POWER ASSISTED STEERING

Rolls-Royce Silver Cloud II

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Power assisted steering, taken for granted and practically unperceived by today's motorists is a relatively new addition to the list of standard accessories fitted to nearly every car, van and truck built today. Only when these systems fail, does it become apparent just what a difference they really make to the driving experience. Very soon only those of us interested in the preservation of older vehicles will be able to remember how unassisted steering feels to drive.

One only has to try hauling on the steering wheel of any pre-war car at parking speeds, to understand where the inspiration to design such a system came from.

The Chrysler Corporation were the first company to offer power assisted steering. Initially known as" Hydraguide", it first appeared on the Chrysler Imperial in 1951. This clever piece of engineering had been invented by Francis W. Davis and George Jessop of Walthom Massachusetts USA. Their designs had been taken up by The Chrysler Corporation who foresaw the great potential of the system in aiding weary Americans when hauling their huge motor cars into parking spaces.

Rolls-Royce kept a close eye on developments in the American automotive industry. They enjoyed a particularly co-operative relationship with Chrysler, exchanging information on many technical issues.

In the early 1950's Rolls-Royce were working on designs for the Silver Cloud. As never before Rolls-Royce knew they would be dependent on their export sales if they were to survive. The new Silver Cloud would therefore need to be designed with the lucrative American market clearly in mind. In America the car would have to compete in a market awash with technically advanced cars. Cadillac and Chrysler, to name but two of a multitude of American manufacturers made a range of very large, superbly equipped, and affordable cars compared to Rolls-Royce. These companies listed a range of optional equipment unsurpassed by any European motor manufacturer. With such technically impressive cars readily available, and at very competitive prices, Rolls-Royce knew they had to raise their game in the equipment stakes. They sought the advice of their U.S. agents. The Silver Dawn and Bentley R type had not enjoyed popularity in the U.S. They had been seen as somewhat dated and rather small when they were launched in America. It was therefore desirable that American tastes were catered for. Rolls Royce listened and heeded when agents like Inskip told them they must provide power assisted steering if they wanted to be taken seriously in the US market.

At the start of the design process, Harry Grylls (Rolls-Royce's technical director) became convinced of the dangers of what was termed "sneeze factor". This term described the potentially dangerous scenario of very sensitive highly assisted steering being dangerous if suddenly jolted at higher speeds by a driver sneezing etc. A sudden jolt, it was thought would cause the car to run wildly off line, and could cause serious accidents. With this theory in mind, Rolls-Royce's engineers set about the task of designing a system able to guard against potential danger. The resulting system was by today's standards ludicrously low geared. A low geared system of course guards best against sneeze factor, because it moves much slower than a high geared one. No doubt numerous test drivers suggested a rise in ratio, but Harry Grylls was against that idea. He decided to keep the low ratio, even though other manufacturers had proved sneeze factor not to pose any serious problem by the time the Silver Cloud was ready to be put into production. A higher ratio would have made a dramatic improvement to the way Silver Cloud handled, but it was not to be. Harry Grylls had his way.

Despite their best attempts Rolls-Royce did not have their power assisted steering perfected for the launch of the Silver Cloud in April 1955. It was perhaps just as well export orders would not commence until the end of that year, by which time PAS was available. All cars destined for the USA were equipped with the system, which was received by the public to almost universal acclaim.

The Rolls-Royce system was designed to impose power assistance on to their normal manual steering. Engineers felt it sensible to retain the complex steering linkage. It gave the driver that all important "feel" of the road, it also prevented harsh shocks being transmitted to the driver. The new system had to provide light and positive steering and had to be failsafe. In the event of a leak or a belt breaking, the steering simply became unassisted with no dangerous side effects.

The addition of PAS to the Silver Cloud chassis was no simple modification. In order to accommodate the hydraulic power cylinder the front chassis pan had to be completely redesigned. Having gone to this amount of trouble and expense to provide PAS, I can't understand why the system was never made a standard fitting on the Silver Cloud I. Buyers would have to wait for the arrival of the V8 powered Silver Cloud II in 1959 to see PAS fitted as standard.

As a rule, the Silver Cloud and Phantom V and VI steering systems don't seem to present many problems in service. The system if properly maintained is very reliable. Leaks however are a persistent source of irritation to many owners myself included.

Most of the steering system is fairly straightforward to overhaul. The Steering box itself however is a notable exception. The difficulty here is the successful overhaul of the spool valve assembly.

Early in my ownership of 151 GWY, I was obliged to remove the engine and gearbox. During the process of removing the engine, I noticed with some horror that the PAS had been filled with engine oil (of course it should have been filled with automatic transmission fluid). I had noticed some juddering of the steering as it turned lock to lock. On top of these problems I had noticed a nasty leak from the hydraulic power cylinder, several disturbing leaks from the steering box, and several leaks from the hydraulic pump. I suppose the rationale for filling the PAS with engine oil was to try to stop leaks. The vastly higher viscous of engine oil would find it harder to get past the worn seals. I decided on a full overhaul of the system, mainly to ensure all the engine oil would be completely removed and to stop the leaks. Little did I realise what a horrid job I had taken on.

My purpose in writing this article is not to bore people with a faithful narrative covering every detail of how I overhauled my PAS. I hope to pass on a few tips on how I got things to seal and make people aware of the importance of some adjustments. These adjustments are in my experience on many cars not correct. These adjustments make a great deal of difference and can help prevent strain and leaks.

If an overhaul is being seriously considered, I would urge anyone embarking on such a task to acquire a factory workshop manual. It gives easy to follow advice on most of the components. The Workshop manual does not however give an adequate impression of how difficult it really is to remove and overhaul the steering box. I would urge anyone not fully conversant with the overhaul of such accurately made selectively assembled, hydraulic components to leave the overhaul of these particular steering boxes to an expert of which there are few. It may surprise many owners that very few Rolls-Royce specialists are willing to undertake the overhaul of Silver Cloud, Phantom V /VI power steering boxes. Even some of the most eminent restorers employing highly skilled technicians prefer to leave faulty steering boxes to the experts. They realise, probably through experience, someone working on these assemblies needs to be properly equipped. Without a suitable test rig it is difficult to tell if the spool valve assembly is working properly. It can be very tiresome having to remove the steering box from the chassis several times in order to get it right! Fortunately in my own case I managed to successfully rebuild my steering box. I most certainly didn't find it at all easy. Despite having at my disposal the tool making and engineering capabilities of several time served experts, I learned in the process of overhauling my steering box how much more difficult the job would have been if I had been less adequately supported and equipped. A range of accurately ground hardened selective adjusting washers (like shims) are needed. A supply of correctly graded correctly wound replacement spool valve springs could also be a necessity. Even the replacement of the rocking shaft bearing requires a supply of suitable shims for the job to be successful. The above are small consumable parts. I

dread to think of the difficulty, let alone the very substantial cost of having to have new gear sets made should the original components be worn beyond use.

Having decided to tackle the job I adopted the contortions necessary to even see some of the banjo fittings securing the power steering hoses to the spool valve. I made a specially shaped spanner to reach the most awkward to reach fittings and finally succeeded in releasing the hoses.

I separated the ball joint on the end of the pendulum lever. I removed the mounting brackets and finally removed the unit from the chassis.

Following the workshop manual I attempted to dismantle the unit for inspection. Almost immediately I ran into problems. I simply could not persuade the pendulum lever to part company with the splines on the rocking shaft (see drawing 1 (file name colour 0003) item 39 is the pendulum lever, item 16 is the rocking shaft). I did not want to risk using heat for fear of damaging the hardening on the rocking shaft, and the further possibility of melting seals etc. in the steering box.

A very good friend and engineer came to my rescue. He made a very heavy “C” section steel pulling block to slip closely around the rocking shaft. With substantial bolts through this we were able to attach a 12 tonne hydraulic puller, fortunately this arrangement proved more persuasive than my former attempts, and finally the two parts separated with quite a bang.

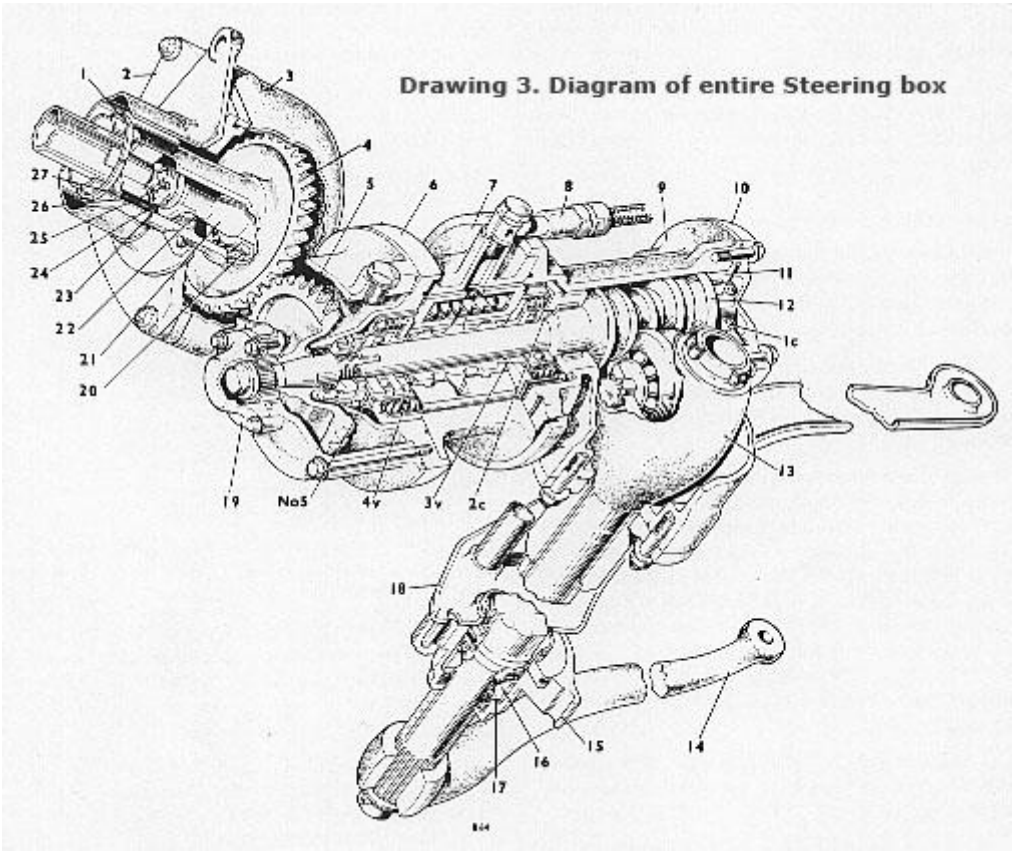
With the steering box fully dismantled and clean, I laid all the components out on the bench for detailed inspection. I found two of the four primary spool valve springs slightly bent, shortened and misshapen (see item 3 of drawing 2(file name colour)). Fortunately, at this point, chance conversation with a friend put me in touch with a spring specialist in Redditch Worcestershire, who was kind enough to make me a new set free of charge, to specifications I obtained from drawings held in the RREC archives at the Hunt House. I carefully checked the poundage and free length readings for all the remaining secondary springs (see item 9 drawing 2). (The specifications for which I gained from drawings held at the Hunt House) New rocking shaft bearings were also necessary, they are taper roller bearings and had worn a slight ridge in their outer races on one side, of course this made them useless. The lower rocking shaft bearing housing seal had radial cracks in it. Small wonder it did not hold fluid - that too would need replacing. I also decided to replace all the “O” ring seals as a matter of course. All the remaining parts were subjected to close scrutiny and found to be serviceable.

I followed the advice of the workshop manual to the letter during re-assembly. Despite this I had several moments of anxiety. I really wondered if I would ever see the thing back in one piece!

A Modern double lipped shaft seal was used as a superior replacement to the original lower rocking shaft bearing housing seal. It must be remembered to ensure the correct bearing preload has been achieved by selecting appropriate shims and checking the poundage required to turn the rocking shaft without the worm gear in place before fitting the new shaft seal to the housing. Several attempts may be required to get the setting correct. Damage to the rocking shaft lower bearing housing seal would almost certainly result if it were slid on and off the splined shaft several times.

When fitting the rocking shaft lower bearing housing complete with its seal to the steering box, it’s a very good idea to first cover the splines of the rocking shaft with parcel tape to prevent the splines slicing into the lips on the new seal. I took the further precaution of stoning off any damage and burrs on the splines, Then I polished the rocking shaft to ensure that the shaft seal slid easily along it without damage. Having ascertained where the cam roller and worm gear tight spot was. I put masking tape on the steering box casing and the exposed part of the rocking shaft. I drew 3 arrows on the tape on the casing and one on the tape on the rocking shaft. The centre arrow showed the exact centre of the tight spot, the outer arrows showed the points were the tight spot started and ended. These arrows when aligned showed at a glance where the gearing was in relation to the position of road wheels, with the box re-fitted to the chassis.

I decided it would be a good idea to check that everything fitted together properly. So I re-fitted the steering box to the car. (See picture) To ensure the wheels were in the straight ahead position I used a Dunlop alignment gauge, before connecting the ball joint at the end of the pendulum lever to the steering linkage. With everything in order I checked the position of the steering wheel, and made certain that the self-cancelling mechanism for the indicator switch was working properly.



Satisfied, the alignments were correct and everything fitted together properly it was time to make the necessary adjustments to mesh etc. I carefully adjusted the mesh of the transfer gears (See drawing 3 item no's 4 & 5(file name colour 0001)) (The Silver Cloud I is not fitted with transfer gears. These were a necessary addition to maintain the position of the steering column when the steering box had to be relocated outside the frame when the Silver Cloud I chassis was modified to accept the wider V8 engine of the Silver Cloud II) This is an important job that is worth spending some time over to ensure a pleasing action. A light click through the steering column when briskly turning the steering wheel one way then the other can indicate that the mesh of the transfer gears may require adjustment. I followed the instructions given in the workshop manual. However I think it worth emphasising that I found it essential make certain the adjuster lock nut is fully tightened before checking the setting. If this nut is at all loose a completely false impression is gained (the adjuster and its locknut can be seen in Picture 2)

Having set the transfer gears mesh, with the steering in the straight ahead position I removed the ball joint connecting the pendulum lever to the steering linkage. Again I checked the arrows were in alignment ensuring the gears were positioned at the start of the tight spot. I attached a spring balance to the end of the pendulum lever to check the poundage through the tight spot.

If the other internal settings in the spool valve and rocking shaft bearings are correct, the poundage reading at the end of the pendulum lever will show if correct mesh between the cam roller and worm gear has been achieved.

I found I had a low reading indicating excessive backlash between the cam roller and worm gear, indicating further adjustment was necessary. It is vital that the backlash is checked at the tight spot, because the worm

Picture 3. Uppermost steering box adjustment

gear is machined to have more backlash either side of this. This is done to allow wear in service to be adjusted out without making the steering tight on lock.

I slackened the nuts on the top cover, and the bolts on the lower rocking shaft bearing housing. A pointer is cast into the top cover (see picture 3) and second pointer is present on the lower rocking shaft bearing housing (see picture 4). Engraved on the steering box casing is a set of incremented settings for the top cover. A similar array of setting increments are present on the lower mounting arm adjacent to the pointer on the lower rocking shaft bearing housing. To make the increments more visible I rubbed chalk into them (see picture 4).

To reduce the backlash between the cam roller and worm gear. I turned both top and bottom covers by exactly the same amount clockwise half an increment at a time then re-tightened the securing nuts and bolts before re-checking the backlash between the cam roller and worm gear by once again noting the spring balance reading whilst the mechanism turned through the tight spot. The process takes several attempts to get the setting correct. It is worth trying to adjust the mesh of the cam roller and worm gear before the system is filled with fluid. It is vital all the nuts and bolts are tight before any attempt is made to check the poundage readings. I should point out that to disturb an unrestored steering box to adjust these settings without being sure of the poundage settings on the internal bearings is not a good idea. If nothing else disturbing the covers will cause leaks, because the “O” rings will nearly always tear when the covers are moved.

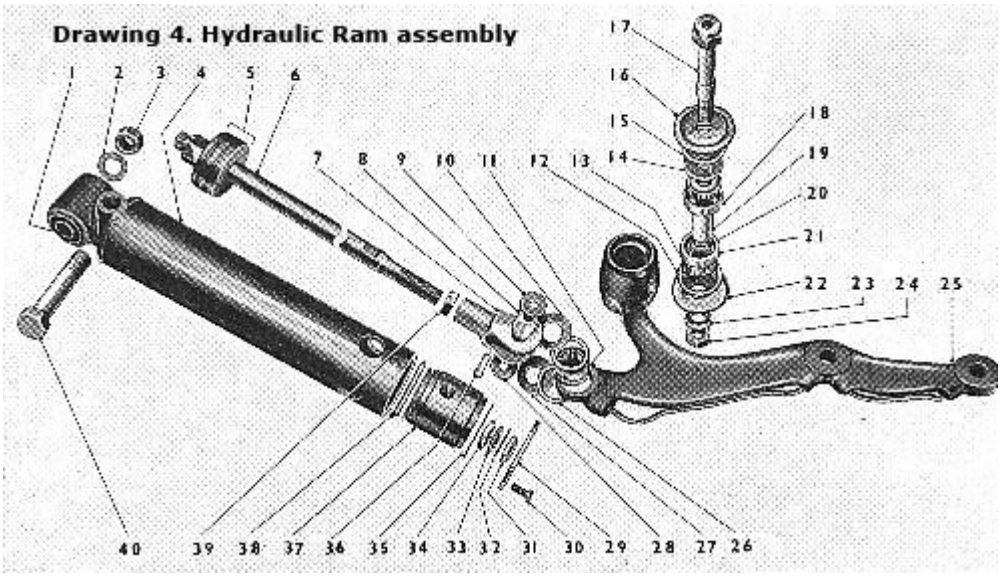
Picture 4.
Vernier adjustment on steering box 1

Having satisfied myself the adjustments were correct I filled the system with fresh Dextron II automatic transmission fluid. It takes quite a time to purge the system of air. This is done by turning the wheels from lock to lock, with the engine running, and constantly adding fluid until the fluid returning to the pump reservoir has no air bubbles in it.

I checked the steering box for leaks and I was annoyed to find fluid weeping past the new “O” rings in three places. The leaks were only slight, but those slight leaks make such a mess over time.

Once again I drained the system. I removed the leaking covers, and cleaned off all the transmission fluid from them, their “O” rings and the mating faces of the steering box housing. Certain the parts were spotless, I applied a small amount of RTV (room temperature vulcanising silicone) sealant to the “O” rings. After re-assembly and re-filling the system the leaks, much to my relief, had disappeared. I should say at this point how vitally important it is to use only very sparing amounts of RTV on the “O” rings. An excess amount of sealant can create more problems than it solves. If lumps of excess sealant break free and start moving about the system in the fluid it is only a matter of time before some enters the spool valve and/or the pressure regulating valve in the pump. If this happens a whole new range of unpleasant symptoms could result.

Finally happy with the steering box I noticed the hydraulic power cylinder that I had rebuilt with new Rolls-Royce seals was weeping fluid after a few miles service. (A view of the hydraulic cylinder can be seen in picture 5)



I don't think I have ever come across a Silver Cloud that did not have a leak in this area. I decided modification was the best plan because the original seals certainly were not much use. Time to drain the system again! With the hydraulic cylinder dismantled for the second time, I decided to slightly modify the end bush (See item no 37 in drawing 4). The bush locates inside the outer cylinder and is sealed with an "O" ring (see item no 38 drawing 4). Again it may be found advantageous to use a small amount of RTV to ensure a perfect seal between the bush and the outer cylinder. The recess which houses the shaft sealing arrangement needed slight modification to take a modern nitrile garter style shaft seal. A local seal specialist provided some seals that fitted the shaft and the bush housing diameters perfectly. It was just as well I bought several seals to experiment with. I ruined several attempting to fit them. To overcome these difficulties, I found it essential to add a chamfer to the leading edge of the seal recess and polish the recess. This allowed the seal to be pressed in without distortion. A second pitfall in assembling the cylinder came to light when I tried to slide the shaft through the new seal. The shaft has two flats milled in it near the threaded end for adjustment of the sponge gap. The sharp edges of the flats proved perfect for slicing through the sealing lip! My usual trick with parcel tape to cover the threads and flats would not work in this case. The clearance between the seal and the shaft is so exact the thickness of the tape cannot be accommodated. I had to apply great care to ease the seal over the obstacles without damage.

The final adjustment when fitting the power cylinder is the sponge gap setting. This is the clearance that MUST be present at the extreme ends of the piston travel. I followed the instructions in the workshop manual, to ensure the sponge gap was correct. Failure to ensure an adequate gap can place huge stresses on the support bush and seals, thus creating leaks.

View of steering mech from underneath

I am glad to say that after all this work the steering on my car has a beautifully smooth action. The rattles, clicks and leaks that dogged the car have all gone. Having said that, I would not like to have to repeat the exercise!