United States Patent [19]

Martin

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[45] **Feb. 25, 1975**

[54] **SELF-LEVELLING LAMPS**

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[21] Appl. No.: **328,057**

Related U.S. Application Data

[63] Continuation of Ser. No. 51,139, June 30, 1970, abandoned.

[30] **Foreign Application Priority Data**

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Apr. 22, 1970 Great Britain 19361/70

[52] **U.S. Cl.** ..... **240/7.1 LJ,** 240/62
[51] **Int. Cl.** **B60g 1/10**
[58] **Field of Search** ..... 240/7.1 LJ, 41.6, 52 R, 240/57, 62, 62.3, 62.6, 62.62; 248/291, 481, 483

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[57] **ABSTRACT**

A headlamp self levelling system including front and rear body angle signals sent to a mixing unit for combination as a single lamp tilting signal which may be suitably damped. The mixing unit may comprise two springs working in opposition in a common housing. The lamp motion is damped by a force which may be greater when resisting lamp raising than when resisting dipping, or alternatively may be greater when resisting fast deflections than when resisting slow deflections. The lamps may be mounted on a two point support, one of which points is a ball and socket device and that or the other point will include a spring detent connection.

7 Claims, 15 Drawing Figures

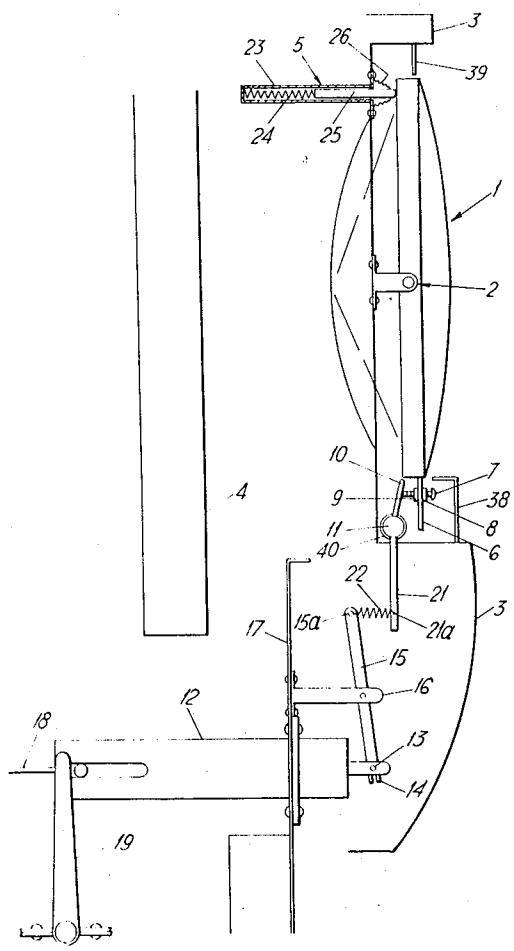
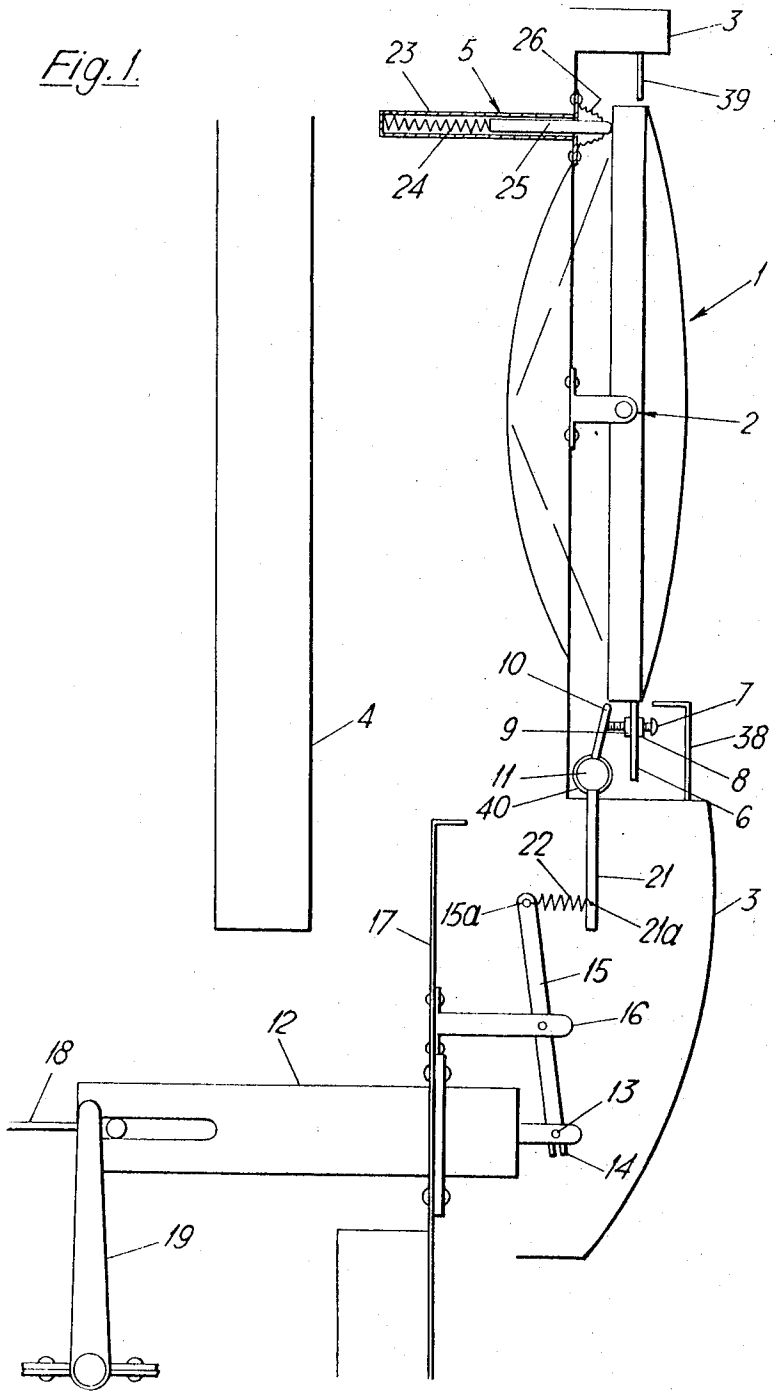


Fig. 1.



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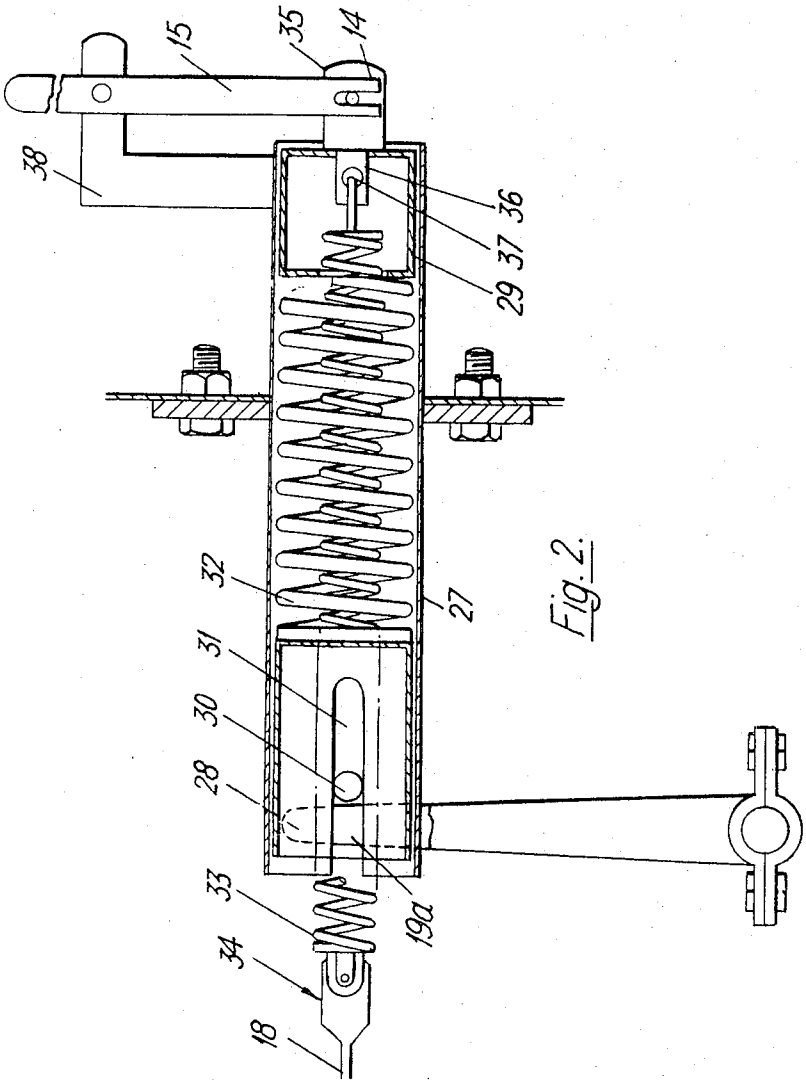
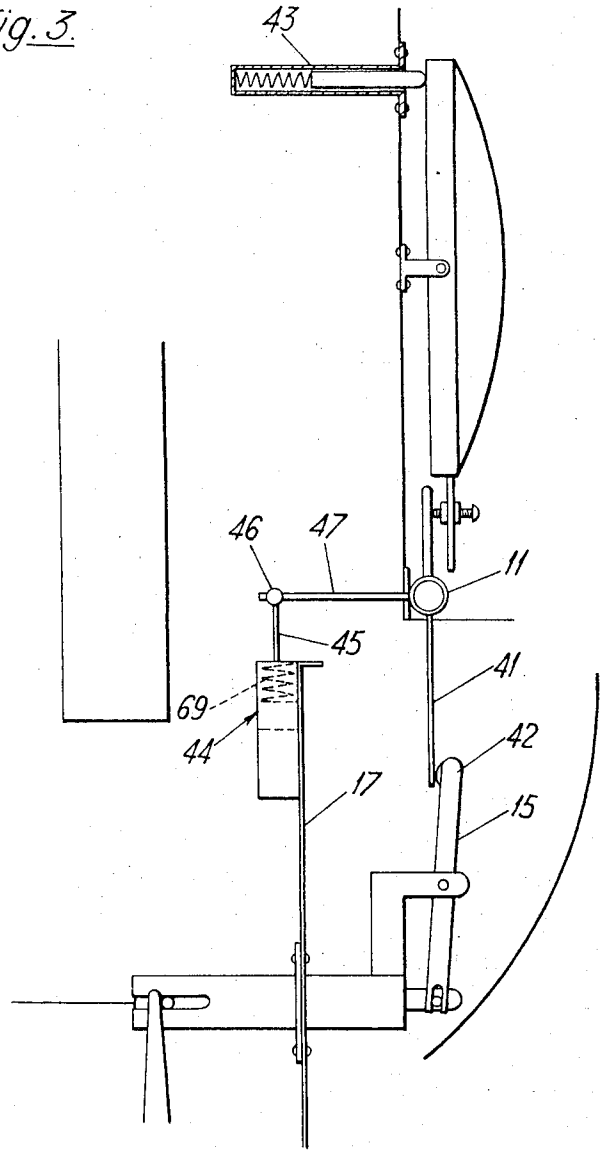


Fig. 2.

Fig. 3.



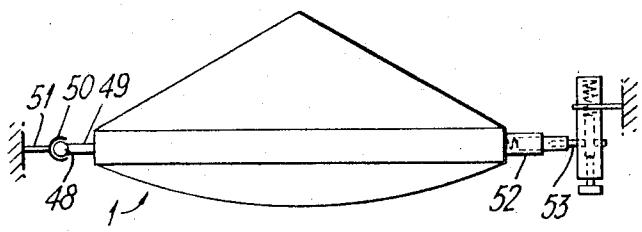


Fig.4.

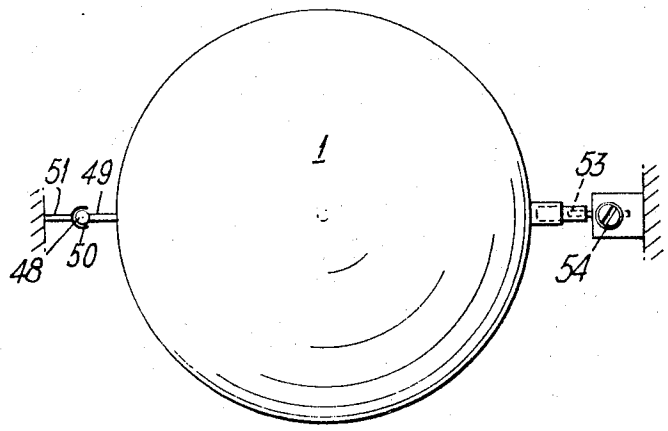


Fig.5.

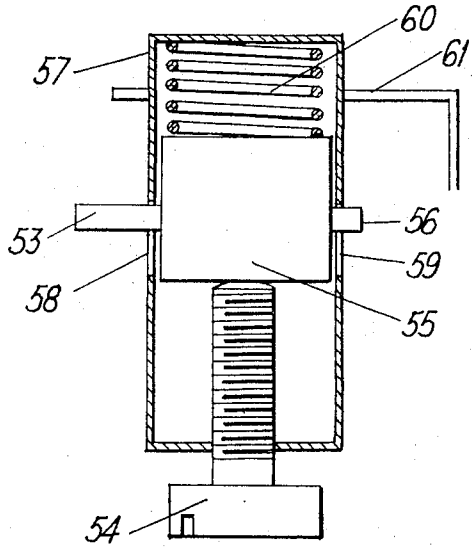


Fig. 6.

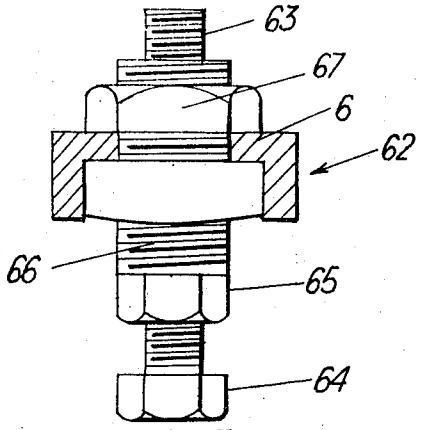


Fig. 7.

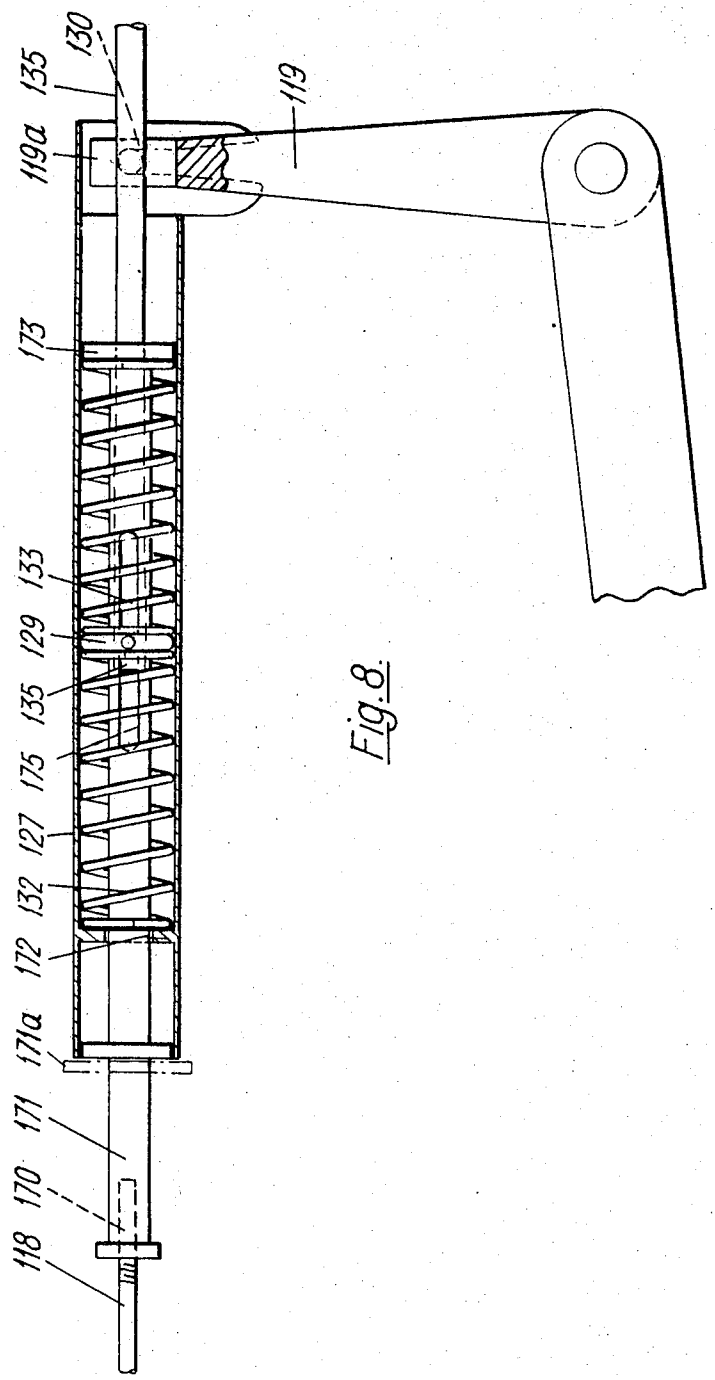

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Fig. 8

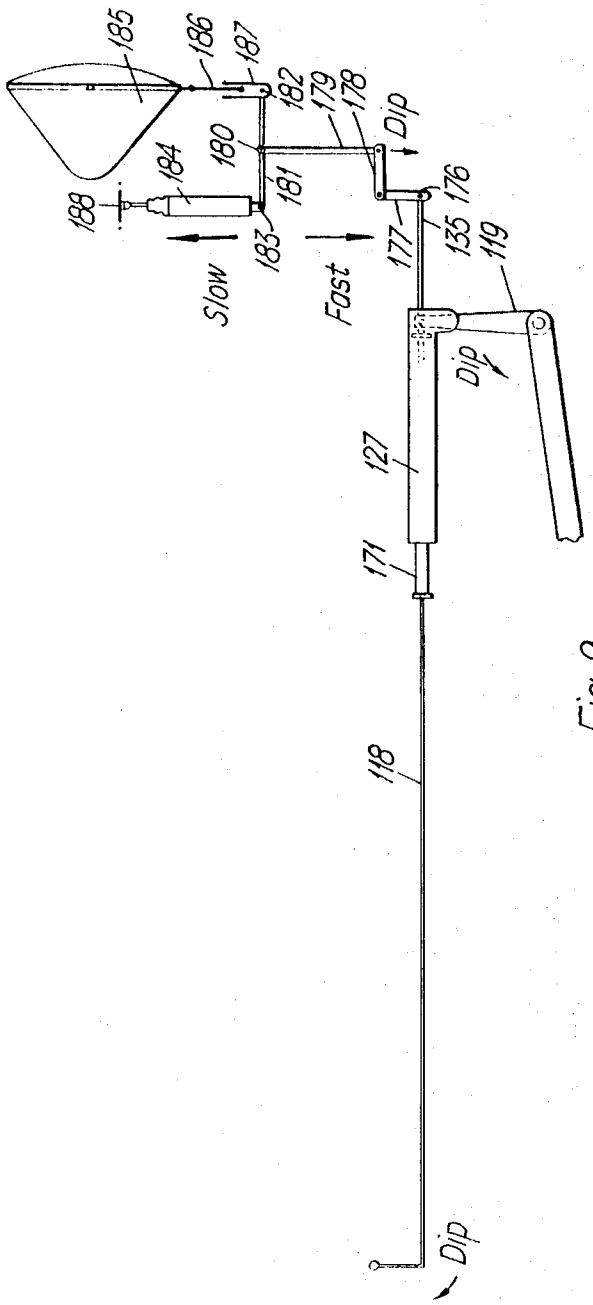

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Fig. 9.

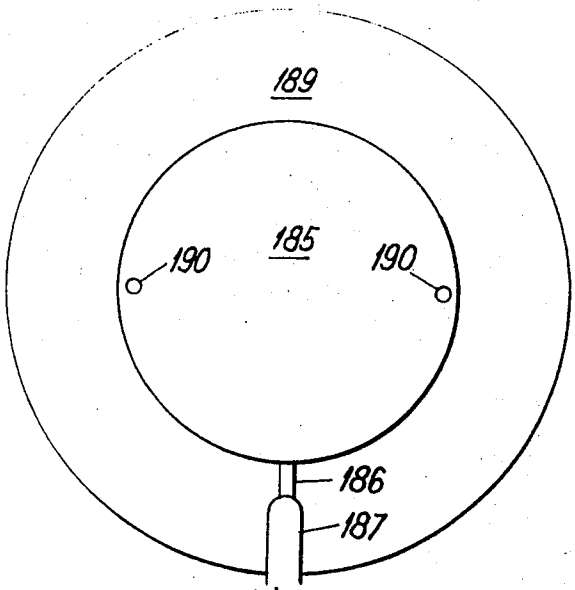


Fig. 10a.

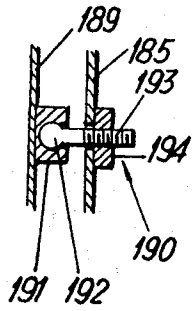


Fig. 10b.

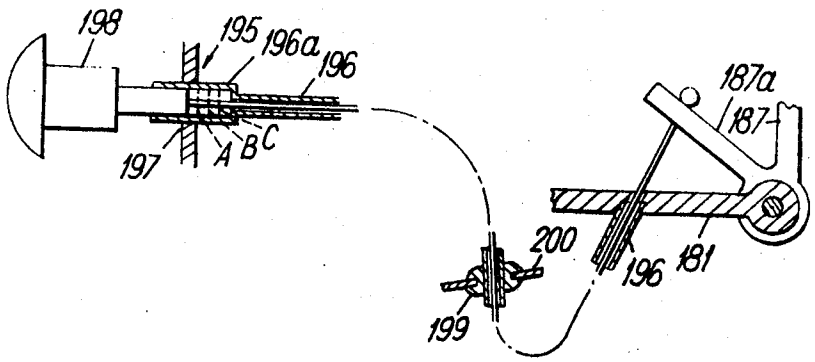


Fig. 11.

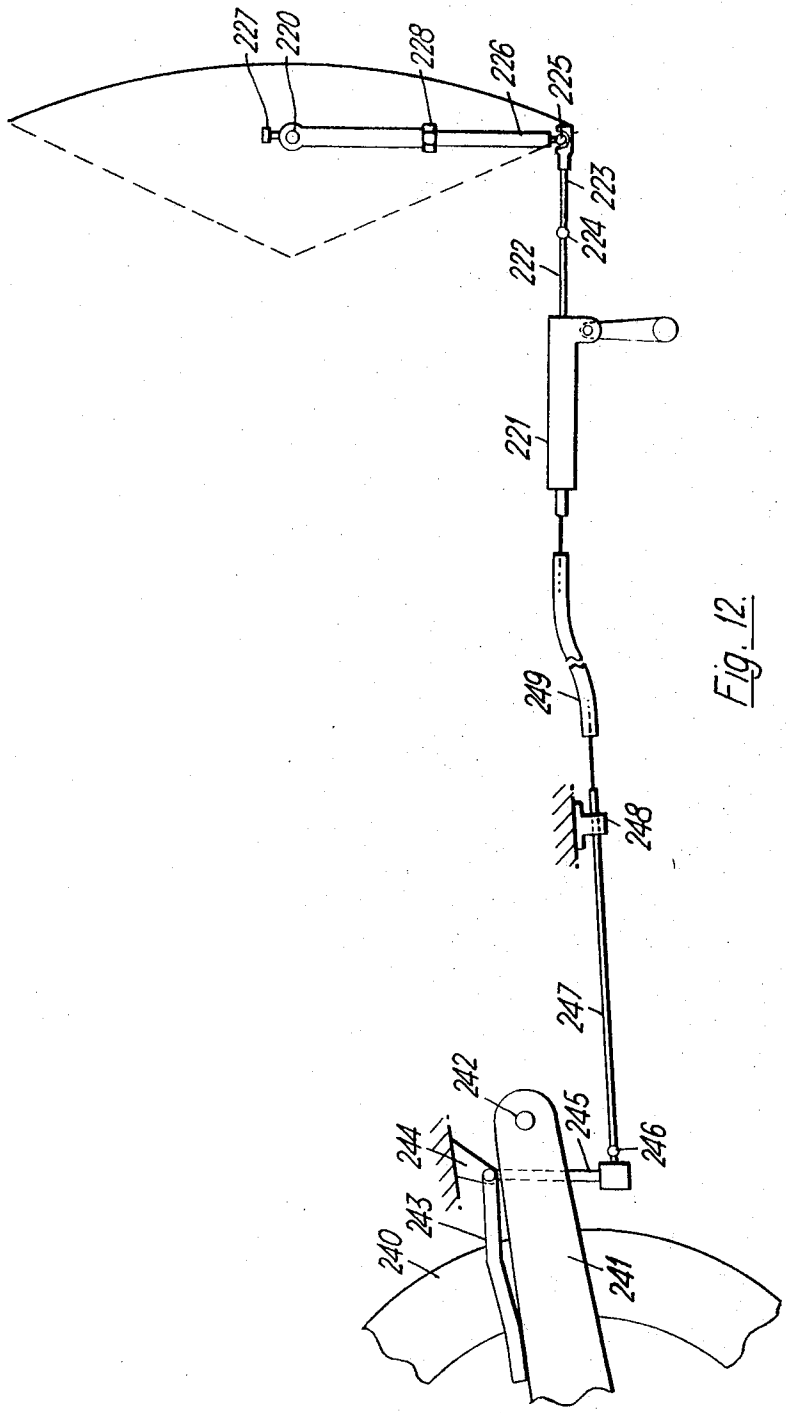

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Fig. 12

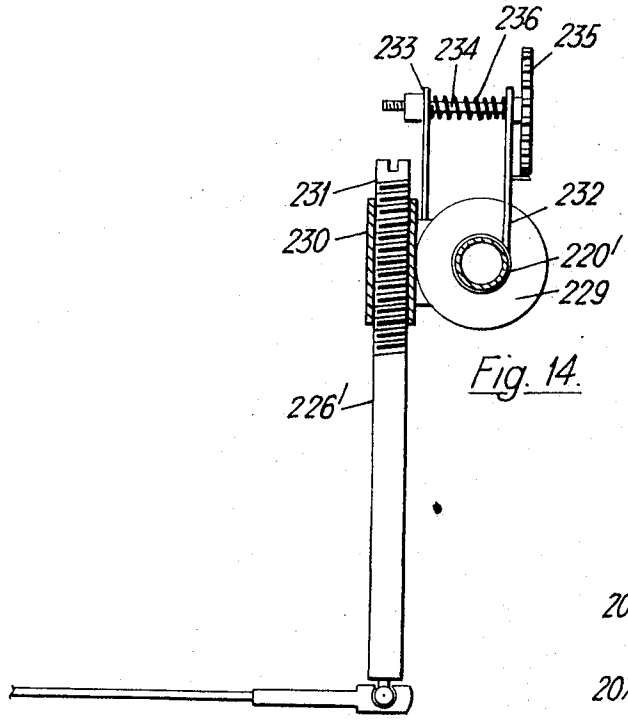

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Fig. 14.

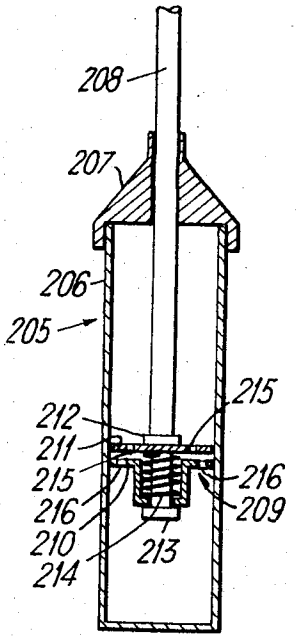

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Fig. 13.

SELF-LEVELLING LAMPS

This is a continuation, of application Ser. No. 51,139, filed June 30, 1970, now abandoned.

The present invention relates to an improved form of self-levelling lamp system, and in particular to a self-levelling system in which the elevation of the lamp beam is automatically adjusted to compensate for displacement of a vehicle body with respect to its ground wheels, by virtue of distortion of the suspension system.

According to one aspect of the invention there is provided in or for a vehicle headlamp system having a front vehicle body angle signal transmission mechanism and a rear vehicle body angle signal transmission mechanism, a signal mixer unit comprising two springs connected to an output signal transmission member adapted to be connected to the vehicle lights, one of the springs having spaced points of connection to the rear body angle signal transmission member and the output signal transmission member, and the other spring having spaced points of connection to the front body angle signal transmission member and the output signal transmission member, the two springs being stressed in opposition to each other in use of the device.

According to a second aspect of the invention there is provided a vehicle lamp self-levelling system comprising front and rear body angle signal generators and a mixer unit producing a single output signal for lamp angle controlling movement, and including at least one adjuster in the system between the mixer unit and the lamps for varying the gearing between the mixer unit output signal movement and the resulting lamp angle deflection, whereby the response rate of the lamps may be varied.

According to a third aspect of the invention there is provided a vehicle lamp self-levelling system comprising means for sensing the angle of the vehicle body relative to the plane of the ground wheels, means for effecting raising and lowering of the vehicle lamps in response to said angle to retain the lamp beams at the same angle relative to the plane of the ground wheels, and a damper for resisting lamp raising movement above a given deflection rate corresponding to passage of one or more wheels over a violent bump, but allowing lamp raising movement to correct for body angle changes of a lower deflection rate.

According to a fourth aspect of the present invention we provide a vehicle lamp self-levelling system comprising means for sensing the angle of the vehicle body relative to the plane of the ground wheels, means for raising and lowering the angle of vehicle lamp beams in response to variations in the angle sensed by said sensing means, and damping means comprising a pivotable lever forming part of the linkage between the sensing means and the lamps and a damper connected between a mounting fixed to the vehicle body and a point of connection on the lever, means being provided to move the said point of connection towards and away from the fulcrum of the lever for varying the damping effect.

According to a fifth aspect of the present invention there is provided a vehicle lamp self-levelling system comprising means for sensing the angle of the vehicle body relative to the plane of the ground wheels, means for raising and lowering the angle of the vehicle lamp beams in response to the sensing means, a linkage transmitting a lamp deflecting signal between said sensing means and said lamp raising and lowering means, and means operable by a vehicle occupant for varying the linkage independently of the signal transmitted from the sensing means whereby the vehicle occupant may adjust the angle at which the lamp beams are controlled in response to a predetermined angle sensed by the sensing means.

According to a sixth aspect of the invention we provide a vehicle lamp self-levelling system including at least one lamp support, a lamp unit adapted to be connected to said lamp support by means of two spaced pivotal connections at least one of which is a spring detent connection, and either the said at least one or the other connection comprising a ball and socket connector, and a lamp control linkage for effecting pivoting of said lamp unit about a pivot axis passing through said two connections, means being provided for adjusting a selected one of said connections towards and away from said lamp support for deflecting the lamp unit beam axis about an axis perpendicular to said pivot axis.

According to a seventh aspect of the invention we provide a vehicle lamp self-levelling system which includes an elongate member extending between the vehicle rear axle and a signal mixer unit at the front of the vehicle for transmitting to the mixer unit a movement signal responsive to the height of the rear of the vehicle body above the rear axle, and a passage carried by a laterally deflectible steering component and through which passage said elongate member extends, said steering component being deflected whenever the steering is deflected from the straight-ahead position to cause said elongate member to transmit a lamp-dipping movement signal to said mixer unit.

According to a final aspect of the invention we provide a damper comprising a closed cylinder adapted to contain hydraulic fluid, a piston rod extending sealingly through one end of said cylinder, and a two part piston slidably connected to said piston rod between spaced lands thereof, means being provided for bearing the two parts of said piston axially outwardly against said lands, and said parts of the piston each including a disc portion having an outer periphery arranged to be closely adjacent the cylinder wall and provided with at least one passage disposed radially inwardly of said perimeter portion but arranged so as to be non-alignable with the corresponding passage or passages of the other piston part.

In order that the present invention may more readily be understood, the following description is given, merely by way of example, reference being made to the accompanying drawings in which:

FIG. **1** is a side elevational view of a self-levelling headlamp system in accordance with the present invention;

FIG. **2** is a detailed, partly sectional view showing the add and subtract box of FIG. **1**;

FIG. **3** is a view, similar to FIG. **1**, but on a reduced scale and showing an alternative embodiment of transmission linkage;

FIG. **4** is a plan view showing the lamp of FIGS. **1** to **3** and illustrating clearly the quick release lamp mounting system;

FIG. **5** is a front elevational view of the lamp of FIG. **4**;

FIG. **6** is a detailed view of the horizontal direction adjustment unit shown in FIGS. **4** and **5**;

FIG. 7 is an underneath plan view showing an alternative embodiment of elevation and response ratio adjustment unit;

FIG. 8 is a side sectional view showing a modified form of signal mixer unit;

FIG. 9 is a side elevational view showing the mixer unit of FIG. 8 incorporated in a self-levelling system similar to that of FIG. 3;

FIGS. 10*a* and 10*b* illustrate a modified form of quick release lamp fitting and represent schematic front elevational and side sectional views, respectively;

FIG. 11 is a side view, mainly sectional, and showing a manual lamp beam elevating mechanism for cooperation with the self-levelling system of either FIGS. 1 to 3 or FIGS. 8 and 9;

FIG. 12 is a side elevational view illustrating the derivation of a rear body angle signal on a vehicle implying a DeDion type of rear axle and showing a much simplified front linkage between the signal mixer unit and the lamp cross tube;

FIG. 13 shows a side sectional view of a modified form of shock-absorber suitable for use in the self-levelling system of either FIGS. 1 to 3 or FIGS. 7 and 8; and

FIG. 14 shows a section through the cross member of a preferred form of linkage similar to that of FIG. 12.

Referring now to the drawings, and in particular to FIGS. 1 to 3 which show a first embodiment of self-levelling headlamp system comprising a headlamp 1 pivotally mounted at 2 for tilting about a horizontal diametral axis, and mounted within a surrounding body structure 3 of a vehicle such as an automobile within which the self-levelling headlamp system is installed. In the specific embodiment illustrated in FIGS. 1 to 3 the vehicle is a motor car and has a radiator 4 in front of which an array of lamps, including the lamp 1, is positioned. The upper part of the lamp periphery abuts against a spring biased damper unit 5 secured to the vehicle body structure 3, and the lower part of the lamp includes a bracket 6 which is pivoted by way of a mechanical contact stud comprising a screw 7 and nuts 8 and 9, by pivoting movement of an associated tongue 10 projecting radially outwardly of a linking cross member 11 in the form of a rod or tube extending transversely across the front of the vehicle mounted in suitable bearings (not shown). It will be apparent from FIG. 1 that rotation of the cross member or tube 11 in a clockwise sense will result in increase in elevation of the lamps 1, whereas anti-clockwise rotation of the cross member 11 will permit the spring-biased damper unit 5 to effect dipping or decrease in elevation of the lamps.

Rotation of the cross member 11 is effected by way of a linkage comprising a signal mixer unit 12 which combines mechanical signals corresponding to rise and fall of the front and rear of the vehicle, to create a single output signal at a thrust pin 13 riding in a clevis 14 at the end of a rocking arm 15 pivoted to a bracket 16 riveted to a bulkhead 17 of the vehicle.

The signal of rear body raising and lowering movement is derived by way of a cable 18 extending from the signal mixer unit rearwardly substantially parallel to the vehicle axis, over a rotatable pulley and secured to a point near the top of the casing of the rear axle differential unit, the pulley and differential casing attachment point thus serving as a rear body movement signal generator. Any tail-down movement at the rear of the vehicle will result in the body mounted pulley descending while the axle mounted cable end retains its position and the length of the cable run between the pulley and the point of securing to the differential casing will increase to effect rearward movement of the cable 18. The signal corresponding to rise and fall of the front of the vehicle is derived from a lever 19 secured to the anti-roll bar 20 of the vehicle so that a nose-down movement of the front of the body will result in clockwise rotation of the anti-roll bar and corresponding clockwise pivoting of the lever 19.

For example, if both the front and rear of the vehicle descend together the headlamp beam elevation will be required to remain substantially constant since the angle of the vehicle body with respect to the mean plane of the road surface will remain constant and there will therefore merely be a slight tendency for the headlamp beam to shorten since the headlamp units 1 are now closer to the road surface. In such a situation the lever 19 will pivot clockwise and the cable 18 will move rearwardly and the net result at the output end of the signal mixer unit will be a substantially unchanged signal which will retain the headlamp elevation at the desired value. The precise operation of the mixer unit will be described more fully below with reference to FIG. 2, but it will appreciated from the foregoing that the fore and aft movement of the thrust pin 13 will, due to the functioning of the mixer unit, provide a rectilinear displacement signal the direction and extent of which will represent the sense and angular displacement of the body in the nose upward and nose downward directions. Nose-up body tilt will result in rearward movement of the thrust pin 13 and vice versa. The upper end of the rocking arm 15 is linked to a further tongue 21 of the cross member 11 by means of a helical tension spring 22 connecting appropriately placed locations 21*a* on the tongue and 15 *a* on the rocking arm.

The spring-biased damper unit of FIG. 1 comprises a closed ended tube 23 secured to the vehicle frame and enclosing a compressing spring 24 and a loose fitting plunger 25 urged rightwardly by the spring 24. The space within the tube 23 is filled with hydraulic fluid and the outer end of the tube is sealed by means of a bellows 26 so that, upon rightward movement of the piston 25, hydraulic fluid will move leftwardly along the clearance between the plunger 25 and the tube 23. Clearly the motion of the plunger will be biased rightwardly and will be damped by the flow of the hydraulic fluid. It will be appreciated that each of the headlamps 1 of an array driven from the torque rod or tube 11 will be provided with its own damper unit 5.

However, it is equally possible for the self-levelling system to be constructed so that a single damper unit serves to control the entire system as shown in FIG. 3 where the spring-biased damper unit 44 mounted on the bulkhead 17 acts upon an arm 47 to damp rotation of the cross member 11. The positioning of the spring 69 again ensures that the spring-biasing effect is tending to assist lamp dipping movement. The arrangement of FIG. 3 has a further advantage that the fulcrum point 46 of the shock absorber strut 45 on the arm 47 can be moved towards and away from the axis of the cross member 11, thereby varying the extent of the damping moment exerted by the single shock absorber. An alternative form of shock absorber which exhibits the same effect of providing a higher resistance in one direction

than in the other would be one in which the spring **69** were omitted but the piston were provided with a throughbore and non-return valve so that piston movement in a first direction would open the non-return valve and cause hydraulic fluid to flow along the piston throughbore with low flow resistance, whereas piston movement in the opposite direction would close the non-return valve and effectively increase the flow resistance. Yet a further form of shock absorber suitable for the present system is illustrated in FIG. **13** and will be described in greater detail hereafter.

Turning now to FIG. **2,** there is shown a detailed view of the mixer unit **12** which consists of an outer tube **27** having slidable inner tubular pistons **28** and **29** at the rear and front ends thereof. The rear piston **28** is provided with a pair of diametrically opposed outwardly extending pegs **30** which engage in diametrically opposed longitudinal slots **31** of the outer tube **27.** Driving movement of the rear piston **28** is effected by way of engagement between a bifurcated upper end **19***a* of the anti-roll bar lever **19** engaging against the pegs **30** to urge them in a rightward direction.

Rightward movement of the rear piston **28** is transmitted to the front piston **29** by way of an outer helical compression spring **32** disposed within the tube **27** between the pistons.

The signal from the rear of the vehicle via the cable **18** is introduced to the front piston **29** direct by way of a helical tension spring **33** the rear of which is secured to the front end of the cable by means of a clevis assembly **34.** The hollow front piston **29** carries an integrally formed outwardly extending lug **35** supporting the thrust pin **13** for engagement with the clevis **14,** and also an inwardly extending tab **36** provided with an aperture **37** within which the front end of the tension spring **33** may be received. The outer tube **27** is provided with an integrally formed L-shaped bracket **38** which serves as a mounting for the fulcrum of rocking arm **15.**

The spring rates and geometry of the mechanism are so chosen that both front and rear of the vehicle may descend by the same distance and the ensuing modified compression of spring **32** and the modified tension in spring **33** will provide equal and opposite forces acting on the front piston **29** in a direction axially of the tube or cylinder **27.** However a nose-up pitching tendency will result in an increase in tension of spring **33** and a reduction in compression of spring **32** causing a simultaneous leftward movement of the front piston **29,** and likewise a nose-down pitching tendency will cause rightward movement of the front piston **29.** It will be appreciated that the springs **32** and **33** are prestressed upon assembly of the mixer unit **12,** to ensure that spring **32** is always under compressive strain and spring **33** under tensile strain for all possible values of front and rear body angle signals.

The screw **7** in the lock nuts **8** and **9,** as illustrated in FIG. **1,** provides a dual adjustment facility in that adjusting the screw by rotation within the lock nuts while maintaining the same position radially of the lamp unit will alter the neutral setting of the lamp, i.e. screwing in will raise the lamp beam for a given position of the vehicle body and screwing out will result in lamp dipping. However, additionally the screw **7** extends through a slot in the bracket **6** permitting adjustment of the position of the screw radially of the lamp unit, thus varying the relative effective lever arms of the engaging bracket **6** and tongue **10** and enabling a variation in the "gearing ratio" between the output signal from the mixer unit and the lamp angle change resultant therefrom. For example raising of the screw **6** will increase the lamp angle change for a given output signal from the mixer unit, and lowering of the screw will decrease the lamp angle change.

By providing the ratio adjustment mechanism **7, 8,9** at the individual lamp rather than on the cross member **11,** it has been ensured that, if desired, individual lamps driven from the same torque tube may have deliberately differing response ratios, if desired.

FIG. **1** shows the existence of a shroud **38** which conceals the ratio adjustment and mechanical contact stop screw **7** and thereby eliminates the possibility of inadvertent damage to, or unauthorised tampering with, the screw **7.** Clearly such a shroud **38** will be made readily removable in order to provide easy access to the screw **7.** The shroud **38** will also serve as a rotation limiting stop to limit the extent of increase in elevation of the lamp **1,** apart from exhibiting certain decorative advantages. A similar purely decorative shroud is provided at **39** adjacent the top of the headlamp unit.

Clearly, some form of adjustment mechanism, for example a screw adjuster in the cable **18,** may be provided in order to ensure that the two springs **32** and **33** of the mixer unit are comfortably balanced when the remainder of the linkage is conveniently adjusted.

The tension spring **22** may be replaced by a transversely extending limb adjustably mounted on the arm **21** by means of a slidable collar surrounding the arm **21** and lockable by means of a grub screw. The free end of the limb would be of bifurcated construction and provided with a roller which engages against the rear of the rocking arm **15** received within the bifurcated end. Thus, upon movement of the collar and limb axially of arm **21,** the roller will ensure a self adjusting engagement with the rocking lever.

Turning now to FIG. **3,** it would be appreciated that the mechanism is substantially identical with that of FIGS. **1** and **2,** except that the tongue **21** and tension spring **22** have been replaced by a single leaf spring **41** secured to the cross member. In this instance adjustment of the imbalance from the mixer unit springs may be effected by raising and lowering the contact stud **42** on the rocking arm **15.**

Moreover, in the embodiment of FIG. **3** the individual spring-biased damper units **5** have been replaced by straightforward spring-loaded anti-flutter assemblies **43** to maintain contact between the tongue **10** and screw **7,** a single damper or shock absorber **44** being provided as described above.

In FIG. **1** and **3,** the headlamp unit **1,** when in position, is acted upon from the rear at two points by on the one hand the spring damper unit **5** and on the other hand the tonuge **10.** This arrangement, together with the simple quick release attachment on the control horizontal pivot axis of the lamp enables a very rapid and convenient installation procedure to be devised for the lamp unit **1.**

The quick release installation system of the headlamp unit **1** is shown in FIGS. **4, 5** and **6.** The plan view of FIG. **4** shows the lamp unit **1** provided on a horizontal diameter with, at one end a ball **48** mounted on a peg **49** and engageable with a suitably disposed cup **50** on a similar peg **51** secured to the vehicle body, and at the other end with a spring-loaded tube arrangement **52**

which can engage over an adjustable peg **53** to provide for horizontal directional adjustment of the headlamp. The peg **53** and associated adjustment device are shown more clearly in FIG. **6**, but the front elevational view of FIG. **5** illustrates an adjustment screw **54**, rotation of which effects fore and aft movement of a suitable trunnion including the peg **53**, and thus, due to cooperation with the fixed cup **50**, results in adjustment of the horizontal adjustment of the beam from the headlamp unit **1**.

FIG. **6** shows, in greater detail, the adjustment trunnion **55** in the form of a solid cylinder having two diametrically opposed outwardly extending pegs **53** and **56**, the peg **53** being longer and being positioned for engagement with the spring-loaded tube **52** on the lamp unit. The shorter peg **56** serves merely to restrain the trunnion against rotation within an outer cylinder or chamber **57**, and this restraint is assisted by the action of the longer peg **53** in that both of the pegs cooperate with longitudinally extending slots **58** and **59** formed in the cylinder body. A helical compression spring **60** bears against an end wall of the chamber **57** and urges the trunnion **55** outwardly against the shank of the adjustment screw **54**, and clearly the axial positioning of the trunnion **55** within the cylinder or chamber **57** is thus achieved by rotation of the screw **54**. The chamber **57** is provided with a suitable mounting bracket **61** which can be fastened to the vehcicle body by riveting, screwing or any other suitable means. Thus, by adjustment of the screw **54** the peg **53** may be moved in the fore and aft direction so that the central horizontal axis of the lamp is rotated about a substantially vertical axis to effect adjustment of the direction of projection of the headlamp beam.

FIGS. **10***a* and **10***b* show an alternative form of lamp mounting system employing two similar connectors **190** in the from of cups **191** engaging balls **192** and thus the lamp unit **185** is mounted with relation to the cell **189** for pivotal movement about its horizontal axis. One or both of the connectors **190** may be adjustable, for example by means of the nut **194** and the screw shank **193** of the bore so that the angle of the beam about a vertical axis may be adjusted.

In an alternative form of quick release lamp mounting which is particularly suitable with the linkage of FIG. **12**, one of the ball and socket connections **190** may be replaced by a sideways facing connector which can engage with the control linkage cross member extending between the lamps to provide a driving engagement whereby the lamp beams may be raised and lowered upon rotation of the horizontal cross member. Such a driving engagement may be provided by using a ball joint connection between the cross member and lamp but with a pin extending through the ball and engaging with a pair of diametrically opposed tapered grooves extending longitudinally of a tubular cross member.

FIG. **7** shows a view, corresponding to an underneath plan view of the response ratio and lamp elevation adjustment mechanism of FIG. **1**, but illustrates instead an alternative construction of adjustment mechanism which provides quite separate adjustment facilities for the lamp elevation and mechanism response ratio. The adjustment mechanism **62** is secured to the bracket **6** extending radially outwardly from the head lamp, as in the FIG. **1** embodiment, and comprises a lamp elevation adjustment screw **63** which may be rotated by means of the hexagonal head **64** and locked by a hexagonal lock nut **65** engaging against one end of an internally and externally threaded tube **66**. The tube **66** engages slightly within the narrower of a pair of longitudinally extending slots on the bracket **6** and may be locked at any particular location along the bracket to provide a locked response ratio setting. The elevational adjustment of the headlamps is then effected by loosening the lock nut **65**, rotating the head **64** of screw **63** by means of a suitable spanner device, and then once the appropriate headlamp elevation setting has been obtained, the lock nut **65** is retightened to clamp the screw **63**.

The tube **66** is locked at any particular response ratio setting by means of a hexagonal nut **67** engaging against one side of the bracket **6** and a square headed nut seated within the wider of the two slots disposed on the opposite side of the bracket **6**. Adjustment of the response ratio setting is effected by slackening the hexagonal lock nut **67**, movement of the tube **66** longitudinally of the double slotted bracket **6** to the desired response ratio positioning, and then retightening of the lock nut **67** to clamp the tube into position. Once the response ratio setting has been adjusted it may be necessary to readjust the elevational setting by means of lock nut **65** and screw head **64**.

The above described self-levelling headlamp system may be further modified in order to provide an automatic dipping facility upon deflection of the steering. Such a modification may include some form of deflection of the rear body movement signal cable **18** upon movement of the steering, and a particularly suitable means of effecting this deflection would be the provision of a bell crank one arm of which has a clevis end for engagement with a suitable pin on the vehicle steering linkage, the other arm of which is provided with a grommet or nylon bush through which the rear body movement signal cable **18** passes. The bell crank is best orientated so that, when the steering is in the "dead ahead" position the nylon bush or grommet is disposed so that the rear body movement signal cable is taut and undeflected. Thus, upon deflection of the steering to one side of the dead ahead position the nylon bush will deflect the cable **18** away from its straight line condition and upon reverse steering deflection the bush will be displaced in the opposite direction by an equal distance, thereby simulating a rear body lowering signal and effecting dipping of the headlamp units **1** of the vehicle.

FIGS. **8** and **9** show an alternative form of mixer unit and from these Figures it may be seen that the rear vehicle body signal transmitted from the rear axle via a cable or flexible rod **118** is transmitted to a tube **171** by way of threaded engagement with a threaded end **170** of the cable or rod **118**. The front vehicle body signal is transmitted by way of a lever **119** secured to the vehicle anti-roll bar having a bifurcated end **119***a* engaging a pair of stub pins **130** for urging the tubular housing **127** of the mixer unit in a rightward direction. It can be seen that one essential difference between the device illustrated in FIG. **8** and that of FIGS. **1** to **3** is that the tubular housing **127** in this embodiment is freely suspended between the cable **118** and the anti-roll bar lever **119**, whereas in the earlier embodiment the housing is bolted to a convenient part of the vehicle body.

The two springs of the mixer unit are arranged end to end such that the front body signal spring **132** is arranged rearwardly of the rear body signal spring **133.** The front body signal spring **132** is compressed between, at the one end a slide disc **129** which is disposed between the adjacent ends of the two springs **132** and **133,** and at the other end an inwardly extending flange **172** secured to the tubular housing **127** to define an abutment surface. Likewise, the rear vehicle body signal spring is compressed between the slide disc **129** and a radially outwardly extending flange **173** formed at the front end of the tube **171.** Thus the arrangement is such that tightening of the rear vehicle body signal cable **118** will compress the spring **133** and urge the slide disc **129** leftwardly while clockwise movement of the anti-roll bar lever **119** will move the tubular housing **127** rightwardly and thereby compress the spring **132** moving the slide disc **129** rightwardly. Since tightening of the cable **118** corresponds to downward movement of the rear of the vehicle, and clockwise movement of the antiroll bar arm **119** corresponds to downward movement of the front of the vehicle, the geometry of the various components will be arranged such that equal downward movement of front and rear of the vehicle will leave the slide disc **129** static in relation to the vehicle body.

Although the drawings illustrate two separate compression springs **132** and **133,** it will be appreciated that the mixer unit may equally comprise one long spring with an output signal connection at a point intermediate its ends dividing the spring into two separately acting spring portions.

Movement of the slide disc **129** will be transmitted to the lamp angle signal output rod **135** by way of a pin **174** which extends snugly through the disc **129** and the rod **135** and slidably through diametrically opposed slots **175** of the tube **171.** The front of the lamp angle signal output rod **135** is connected to the lamp control linkage by way of an articulation connection which is shown more clearly in FIG. **2.**

In FIG. **9** the articulation connection just referred to is referenced **176** and connects the rod **135** with one limb **177** of a bell crank, the other limb **178** of which is articulated to a vertically movable strut **179** articulated at **180** to a lever **181** between its fulcrum point **182** and its free end which is articulated at **183** to a telescopic fluid-filled damper unit **184.**

The lamp unit **185** is mounted for pivotal movement about a horizontal axis and is provided with a tab **186** which engages with a further lever **187** having a common fulcrum with the lever **181.**

In practice the fulcrum **182** consists of a cross member extending transversely across the vehicle and linking the various headlamps and/or spot lights at the front of the vehicle so that they may all be levelled by the single linkage comprising components **176** to **184.**

The cross member **182** may either be connected across the vehicle beneath the vehicle radiator in such a way the cross member is carried by bearings secured to the vehicle front sill, or alternatively the cross member **182** may be carried by bearings mounted in the two headlamp nacelles of the vehicle in which case the member **182** is disposed at a much higher location in the vehicle. Such an arrangement is shown in FIG. **12.**

As in the embodiment of FIGS. **1** to **3,** the shock absorber or damper unit **184** is arranged to exert a much higher viscous drag in one direction than the other, in this case the higher drag is exerted during compression of the shock absorber. This may be achieved by providing a one-way flow permitting valve in the piston of the shock absorber so that during compression of the shock absorber the flow of damper fluid will close the one-way valve and thus damper fluid will have to be transferred around the edges of the piston, whereas during extension of the shock absorber the flow of damper fluid will open the one-way valve and thus a much lower viscous drag will be exerted on the fluid.

It will be appreciated that, by virtue of the slow compression but rapid extension of the shock absorber **184,** the lamp unit **185** can be dipped rapidly but will be much slower in rising. Thus, in the event of the vehicle striking a rough road surface the lamp will tend to overdip and will thus not be subjected to violent lamp flutter which might otherwise be the case if the vehicle vibration were of sufficiently high frequency to defeat the lamp levelling system.

Since it is a common characteristic of automobile shock absorbers that they offer a higher resistance force to movement of the body towards the wheels than to movement of the body away from the wheels, it is usual for the beams of conventional fixed headlamps to rise very rapidly but to descend more gradually and thus there is a strong likelihood of dazzling oncoming or preceding traffic. For this reason the "double-resistance" shock absorber is considered a particularly desirable feature of the present invention.

A further advantageous feature of the doubleresistance shock absorber is the face that its point of articulation **183** with the lever **181** can be varied in order to alter the damping moment exerted on the lever **181.** Although, once the characteristics of the system have been evaluated, it will be possible to determine the correct positioning for the shock absorber articulation point **183** it is desirable for some adjustment to be possible to compensate for varying damper fluid viscosities in response to varying ambient temperatures. Thus the lever **181** may bear calibrated graduations corresponding to different mean ambient temperatures and the position point of articulating **183** can then be varied, for example by articulation the shock absorber to a sliding collar on the lever **181** so that sliding of the collar along the lever will vary the moment arm of the shock absorber on the lever **181.** Additionally, more than one possible location for the upper articulation point **188** may enable the shock absorber to be positioned such that its line of action is always perpendicular to the neutral position of the lever **181.**

A further embodiment of shock absorber is illustrated at **205** in FIG. **13,** and in this instance comprises an oil filled cylinder **206** having an end cap **207** through which a piston rod **208** sealingly extends. The piston **209** is of bipartite construction comprising a cup member **210** and a plate **211** which are slidably urged apart between upper and lower lands **212** and **213,** respectively, by means of a compression spring **214.** The disc member **211** includes four equiangularly spaced passages **215** and the cup member **210** has a radial outwardly extending flange or disc portion including four further equiangularly spaced passes **216** which are at a different radius from the passages **215** so that hydraulic fluid passing between the regions above and below the bipartite piston **209** follow a tortuous path through the respective passages **215** and **216.** Clearly, the closer the disc member **211** comes to the flange of the cup mem-

ber **210**, the more tortuous will the flow path become.

Slow upward and downward movement of the piston rod **208** will cause oil to bear against the respective one of either the upper face of the disc member **211** or the lower face of the flange of the cup member **210**, tending to urge the disc and the cup together against the action of the spring **214**. However, the spring rate of the spring **214** is of such a value that slow piston movements up to a predetermined rate of movement will be unable to overcome the compression spring **214** and will therefore be resisted by the lighter resistance force experienced when the hydraulic oil follows the less tortuous flow path shown in FIG. **13**. Once that predetermined rate of movement is exceeded the dynamic pressure forces of the fluid against the disc or the cup will urge the disc or the cup towards and substantially into contact with the other of the two members causing the flow path to become more tortuous and providing a much higher resistance to piston movement. Thus, the shock absorber of FIG. **13** is one which will permit slow lamp deflecting movements to be conveyed through the linkage but will resist movements of higher rates, for example those resulting from vehicle wheel flutter as the vehicle runs over a rough surface. Thus the lower frequency movements needed to correct body movement of the vehicle will be passed to the lamps whereas the higher frequency movements correcting for wheel flutter will be damped. In this way the damper or shock absorber achieves the same result as that required in the earlier embodiments employing one-way shock absorbing action except that in this instance there will be no need for the overdipping of the lamps on a rough surface since the system will never be defeated and the lamps will always be correctly controlled.

The shock absorber of FIG. **13** may be positioned at any conventional part of the linkage and in the preferred linkage of FIG. **12** the shock absorber will be arranged to bear against an arm extending radially outwardly of the cross member **220** extending between the lamps. However, for reasons of simplicity of the drawing the shock absorber has been omitted from FIG. **12**.

Where the vehicle rear axle is of the "semiDeDion" type, there will be no need for the cable to pass over a pulley wheel secured to the underside of the vehicle body since the semi-DeDion of axle executes a movement which is a combination of vertical and horizontal components. Thus upward and downward movement of the vehicle body with relation to the ground will result in a simultaneous fore and aft component of movement of the axle and this may be sufficient to provide the necessary movement of the rear vehicle body signal cable **118**.

An alternative way of deriving the rear body angle signal from a semi-DeDion type of axle is illustrated in FIG. **12** where one wheel **240** of the vehicle is mounted on an arm **241** which is itself pivoted to the vehicle body at **242**. The rear body angle signal linkage comprises a sensing arm **243** pivotally mounted to a bracket **244** on the underside of the vehicle body and resting on the arm **241** of the axle mechanism. A downwardly extending portion **255** of the sensing arm is provided at its lower end with a ball and socket connector **246** to transmit to a strut **247** the fore and aft movement of the sensing arm extension **245** resulting from upward and downward movement of the wheel and hence of the sensing arm itself. The front end of the strut **247** passes slidably through a bracket **248** and is connected to the front end of a Bowden cable assembly **249** which transmits the signal to the floating type of mixer unit similar to that described in detail in FIGS. **8** and **9**.

FIG. **11** shows a driver operated beam angle adjuster unit comprising a Bowden cable extending between a push-pull control unit **195** on the vehicle dashboard and the headlamp self-levelling linkage, in particular to a lever **181** driven by the output signal from the mixer unit and the lamp driving crank **187**.

The Bowden cable outer casing **196** is secured to a housing **196***a* attached to the vehicle dashboard **197** at one end and to one of the lever **181** at the other end, and the cable inner is secured to a push-pull button **198** at the dashboard end and to a stub lever **187***a* formed integrally with the main lamp tilting crank **187** of FIG. **9**.

Clearly, as the push-pull control **198** is pulled away from the dashboard, i.e. leftwardly as viewed in FIG. **11**, the stub lever **187***a* will move towards the lever **181** and will thus urge the lamp tilting crank **187** in the anticlockwise direction to a new position which will correspond to a lower beam angle for a given output signal from the mixer unit output rod **135**.

The dotted lines referenced A, B and C at the push-pull control **195** represent alternative positions of the push-pull control button **198** and a suitable mechanism device will be provided for ensuring that the positions A, B and C, and the solid line position **198** illustrated in FIG. **11** are distinct settings to which the push-pull control button **198** can always be returned. For example, the housing **196***a* to which the end of the Bowden cable outer casing **196** is connected may have four recesses formed in its inner wall for engagement with a suitable spring-loaded ball in the shank of the push-pull button **198**, so that fixed positions are defined by engagement of the spring-loaded ball with the respective recesses. The solid line position illustrated corresponds to a "fog" position, position A corresponds to the conventional "dipped beam" position, position B corresponds to the conventional "main beam" position, and position C corresponds to a "long beam" position in which the beam may be set to a substantially horizontal setting for extremely long range vision ahead of the vehicle. Naturally, the use of such a long range setting will depend upon local traffic regulations, but it is envisaged that the extremely accurate self-levelling control of the lamps will enable a beam to be set to a substantially horizontal position without any danger of dazzle to oncoming or preceding traffic.

Since the Bowden cable executes a free loop between the point of attachment of the lever **181** and a grommet **199** in a suitable bulk head **200**, the Bowden cable will not impede the normal operation of the self-levelling linkage. Thus the mechanism provides simple means of adjusting the head lamp settings from within the vehicle without any deleterious effect on the normal operation of the self-levelling lamps.

The driver-operated beam angle adjuster of FIG. **11** may equally well be included with any of the embodiments of FIGS. **1** to **3** or FIG. **12** and it may be connected at any convenient point in the linkage. The precise manner of incorporation of the manual adjuster within any particular vehicle self-levelling system can readily be determined by any expert in this art.

The simplified mechanism of FIG. **12** is one in which the output signal from the mixer unit **221** is transmitted by way of a strut **222** which is connected to a further

strut portion **223** by way of a ball joint **224.** The further strut **223** has at its other end a ball joint **225** engaging with the lower end of a downwardly extending arm **226** carried by the cross member **220.** A screw **227** enables adjustment of the precise positioning of the arm **226** on the cross member **220** to adjust the vertical positioning of the lamps and, additionally, the arm **226** is of telescopic construction and has a lock nut **228** by means of which the selective length of the arm **226** can be held. Clearly, adjustment of the length of the arm **226** will provide the facility for adjusting the response ratio of the lamp.

FIG. **14** shows a particularly suitable type of connection between the arm **226'** and the cross member **220'.** In this instance the arm **226'** is carried by a sleeve **229** rotatably mounted on the vehicle body. The sleeve carries an internally threaded tangentially extending portion **230** within which the upper threaded end **231** of the arm **226'** can engage. The cross member **220'** extends coaxially through the sleeve **229** and is provided with an upwardly extending tab **232** which, together with a similar tab **233** secured to the sleeve **229** supports a screw **234** having a knurled head **235.** The two tabs **232** and **233** are urged apart by a compression spring **236** which is sufficiently strong to provide an effective rigid link between the two tabs **232** and **233.** This part of the adjustment mechanism will be situated adjacent the cross member **220'** just behind the front grille of the vehicle so that adjustment of the screw **234** may be effected either by placing the screwdriver through the grille and engaging a suitable slot in the head **235** of the screw, or by inserting the fingers through the grille to rotate the knurled head **235,** thereby effecting vertical adjustment of the assembly of two or more lamps controlled from the single cross member. The ratio adjustment is effected by placing a screwdriver in the top of the end **231** of the arm **226'** to rotate the arm and cause effective raising or lowering of the arm within the bracket portion **230.** Further adjustment of the lamps will be needed in that it will be possible to adjust the elevation of one lamp with respect to the other and this may be achieved by providing the cross member in two parts, one of which plugs into the other in freely rotatable manner, the plug and socket portions being provided with respective radially outwardly extending tabs which are engaged by a common screw and are urged apart by a suitable compression spring. Thus adjustment of the screw through the tabs moving the tabs towards or away from one another will result in relative angular rotation of two parts of the cross member thereby enabling the two lamps of a set to be adjusted with respect to one another, for example, to provide a pair of level beams. Naturally, when adjusting such a system in practice, it will be necessary first to synchronise the lamps and then to adjust the vertical setting of the synchronised pair of lamps.

Any of the above described systems may be provided with ratio adjusters, and equally the ratio adjusters may be omitted in production systems where the precise geometrical characteristics required of the self-levelling system are known in advance. The system may therefore be constructed to operate in the desired manner upon installation in a particular known vehicle without the need for response ratio adjustment.

In some vehicle installations the anti-roll bar may be positioned very close to and vertically below the vehicle radiator. This would reduce the amount of space available for the anti-roll bar lever required by the front vehicle body angle sensing system in each of the above described embodiments. In such a case it is possible to employ the longest arm commensurate with the space available and to affect the balance of the signals by employing mixer unit front and rear body signal springs which have different spring rates. This may conveniently be achieved by employing springs of identical construction but of different lengths. In this way the effect of the front body angle signal may be magnified within the mixer unit so that a sufficiently large output signal may be derived to drive the lamps for levelling movement. Likewise, if required, the rear body angle signal may be amplified, for example by means of a suitable lever arrangement positioned under the vehicle body. One suitable such lever system can comprise a lever oriented substantially vertically and positioned under the vehicle rear seat but mounted on a bracket for rotation about a horizontal axis extending transversely of the vehicle. The rear body angle signal may then be derived by way of a cable from the rear axle to the upper end of the lever, and the signal is thus transmitted to the mixer unit by means of a further cable connected between the bottom lever and the mixer unit itself, if necessary, through the agency of a strut as shown at **247** in FIG. **12.** By varying the distances between the lever fulcrum and the point of connection to the cables connecting it to on the one hand the rear axle and on the other hand the mixer unit, the rear signal may be amplified or attenuated at will.

FIG. **8** shows, in chain dotted lines, a pin **171***a* which engages with diametrically opposed holes in the tube **171** to act as a keeper, retaining the springs **132** and **133** appropriately stressed when the mixer unit is removed from the vehicle. Thus installation or reinstallation of the mixer unit will merely require hooking of the front end of the housing **127** over lever **119,** connecting up to cable **118** and lever **177** (FIG. **9**) and tensioning the cable **118** until the keeper pin **171***a* falls out, indicating that the system is connected and correctly tensioned.

I claim:

1. In a lamp self-levelling system comprising front and rear vehicle body angle signal generating means, and a lamp tilting linkage connected to at least one lamp to be levelled; signal mixing means operably connected to said vehicle body angle signal generating means and said lamp tilting linkage; a pair of springs in said mixing means operably connecting the lamp tilting linkage with respective ones of the front and rear body angle signal generating means; adjuster means in at least one of said front and rear body angle signal generating means for initially prestressing said springs; and indicator means responsive to the strain of said springs for indicating when the prestressing of said springs by said adjustor means has attained a strain value equivalent to a predetermined operating stress value.

2. A system as set forth in claim **1,** wherein said signal mixing means includes a housing and an elongate member extending into said housing for connection to one of said springs, the other spring being connected to said housing, wherein said adjuster means is effective to modify the rear body angle signal to stress said springs and wherein said indicating means comprises a pin loosely extending transversely through said elongate member and frictionally held in position by the strain in said springs at a position such that adjustment of the

rear body angle signal generating means to said predetermined strain will expand the springs and allow the pin to fall from the elongate member.

3. A vehicle including a lamp self-levelling system, and comprising ground wheels and a body, at least one lamp to be levelled, means for sensing the angle of the vehicle body relative to the ground wheels, means for effecting pivoting of said at least one vehicle lamp about a horizontal axis in response to said angle to retain the lamp beam at a constant inclination relative to the ground wheels, and means for damping movement of said lamp, said damper comprising a cylinder having a longitudinal axis, a loose fitting two-part piston slidably mounted within said cylinder and a liquid damping medium within said cylinder damping movement of said piston along said cylinder, said piston comprising first and second parts, means biasing said first and second parts apart, respective through passage means in said first and second parts defining together tortuous fluid flow passage means, said piston parts being constructed with said respective through passage means arranged at different radial distances relative to the longitudinal axis of said cylinder.

4. A vehicle having a front suspension anti-roll bar extending transversely of the vehicle, a rear axle and a lamp self-levelling system comprising:

a. at least one lamp to be levelled;
b. an arm extending vertically from the front anti-roll bar;
c. a cylindrical housing;
d. pivot means for hooking said housing to said arm at a location remote from the front anti-roll bar;
e. an output signal piston slidably carried within said housing;
f. a lamp tilting linkage connected to said output signal piston and to said at least one lamp;
g. a first coil spring in said housing and having a first end connected to said output signal piston and a second end connected to said housing;
h. a second coil spring in said housing and having first and second ends, said first end being operably connected to said output signal piston;
i. a cable having a first end operably connected to the second end of said second spring and having a second end disposed at a location on the vehicle remote from said housing; and
j. means operably connecting said second end of the cable with said rear axle for pulling said second end of the cable away from said housing in response to a vertical movement of the rear of the vehicle body.

5. A vehicle as set forth in claim 4 wherein said means operably connecting the second end of said cable with the rear axle comprises an L-shaped arm having a first limb resting on the rear axle and a second limb operably connected to said second end of the cable, and a bracket secured to the vehicle body supporting said arm for pivoting movement whereby raising of the vehicle rear ground wheels relative to the vehicle body effects rearward movement of said second limb relative to the vehicle body.

6. A vehicle as set forth in claim 4 and including a rear body angle signal transmission piston slidable within said housing, said second spring being compressed between said output signal transmission piston and said rear body angle signal transmission piston; and a front body angle signal transmission abutment member secured within said housing, the said first spring being compressed between said output signal transmission piston and said front body angle signal transmission abutment member.

7. A vehicle having a lamp self-levelling system comprising:

a. at least one lamp to be levelled;
b. a cylindrical housing;
c. first and second springs in said cylindrical housing and each having first and second ends;
d. an output signal transmission piston slidably mounted in said housing and operably engaging said first ends of said first and second springs;
e. means responsive to movement of the vehicle body for generating a front body angle signal, said front body angle signal generating means including a front body angle transmission piston operably engaging said second end of said first spring and secured within said housing and being connected to said front signal generating means movement longitudinally in response to vertical for movement of the front of the vehicle body relative to the vehicle point ground wheels;
f. means responsive to movement of the vehicle body for generating a rear body angle signal, said rear body angle signal generating means including a rear body angle transmission piston connected to slide longitudinally of said housing in response to vertical movement of the rear of the vehicle body relative to the vehicle rear ground wheels, said second spring being compressed between said output signal transmission piston and said rear body angle signal transmission piston;
g. lamp tilting linkage connected to said output signal transmission piston and to said at least one lamp for tilting said at least one lamp in response to movement of the vehicle body; and
h. damper means operably connected to said lamp tilting linkage for damping lamp tilting movements;
j. said rear vehicle body angle signal generating means further comprising a tubular piston support passing through said front body angle signal transmission piston and protruding from said housing for attachment to the remainder of the rear body angle signal generating means;
k. said lamp tilting linkage further including:
(*ka*) a diametrically extending pin on said output signal transmission piston;
(*kb*) a piston rod mounted slidably within said tubular piston support;
(*kc*) a pair of diametrically opposed slots extending longitudinally of said tubular piston support and slidably receiving said pin to lock the output signal transmission piston to said piston rod.

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