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VEHICLE SPRINGING
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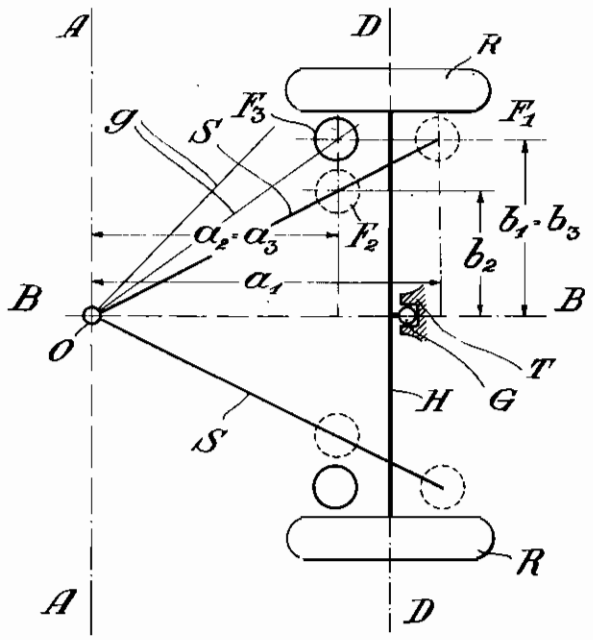

Fig. 1.

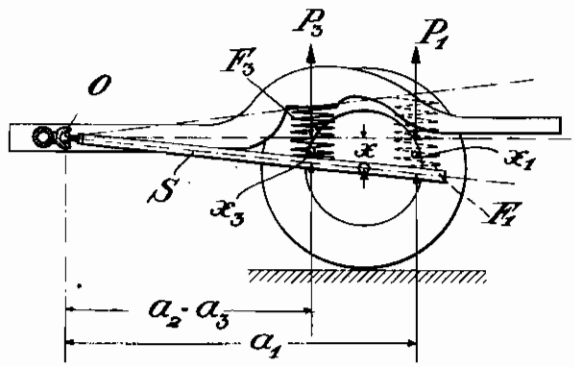

Fig. 2.

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VEHICLE SPRINGING

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This invention relates to the springing of a rigid axle, more particularly the rear axle of a motor vehicle, which is supported with reference to the frame by a strut or radius rod arrangement in such manner that it can pivot with respect to the frame against the action of helical springs, not only about a central longitudinal axis but also about a transverse axis determined by the pivotal attachment of the strut or radius rod arrangement to the frame.

In the known springing arrangements, the springs constructed as displacement springs, e. g. helical springs were arranged exclusively or at least in part on the side of the axle remote from the point of pivotal attachment of the struts or radius rods to the frame. In contradistinction thereto the invention provides such an arrangement of the helical springs—more particularly a single spring for each wheel side—that they are disposed exclusively on the same side of the straight line passing through the centres of the wheels as the point of pivotal attachment of the strut arrangement to the frame, and preferably they are disposed close to the wheels.

Such an arrangement has the important advantage—apart from the structural advantage that the space on the other side of the axle is not occupied by the helical springs and consequently can be used for other purposes—that the springing can be adapted to desired circumstances in the particularly effective manner, above all in such manner that the vehicle has an increased stability on curves.

In the annexed drawing, the rear axle of a motor vehicle is shown diagrammatically in plan view in Figure 1 and in side view in Figure 2.

The road wheels R are arranged on a rear axle H which is supported forwardly with respect to the frame by means of struts or radius rods S which are connected with the axle, to form a triangle for example. The strut arrangement is pivotally connected to the frame by a ball joint O. Further the axle can be supported against lateral displacement relatively to the frame, in that for example the axle is guided by a joint G guided vertically with respect to the frame. This guidance may be effected by elastic rollers travelling in a vertical guideway arranged in the longitudinal central plane of the vehicle, or by a pair of links or similar means, in such manner that the axle can execute simultaneously on up and down movement about the axis A—A and a pivotal movement about a central longitudinal axis B—B. The springing is effected by helical springs in the example illustrated. For comparison purposes, spring positions in accordance with the invention are shown at F_2, or F_3, and a known spring position is shown at F_1.

With similarly directed equal displacements of the wheels about the axis A—A, any spring F or its spring power P will exercise against pivotal movement of the axle a restoring moment $M_A=P.a$, which is assumed to be the same in all cases for the same displacement of the wheel. Thus

$$M_A=P_1.a_1=P_2.a_2=P_3.a_3$$

As

$$P_2=P_3=\frac{a_1}{a_2}\cdot P_1$$

and (for a wheel displacement x)

$$x_2=x_3=\frac{a_2}{a_1}\cdot x_1$$

there results for the spring F_1 a stiffness

$$f_1=\frac{P_1}{x_1}$$

and for the springs F_2 and F_3, a stiffness

$$f_2=f_3=\frac{P_2}{x_2}=\frac{P_3}{x_3}=\left(\frac{a_1}{a_2}\right)^2\cdot f_1$$

Thus with the same restoring moment with respect to the transverse axis A—A, the spring stiffness is inversely proportional to the square of the distance of the spring from this transverse axis. For restoring moments about the longitudinal axis B—B, which for example come into consideration for tilting of the vehicle body on curves, the following values are obtained:

(1) For the spring F_1, a restoring moment

$$M_B=P_1.b_1$$

(2) For the spring F_2, a restoring moment

$$M_B=P_2.b_2$$

or as

$$P_2=\frac{a_1}{a_2}P_1$$

and

$$b_2=\frac{a_2}{a_1}\cdot b_1$$

$$M_{B_2}=P_1.b_1=M_{B_1}$$

i. e. all springs arranged on the straight lines O—F_1 and giving the same restoring moment about the axis A—A also give the same restoring moment about the axis B—B; the spring F_1 can thus always be replaced by equivalent springs arranged on these straight lines (i. e. along the struts S in the case shown in the drawing).

(3) For the spring F_3 the following restoring moment is exerted about the axis B—B:

$$M_{B_3} = P_3^1 . b_3 = P_3^1 . b_1$$

As in this case the displacement of the springs F_3 and F_1 is the same,

$$P_3^1 = \frac{a_1}{a_3} . P_3 = \left(\frac{a_1}{a_3}\right)^2 . P_1$$

Correspondingly

$$M_{B_3} = \left(\frac{a_1}{a_3}\right)^2 . P_1 . b_1 = \left(\frac{a_1}{a_3}\right)^2 . M_{B_1} = \frac{f_1}{f_1} . M_{B1}$$

Thus under the above conditions and with the springs arranged on a line parallel to the longitudinal axis B—B, the restoring moments of the springs about this longitudinal axis are proportional to the stiffness of the springs and thus inversely proportional to the squares of the distances of the springs from the transverse axis A—A.

If, for example, $a_3 = \frac{3}{4} a_1$, then with equal springing of both springs F_1 and F_3 with respect to obstacles encountered by a road wheel (restoring moment about the axis A—A), the stiffness on curves of the spring F_3 is 16/9 i. e. almost twice as much as the stiffness on curves of the spring F_1.

In general, it follows therefrom that, assuming an equal restoring moment about the axis A—A, all springs arranged top left of the straight line O—F_1 will have a greater stiffness on curves the farther they are away from the straight line O—F_1, the points of equal stiffness on curves (i. e. equal restoring moment about the axis B—B) lying on straight lines which pass through the pivot point O and some of which are indicated at *g* for example. Similarly by arranging the springs (in Fig. 1) bottom right of the straight line O—F_1, the stiffness of the springs on curves will be smaller until the value of zero is reached when the springs are arranged on the straight line B—B itself.

Conversely instead of increasing the stiffness on curves with the same obstacle springing, the same arrangement of the helical springs can give a softer obstacle springing with the same stability on curves, the latter determining the choice of spring stiffness.

By the arrangement of the helical springs in accordance with the invention in such manner that they lie between the straight line D—D joining the centres of the wheels, and the point of attachment O of the strut arrangement or the transverse axis A—A passing through the point O, the stability on curves and the obstacle springing can be adapted to the desired conditions in a particularly effective way, an increased stability on curves being desired as a rule.

When there is combined movement, as when there is pivotal movement about the axis A—A as well as about the axis B—B, for example when one road wheel only is lifted, a springing is obtained which has the properties of both kinds of springing.

Thus, according to the predominance of one or the other mode of movement, a restoring moment will be exerted which approximates more or less to that about one or the other axis.

In the practical construction, abutments for the helical springs could be provided laterally on the struts or radius rods, on the axle, or on the brake supports or the like, unless the springs bear directly against the axle or its struts. The upper ends of the springs suitably bear directly against the longitudinal bearers of the frame, which may be stepped upwardly at the springs as shown in Figure 2. Instead of a helical spring any other displacement spring arranged in a similar manner can be used. Also, in place of the triangular strut or radius rod arrangement for the axle as shown diagrammatically in the drawing, any other strut or radius rod arrangement giving a similar effect can be used.

JOSEF MÜLLER.