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# OPTIMIZATION OF THE DYNAMIC CHARACTERISTICS FOR MERCEDES A170 CDI AUTOMOBILE

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## ABSTRACT
*The main task of calculation of outer characteristics of the tractive force of the vehicle is the determination of main parameters of the engine and the reports of the transmission of the power transmitter, which should ensure the vehicle the necessary tractive force in order to overpower the outer resistance which affect the engine while in move, and ensure the possibility of movement on the ordinary horizontal road with its maximal speed for which the engine has been designed.*
**Keywords:** tractive force, dynamic characteristics, gear-shift.

### 1. INTRDUCTION
Outer characteristics of outer tractive force of the passengers' vehicle and this for transport could be analyzed in many ways. The best way is to this through the tractive diagram.
The tractive diagrams show the graphic interpretation of tractive balance, respectively the equilibrium between the tractive and resistant force for all kinds of vehicle accelerations.
While the vehicle is in moving state the tractive force from the driving wheel should be higher than the total resistant force which acts in the vehicle, therefore the disbalance should be filled [1]:

$$F_A \geq F_B \qquad (1)$$

### 1.1. Resistant Force
Resistant forces are forces which impede the car movement and these forces vary among themselves in intensity, way and their action point.
Total resistant force which affects the vehicles could be defined in this equation:

$$F_{Z,B} = F_R + F_{st} + F_L + F_a \qquad (2)$$

The resisting rolling force while the vehicle is moving on the slope roads could be defined with the expression:

$$F_R = f_R \cdot m_F \cdot g \cdot cos\,\alpha_{St} \qquad (3)$$

The resistant coefficient of the rolling according to [3] is taken with the interval $f_R$=0.01 … 0.030, while calculating out could be acquainted the value $f_R$=0.020 and gives the report:

$$f_R = \frac{e}{r_{dyn}} \qquad (4)$$

The resistant force of the acceleration could be defined with the expression:

$$F_a = \lambda \cdot m_F \cdot a \qquad (5)$$

The resistant force of the road slope could be defined with the expression:

$$F_{st} = m_F \cdot g \cdot sin\alpha_{St} \qquad (6)$$

Air resistant force could be defined with the expression:

$$F_L = \frac{1}{2}\rho_L \cdot c_w \cdot A \cdot v^2 \qquad (7)$$

**1.2. Torque**

The torque in the running wheels forces the vehicle to move, in case this force is higher than the amount of all resistant forces which act on the vehicle while in move, therefore this inequality should be completed.

Maximal tractive force $F_A$, on the running wheels could be defined with the expression:

$$F_{A\max} = \frac{T_{e\max} \cdot i_n \cdot i_o \cdot \eta_n \cdot \eta_0}{r_d} \qquad (8)$$

**2. CHARACTERISTICS OF THE FIVE SPEED GEAR BOX**

If in the general Force transmitter there is assembled the five speed gear box according to (10). If the torques on the running wheels of the passengers' vehicles will be calculated with the expression (10) and the results achieved will be graphically given in diagram in fig.2 for more correct data.

The total report of the passengers' vehicle transmitter which is run only through one axel could be defined as follows:

$$i_A = i_n \cdot i_0 \qquad (9)$$

Whereas

$i_n$– the transmission report of the gear box in the corresponding velocity; n=1,2,3,4,5

$i_0$– the transmission report of the differentially.

Effective momentum of motor torque will be determined through equation:

$$T_e = \frac{30 \cdot P_{e\max}\left[c_1 \frac{n_e}{n_{e\max}} + c_2\left(\frac{n_e}{n_{e\max}}\right)^2 - c_3\left(\frac{n_e}{n_{e\max}}\right)^3\right]}{\pi \cdot n_e} \qquad (10)$$

In fig.1 the section of two-step five speed gearboxes is presents of the passengers' vehicle MERCEDES 170A CDI with respective moving with the following characteristics.

$P_{emax}$=66 kW–engine maximal power,

$m_F$=1160 kg–vehicle weight,

$n_{emax}$=4200 $min^{-1}$– number of maximal rotations of the engine,

$i_1$=3.27; $i_2$=1.92; $i_3$=1.26; $i_4$=0.88; $i_5$=0.70–transmission report in the corresponding moving speed,

$i_0$=3.61–transmission report at the main transmitter,

$r_d$=0.312 m – running wheel dynamic radius.

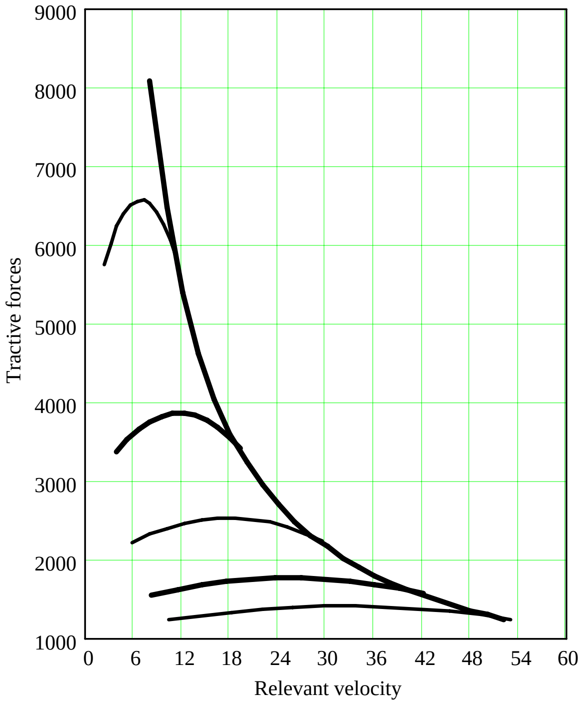


*Figure 1. Dependence of tractive forces and ideal force in the speed function*

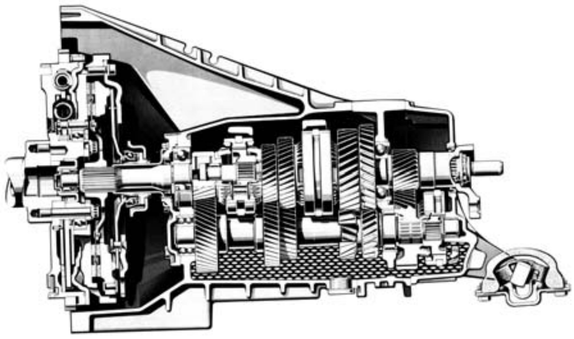

*Figure 2. The section of two-step five speed gearboxes*

In fig.1 graphically it has been given the dependence of tractive forces and ideal force in the speed function.

**3. DYNAMIC CHARACTRESTICS**

The Dynamic characteristic shows the report between the change of the tractive power and air resisting power towards the total vehicle weight.

The distinguishing of the dependence of the volume of the tractive force from the vehicle move force could be defined in many constructive parameters of the vehicle. If two vehicles having the same tractive force, the vehicle with the light weight will have better tractive characteristics.

The dynamic characteristics could be defined through the expression:

$$D_j = \frac{T_{ej} \cdot i_{Aj} \cdot \eta_p - K \cdot A \cdot v_j^2}{G} \qquad (6)$$

Where j=1,2...4

If the report at the first gear of the acceleration is in the interval $i_1$=3.2…4.0 while the transmission report in the five gear is in the interval $i_5$=0.55…1.0.

The dynamic characteristics will also change in the first gear and fifth gear and these changes could be seen in figure.3

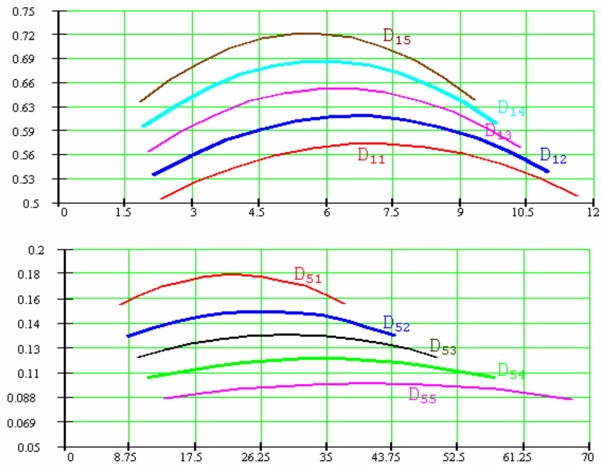


*Figure3. Dependence of dynamic speed at the first and five gear*

*Table 1. Values of Dynamic characteristics and the velocity according to the rotation number and the transmission reports in the first and five gear.*

| $i_{ij}$ | 3.2 | 3.46 | 3.6 | 3.8 | 4.0 |
|---|---|---|---|---|---|
| $n_e$ | $D_{11}$ | $D_{12}$ | $D_{13}$ | $D_{14}$ | $D_{15}$ |
| 1100 | 0.528 | 0.561 | 0.594 | 0.627 | 0.659 |
| 3500 | 0.55 | 0.584 | 0.681 | 0.652 | 0.686 |
| 4100 | 0.509 | 0.540 | 0.572 | 0.603 | 0.634 |
| $i_{ij}$ | 1.0 | 0.85 | 0.75 | 0.65 | 0.55 |
| $n_e$ | $D_{51}$ | $D_{52}$ | $D_{53}$ | $D_{54}$ | $D_{55}$ |
| 1100 | 0.165 | 0.140 | 0.123 | 0.107 | 0.09 |
| 3500 | 0.172 | 0.145 | 0.128 | 0.110 | 0.093 |
| 4100 | 0.159 | 0.134 | 0.118 | 0.102 | 0.085 |

## 4. CONCLUSION

In figure 3 it could be seen that $D_{11}<D_{12}<D_{13}<D_{14}<D_{15}$ because $i_{11}<i_{12}<i_{13}<i_{14}<i_{15}$ while the velocity will be: $v_{11}<v_{12}<v_{13}<v_{14}<v_{15}$ and $D_{51}>D_{52}>D_{53}>D_{54}>D_{55}$ because $i_{51}>i_{52}>i_{53}>i_{54}>i_{55}$ while the velocity will be: $v_{51}<v_{52}<v_{53}<v_{54}<v_{55}$.

Dynamic characteristic values are increased together with the total report of transmission in the power transmitter. Minimal value of the transmission report is limited to minimal value of dynamic characteristics which could have negative value, in case when the air resistance is higher than the tractive power.

Therefore the most optimal values of the transmission report which could be peculated are: for the first gear $i_1$=2.83–3.27, for the five gear $i_5$=0.70-0.82

## 5. REFERENCES

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