Questions About Draw-Bar Pull.

A Canadian Railway and Marine World subscriber wrote recently asking the following questions:

"How much power applied at the draw-bar is necessary to move a train of given weight on a level track?

"How much more power is required to start this train in motion?

"How much should be added to the above for variations in the track i.e., if the track has been roughly laid or improperly ballasted?"

We referred the enquiry to **Alfred Price**, Assistant General Manager, Eastern Lines, C.P.R., who has favored us with the following information:

"The draw-bar pull necessary to keep a train moving at a uniform velocity on straight, level track depends chiefly upon the nature and condition of the track and equipment, the velocity, and the average weight of the cars comprising the train.

"On good track and under favorable conditions the draw-bar pull required may vary from 7¾ lb. ton at 5 miles an hour, to 12¼ lb. a ton at 35 miles an hour, for an empty flat car weather conditions, the draw-bar pull required may vary from 3 lb a ton at 5 miles an hour to 5 lb. a ton at 35 miles an hour, for a loaded car having a total weight of 75 tons.

"The draw-bar pull necessary to start a train is even more variable than that required to keep it in motion. On level track the pull may vary from about 6½ lb a ton to over 20 lb. a ton for the individual cars. A locomotive will not usually have to start the whole at the same moment, and therefore the starting resistance per ton for the whole train may be somewhat less.

"Poor track may increase train resistance 100%."

H. D. Cameron, Mechanical Engineer, Canadian Northern Ry., to whom the questions were also referred, has favored us with the following replies:—"In order to reply intelligently to these questions it will be advisable to recall the principal factors that enter into the calculation in determining train resistance. Train resistance may be defined as the sum of all resistances which constitute a tax on the adhesion of the locomotive, and may be considered under the following heads:—

"Grade resistance is due to the retarding of gravity, is an invariable factor, and can be calculated exactly by resolving the triangle of forces which act when a train moves up a known incline. This works out to 20 lb. a ton for 1% grade.

"Curve resistance is made up of several different factors, which are difficult to determine exactly, and different authorities give figures which vary from 0.5 of a pound per degree to 1.75. For ordinary purposes we have used 0.8 of a pound as a fair average for resistance on curves.

Speed resistance is comprised of the following variable factors which always act together, and are, therefore, usually considered under the one heading of speed resistance. These factors are:—1, Journal friction, between journal and bearing; 2, Rolling friction, between rail and wheel; 3, Resistance due to weather conditions; 4, Flange friction, due to oscillation and concussion; 5, Resistance due to change in velocity. These variables, with the exception of resistance due to change in velocity, are rather hard to isolate and determine accurately, and for ordinary rough calculation we assume about 6 lb. per ton for speed resistance other than that required for change in velocity. The latest tables on speed resistance, compiled by the American Locomotive Co., show the resistance of freight cars comparatively constant between 5 and 30 miles an hour, and varying only according to the weights of car as follows:—

"Weight of car in tons (tare & contents)	Resistance (pounds per ton)
20	7.84
25	6.62
30	5.78
40	4.65
50	3.94
60	3.44
70	3.06
70	3.00

"The resistance due to change in velocity can be determined with reasonable accuracy from the formula $P = \frac{70V2}{S}$ where V represents the change in velocity in miles per hour, and S the distance in which it is acquired.

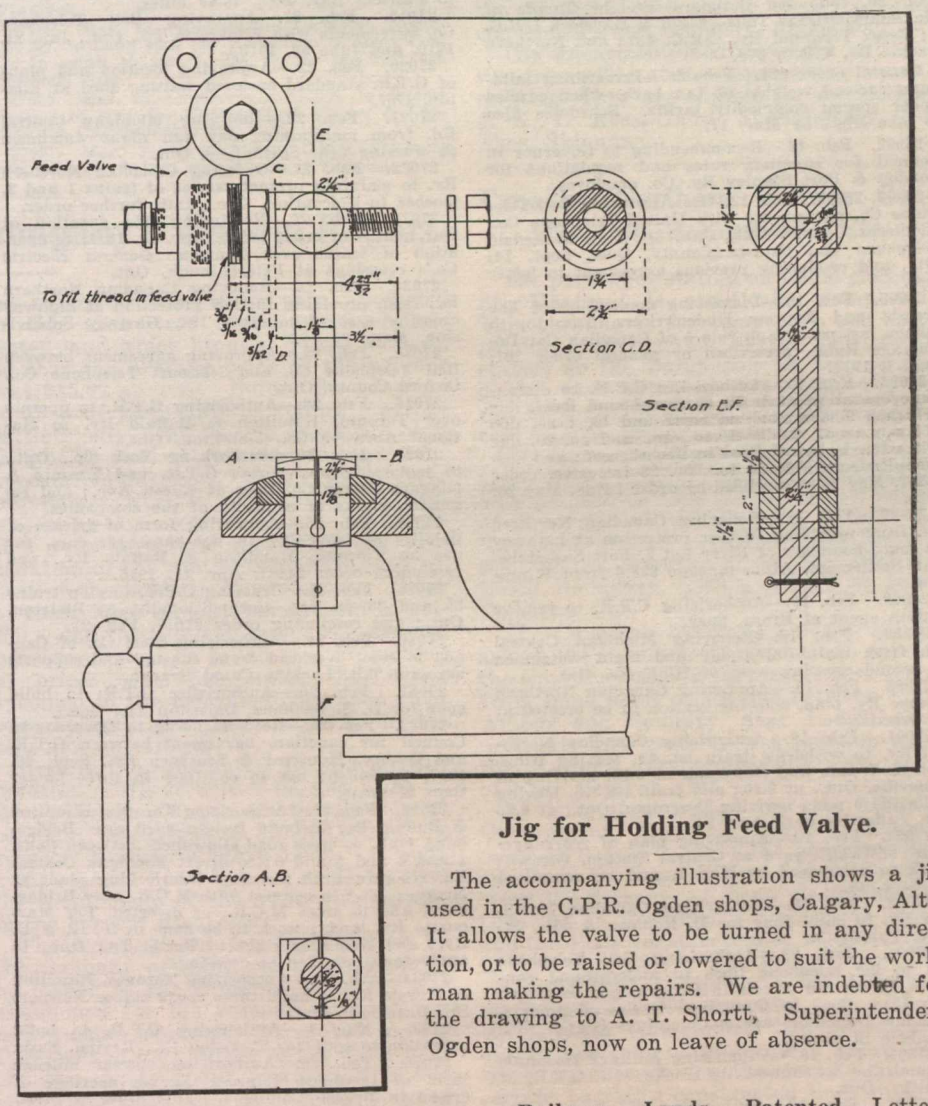
"Referring again to questions 1 and 2. The writer is not very clear as to the difference between power required 'to move' a train on level track and power required 'to start this train in motion.' Probably your correspondent wanted to distinguish between speed resistance, and resistance required to overcome inertia or change in velocity. The other question regarding allowance for variation in track is liable to vary between such wide limits that it is not possible to give a definite answer. In practice it would be determined by experiment.

"To summarize, the power required, in pounds per ton, to move a train on straight level track would have to be sufficient to overcome rolling resistance and resistance due to change in velocity. For example, a train composed of 50 units started from rest, and brought to a speed of 20 miles an hour in a distance of 2,000 ft. requires:—

"Resistance to overcome inertia $= \frac{10 \times 20^2}{2000} =$ 20 lb. per ton

"Speed resistance (see table = 4 lb. per ton

"Total power required = ... 24 lb. per ton



Jig for Holding Feed Valve.

The accompanying illustration shows a jig used in the C.P.R. Ogden shops, Calgary, Alta. It allows the valve to be turned in any direction, or to be raised or lowered to suit the workman making the repairs. We are indebted for the drawing to A. T. Shortt, Superintendent Ogden shops, now on leave of absence.

Railway Lands Patented.—Letters patent were issued during February, respecting Dominion railway lands in Manitoba, Alberta and British Columbia, as follows:—

	Acres
Alberta & Great Waterways Ry.	246.20
Calgary & Edmonton Ry.	2,533.00
Canadian Northern Ry.	3,864.39
Canadian Northern Alberta Ry.	6.00
Canadian Pacific Ry. roadbed and station grounds.	9.79
Qu'Appelle, Long Lake & Saskatchewan Rd. & Steamboat Co.	1,122.00
Total.	7,781.38

Nova Scotia Society of Civil Engineers.—Subject to the approval of both societies, a resolution has been adopted by this society favoring its amalgamation with the Canadian Society of Civil Engineers. It has also been decided to make application for the formation of a branch of the C.S.C.E. in Halifax, N.S.

Ontario Railway and Municipal Board. The Ontario Legislature has voted $41,200 for the board's estimates for this fiscal year.