with a draw bar pull up to 60,000 lb. The oil from both ends of this cylinder is piped to a small recording machine in the cupola of the car. This recording machine has pistons with ½ in. end area. This portion of the machine was changed to a piston, with 2½ sq. in. end area, in order to enlarge the scale to read the small pressures that would be produced in hauling a single car.

Six or seven tests were made in hauling this loaded car over this 8° 10′ curve, which was over 1,000 ft. long, then over a distance of 2,000 ft. of straight level track, thence over a short 5° curve in the reverse direction. It was apparent from the start that on account of the packing our machine was not delicate enough to accurately measure small pressures. The writer, therefore, abandoned the idea of attempting to get a definite figure in pounds per ton with this machine, but the results prove conclusively what the writer expected, viz., that the resistance on the 8° 10′ curve was only 50% to 60% of the resistance on straight track, and when the car was pulling over the 5° reverse curve, which was really too short to get a constant pressure, being less than 150 ft. long, the indicator went up 10 to 20% over what it had been on straight track.

A very instructive lesson was obtained through a mistake that had been made. In going around the long 8° 10′ curve at all speeds, varying from 5 to 20 miles an hour, it was noticed that the trucks would first run against one rail and then against the other. It was further noticed that the conditions were the same at every trial; that is, the location where the trucks would press against the outer rail were the same. The writer sent for the resident engineer, who was instructed to measure the curve, and he reported:—"I thought you wished to know what degree of curve would best fit this location; the curve is not true, it must be thrown 5 or 6 in. in or out at several points." This, of course, was the explanation why the trucks did not run true. We simply had a series of compound curves, some sharper and some flatter than 8° 10′; the elevation at this time was about 3 in.

The next test consisted of pulling C.P.R. flat car 310,173, similar in all details to 311,074, except that the former had standard trucks, which were in very good shape. The dynamometer car results indicated, as we expected, that the resistance on straight track was only 40% to 50% of the resistance on the 8° 10′ curve. The tests were then stopped, the curve was properly lined and surfaced and the elevation reduced to 2 in. At a later date exactly the same tests that were mentioned above were repeated. The packing was somewhat loosened up and more accurate results obtained, but still not accurate enough to be given as a measure of either curve or track resistance. While the relative resistance of straight, versus curved track, was quite constant, the indicated resistance of different tests on the same track varied too much to justify even taking the mean of the number of tests we made as a measure of track resistance. The results, however, prove conclusively that the resistance offered on an 8° 10′ curve to the car with the special wheels, was only 50% to 60% of the resistance on straight track, and, as you would expect, with another similar car 310,026 with a total weight of 129,000 lb., with nearly new standard wheels, the resistance on straight track was only 40% to 50% of the resistance on the curve; but the most important feature of this test was the fact that the trucks under 311,074, while going around the 8° 10′ curve, never pressed against the head of either the inner or outer rails, but ran exactly as true as the ordinary truck runs on a straight track, as this was true regardless of the speed, from 5 to 25 miles an hour, thus proving, at least to the writer's mind, that the rectangular shape of wheel-base, especially so for the short wheel-base of a freight truck, has very little, or nothing, to do with causing the pressure of the wheels against the outer rail.

The next test that was made was one to determine, if possible, which wheels of a railway car do the skidding and the amount thereof. The writer has always been of the opinion that on account of the extra horizontal pressure of the leading wheel of a truck against the outside rail, that unless the vertical pressure on the inner rail was largely in excess of the vertical pressure on the outer rail, there would be very little or no skidding of the