March 22, 1938. H. WOLF 2,111,716

STABILIZING DEVICE

Filed May 4, 1936 4 Sheets-Sheet 1

Fig. 1

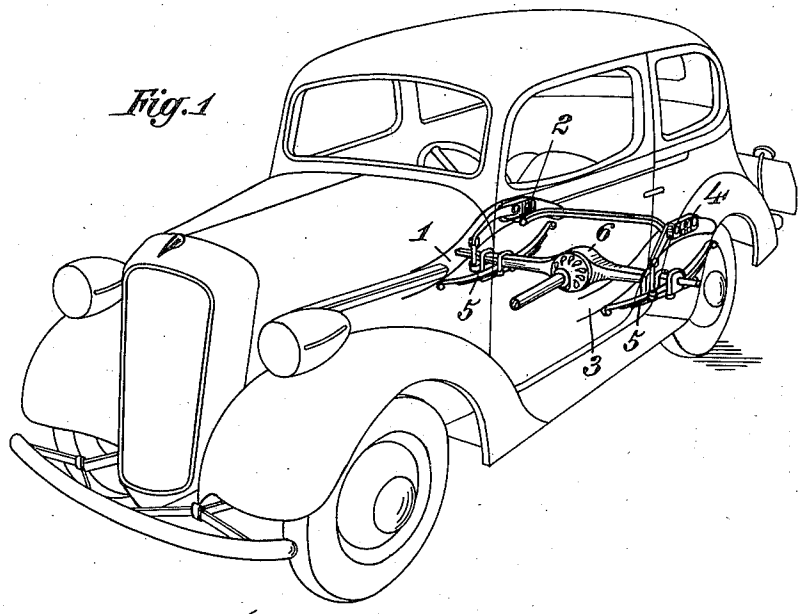
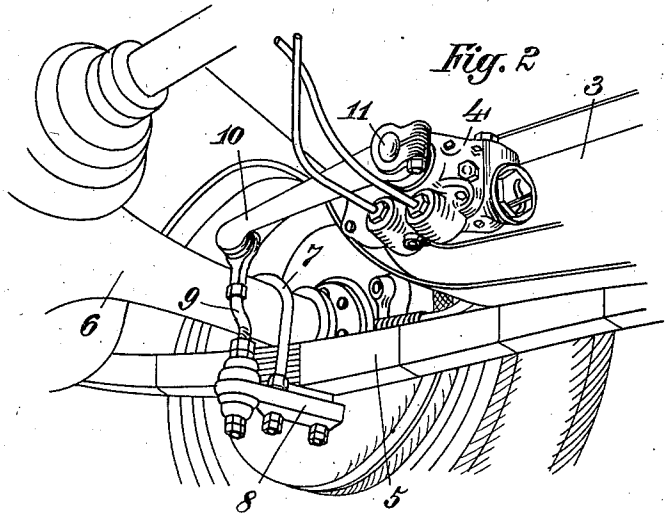


Fig. 2



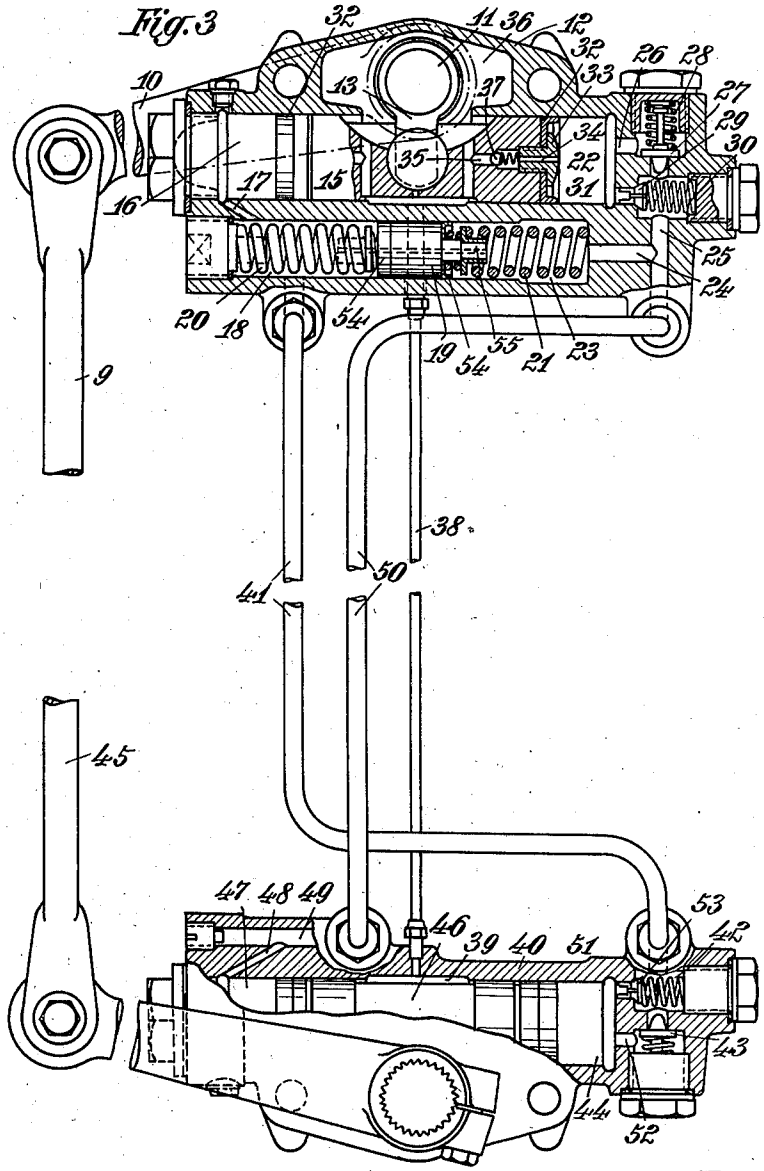
Inventor:
Hermann Wolf,
By Watson, Coit, Morse & Grindle
Attys.

March 22, 1938. H. WOLF 2,111,716

STABILIZING DEVICE

Filed May 4, 1936 4 Sheets-Sheet 2

Fig. 3



Inventor:

Hermann Wolf,

By Watson, Coit, Morse & Grindle

Attys.

March 22, 1938. H. WOLF 2,111,716

STABILIZING DEVICE

Filed May 4, 1936 4 Sheets-Sheet 3

Fig. 4

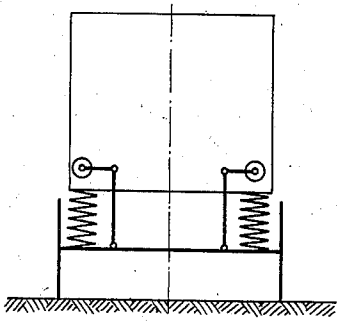


Fig. 6

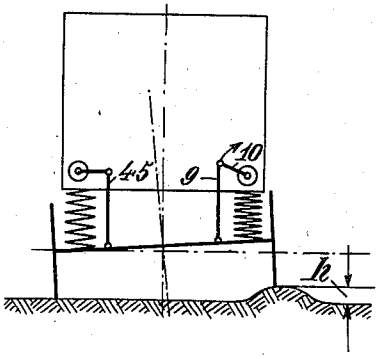


Fig. 5

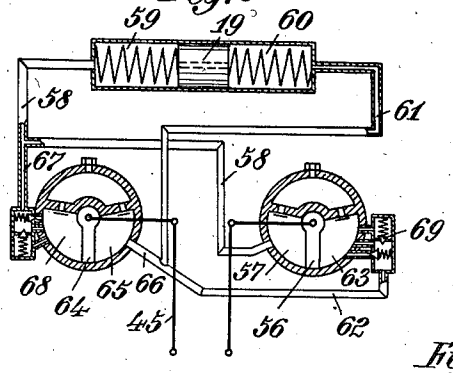


Fig. 7

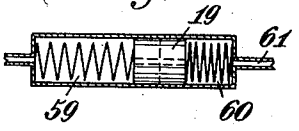
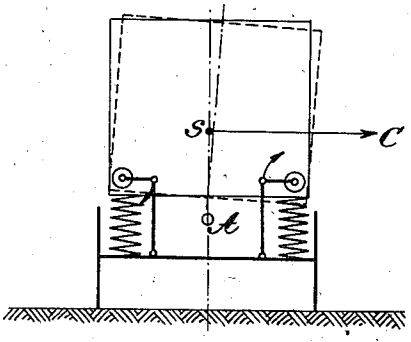


Fig. 8



Inventor:

Hermann Wolf,

By Watson, Cole, Moser & Grindle

Attys.

March 22, 1938. H. WOLF 2,111,716

STABILIZING DEVICE

Filed May 4, 1936 4 Sheets-Sheet 4

Fig. 9

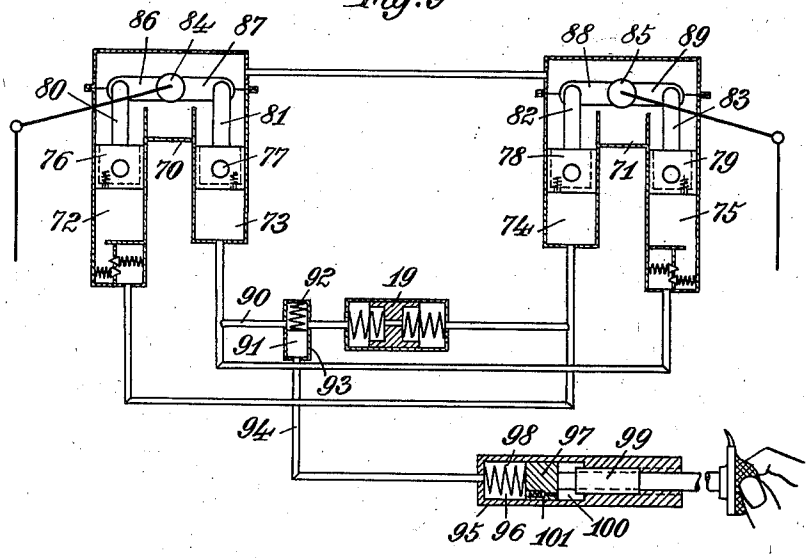


Fig. 10

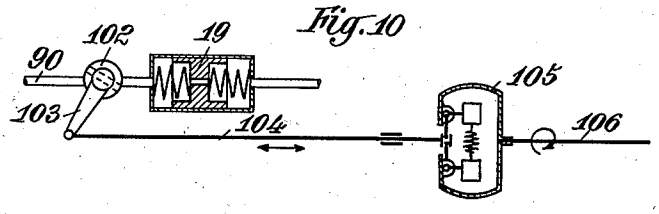
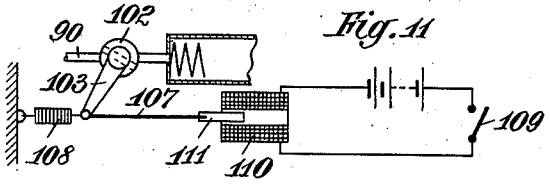


Fig. 11



Inventor:
Hermann Wolf,
By Watson, Cole, Moore
& Grindle. Attys.

Patented Mar. 22, 1938

2,111,716

UNITED STATES PATENT OFFICE

2,111,716

STABILIZING DEVICE

Hermann Wolf, Coblenz, Germany

Application May 4, 1936, Serial No. 77,865
In Germany May 6, 1935

7 Claims. (Cl. 267—11)

In the spring suspension of vehicles there is merely a differentiation between sprung and unsprung masses. To the sprung masses appertain all the masses which are above the springs whilst all the masses below the springs are termed as not spring suspended.

The task of the springs is to take up the forces which on running over inequalities of the road produce an acceleration of the unsprung masses. The weaker the springs are the less do they transmit the forces on to the sprung masses and the less are these set in motion. The sprung masses take up the goods being conveyed or in the case of passenger vehicles they support the passengers. The steadier the sprung masses behave whilst running the more pleasant is the journey to the passenger, and a well or badly sprung vehicle is generally spoken of.

Now not only the forces arising from the road act on a vehicle but there are produced during running certain torques which arise from the property of the differential, and also centrifugal forces which develop on the steering, as for example when running on a curve. The weaker the springs are the more the vehicle body, that is, the sprung mass, inclines. It carries out here a rotation about the ideal axis, which is located in the longitudinal direction of the vehicle and which is formed by the springs. In this the outwardly located springs are loaded and compressed, whilst those on the inside are relieved and distend.

This is an unpleasant sensation for the passengers in the vehicle and since they involuntarily tend to oppose the lateral inclination it rapidly leads to tiring them. It has also an unsafe feeling, for which there does actually exist a reason. It is known from experience that strongly fluctuating vehicles have a bad road and curve position and tend on the least inducement to roll. Sensitive people cannot for this reason bear travelling in automobiles.

Recently automobile motor building has developed to such an extent that the speeds which can be attained no longer bear any relation to the roads and curves as they exist. It has therefore been necessary to provide a device which effectively and reliable overcomes this defect. Devices are known which by hydraulic means produce positively a parallel guiding of the axle to the top body. This takes place by cylinders being fitted on both sides of the vehicle body which are alternately connected together by tubes. To all these known devices there attaches the defect that whilst they can produce the intended parallel guiding of the upper body they are not able to ensure a soft spring suspension with an uneven road. Their greatest defect is that the wheel of one axle when running over an uneven part necessarily causes the lifting of the wheel on the other side of the same axle. It is also not correct and does not comply with physical laws, if the stabilizing starts suddenly, as is the case with these devices.

The apparatus described in the invention obviates the said defects and stabilizes the upper body gently but absolutely.

Various embodiments of the invention as also the method of operation thereof are shown graphically on the drawings, in which:

Figure 1 shows the mounting of the device in a vehicle,

Figure 2, the mounting of a part of the device,

Figure 3, the device in section,

Figure 4 is a diagrammatic illustration of a vehicle when running on a level road.

Figure 5 is a diagrammatic illustration of the device corresponding to Figure 4.

Figure 6 is a diagrammatic illustration of the vehicle when one wheel runs over an elevation.

Figure 7 shows a portion of the device according to Figure 5 at the instant of running over the elevation as shown in Figure 6.

Figure 8 is a diagrammatic illustration of the vehicle when this runs round a curve.

Figure 9 is a diagrammatic illustration of the device with a regulating arrangement actuated by hand.

Figure 10 is a regulating device according to Figure 9 driven by centrifugal weights,

Figure 11 shows the same regulating device operated electrically.

In Figure 1, 1 indicates the right hand chassis arm on which is fixed the casing 2, and 3 is the left hand chassis arm with the casing 4 thereon, 5 are the carriage springs which are fixed on to the rear axle 6 of the vehicle.

Figure 2 shows the casing 4 screwed on to a chassis bearer 3, a carriage spring 5 and a part of the rear axle 6, on to which the spring 5 is fixed by means of straps 7, which also hold a plate 8. The plate 8 takes the rod 9, which on its part forms a joint with the lever 10. The lever 10 is fitted on the shaft 11 of the housing 4.

The arrangement is so mounted that variations in the distance between the chassis arm 3 and the axle 6 produce a rotation of the shaft 11.

If the rod 9 (Figure 3) moves upward, the lever 10 also carries out a rotary movement upwards and thus rotates the shaft 11, which is

carried in the housing 12 and is provided with the finger 13, in a clockwise direction. The finger 13 slides in a cylindrical block 14 which is itself carried in the piston 15, and displaces the piston to the left, when liquid passes out of the space 16 through the conduit 17 into a space 18 in which a piston 19 is slidably arranged. On both sides of the piston are arranged the springs 20 and 21. Now whilst the liquid is displaced by the piston 15 out of the space 16, the space 22 takes up the same quantity of liquid. This liquid is supplied from the space 23, the piston 19 moving towards the right, tensioning the spring 21 and relieving the spring 20. The liquid must, in order to pass from the space 23 into the space 22, flow through the conduits 24, 25 and 26, when it must pass the valve 27, which is pressed by the force of the spring 28 on to its seat.

This process takes place when a wheel of the vehicle is thrown upward by any unevenness. The downward movement of the wheel causes a rotation of the shaft 11 in counter-clockwise direction and thus a displacement of the liquid in the space 22, which must now overcome the valve 29 and the force of the spring 30.

It then passes through the conduits 25 and 24 again into the space 23, forces the piston 19 to the left and this displaces the liquid in the space 16 again through the conduit 17 into the space 16. The valve 29 has a slot 31 which opens a constant passage for the liquid, so that a sudden transition of the liquid is avoided. The piston 15 carries at its ends for the purpose of obtaining a perfectly tight joint, leather cups 32 which by means of a screw cap 33 are forced against the body of the piston. The screw cap 33 is provided with a hole 34 through which reserve oil can be filled in. The conduit 35 represents the connection with the reserve oil chamber 36 which is closed by a ball valve 37. The reserve chamber 36 of the housing 12 communicates through the pipe 38 with the reserve chamber 39 of the housing 40 which is on the other side of the vehicle, and equalizes the level of the oil in the two chambers. On the displacement of liquid from the chamber 16 into the space 18 the pressure arising in these spaces is conveyed through the pipe 41 into the space 42. It is here opposed by the force of the spring of the valve 43 which must be first overcome before liquid can penetrate into the space 44.

Exhaustive tests have shown that the inequalities arising from the road are effectively counteracted when the rod of an apparatus, e. g., the rod 9, can deflect upwards by 25 mm. The quantity of liquid thereby displaced is to correspond approximately to the liquid taken in the space 18.

The strength of the springs 20 and 21 must be so selected that a springing of the wheels off the road is not possible.

In the same way as the rod 9 can carry out a movement upward whilst the rod 45 is at rest, the rod 45 can carry out a movement whilst the rod 9 is at rest. On a movement of the rod 45 the piston 46 is moved to the left in the casing 40 and liquid is thereby forced out of the space 47 through the conduits 48 and 49 and the pipe 50 into the conduits 24 and 25, when the space 23 is filled up and the piston 19 must carry out a movement to the left. This then tensions the spring 20 whilst the spring 21 undergoes relief. The space 51 takes up with this process the same quantity of liquid as was displaced in the space 47 and which is supplied from the space 18 through the pipe 41, the liquid having again to pass the valve 43 and through the conduit 52.

With the opposite movement of the rod 45 the liquid is again forced out of the space 51; after overcoming the force of the spring of the valve 53 it must flow back through the pipe 41 into the space 18, the piston 19 being moved to the right, and the space 23 giving up liquid through the conduit 24, the pipe 50 and the conduits 49 and 48, into the space 47. The piston 19 is provided with spring loaded leather cups 54 and has a hole 55 the opening of which can be determined by nozzles. This bore or hole 55 has for its task of regulating in the shock-absorbing action as well as in the stabilizing action of the device, the gradual increase of pressure in the individual chambers and thus to obviate shocks or sudden transitions.

In Figure 4 is shown diagrammatically a vehicle when it is on a level road and below this Figure 5 shows the position diagrammatically at the moment of Figure 3, round casings and wing pistons having been chosen. According to Figure 4 the aggregate according to Figure 5 is at rest and the piston 19 of Figure 3 is in the centre.

If now the vehicle is driven as shown diagrammatically in Figure 6, over an elevation, the amount of which is *h*, the rod which is on this side and which according to the description of Figure 3 is indicated by 9, is raised, and thus the lever 10 is rotated clockwise. The piston 19 (Figure 7) carries out a movement to the right. According to Figure 5 the wing piston 56 is then rotated in the same sense so that it forces liquid out of the chamber 57 through the pipe 58 into the space 59. The piston 19 shifts to the right and forces liquid out of the space 60 through the pipes 61 and 62 into the space 63. The same procedure takes place when the rod 9 is at rest, the rod 45 is raised and liquid is forced by the wing piston 64 out of the chamber 65 through the pipes 66 and 61 into the space 60, except that the piston 19 now carries out a movement to the left, and forces liquid out of the space 59 through the pipe 67 into the space 68. With like alteration of the distance between the axle and the upper carriage on both sides the piston 19 remains at rest and there takes place a movement of the liquid from the space 65 into the space 63 or respectively from 57 into the space 68.

Figure 8 shows diagrammatically the procedure of the stabilization. If there takes place a centrifugal force C, which is applied at the centre of gravity 8 of the vehicle upper body, it rotates this about the ideal axis indicated by A, when the levers are oppositely directed as indicated by the arrows. The pistons in this case force liquid into a pipe, e. g., into the pipe 58 in Figure 5. The quantity of liquid reaching the space 59 is then double as great and the piston 19 is forced to the right at twice the speed, the liquid from the space 60 passing through the pipe 61 into the pipes 62 and 66 and being able to fill each of the spaces 63 and 65 up to one half. It is here important that the liquid before penetrating into the space 63, must pass through the valve 69, whereas it can freely pass into the space 65. An inclination of the upper body is practically prevented by this device and connection.

Figure 9 shows the same device but here adjacently located cylinders are chosen. The device consists in the main of the casings 70 and 71 which have each two adjacently located piston bores 72, 73, 74 and 75, in which are the pistons 76, 77, 78 and 79. The pistons are driven by the connecting rods 80, 81, 82 and 83, which on their

part are driven by the arms 86, 87, 88 and 89 on the shafts 84 and 85. The running of the pipes and the arrangement of the equalizing device with the piston 19 correspond to Figure 3, except that here there is connected in the pipe 90 a slide valve 91 which is kept open by the spring 92. The slide valve 91 is in the casing 93 into which opens on the opposite side of the spring, the pipe 94 which at its other end is connected with the part 95. In the pipe 94 is liquid which is communication with the space 96. In the space 96 is a piston 97 which is pressed by a spring 98 against the pin 99. Above the piston 97 is the space 100 and this connects through a check valve 101 with the space 96. If the pin 99 is moved to the left the piston 97 forces liquid out of the space 96 and through the pipe 94, the slide valve 91 closing the pipe 90, and the movement of the piston 19 is stopped.

This device is necessary with vehicles in which, when standing, recoils caused by implements are to be expected (cannon). If the pin 99 is again moved back, that is, to the right, the spring 96 forces the piston 97 also to the right and the liquid in the space 100 can pass through the check valve 101 into the space 96 and the liquid behind the valve 91 can also pass through the pipe 94 into the space 96. The slide valve is forced back by the spring 92, thus freeing the pipe 90.

Figure 10 shows the same device, the valve 102 being made as a rotary valve on which is the lever 103 which communicates through a joint with the rod 104 and a centrifugal governor 105. The centrifugal governor is driven by the shaft 106 which on its part is coupled with a gear shaft of the vehicle gear, and which only carries out movements of rotation when the vehicle is moving forward. On standing still, the rotary valve 102 is closed whilst it is opened immediately on the commencement of running.

Figure 11 shows the same device actuated electrically, the rotary valve 102, on the lever 103 of which there is a rod 107, being kept constantly closed by a spring 108, whilst on the closing of the current circuit by the switch 109, the coil 110 attracts an iron core on which is the rod 107, and opens the rotary valve 102.

The embodiments shown in Figures 1 to 11 can be developed as desired and the function and operations of the piston 19 can be replaced by other means.

I claim:—

1. Apparatus for preventing excessive swaying of spring-supported vehicle bodies, comprising a pair of oppositely disposed damping devices arranged on the respective sides of said vehicle, and connected for inter-transmission of forces acting thereon, and means whereby one of said devices may be permitted to act through a predetermined distance before any part of the force acting on said device is transmitted to said other device, said last means being adapted, when said predetermined distance is exceeded, to transmit the force acting on said first damping device to said second damping device in a proportion depending upon the quantum of said force.

2. Apparatus for preventing excessive swaying of spring-supported vehicle bodies, comprising a pair of oppositely disposed hydraulic damping devices arranged on the respective sides of said vehicle, fluid conduits connecting said devices for transmitting forces therebetween, and an auxiliary device connected between said damping devices for preventing the transmission of a force from one of said damping devices to the other said damping device until the first said damping device shall have acted through a predetermined distance, said auxiliary device being adapted, when said predetermined distance is exceeded, to transmit the force acting on said first damping device to said second damping device in a proportion depending upon the quantum of said force.

3. Apparatus for preventing excessive swaying of spring-supported vehicle bodies, comprising a pair of oppositely disposed hydraulic damping devices arranged on the respective sides of said vehicle, each said device comprising a cylinder having a fluid chamber at either end thereof and a piston reciprocable therein, conduits cross-connecting opposite ends of said respective cylinders, and an auxiliary device connected to said conduits for preventing the transmission of a force from one of said damping devices to the other said damping device until the piston of said other damping device shall have acted through a predetermined distance, said auxiliary device being adapted, when said predetermined distance is exceeded, to transmit the force acting on said first damping device to said second damping device in a proportion depending upon the quantum of said force.

4. Apparatus for preventing excessive swaying of spring-supported vehicle bodies, comprising a pair of oppositely disposed hydraulic damping devices arranged on the respective sides of said vehicle, each said device comprising a cylinder having a fluid chamber at either end thereof and a piston reciprocable therein, conduits cross-connecting opposite ends of said respective cylinders, and an auxiliary device connected to said conduits for preventing the transmission of a force from one of said damping devices to the other said damping device until the piston of said other damping device shall have acted through a predetermined distance, said auxiliary device comprising a cylinder having fluid chambers at either end connected to said respective conduits, and having a piston reciprocable therein and spring means for opposing movement of said piston from its central position within said cylinder, said spring means being capable of elastically resisting the maximum normal shocks transmitted thereto.

5. Apparatus as described in claim 4, one end of each said damping device being connected directly to said auxiliary device, the other end of said damping device being connected to said auxiliary device through a spring pressed valve.

6. Apparatus as described in claim 4, having means for rendering said auxiliary device inoperative.

7. Apparatus as described in claim 4, having automatic means for connecting and disconnecting said auxiliary device from operative relationship to said damping devices.

HERMANN WOLF.