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(19)

(54) IMPROVEMENTS IN OR RELATING TO POWER-ASSISTED STEERING SYSTEMS

(71) We, CAM GEARS LIMITED, a British Company, of 45 Wilbury Way, Hitchin, Hertfordshire SG4 0TU, do hereby declare the invention for which we pray that a Patent may be granted to us and the method by which it is to be performed to be particularly described in and by the following statement:—

The invention relates to power-assisted steering systems.

It is desirable that vehicles fitted with power-assisted steering should be provided with some means of increasing the effort required to turn the steering wheel as the vehicle speed increases. Examples of ways in which this can be achieved are disclosed in Patent Specification No. 1,432,555 and our Patent Application No. 47530/76. (Serial No. 1 591 309).

According to the invention, there is provided a power-assisted steering system comprising a PAS valve as hereinafter defined controlled through a feel unit as hereinafter defined which is operable by fluid supplied from a pressure fluid pump, a fluid branch line communicating with the feel unit, and a solenoid valve responsive to an electrical signal representative of vehicle speed to control fluid flow through a part of the system, said solenoid valve being located in the branch line, and having a single inlet and a single outlet, in which the components of the system are arranged so that fluid pressure transmitted by the branch line to the feel unit is increased with increase in vehicle speed whereby the feel unit offers a greater resistance to manual operation of a steering control at higher vehicle speeds than at lower speeds.

A PAS valve is a power-assistance steering valve for controlling the supply of hydraulic power-assistance to the steering of steerable vehicle wheels.

A "feel unit" as the term is used in this Specification is a device, such as is disclosed for example, in Patent Specification No. 1,432,555 or Patent Application No. 47530/76, (Serial No. 1 591 309) which increases the effort required to turn a manual steering control of a vehicle fitted with power-assisted steering when increased hydraulic pressure, representative of increased vehicle speed, is applied to a hydraulic pressure-receiving member, such as a plunger or a ball.

In certain embodiments of the invention the branch line may be connected to a pressure fluid line which extends between the pump and the PAS valve.

In another embodiment, the branch line may be connected to a return line of the PAS valve upstream of a restrictor located in said return line.

In another embodiment, the solenoid valve may be provided in the return line downstream of its connection to the branch line; said solenoid valve being arranged to provide increased resistance to fluid flow with increased vehicle speed.

Embodiments of the invention will now be described by way of example with reference to the accompanying illustrative drawings in which:—

FIGURE 1 is a schematic diagram of a power-assisted steering system constituting a first embodiment of the invention;

FIGURE 1*a* is a schematic diagram of a valve for use with the system of Figure 1, Figure 2 or Figure 3;

FIGURE 2 is a diagram, similar to Figure 1, of a power-assisted steering system constituting a second embodiment of the invention;

FIGURE 3 is a diagram, similar to Figure 1, of a power-assisted steering system constituting a third embodiment of the invention;

FIGURE 4 is a diagram, similar to Figure 1, of a power-assisted steering system constituting a fourth embodiment of the invention; and

FIGURE 4*a* is a diagram, similar to Figure 1*a*, of a valve for use with the system of Figure 4.

Referring to Figure 1, a power-assisted steering system comprises an oil reservoir 1, a pump 2, a power-assisted steering (PAS) valve 3 connected through a feel unit 4 associated with the steering column 5, and a solenoid valve 6.The PAS valve 3 controls

the steerable road wheels of the vehicle by means of a rack and pinion gear (not shown). The PAS valve 3, feel unit 4, and rack and pinion gear may be as referred to and described in Patent Specification No. 1,432,555 or in our Patent Application No. 47530/76 (Serial No. 1 591 309), the text of which is hereby incorporated into this Specification by reference. The reservoir 1 is connected to the pump 2 by a line 7 and the pump 2 delivers pressure fluid to the PAS valve by a line 8, from which a branch 9 leads to the feel unit 4. Flow through the branch 9 is controlled by the solenoid valve 6. The line 8 is provided with a restrictor, 10 situated between the PAS valve and the junction of the branch 9 with line 8. From the PAS valve 3 a return line 11 leads to the reservoir 1.

The restrictor 10 causes a pressure drop from say 100 p.s.i. upstream of the restrictor to say 20 p.s.i. downstream of it.

An electrical signal representative of vehicle speed is generated by a vehicle speed sensor (not shown) which may be interconnected with the vehicle transmission of the speedometer drive, and this signal is fed to the solenoid valve 6 causing it to gradually open as speed increases and to allow fluid pressure to be communicated to the feel unit. At low speeds the solenoid valve is in its closed position, as shown in Figure 1*a*. The increased pressure transmitted to the feel unit 4 at higher speeds means that increased manual effort is required to turn the steering wheel.

It will be noted that the solenoid valve has a single inlet and a single outlet.

The second embodiment, shown in Figure 2, is similar to the embodiment of Figure 1 except that the restrictor 10 has been dispensed with. The valve 6 is as shown in Figure 1*a*. Operation is similar to the first embodiment.

The third embodiment, shown in Figure 3, is similar to the embodiments of Figures 1 and 2, except that the restrictor 10′ is provided in the return line 11′ from the PAS valve 3, and the branch line 9′ to the feel unit 4 joins the return line 11′ between the restrictor 10′ and the PAS valve 3. The solenoid valve 6 is the same as that shown in Figure 1*a*. Operation is again similar to the first and second embodiments.

The fourth embodiment, shown in Figure 4, is similar to the foregoing embodiments ept that a different solenoid valve 6′ (Figure 4*a*) is employed, and the return line 11″ and branch line 9″ differ as will be explained. The line 11″ has no restrictor but, instead, the solenoid valve 6′ is so constructed that it is never fully closed but, in its nominally closed position, acts as a restrictor.

In contrast to the foregoing embodiments, the valve 6′ is initially fully open, but as the speed increases the resistance of the valve 6′ to hydraulic flow increases, thus increasing the magnitude of the pressure signal fed to the feel unit through the branch line 9″, which joins the return line 11″ upstream of the valve 6′ and downstream of the PAS valve. Operation is otherwise similar to the foregoing embodiments.

It will be noted that in the fourth, as in the first to third embodiments, the solenoid valve 6′ has a single inlet and a single outlet.

WHAT WE CLAIM IS:—

1. A power-assisted steering system comprising a PAS valve as hereinbefore defined controlled through a feel unit as hereinbefore defined which is operable by fluid supplied from a pressure fluid pump, a fluid branch line communicating with the feel unit, and a solenoid valve responsive to an electrical signal representative of vehicle speed to control fluid flow through a part of the system, said solenoid valve being located in the branch line, and having a single inlet and and single outlet, in which the components of the system are arranged so that fluid pressure transmitted by the branch line to the feel unit is increased with increase in vehicle speed whereby the feel unit offers a greater resistance to manual operation of a steering control at higher vehicle speeds than at lower speeds.

2. A system as claimed in Claim 1, in which the branch line is connected to a pressure fluid line which extends between the pump and the PAS valve.

3. A system as claimed in Claim 1, in which the branch line is connected to a return line of the PAS valve.

4. A system as claimed in Claim 3, in which the branch line is connected to the return line upstream of a restrictor located in said return line.

5. A system as claimed in any preceding Claim in which the solenoid valve comprises a piston movable along a cylinder against the action of a biasing means in response to an electrical signal applied to the solenoid to provide communication between said single inlet and outlet as required.

6. A system as claimed in Claim 5 in

which the solenoid valve is in its closed position at low vehicle speeds and is moved to its open position at higher vehicle speeds.

7. A system as claimed in Claim 3, in which the solenoid valve is provided in the return line downstream of its connection to the branch line; said solenoid valve being arranged to provide increased resistance to fluid flow in the return line with increased vehicle speed.

8. A power-assisted steering system substantially as herein described and shown in the accompanying drawings.

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Sheet 1

Fig.1a.

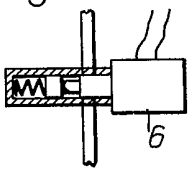
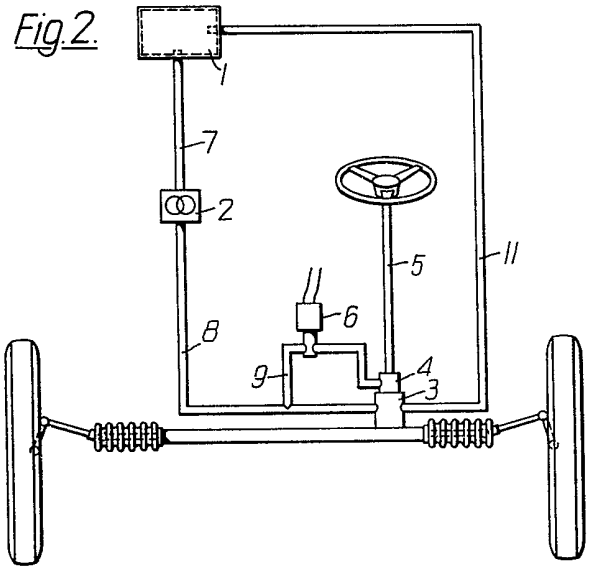


Fig.1.

Fig.2.



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Sheet 2

Fig.3.

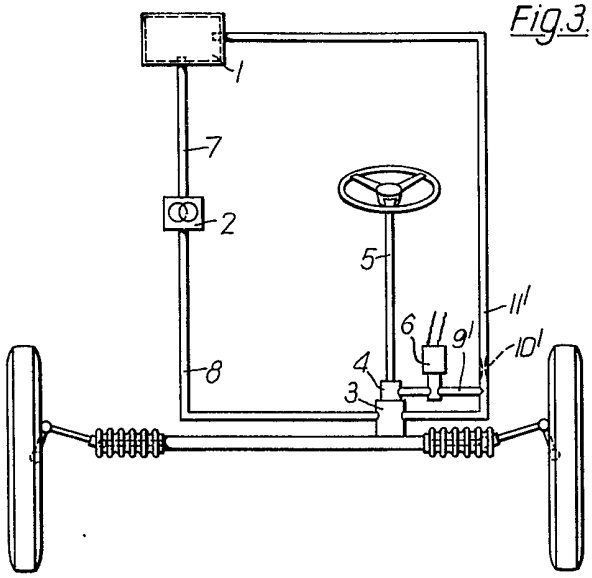

Fig.4a.

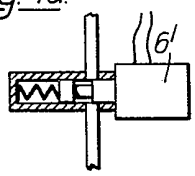

Fig.4.