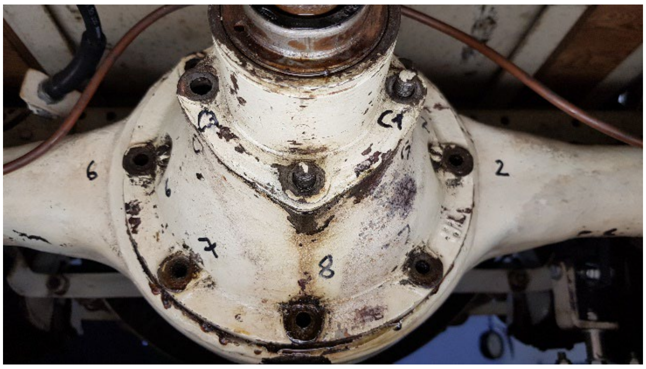
Singer Le Mans: Story of rear axle repair

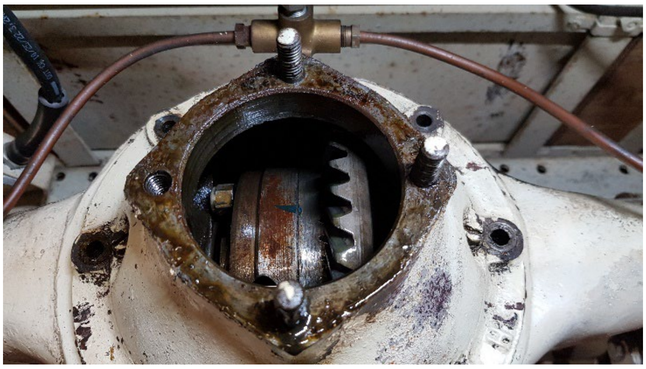
Hans-Christoph Mertins, 22.8.2024, hc.mertins@gmx.de

My car, Singer Le Mans, 1934, 2-Seater, 1 litre, Car No 62743 had problems with the differential. It produced noise when the gears are changed, i.e. when the clutch is released and the transmission is under load. The right wheel also wobbles. The backlash of the drive shaft is large, i.e. it rotates by hand 90 degree before wheels start to rotate. In the following the repair process is described. However, a very detailed, general description of rear axle repair is found at mothy.co.uk by Roly Alcock who gave advice to identify and solve problems.

A) Inspection of situation

Dismantling the Differential/Removing Pinion:
Differential housing screws 1) – 8) show different length but can easily be removed
Pinion housing screws C1) – C4 easy to remove
Pinion unit can be removed with help of levering screwdriver





Pinion unit
Teeth 7, printed on the body: 97 (unclear) and below 460;

All teeth are very rough and partially damaged with 1-3 mm roughness;
No wobble when rotated, easy to rotate but slight scratch after half revolution;

Crown Wheel

Label: Bcwp /6/ 555 / 203 (or first letter R?)

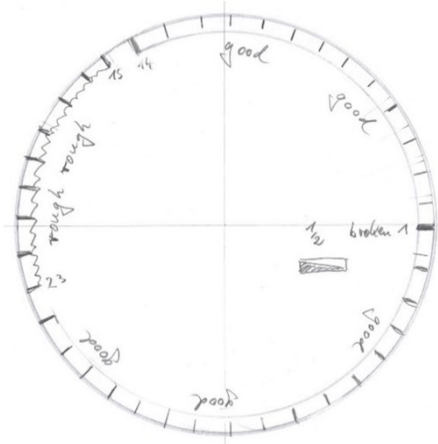
Type: 39 teeth

The crown wheel teeth are damaged partially;

No 1: broken, half tooth along length direction is missing (sketch);

No 15 to 23 are damaged on top, very rough 1-3 mm missing;

Broken tooth No 1 and damaged region are on opposite positions of the crown wheel =>



Left, center: Broken tooth No 1 at begin of labelling Bcwp/6/555/203.

Top: damaged, rough teeth No 15 – 23 at opposite position

Backlash: when rotating the CW it takes about 3-4 mm until the half shaft (wheel at the side of the CW) starts to rotate. This is about 2 degree backlash and does not explain the large back-lash of 90 degree when rotating the mounted drive shaft before the wheels start to rotate

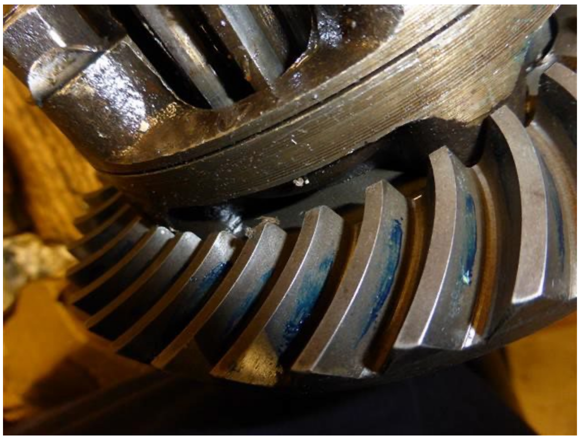
Next week we will continue to remove the two half shafts and continue with dismantling the diff

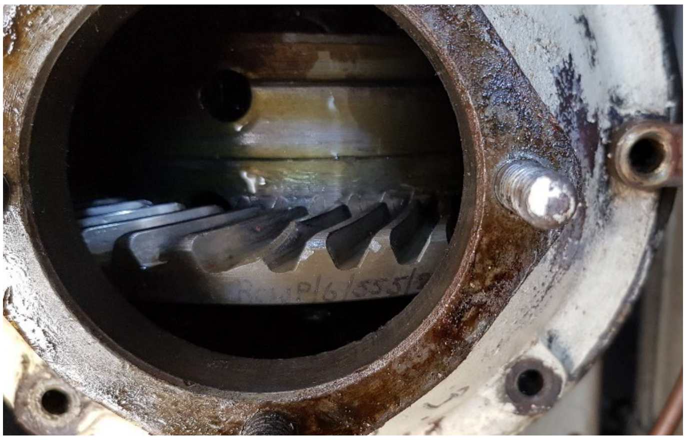
Rear Axle Housing – which model?

The rear axle housing of my car is different from classical Singer Le Mans 1934 as shown in the next figures. But fortunately the differential with crown wheel and pinion are identical and can be replaced by those offered at Hardwick Spares!

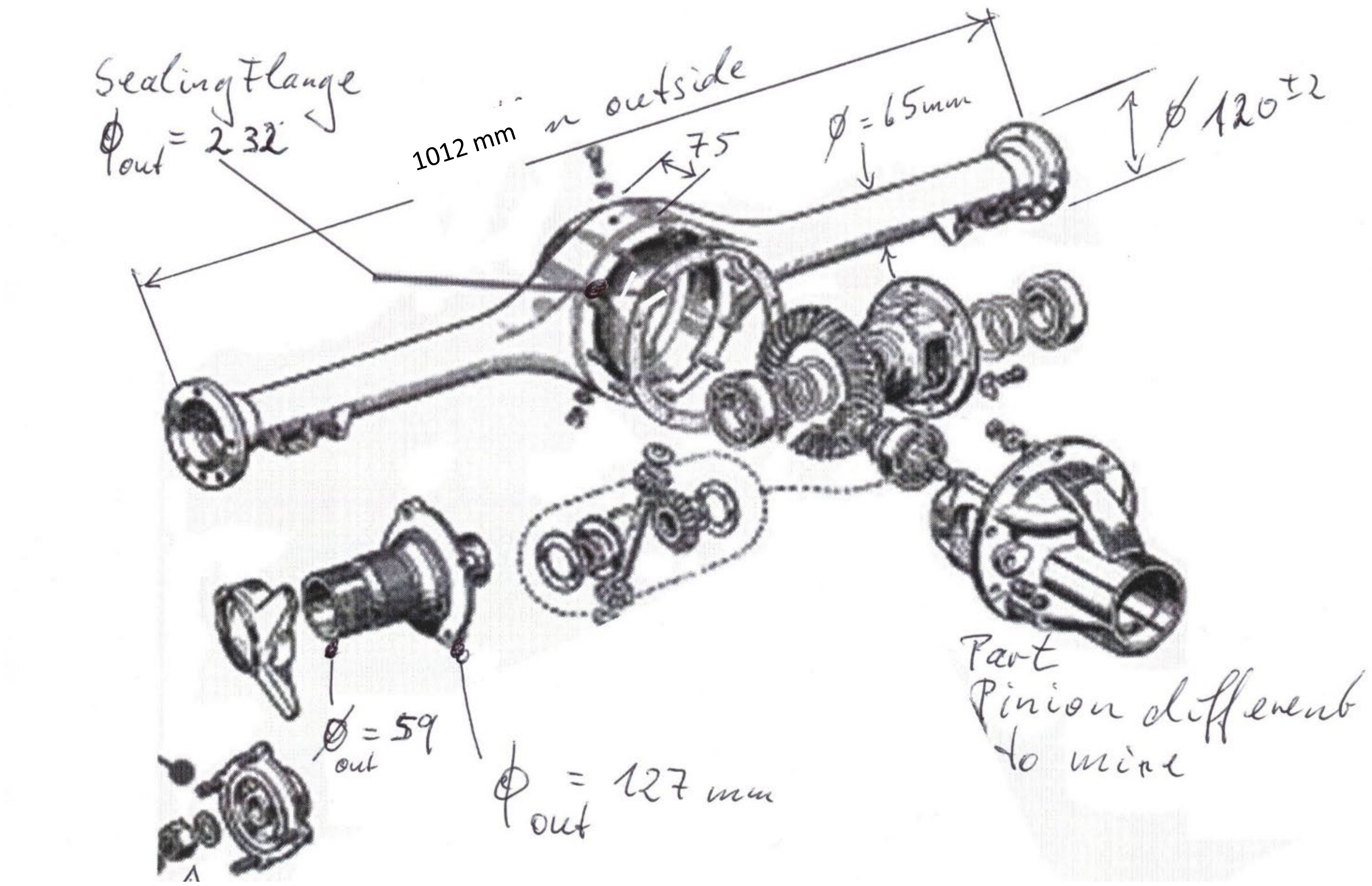
Singer Le Mans parts Info Roly Alcock

My Parts Hans-Christoph Mertins

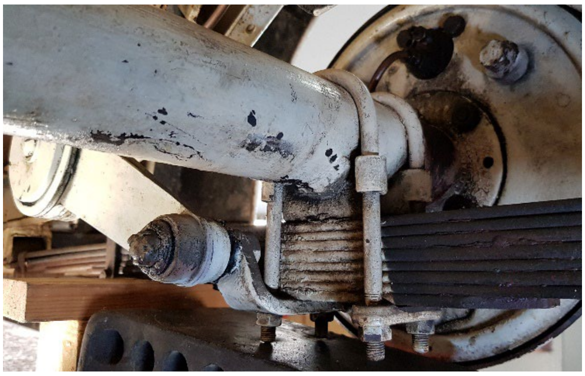


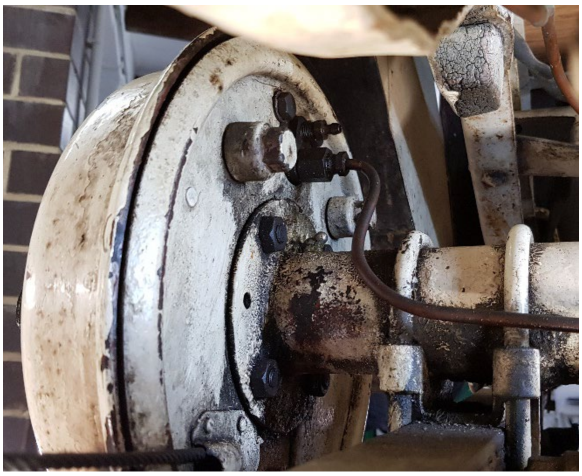


Principle set up close to mine: image from https://forestcustom.co.uk/shop/drive-line/rear-axle



My Singer Le Mans



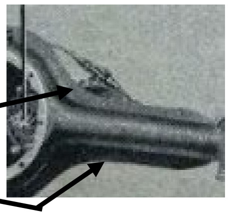


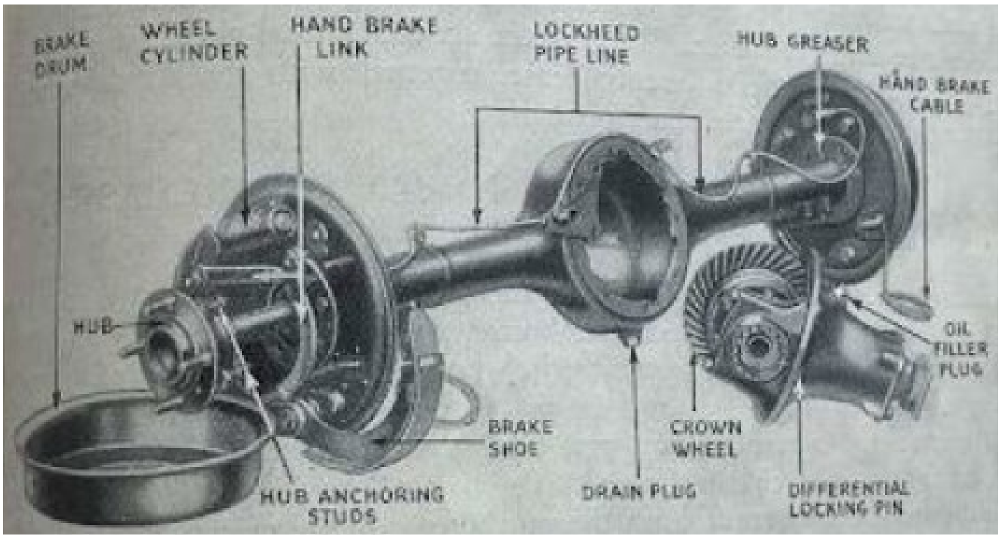
Drawing for Singer 9hp

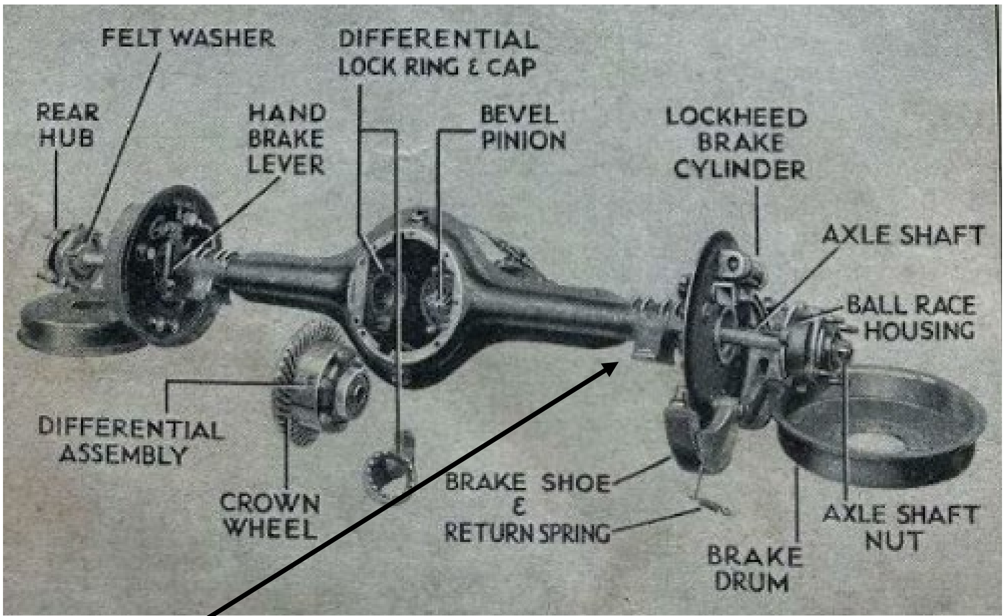
looks like mine with respect to the hubs, brakes

Just the Differential housing in particular the pinion-part is different

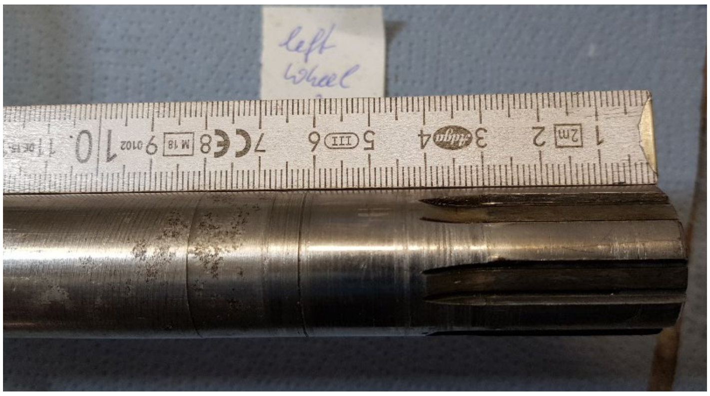
Different are the wings on top and bottom of the axle housing







Mounting of axle housing to the springs/shock absorber via U-bolts is identical



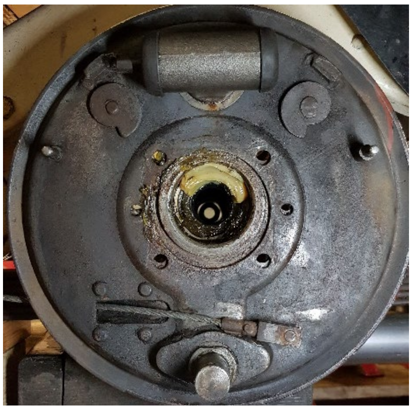
Right:	bearing defect, moveable in axle direction +/- 1-2 mm
Left:	defect radial: shaft at Wheel side D = 28.3 and bearing D = 28.55 Shaft too thin
Half shaft	left, right side identical with Diameter = 25.25 – 25.35 mm (figure above at 45 mm position and 60 mm) in Diff Total Length 494 mm, Notches are ok

Bearings	Outer ring:	Diameter = 71.45 mm	MJ1 I/8-	
	Brass ring:		J 30 – A	
	Inner ring:	Diameter = 28.62	R&M 31/SM	19AST
	Thickness	20.6 mm		

Sealing Dout = 60.3-60.5, Din = 41.2, w = 7.0 – 8.5 mm

Simmering Doppellippe Din = 41.2, Dout = 60.3, w=9.5,

Axle-Housing-Simmering



Axis: D = 25.4 (25.39 – 25.6 mm)

Simmering Din = 25.4 Dout = 44.7 (44.3 – 44.8), w = 4-7

Ordered: 25.4 x 44.45 x 6.3 2 x Type: OAS… , NBR

2 x Type: BC…

Rear Axle – Brake – Housing

Housing (ring inside)

Din = 44.4 Dout = 71.35

Fits to axle Din = 71.25

Brake-Plate

Din = 79.6 w = 3.6

Fits to axle Dout = 79.35

Axle Alignment Ring at Bearing cup

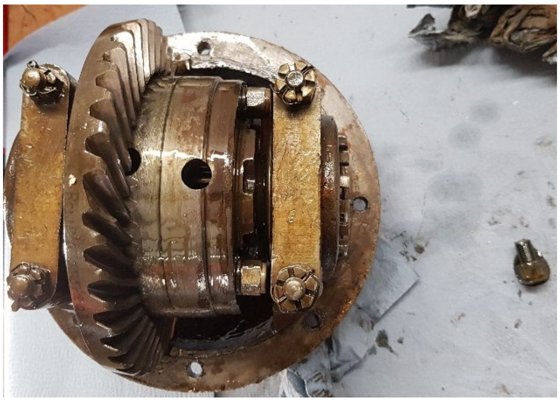
Dout = 79.35 Din = 71.25

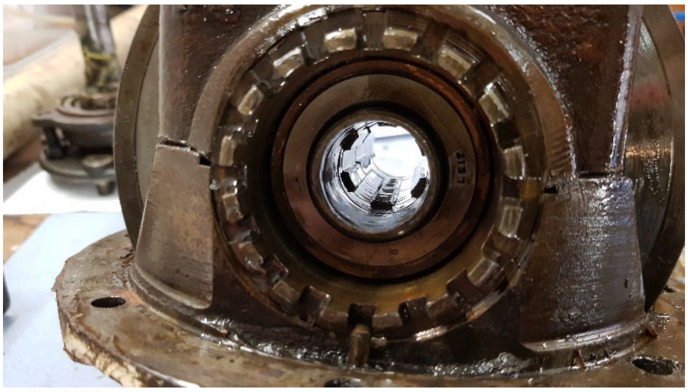
=> Brake-Plate is aligned with respect to axle housing via axle alignment ring

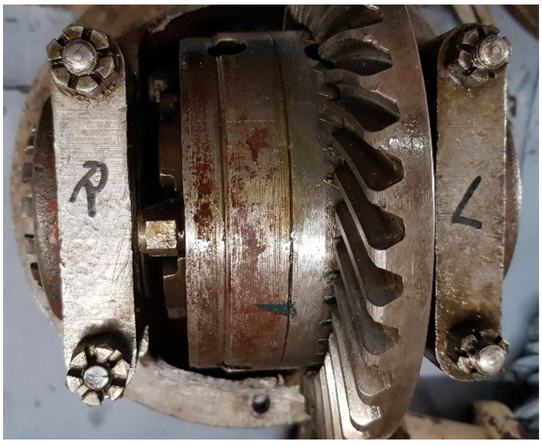
Differential Crown Wheel: 39 teeth Pinion: 7 teeth

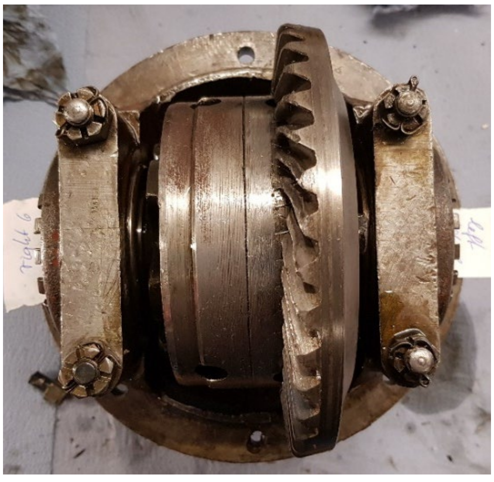
Label: Bcwp /6/ 555 / 203 (or first letter R?)

Problem: one of three screws fixing the Crown Wheel was broken (left figure) and the two other were not tight so that the CW was not pressed perfectly to the pinion which must be the reason for scratched teeth on the CW.

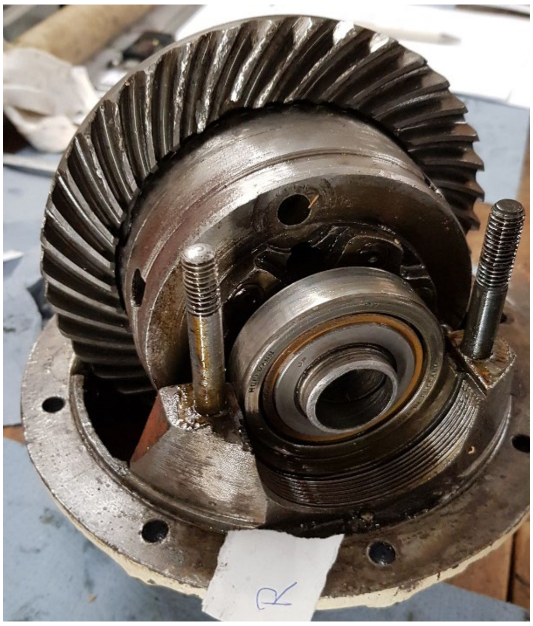




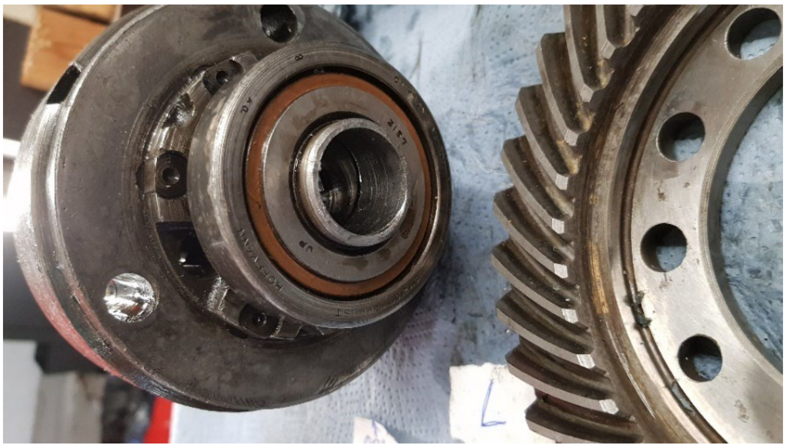


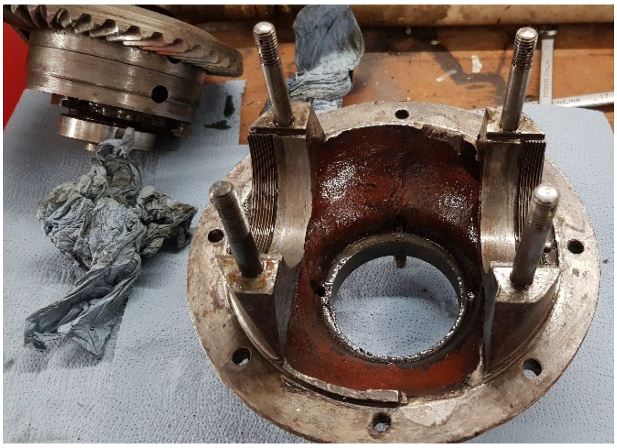



6
2




HOFFMANN
JP
LS12
MADE IN ENGLAND





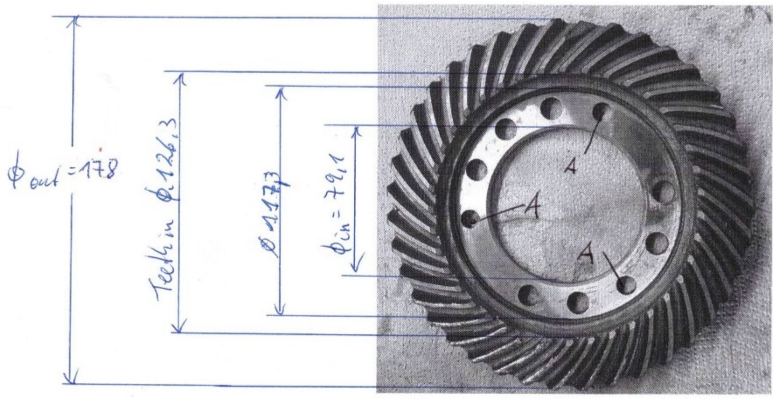
Differential Singer Le Mans 1934, 2 seater, 1 litre, Hans-Christoph Mertins 23.3.2024

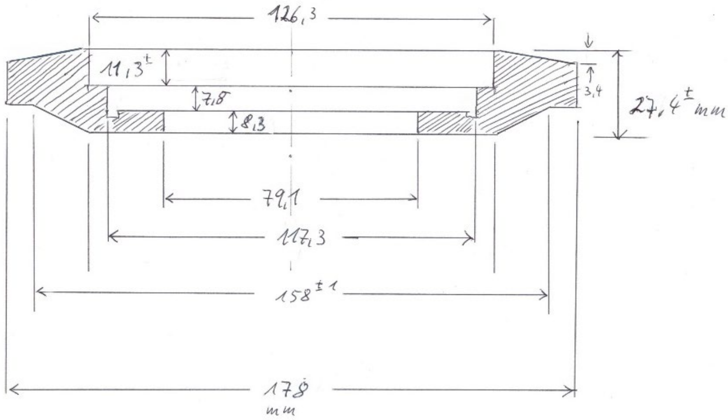
Crown Wheel 39 teeth No Rcwp/6/555/203 (R or B?)
Pinion 7 teeth

Bearing in Differential: LS 12 JP B AC, Thrust Hoffmann, AQ, England
Din = 31,8 Dout = 69,88 width = 16,7 gemessen bei mir

LS 12 AC: Din= 1,25 "=31.75, Dout= 2,75" = 69,85, w = 11/16" = 17,46

CW
outer & inner Diameter seem to be identical to values for Singer 1934-35 9hp, 34-37 Sports 36-38 Bentam, tabulated in old manuals and workshop books; Figures below with millimeter units



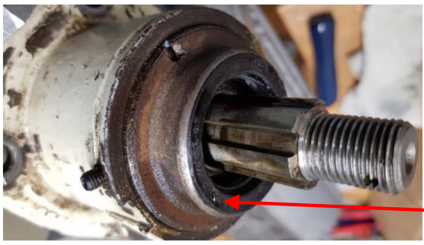


Holes A of diameter D = 9.5 mm (Fig. left), other holes D = 11.2 mm, only 3 holes used for screws

Pinion unit

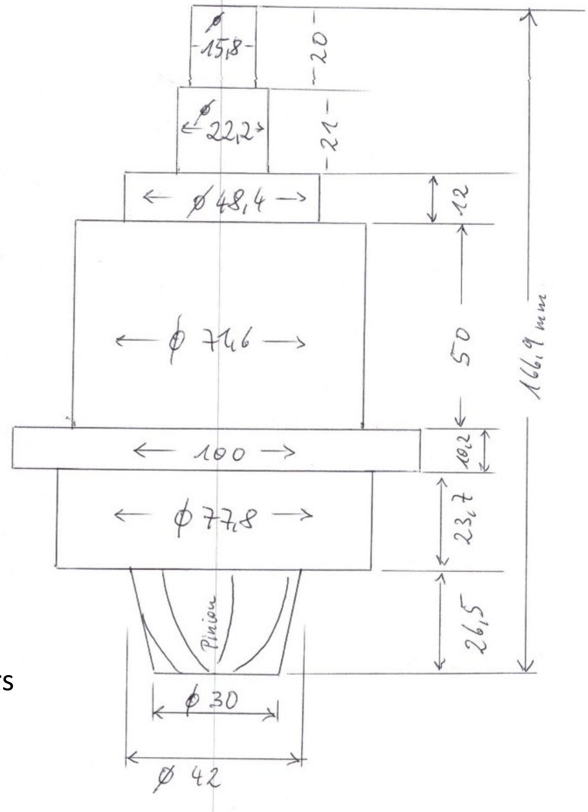
Teeth 7

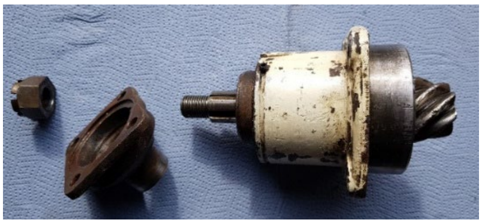
No printed on the body: 460



Top Screw, Distance washers

Simmering





Pinion:
Central hole D = 4,7 mm
Central ring D = 16.4 mm
Pinion D = ~ 30 mm out, in ~ 41.9 mm

Screw top	D = 15.7 mm, length 20, 16 G/inch
Simmering:	BA 30 – 45 – 8 , Cortego 9
Distance waschers:	on pinion shaft 12 pieces, total thickness 12,8 mm, Din =22,2, Dout = 33,8
Bearings:	outside to drive shaft: Din 22,2 mm, Dout = 55,5 mm inside to Pinion-Diff: Din = ? Dout = 64 +/- 1 mm, SKEFKO 8 England EFB

The Pinion rotates smoothly, no wobble or backlash

The teeth are slightly worn, but in better condition than those of the Crown Wheel

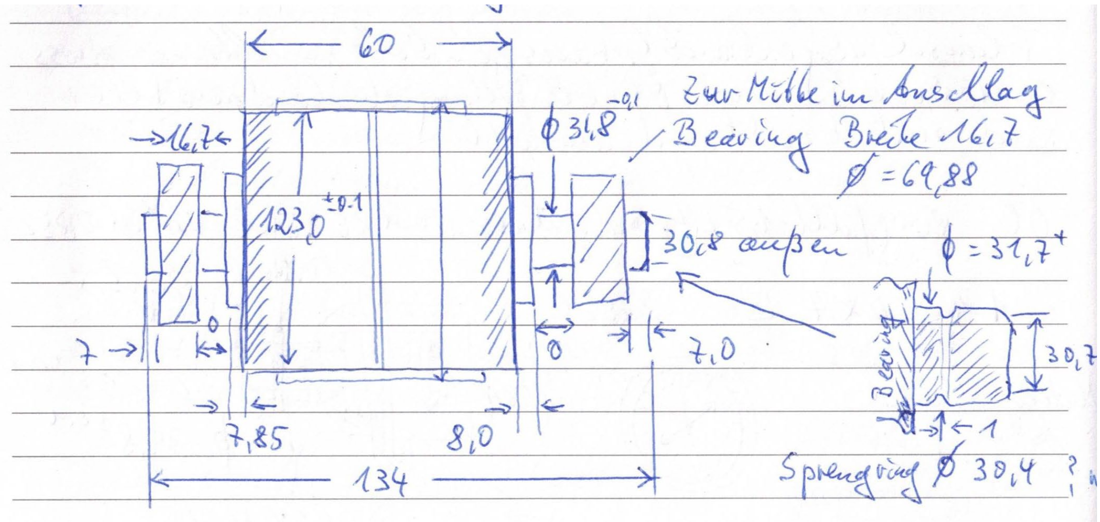
The ring nut with Simmering opened via applying heat near 600°C

B) Repair Differential & Pinion

Crown Wheel, Pinion shaft and bearings for the Diff were ordered at Hardwick Spares and fit well.

Differential Planet Gear & Crown Wheel

The drawing shows the individual diameter and thickness. New ball bearings where implemented identical to the old ones: LS12 Diameter Din = 31.6, Dout = 69.84 ordered at Hardwick Spares.

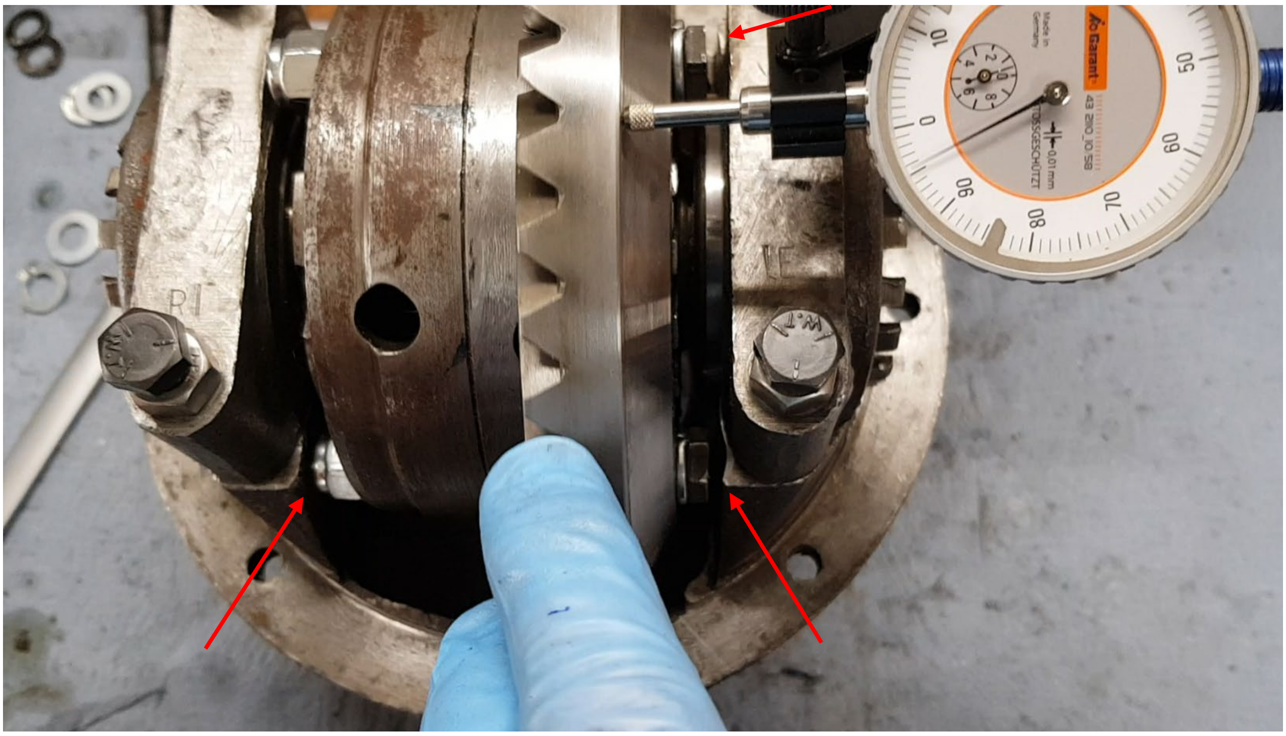


The annular adjusting rings (castellated rings bottom center figure) are used to adjust the backlash between CW and Pinion (see text below). Typically these rings are of different thickness. In my case both rings were too thin for adjustment and I had to buy spacer washers with diameter Dout = 68, Din = 55 t = 0.5 which press to the outer ring of the bearing. For adjustment I had to select 6 washers at least. These are placed at the left or right side of the bearings (not shown in the above, bottom left figure).

To hold bearings and annular adjusting rings the housing is split in two parts each side (fig. bottom center, right). The two bottom parts are carrying the bearings. The two top parts can be removed to release the annular adjusting rings. Two long screws (BSW or UNC 3/8 " 16 threads /inch). In my case these screws were not parallel resulting in tilting the top part of the housing and clamping the annular rings. So, I changed the thicker stud bolts against thinner screws to win 0.5 mm. Additionally for assembly and smooth adjustment mount all parts before these screws are tightened. At the end fix the screw to lock the annular rings (Fig. bottom right bottom).

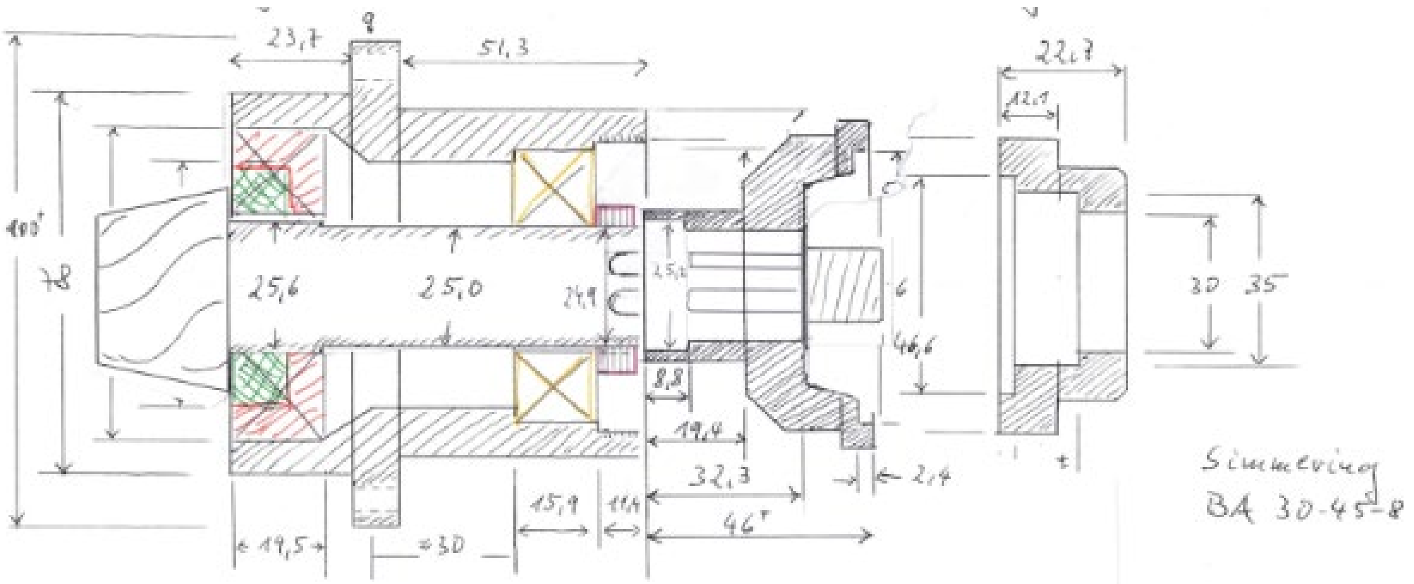
The Crown Wheel was fixed with 3 screws BSF 3/8 x 3.5" and self locking nuts (Fig. below). There is extremely small space of 3.5 mm on each side between screw and body which is needed for later alignment of the Pinion. So the heads of the screws have been thinned by filing. At the end I also skiped the washer to win 1.5 more mm. Alternatively you might exchange thick self locking nuts against standard (thinner) nuts ti gain some mor millimetres but you should glue the nuts with *LocTite* blue which allows removal when applying heat (200 – 300 degree Celsius).

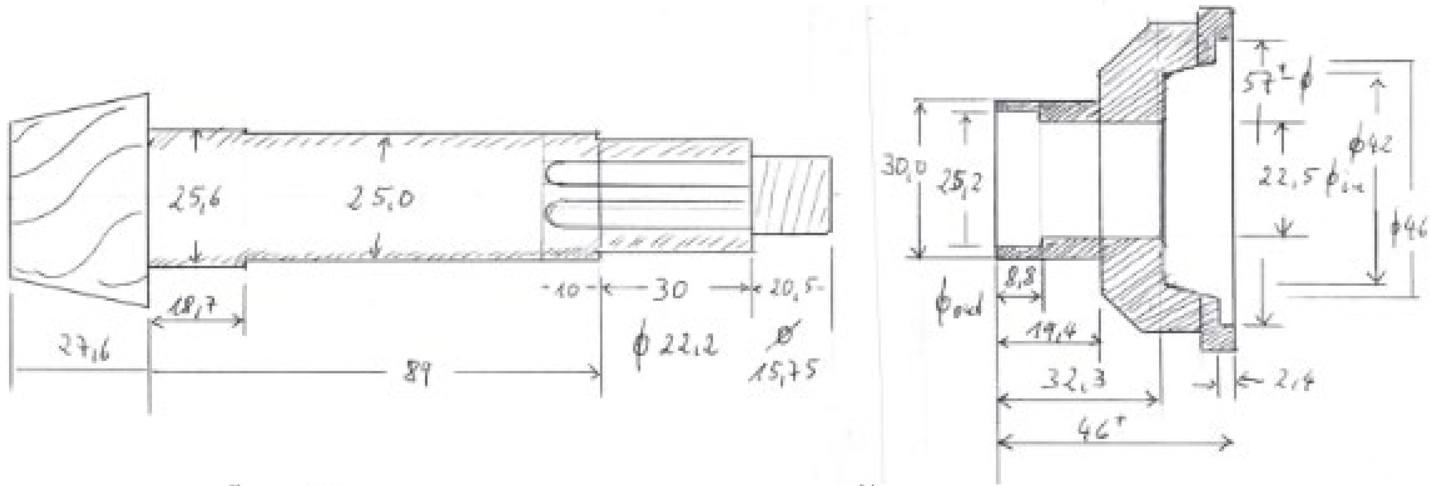
When tighten the screw you are producing a tilt of the CW with respect to the axis of rotation. You must monitored and aligned with a dial gauge. Additionally for a perfect alignment of 90 degree between CW and rotation axis I placed micrometer foil (some pieces of 50 µm and 100 µm, size some cm, stainless steel) between CW and the planet gear where the CW is screwed on. This compensates the tilt. I stopped alignment procedure when I received a wobbling of the CW by +/- 50 µm monitored with the dial upon rotation of the CW.

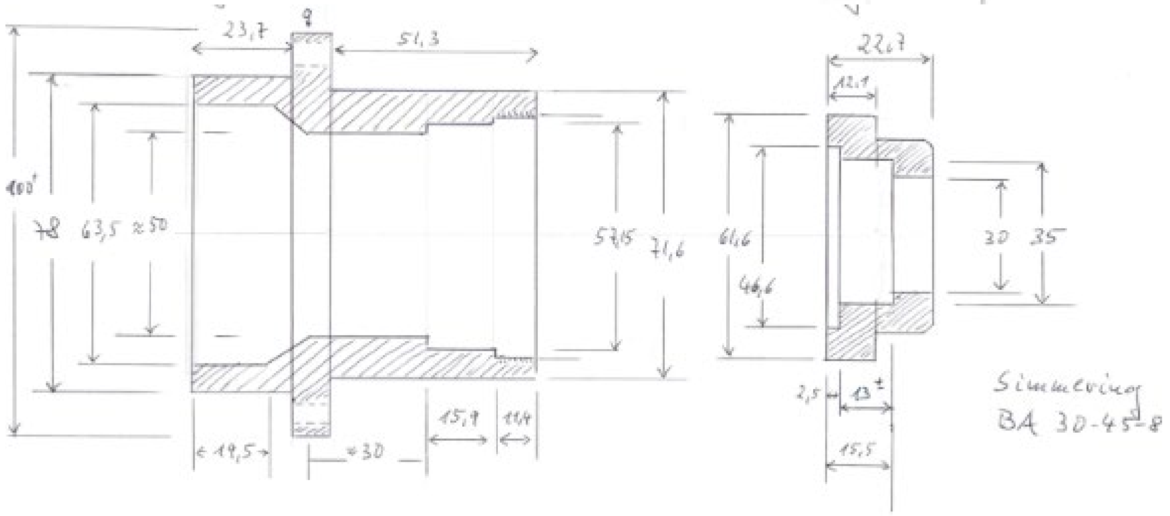


Repair Pinion

Now we are coming to the most challenging part – my pinion housing which differs from the typical Singer LM. So I show drawings with values for those who might face same problems like me (hopefully not). However, the new pinion shaft I ordered at Hardwick Spares exactly fits to the housing with respect to the length so that CW and Pinion match perfectly at the end. However, the shaft diameter varies slightly and must be adapted using the central ball bearing with appropriate diameter.



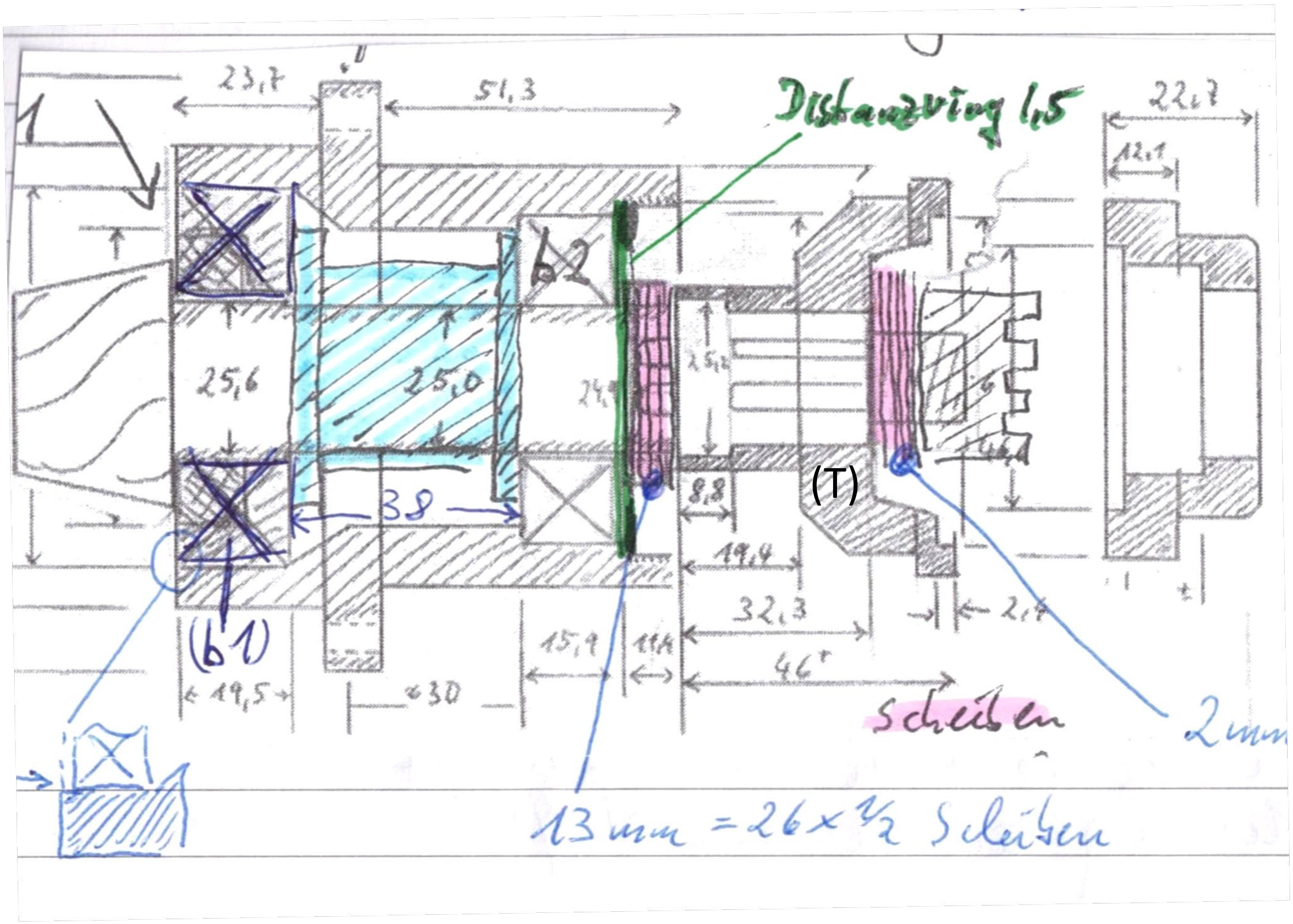




The Pinion housing (Fig. above bottom) has to be modified to accept the right ball bearing with slightly large diameter compared to the old ball bearing using a lathe.

Most important is the implementation of a spacer tube between the two ball bearing (not shown in the above figures but in the fig. below in blue). The job is to reduce the huge forces between bearing (b1) and (b2) (Fig. below) when driving and to avoid damage of the bearings.

The distance tube (spacer) length is 38.0, diameter Din = 25.0, Dout = 38.0 (Fig. below, blue)



Bearing (b1)	RMS8 from SKF	Dout = 63.5, Din = 24.4, t = 19.05 Basic dynamic load rating 22.5 kN Deep Grove Ball bearing!
Bearing (b2)	NTC 62/28/25 C3	Dout = 57.87, Din = 24.994, T = 16.0 Basic dynamic load 19.8 kN
Simmering	QAS-30 x 45 x 8	double lips

Forces

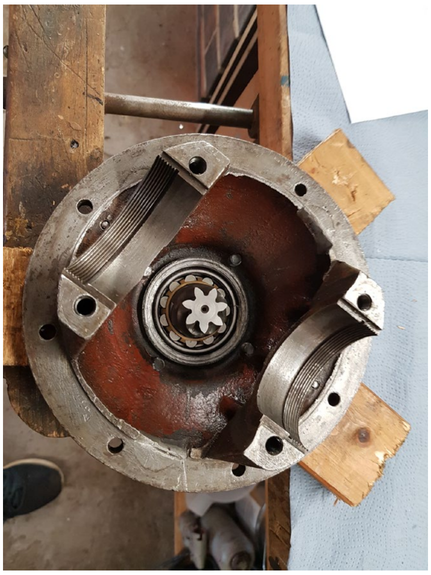
I calculated the forces acting on the pinion shaft. If starting to drive the car with acceleration of 0 – 100 km/h in 20 seconds with gear ratio 39/7 I find 1.9 kN which is a factor of 10 lower than provided by this ball bearing (sufficient dynamic load rating needed as back up additionally to the spacer).

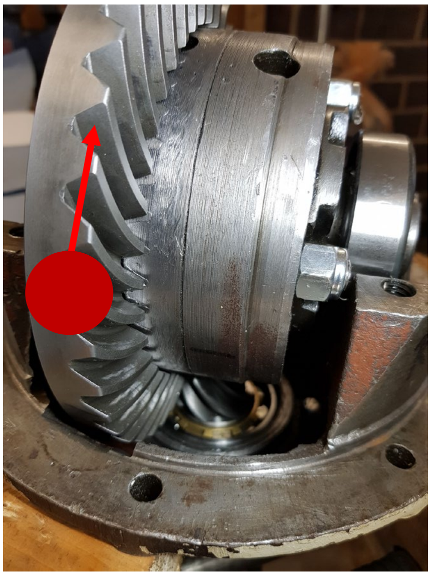
We need distance washers (Fig. above, pink) to fix the pinion shaft in the housing. Additionally a special washer (above figure, green) was produced via Laser cutting. The job is to produce contact between the pinion housing and pinion shaft via part (T) fixed via the castellated nut. This green washer has to be produced because we had to work with a larger ball bearing (b2).

In the centre 13 mm washer distance and on the right, close to the castellated nut, 2mm are used. A precise washer thickness avoids a longitudinal backlash of the pinion shaft and maintains the distance between pinion head and crown wheel when driving (see below).

Alignment Crown Wheel – Pinion

The pinion housing is mounted to the differential housing first. The pinion head extends into the diff-housing (Fig below, left). Then the Crown wheel is placed (Fig. below, right) so that both wheels fit. Then the housing (seat) is mounted (Fig. page 12, 13).





The alignment of backlash between Pinion and Crown Wheel is done as follows: hold the pinion shaft tight and avoid its rotation. Install a dial gauge (see p 13 but rotate by 90 degree as sketched in the Fig. above, red arrow) at the outer diameter of the crown wheel. It must measure the travel distance of a CW tooth when rotating the CW until it is stopped by the pinion. This backlash should be between 100 µm and 150 µm as I learned from Roly Alcock. The backlash is tuned by moving the CW along its rotation axis, i.e. in the Fig. above horizontally. Therefor the annular adjusting rings (not shown) have to be aligned and if necessary washers have to be implemented. I set the backlash to 150 µm and with this value the differential was working without noise at least when the car was running.

To check the matching between teeth of pinion and teeth of crown wheel I tried with *Mechanics blue* (I used white) (Fig. above, right, white spots) but it is not helpful because the thickness of paint influences the contact more than the alignment of CW and pinion. Fortunately the metallic surfaces of both, pinion and CW teeth were completely new so that the traces of “first” metal contact could directly be seen (grey in Fig right). The matching was perfect according the pattern found in the literature (not shown here).

Repair Rear Axle: Wheel bearing

The old half shaft was too thin in diameter by 0.25 mm so that the bearing was not fix on the half shaft and leads to the wobble of the wheel. We had to increase the half shaft diameter at the bearing position. Therefor we decided to wrap two layers of micrometer foil (0.2 mm thick, stain-less steel) which was laser welded on the half shaft. Laser welding set about 200 welding points so that the half shaft diameter increased. Then the needed smaller diameter to fit the ball bearing was produced on a lathe. Laser welding avoids thermal stress and bending of the half shaft!

Following bearings where applied:

Ball bearing	MJ1 – 1/8, from NKE Diameter Din = 28.55, Dout = 71.4
Sealing	Simmering, double lip, Din = 41.27, Dout = 60.32, thick = 7.93

Now the car is running with the help of many friends!