نظرية مركبات
المرحلة الرابعة
نسخه

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المحاضرة الثالثة:

Relation between the Resistance power and the Power at roadwheels

Performance curves of resistance power $(p_R)$and power at the roadwheels $(P_r)$are plotted on km/h base. The relationship of one to other will ascertain whether the vehicle is *overgeared or undergeared*. The optimum final drive setting will ensure that the maximum power available p_r crosses the resistance power curve P_R to give the maximum possible road speed. Fig -1. If the power curve p_r is moved to the left relative to the resistance curve P_R *the maximum road speed will be reduced*, but more power becomes available for acceleration, etc., and the vehicle is termed ***'undergeared'***. The vertical distance between the two curves shows the power available for acceleration. If the p_r curve is moved to the right of the optimum setting. *Maximum road speed will be reducedtogether with the power available for acceleration* and the vehicle is ***'overgeared'***. These graphs, together with other information, required before the *finale drive ratio and gearbox ratios for a vehicle can be decided.*

Engine Characteristics and Gear Ratios

Study the two characteristics engine test curves for engines **a,b** and **c** in Figure (2). Engine **a,** has a high torque at the lower end of the revolution rate range, which results in a falling curve with a limited maximum power figure. However, as the working rev/min range of the limited engine should be between the points of maximum torque and maximum power, this engine gives a wide range between theses points, resulting in flexibility, and *enables the number of gear ratios to be kept to a*

minimum, two or three gearbox may be enough. Engine **b,** is a more highly tuned unit having a slightly higher but flatter torque curve. The torque is also maintained at a higher figure at the top end of the revolution rate range so *more power is available.* Flexibility is somewhat sacrificed due to the limited working rev/min range and *a four or five gearbox would be necessary.* Engine **c,** is a high tuned unit with a camshaft and valve timing design to enable the engine to breath well at the higher engine speeds. To obtain these characteristics the torque is bound to fall rapidly as the engine speed drops, and this, together with the limited rev/min range reduces flexibility and *five or more gear ratios would be necessary.*

Constant Power and Tractive Effort/ Road –Speed Curves:

Since power at the roadwheels is the product of tractive effort and velocity. It follows that tractive effort is proportional to the power and inversely proportional to the road speed.

$$TE = \frac{Power\ at\ roadwheels}{velocity} = \frac{P_r}{v} N$$

A curve of constant power will produce an ideal form of tractive effort curves, and is approached by *the steam engine and the series-wound electric traction motor.* It could be attained with the internal combustion engine if an *infinity variable gearbox of 100% efficiency was possible.*

Consider the torque at the roadwheel, see Fig. (3). If the vehicle losses road speeds from point '**a**', due to increased resistance, both the road speed and engine revolutions would fall, but the rising torque may restore a uniform road speed without the necessity to change gear. If point '**c**' or '**d**' of the curve applied, any slight increase in resistance would introduce unstable conditions due to the falling torque, and would necessitate change down to a lower gear ratio to improve the torque. The speed of stable running is a point slightly higher than that of maximum torque, such as point

'**b**' and point '**d**' would prove very unstable although it shares the same torque value as point '**b**'.

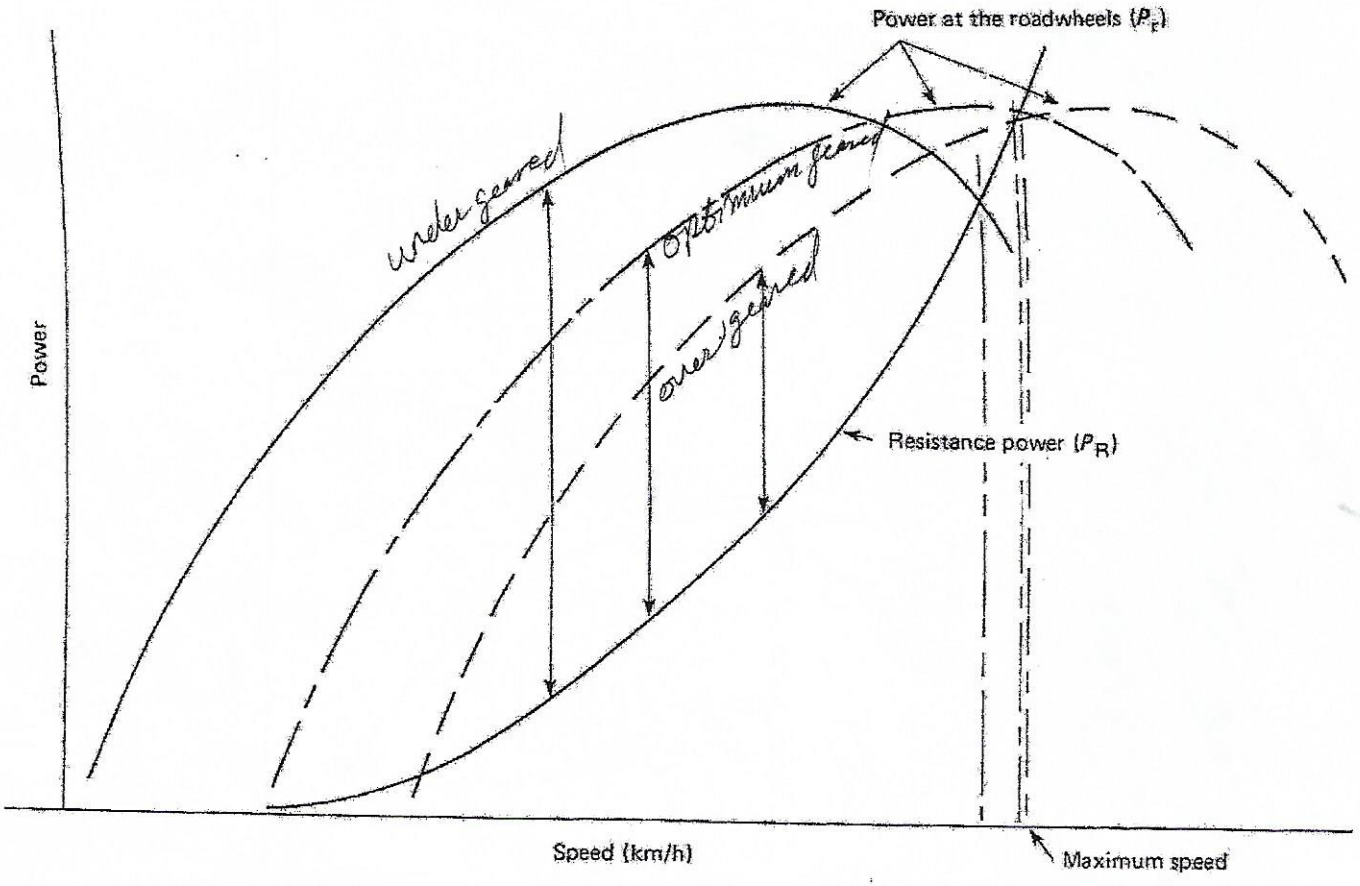

FIG.(1)

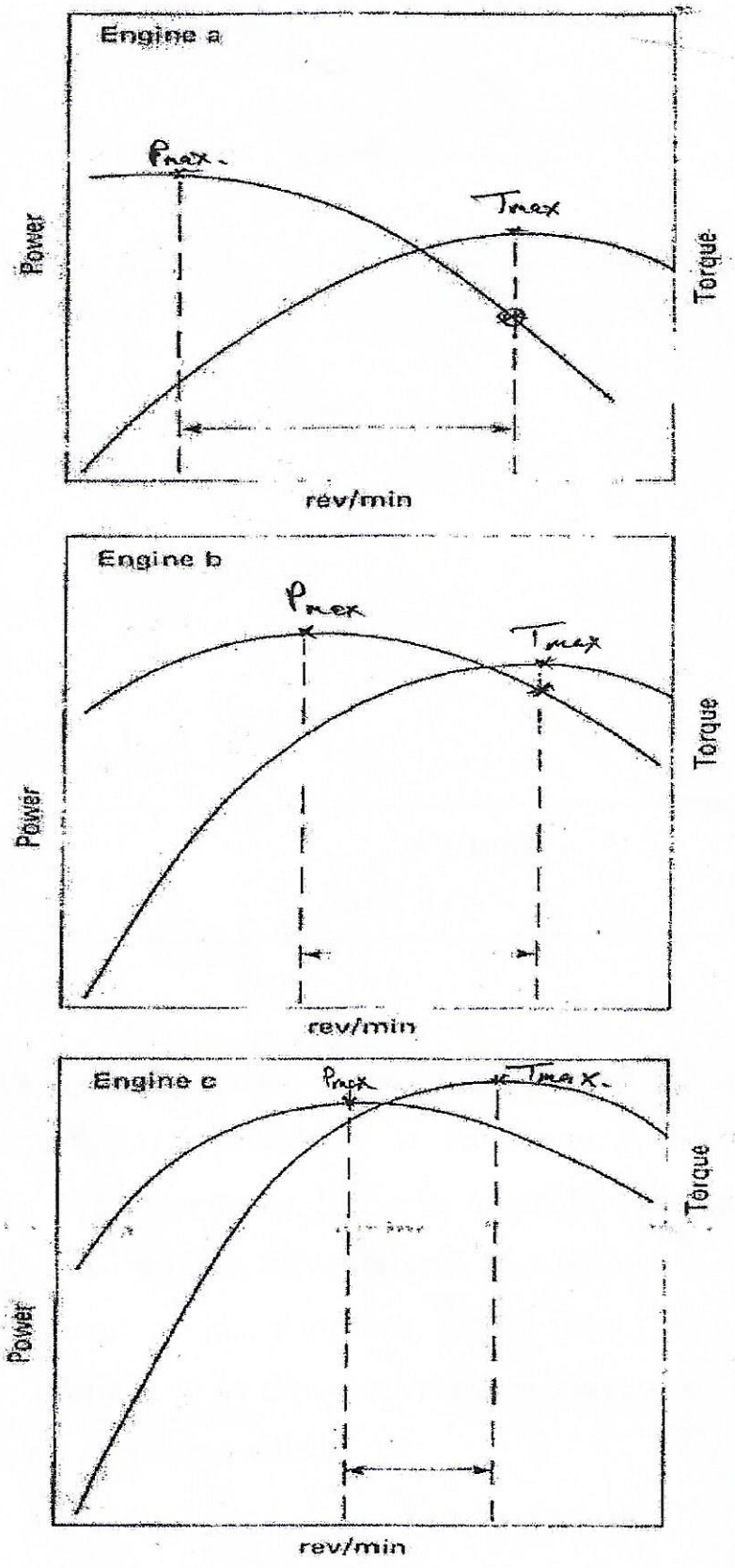

Fig (2)

Engine characteristics and engine speed ratios.

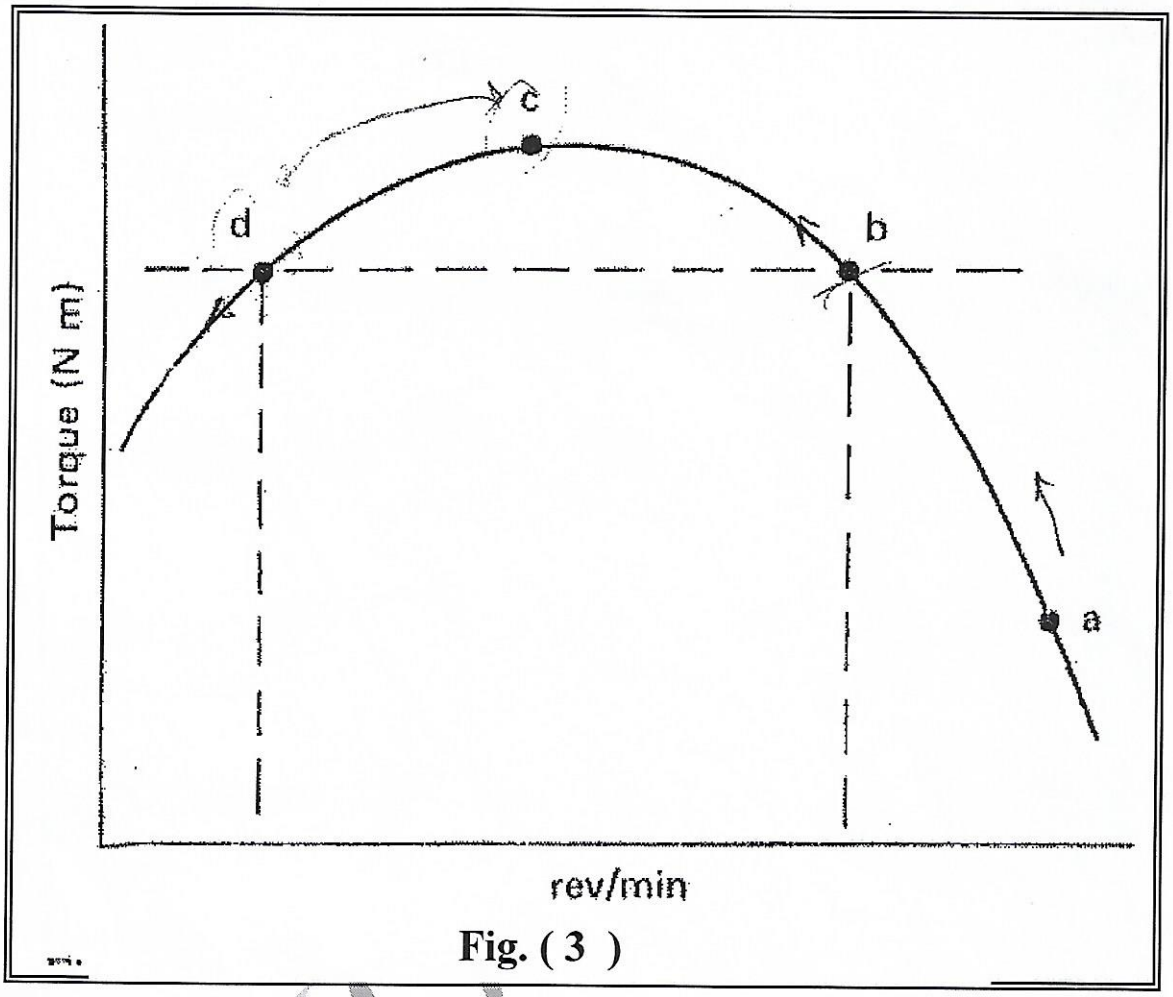

Fig. (3)

FIG.3

A curve of constant power is shown in Figure (4). *As road speed falls the tractive effort in proportion to the increased resistance, thereby providing very stable conditions.* If a point of stability such as point 'b' is marked on the tractive effort curve for each gear ratio, as shown in Figure (3), and these points are joined together, a curve should be produced which bears a close relationship to the constant power curve – or ***ideal tractive effort curve,*** as it sometimes called.

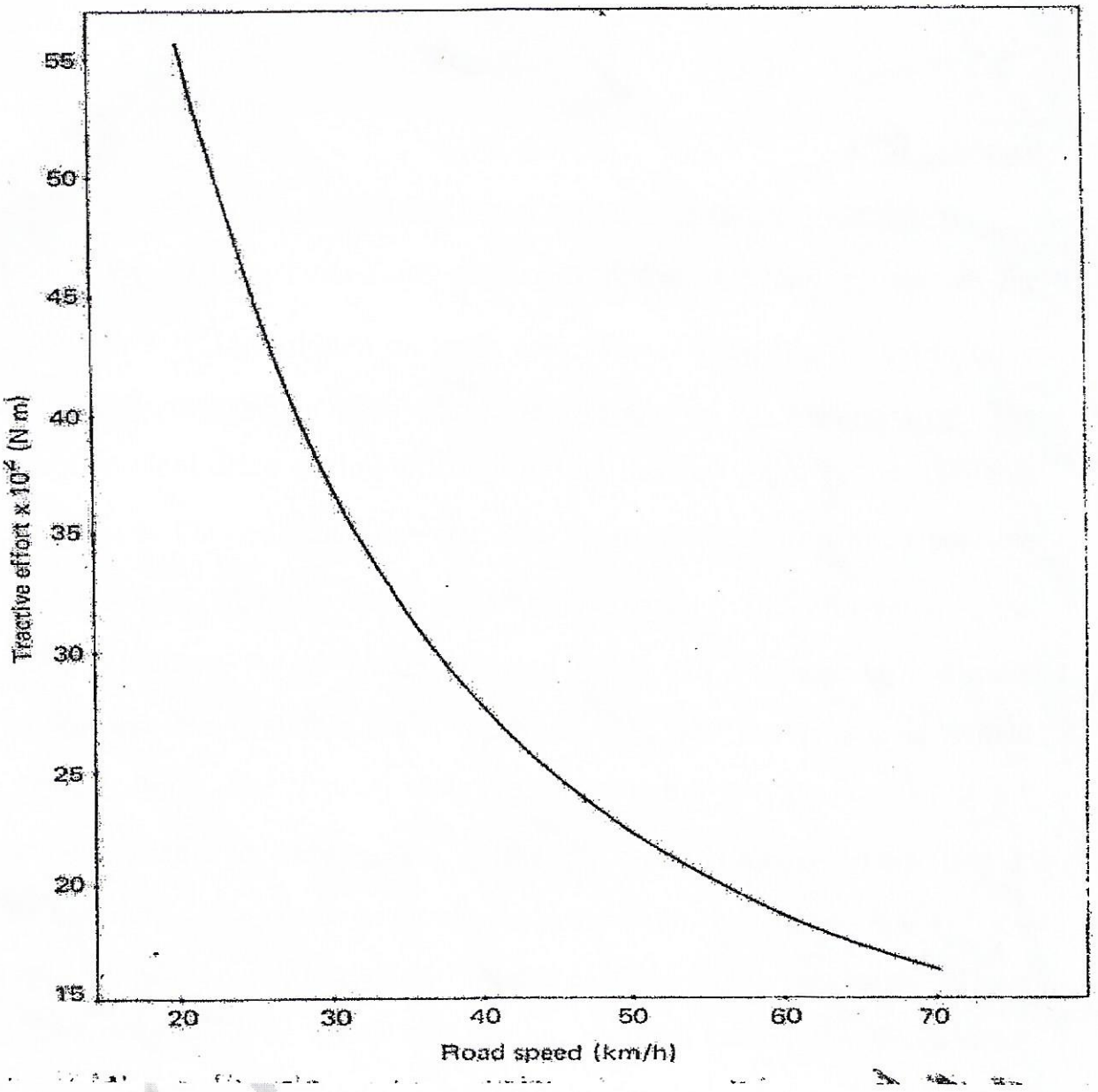
Tractive effort x 10⁴ (N m)
55
50
45
40
35
30
25
20
15
20
30
40
50
60
70
Road speed (km/h)

FIG.4