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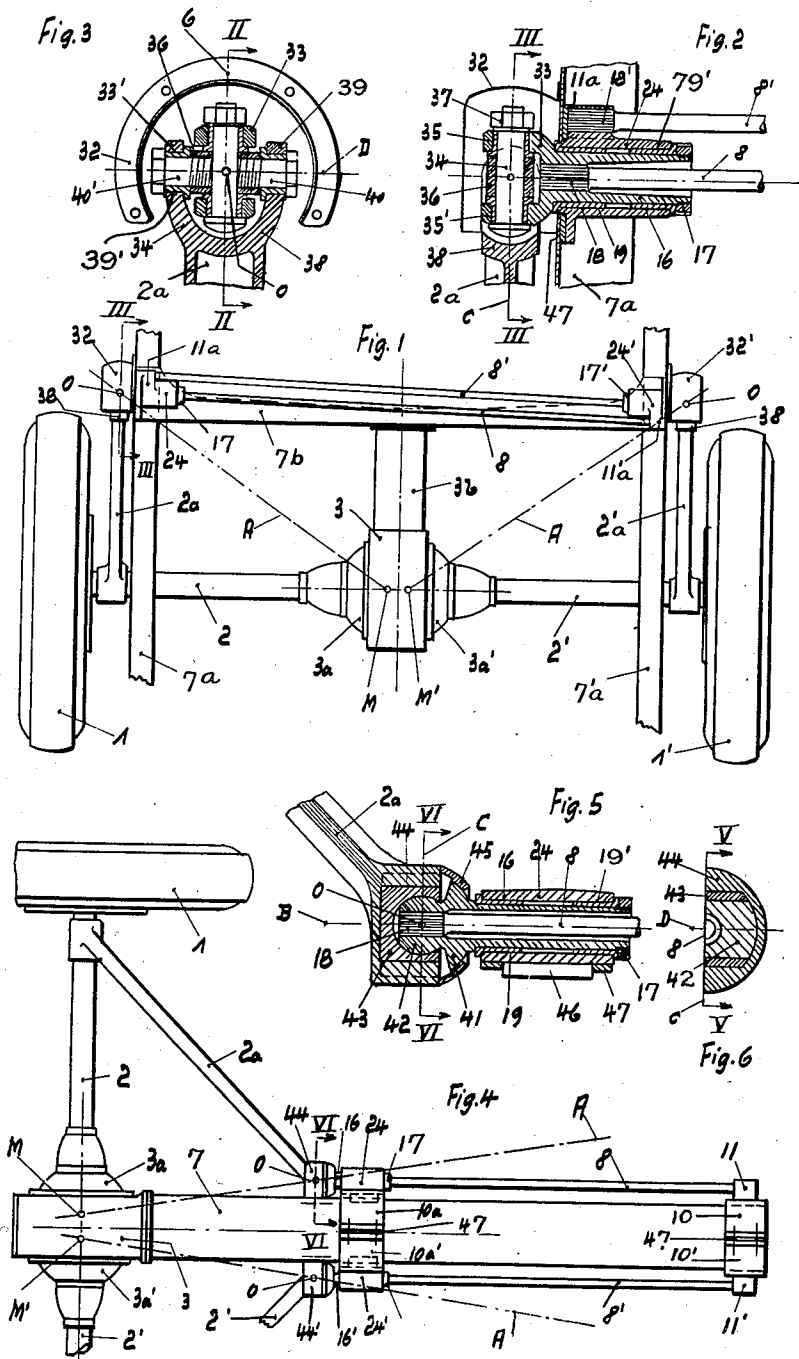
K. RABE

**2,130,431**

## SPRINGING OF WHEELS

Filed Feb. 23, 1934

2 Sheets-Sheet 1



Inventor:  
Karl Rabe

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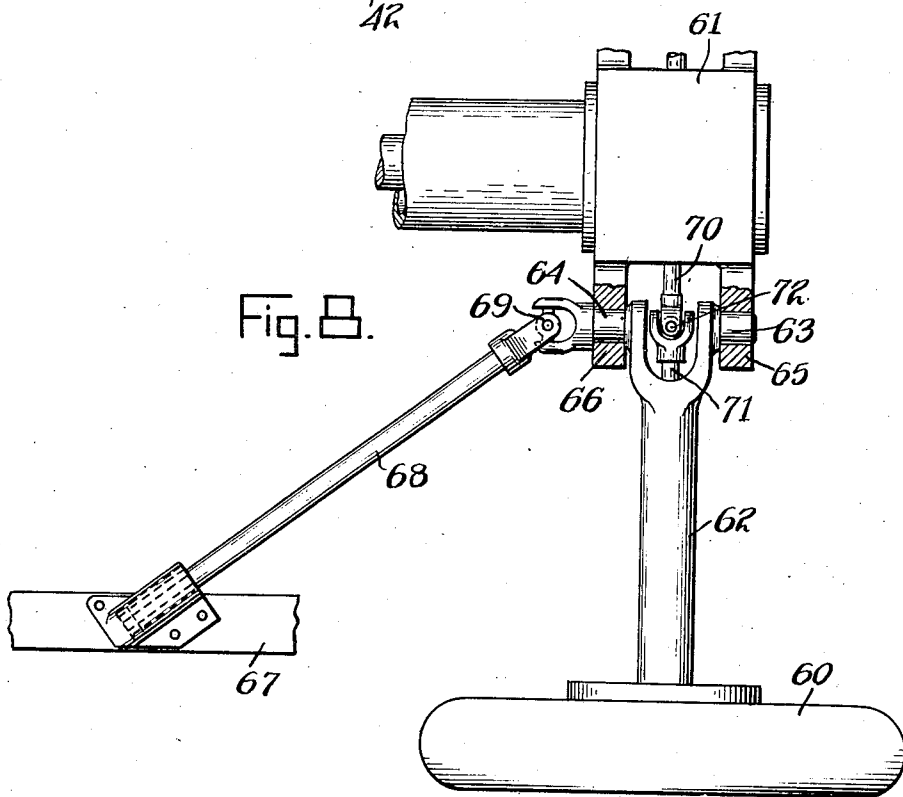
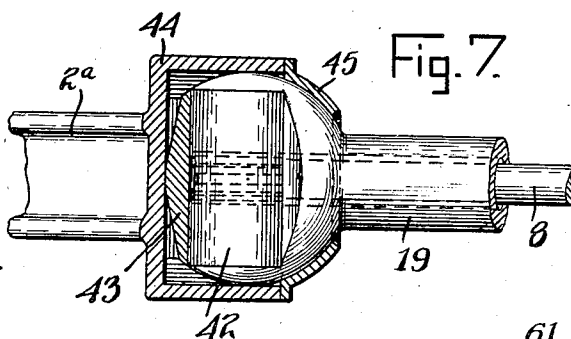
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SPRINGING OF WHEELS

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2 Sheets-Sheet 2



Inventor  
Karl Rabe

By *A. A. Hickey*  
Attorney

UNITED STATES PATENT OFFICE

2,130,431

SPRINGING OF WHEELS

Karl Rabe, Stuttgart, Germany

Application February 23, 1934, Serial No. 712,588  
In Germany February 27, 1933

20 Claims. (Cl. 287-57)

This invention relates to a springing arrangement for wheels journalled on swinging half-axes, more particularly for motor vehicles, with the employment of torsion spring means having its axis of rotation lying outside the theoretical axis of oscillation of the half axes.

It has been found that torsion springs lying in or approximately in the theoretical axis of oscillation of the wheels can in many cases only be arranged in or on the frame in a very inconvenient manner. In the case of swinging half-axes, such as those in which the axle tubes are journalled in spherical shells and the swinging struts in journal pins, this theoretical axis of oscillation extends at an inclination with respect to the longitudinal axis of the vehicle and consequently to the main frame members, whereby it becomes necessary to tolerate a number of additional arrangements for the support of the torsion springs. To these belong more particularly the bearing bodies for the spring ends, the shape and fixing of which cannot in all cases always be adapted in a simple manner to the particular kind of construction. The mounting of these bearing bodies in the frame and their adjustment in the theoretical axis of oscillation of the wheels entails a considerable expenditure of time and in some cases even additional subsequent work, so that this springing arrangement is rendered considerably more costly.

The object of the invention is to avoid these disadvantages in such a manner that the torsion springs can be disposed without regard in each case to the theoretical axis of oscillation of the wheels in the main directions of the vehicle, which naturally are governed by the kind of construction of the vehicle frame. By this means, while deliberately foregoing the greatest possible angle of deformation of the said torsion springs, it is possible to use simple bearing bodies and produce convenient mounting conditions which are economically successful.

The new feature of the invention consists in a construction in which the springs are connected through the intermediation of a universal joint with the swinging struts of the half axes. The result of this construction is that the returning moments which are produced by the torsion of the springs are automatically resolved into part moments, of which in each case one opposes the swinging motion of the wheels in the correct sense, while the others remain as internal moments without influence on the wheel motion. The guiding of the wheels with respect to the frame, which is predetermined by the journalling

of the axle tubes in conjunction with that of the swinging struts, is therefore maintained under all circumstances, whatever the position of the torsional axis of the springs with respect to the frame, and the desired springing of the wheel is secured in a manner which is just as simple as it is economical. This springing arrangement makes it possible to dispose the torsion springs parallel or perpendicular to the longitudinal frame members, so that the springs can be designed a suitable length, the bearing and abutment points can be made conveniently accessible, and the reaction moments of the springs can be transmitted in a perfect manner to the main frame members which are rigid as regards torsion. The arrangement is preferably made such that the angle between the theoretical axis of oscillation of the wheels and the torsional axis of the springs is as small as possible, so as to keep the effective partial moment acting on the springs as large as possible with respect to the ineffective partial moments acting on the joint surfaces.

A further feature of the invention consists in the fact that the free axes of rotation of the universal joint are perpendicular to the torsional axis of the spring. The result of this is that, while the construction of the joint is extremely simple, the angular deflections of the parts of the joint are as small as possible and are equally distributed over all the parts of the joint, whereby the work due to friction and consequently the wear on these parts of the joint can be kept within useful limits. The torques reaching the joint will in this arrangement take the shortest path, that is to say, the transmission of power from the torsion spring to the swinging strut or vice versa will stress the parts of the joint in a clearly and accurately ascertainable manner, so that these parts can be designed so as to be suitably safe.

A further feature of the invention consists in this, that the bearing journal supporting the movable end of the spring is connected to the universal joint with freedom of motion in two directions. By this means not only a simple and safe connection but at the same time a perfect centering of the universal joint with respect to the frame is obtained, with the result that the theoretical axis of oscillation of the wheels retains its original position when the half axes swing. The outer end of this bearing journal may be suitably constructed as a fork, toggle or the like, that is to say as a constituent part of the universal joint, which enables the universal

joint to be constructed in a very compact, and tight manner.

Further features of the invention will be gathered from the drawings and the following description. In the drawings the invention is illustrated in two constructional examples, in each case as applied to the rear or driving wheels of a motor vehicle.

Fig. 1 shows a fragmentary plan view of the rear part of a vehicle embodying the invention,

Fig. 2 the corresponding section along line II—II of Fig. 3 on an enlarged scale,

Fig. 3 the corresponding section on line III—III of Fig. 2 on the same enlarged scale,

Fig. 4 a fragmentary plan view of the rear part of a vehicle embodying a second constructional form of the invention,

Fig. 5 the corresponding section along line V—V of Fig. 6 on an enlarged scale,

Fig. 6 the corresponding half section on line VI—VI of Fig. 5 on the same enlarged scale,

Fig. 7 is a figure, partly in cross-section, of the device shown in Fig. 5 taken at right angle to the section of Fig. 5, and

Fig. 8 shows a further modification.

In the first constructional example shown in Figs. 1 to 3, the axle tubes 2, 2', on which the wheels 1, 1' are journaled in a known manner, are guided on the axle casing 3 in suitable means shown as spherical shells secured by covers 3a, 3a'. The axle casing 3 is connected by means such as the tubular extension 3b in which the pinion shaft is journaled, to the transverse member 7b of the frame, which latter includes two parallel longitudinal members 7a, 7a'. The axle tubes 2, 2' are further supported in a known manner by swinging struts 2a, 2a'.

The springing is effected by two spring bars 8, 8' which are disposed at substantially right angles to the longitudinal central plane of the vehicle between the longitudinal frame members 7a, 7a'. The end of the spring 8, which is capable of turning, is connected by means such as the fluted profile 18 to a hollow bearing journal 16. The bearing journal 16 is guided by means of two bearing bushes 19, 19' in a casing 24 and may be secured against longitudinal displacement by a nut 17. The rigidly fixed end of the spring is shown held by a fluted profile in an eye 11a' which may be formed on the oppositely located casing 24' and is somewhat displaced out of the shortest connecting line between the two casings 24, 24', that is to say is disposed eccentrically with respect to the torsional axis B of the spring bars 8, 8'. The casing 24 is firmly connected to the longitudinal frame member 7a and, if desired, through the interposition of layers of any suitable yielding material shown at 47.

The swinging strut 2a drives the bearing journal 16 through a suitable universal joint. The latter is preferably composed of a cross-piece 36 which is in pivotal connection with the forked ends 33 and 38 of the bearing journal 16 and of the swinging strut 2a. In the forked end 33 of the bearing journal 16 the cross-piece 36 is pivotally connected by means of a pin 34 which is journaled in two bushes 35, 35' and is secured by a nut 37. In the forked end 38 of the swinging strut 2a the cross-piece 36 is pivotally connected by means of two pins 40, 40' which are capable of turning in corresponding bushes 39, 39' and are constructed as screws with heads. The axes C, D of these pins are at right angles to one another in accordance with the cross-piece 36 and are furthermore perpendicular to the torsional axis B

of the spring bars 8 corresponding to the bearing journal 16. The universal joint is enclosed in a sheet metal cover 32 which is connected to the longitudinal member 7a of the frame. While this universal joint has been found extremely advantageous in the present invention, obviously other and well known forms of such a joint can be used in its place.

When for example the wheel 1 springs upwards about the theoretical axis of oscillation A, which is determined by the center M of the spherical guide in the axle casing 3, and by the center O of the universal joint, the swinging strut 2a moves the cross-piece 36, the bearing journal 16 and with it the spring bar 8. As the geometrical motion of the strut 2a and that of the bearing journal 16 of the spring bar 8 is positively determined, a motion will take place about the three axes B, C, D, which are perpendicular to one another and of which only one, namely, that about the axis of rotation B, produces the requisite returning moment for the wheel motion, while the others, namely those about the axes C, D of the joint represent only equalizing motions of the parts which are connected together with freedom of motion in two directions and are centered with respect to the frame. The transmission of power takes place from the spring bar 8 over the bearing journal 16 and the fork 33 to the pin 34; from the latter through the cross-piece 36 to the pins 40, 40' and finally over the fork 38 to the swinging strut 2a. On the wheel 1 springing, the power is thus transmitted substantially directly to the swinging strut 2a, while the axle tube 2 remains substantially unloaded.

If one desires to remove or adjust the spring bar 8, after the vehicle has been jacked up, the wheel 1 which is swung until the pins 40, 40' and the pin 34 can be released and removed. This releases the cross-piece 36, after the removal of which the fluted profile 18 is readily accessible and the spring bar 8 can be withdrawn.

In the second constructional example shown in Figs. 4 to 6 the axle tubes 2, 2' are also preferably guided in spherical shells on the axle casing 3, which are also secured by covers 3a, 3a'. The axle casing 3 can be flanged directly to the end of a vehicle frame which may be in the form of a tubular longitudinal central member 7. The axle tubes 2, 2' are additionally supported by swinging struts 2a, 2a' which extend obliquely forwards and inwards.

The spring bars 8, 8' lie parallel to the longitudinal central plane of the vehicle at either side of the longitudinal central member 7. The one end of the spring bar 8, which is capable of turning, extends through the hollow bearing journal 16 in the longitudinal direction and is rigidly connected to the latter by a fluted profile 18. The bearing journal 16 is journaled by means of two bushes 19, 19' so as to be capable of turning in a casing 24. The casing 24 is preferably connected by flange-like extensions 10a to the flange-like extensions 10a' of the oppositely disposed casing 24', which embrace the longitudinal central member 7 with interposed yielding packing members 47, if desired. The casing 24 is secured against sliding and turning on the longitudinal central member 7 by suitable means such as a tooth or key 46 which projects into the interior of the longitudinal central member 7. The forward immovable end of the spring bar 8 is held by means of a fluted profile in the eye 11 of a shackle 10 which may be connected in a simi-

lar manner as the casing 24 to the longitudinal central member 7.

The form of universal joint shown in Figs. 4, 5, and 6 may be the same as that shown in the co-pending application of Ferdinand Porsche, Serial No. 588,718, filed January 25, 1932, (Patent 1,996,688, granted April 2, 1935) to which reference may be had if necessary.

As shown, the rear end of the bearing journal 16 is widened to form a spherical flange 41, on the end surface of which is a bolt 42 which is perpendicular to the axis of the bearing journal 16 and forms a toggle-like closure for the bearing journal 16. The bolt 42 rests in a joint member 43 of bearing material and rests in a recess in the box-like end 44 of the swinging strut 2a. At right angles to the plane determined by the axis B of the bearing journal 16 and the axis D of the bolt 42, that is to say in the direction of the axis C, the bolt 42 and the joint member 43 have a spherical profile corresponding directly to the spherical surface of the flange 41. The universal joint is maintained with freedom of motion in two directions by a cover 45 which is connected to the box-like end 44 of the swinging strut and is thereby completely closed to the outside. To allow for the necessary diameter of the universal joint, the longitudinal central member 7 may be slightly recessed opposite the universal joint.

On the wheel 1 springing upwards for example, the rotary motion of the axle tube 2 and of the swinging strut 2a is definitely determined by the theoretical axis of oscillation A which extends through the pivotal points C, M. The motion of the box-like end 44 of the swinging strut 2a is thus resolved into three rotary motions about the axes B, C, D of the universal joint, which are perpendicular to one another, of which only the first one about the axis B, which releases a rotary motion of the toggle 42 and of the journal 16 and consequently a torsional stressing of the spring bar 8, produces the returning moment, while the others act only as equalizing motions. The universal joint centres itself with respect to the frame so that the position of its centre O in which the axes B, C, D intersect one another is not changed when the wheel 1 swings. The power is transmitted from the spring bar 8 directly to the toggle 42 and from the latter through the joint member 43 directly to the swinging strut 2a.

The removal and the adjustment of the spring bar 8 is effected from its inner end as the eye 11 is freely accessible. When the universal joint is to be dismantled the cover 45 is released from the strut end, the spring bar 8 being first unstressed, the shackle connection 10a thereupon loosened, and finally, by pushing out the casing 24, the toggle 42 with the joint member 43 is brought out of engagement.

In both constructional examples the excellent position of the springs with respect to the frame, that is to say, substantially perpendicular or parallel to the longitudinal central plane of the vehicle, enables them to be disposed in a very simple manner. The reaction moments of the springs are transmitted to the most strongly dimensioned parts of the frame, as the longitudinal members 1a, 1a' or 7, any twisting of the frame being impossible even when the wheels on one side are bearing the load. The casings 24, 24' and the abutments 11, 11' are of extremely simple construction, and can also be connected in a very simple manner with the longitudinal

frame members, as their axes extend either at right angles or parallel to these longitudinal members.

If, as was shown in the first constructional example, the abutment 11a for the second spring 8' be provided, there is in addition to the constructional simplicity, the advantage that the frictional moment of the bearing journal 16 of one spring 8 partly balances the reaction moment of the other spring 8'. The transverse member 7b can under this assumption be brought as close as possible to the casings 24, 24' and transmits as a rigid member the resultant moment of one longitudinal member 1a to the other longitudinal member 1a'. If, as shown in the second constructional example the two casings 24, 24' and the two abutments 11, 11' be connected with one another, the resultant moments will, assuming the motions of the wheels to be equally directed, act as internal forces in the fixing shackles 10a and 10 and therefore do not affect the frame at all.

The yielding manner of mounting the casings 24, 24' and the abutments 11, 11' on the frame has the purpose of assisting in damping noise. It is for instance known to bed the axle casing 3 in cushions of yielding material with the object of keeping the vibrations of the wheel, acting through the axle tube on the axle casing, away from the frame. The yielding manner of mounting the pivotal pins carrying the universal joint acts in the same way, more particularly as the swinging strut and not the axle tube has to transmit the reaction forces of the sprung wheel to the frame.

In the form shown in Fig. 8 the swinging axle tubes are connected to the torsion springs by means of universal joints. In said figure the road wheel 60 is assumed to be power driven, in which event the numeral 61 represents the usual differential housing attached or forming part of the frame. To said housing are hinged the swinging axles 62 as by means of journals 63 and 64 attached thereto. Said journals are shown as having bearings within lugs 65 and 66 attached to said differential housing or other support. 67 represents some part of the frame which will conveniently serve to support one end of a torsion spring bar 68 or other rotary spring means. The other end of said spring means is shown as connected to the journal 64 through a universal joint 69 of any usual or suitable construction. It will be seen that as in the other forms shown the axis of oscillation of the axle lies at an angle to the axis of the rotary spring means. If the wheel 60 is to be power driven, the power may be delivered thereto by a stub shaft 70 driving the usual driving axle 71 through a universal joint 72 of usual construction.

The invention is not limited to the three constructional examples. According to the particular construction of the frame other excellent positions of the torsion springs can be adopted, which can be coupled over a universal joint with the above-described positions of the swinging struts. The torsion rods illustrated may be replaced by any known type of rotary springs such as a torsion tube, helical spring, etc., or a combination of such springs which act under a rotary turning force. Furthermore, it will be obvious that the suspension system as a whole may be used in conjunction with free wheels as well as with the illustrated driven wheels. As the universal joint any constructional form may be employed in so far as the features of the inven-

tion can be brought into agreement with it. While I have herein shown and described only certain embodiments of certain features of my present invention it is to be understood that they are to be regarded merely as illustrative and that I do not intend to limit myself thereto except as may be required by the following claims.

What I claim is:

1. A vehicle wheel mounting comprising a wheel axle pivoted to swing about a substantially horizontal axis, a torsion spring for resiliently resisting the swinging of said axle and universal means for connecting said spring to said axle.

2. In a vehicle having a chassis, a wheel axle, means for pivotally connecting said axle to said chassis to provide for swinging of said axle relative to the chassis about a substantially horizontal axis, a torsion spring positioned outside of said axis to resist swinging of said axle about said axis, and a universal joint connecting said spring to said axle.

3. In a vehicle having a chassis, a wheel axle, means for pivotally connecting said axle to said chassis to provide for swinging of said axle relative to the chassis about a substantially horizontal axis, a torsion spring positioned with its axis arranged at an angle to the axis about which said axle swings, said spring having one end affixed to said chassis, and a universal joint connecting the other end of said spring to said axle.

4. In a vehicle having a chassis, a wheel axle, means for pivotally connecting said axle to said chassis to provide for swinging of said axle relative to the chassis about a substantially horizontal axis, a torsion spring positioned with its axis arranged at an angle to the axis about which said axle swings, said spring having one end affixed to said chassis, and a universal joint connecting the other end of said spring to said axle, said spring comprising a flexible rod.

5. In a vehicle having a chassis including a frame and a drive shaft housing rigidly connected thereto, a wheel axle, means for pivotally connecting said axle to said housing, a strut attached to said axle adjacent the wheel-carrying end, means for pivotally attaching the free end of said strut to said frame whereby said wheel axle is confined to pivotal movement relative to the frame and drive shaft housing about a substantially horizontal axis, a torsion spring having one end affixed to said chassis, and a universal joint connecting the other end of said spring to said strut to render it possible to resist swinging of said axle about said axis.

6. In a vehicle having a chassis including a frame and a drive shaft housing, a wheel axle, means for pivotally connecting said axle to said drive shaft housing, a strut having one end fixed to the wheel-carrying end of said axle and the other end connected to a substantially horizontally positioned shaft rotatably mounted on the drive shaft housing at a point horizontally spaced from the point of attachment of said axle, whereby said axle is limited to swing about an axis passing through the point of attachment of the axle to the drive shaft housing and the strut-carrying shaft, a torsion spring having one end affixed to said drive shaft housing, and a universal joint connecting the other end of said spring to the shaft carrying said strut.

7. In a vehicle having a chassis, a wheel axle, means for pivotally connecting said axle to said chassis to provide for swinging of said axle relative to the chassis about a substantially hori-

zontal axis, a torsion spring positioned outside of said axis to resist swinging of said axle about said axis, and a universal joint connecting said spring to said axle, said universal joint having one member fixed to the end of the spring and another member pivoted to swing about two axes relative to the first member, both of said axes being perpendicular to the axis of rotation of said spring.

8. In a vehicle having a chassis including a frame and a drive shaft housing rigidly connected thereto, a wheel axle, means for pivotally connecting said axle to said housing, a strut attached to said axle adjacent the wheel-carrying end, means for pivotally attaching the free end of said strut to said frame whereby said wheel axle is confined to pivotal movement relative to the frame and drive shaft housing about a substantially horizontal axis, a torsion spring having one end affixed to said chassis, a rotatable journal affixed to and supporting the other end of said spring, and a universal joint connecting said journal to said strut.

9. In a vehicle having a chassis including a frame and a drive shaft housing rigidly connected thereto, a wheel axle, means for pivotally connecting said axle to said housing, a strut attached to said axle adjacent the wheel-carrying end, means for pivotally attaching the free end of said strut to said frame whereby said wheel axle is confined to pivotal movement relative to the frame and drive shaft housing about a substantially horizontal axis, a torsion spring having one end affixed to said chassis, a rotatable journal affixed to and supporting the other end of said spring, and a universal joint connecting said journal to said strut, said strut being connected with freedom of rotation in two directions through the universal joint relative to the journal.

10. In a vehicle having a chassis including a frame and a drive shaft housing rigidly connected thereto, a wheel axle mounted on each side of the drive shaft housing, means for pivotally connecting said axle to said housing, a strut attached to each axle adjacent the wheel-carrying end, a pair of torsion springs positioned transversely of the chassis, a bracket mounted on one side of the chassis having the end of one spring affixed thereto against rotation and rotatably supporting a journal fixed to one end of the second spring, a corresponding bracket and journal on the other side of the chassis, and a universal joint connecting each journal to a corresponding strut.

11. In a vehicle having a chassis including a frame and a drive shaft housing rigidly connected thereto, a wheel axle mounted on each side of the drive shaft housing, means for pivotally connecting said axle to said housing, a strut attached to each axle adjacent the wheel-carrying end, a pair of torsion springs positioned transversely of the chassis, a bracket mounted on one side of the chassis having the end of one spring affixed thereto against rotation and rotatably supporting a journal fixed to one end of the second spring, a corresponding bracket and journal on the other side of the chassis, a universal joint connecting each journal to a corresponding strut, and resilient means between said brackets and chassis.

12. In a vehicle, a frame, a wheel mounting comprising a wheel axle pivoted to the frame to oscillate about an axis, rotary spring means for resiliently resisting the swinging of said axle

the axis of rotation of said rotary spring means being arranged to intersect the axis of oscillation of said axle, and universal joint means for connecting said spring means to said axle.

5 13. Spring supporting means for vehicle chassis comprising a wheel supporting axle movably supported by said chassis for oscillation about a fixed axis, and rotary spring means mounted upon the chassis for rotation about an axis inclined to the axis about which said axle is movable and connecting means between said spring means and said axle.

14. Spring supporting means for vehicle chassis comprising a wheel supporting axle movably supported by said chassis for oscillation about a fixed axis, rotary spring means mounted upon the chassis for rotation about an axis inclined to the axis about which said axle is movable, and universal joint connecting means between said spring means and said axle.

15. Spring supporting means for vehicle chassis comprising a wheel supporting axle movably supported by said chassis for oscillation about a fixed axis, rotary spring means mounted upon the chassis for rotation about an axis inclined to the axis about which said axle is movable, and articulated connecting means between said spring means and said axle.

16. The combination as claimed in claim 13, wherein the rotary spring means comprises a torsion bar.

17. A vehicle spring suspension comprising a

frame, a wheel carrying member, a pair of swinging levers secured together at one end and separately pivotally mounted on said frame at their other ends, one of said pivots comprising a universal joint, means interconnecting said wheel carrying member to said swinging levers, spring means connected at one end to said frame and at its other end to one of said swinging levers through said universal joint.

18. The combination according to claim 17 in which the vehicle frame includes a central longitudinally extending member on which both of said swinging levers are pivotally mounted.

19. The combination according to claim 17 in which the vehicle frame includes a central longitudinally extending member and at least one longitudinally extending side rail connected to said central member, one of said swinging levers being pivotally mounted on said side rail and the other on said central frame member.

20. In a vehicle having a frame, in combination, a first rod, means for journalling said rod on said frame, a second rod disposed at an angle to said first rod and having an end thereof attached to said frame, a universal joint connecting said two rods, a lever connected to said first rod, and a wheel connected to said lever, whereby motion of said wheel about the bearing axis of said first rod is resiliently resisted by the turning of the joint-connected end of said second rod relatively to its stationary frame-connected end.

KARL RABE