B. Removal and Installation of Left or Right Torque Arm at Axle Tube and Replacement of Rubber Mounting

Removal:

29. Tap up the locking plate (37) and unscrew the hexagon screw (38) Fig. 35 — 4/8).

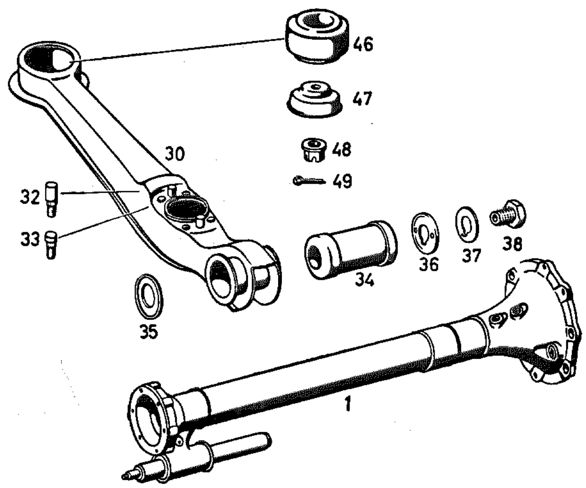


Fig. 35 — 4/8

1 Axle tube
2 Supporting tube
30 Left torque arm
32 Cheese-head screw
33 Cheese-head screw
34 Rubber mounting (rear)
35 Tightening washer (wheel side)
36 Tightening washer (screw side)
37 Locking plate
38 Hexagon screw
46 Rubber mounting (front)
47 Cup
48 Castle nut
49 Cotter pin 3×25

30. Use Puller 120 589 05 33 to pull off the torque arm (Fig. 35 — 4/9) and take off the tightening washers (36) and (35) (Fig. 35 — 4/8).

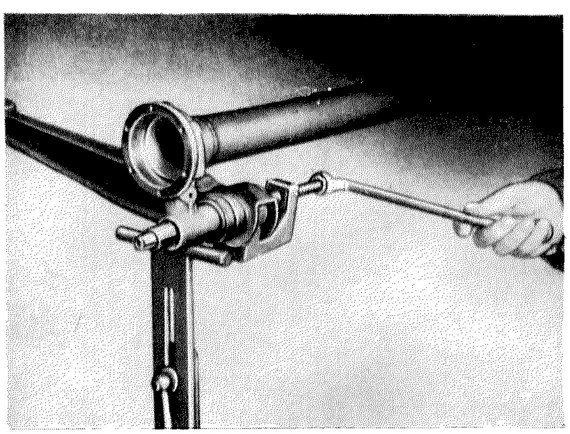


Fig. 35 — 4/9

Checking:

31. Check the torque arm for cracks. If cracks are discovered on a torque arm, it must be replaced.

Replacement of Rubber Mounting:

32. Apply talc around the circumference of the rubber mounting (34) and press it out with the aid of a drift.

33. Apply talc around the circumference of the new rubber mounting (34) and also to the bore in the torque arm (30) and press the mounting into the torque arm (30).

Installation:

34. Slide the tightening washer (35) (wheel side) onto the supporting tube (2). Then press the torque arm (30) onto the supporting tube (2) of the axle tube (1) in such a way that the front edge of the torque arm is approximately on a level with the center line of the joint flange (Fig. 35 — 4/10).

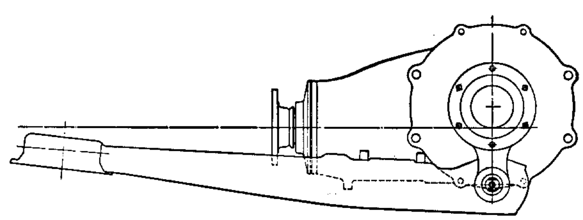


Fig. 35 — 4/10

35. Push the tension disk (36) and a new locking plate (37) onto the supporting tube (2), screw in the hexagon screw (38), tighten it up and lock it by tapping over the locking plate (37) (see Fig. 35 — 4/8).

C. Removal and Installation of Right Axle Tube

Removal:

36. Remove the right rear axle shaft (see Paras. 1—6).

Note: The right axle tube can only be removed or installed with the rear axle removed from the vehicle.
If the right axle tube is only being removed in order to replace the rubber cuff, the rear axle shaft does not need to be removed.

The left axle tube is at the same time the cover for the rear axle housing. Consequently, the outer race of the left taper roller bearing for the differential housing, together with threaded ring for adjustment of the bearing, is fitted at the inner side of the axle tube. Removal of the left axle tube is described in Section "D. Disassembly and Reassembly of Rear Axle Housing".

37. Remove the hexagon nut (16) from the splined bolt (14) (see Fig. 35—4/12) and tap out the splined bolt (Fig. 35—4/11).

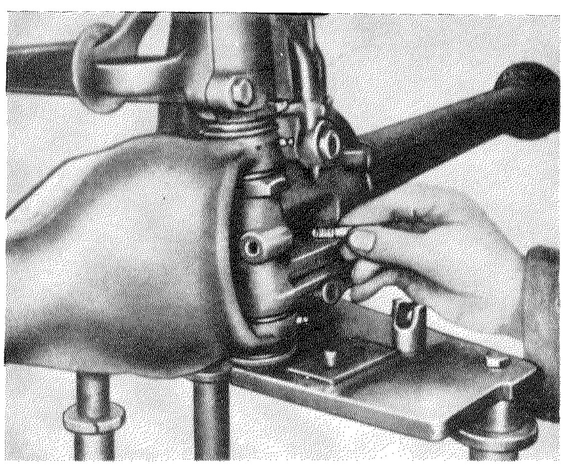


Fig. 35—4/11

38. After removing the hose strap and the hose clamp, release the rubber cuff at the rear axle housing and pull it off the rear axle housing.

39. After bending up the locking plate (2), remove the hexagon screw (1) of the connecting pin (7). Now screw Assembly Arbor 180 589 08 39 into the connecting pin and drive out the connecting pin toward the rear. Then remove the connecting pin from the assembly arbor. Pull the assembly arbor out toward the front again, at the same time removing the support (6), paying attention to the washer 10 a, the backing washer 8 a and the rubber ring 9 a (Fig. 35—4/12).

Take the right axle tube off the rear axle housing, paying attention to compensating washers 13 a and 13 b and rubber rings 9 b and 9 c.

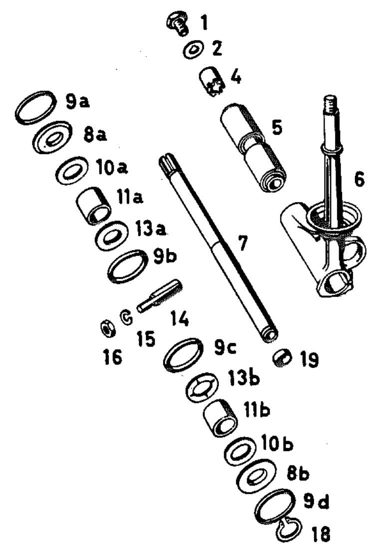


Fig. 35—4/12

1 Hexagon screw	10a, 10b Washers
2 Locking plate	11a, 11b Sleeves
4 Spacer sleeve	13a, 13b Compensating washers
5 Buffer block	14 Splined bolt
6 Support	15 Lock washer
7 Connecting pin	16 Hexagon nut
8a, 8b Backing washers	18 Circlip
9a, 9b, 9c, 9d Rubber rings	19 End plug

40. Press the seal (2) out of the axle tube (1) with a screwdriver (Fig. 35—4/13).

41. After slackening the hose clamp, take off the rubber cuff.

42. Check and, if necessary, repair the axle tube, the connecting pin, and the support for the rear axle (see Job No. 35—5).

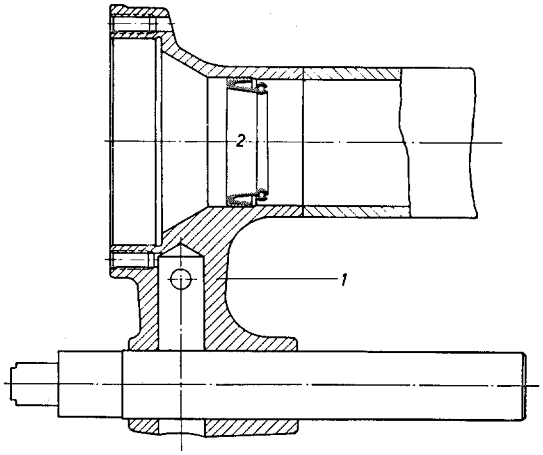


Fig. 35—4/13

1 Axle tube
2 Seal

Installation:

43. Press or drive a new seal into the axle tube as far as the shoulder, using Installing Arbor (Fig. 35—4/14 and Fig. 4/14 a).

44. Push the rubber cuff onto the axle tube. The large bead of the eccentric cuff must be at the top (see Fig. 35—4/15).

45. Push the two rubber rings (9 b) and (9 c) onto the eyes of the axle tube (Fig. 35—4/14 and Fig. 35—4/14 a).

46. Fit the axle tube onto the rear axle housing. To do this, hold the axle tube against the rear axle housing and immobilize it with Assembly Arbor 180 589 08 39. When the assembly arbor is pushed in, the compensating washers (13 a) and (13 b) between the yoke of the axle tube and the rear axle housing must be inserted at the same time (Fig. 35—4/14 a).

Caution: Do not use ordinary steel washers but only the specified compensating washers made of special bronze ("Kuprodur") with lubricating grooves. The lubricating grooves of the two compensating washers must point toward the axle tube eyes.

47. Measure the end play between the axle tube and the rear axle housing.
The play must not exceed 0.1 mm.
For adjusting the play, compensating washers 13 a and 13 b are available in a range of 1.9—2.5 mm, in steps of 0.1 mm. If possible, compensating washers of the same thickness should be used on both sides (Fig. 35—4/14 a).

The play must be strictly maintained. If there is not enough play there is a tendency for the compensating washers to bind and / or to score.

The axle tubes must be easy to move. If, for instance, as a result of scoring or binding compensating washers, they are difficult to move, rumbling noises may be caused in the rear axle.

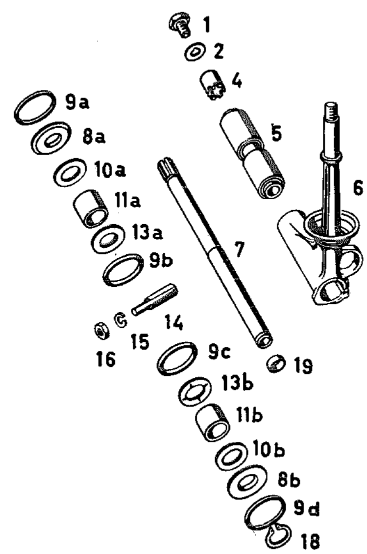


Fig. 35—4/14

1 Hexagon screw
2 Locking plate
4 Spacer sleeve
5 Buffer block
6 Support
7 Connecting pin
8a, 8b Backing washers
9a, 9b, 9c, 9d Rubber rings
10a, 10b Washers
11a, 11b Sleeves
13a, 13b Compensating washers
14 Splined bolt
15 Lock washer
16 Hexagon nut
18 Circlip
19 End plug

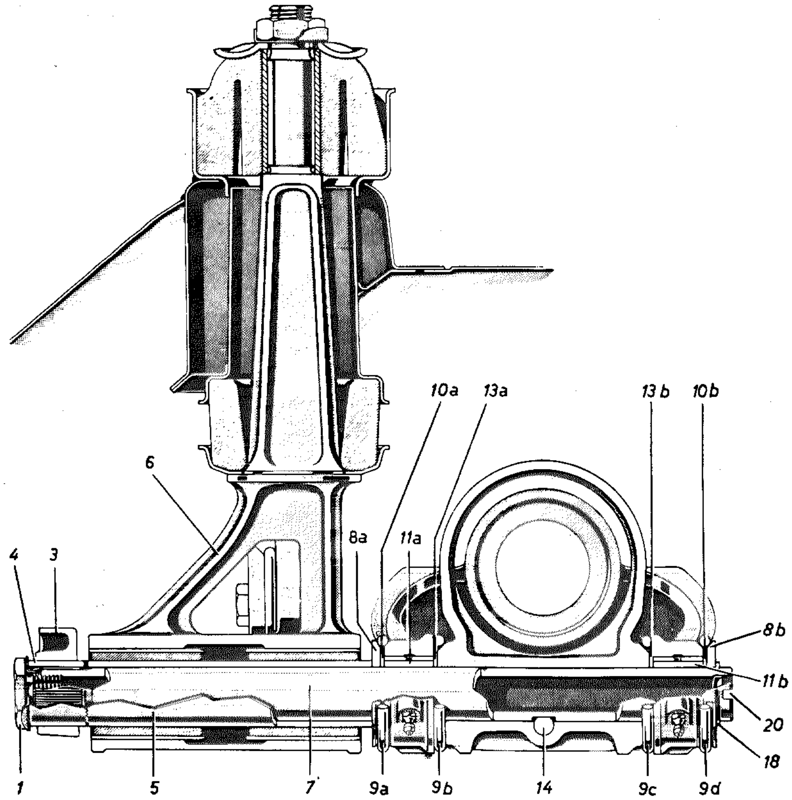


Fig. 35 — 4/14 a

1 Hexagon screw
3 Cover
4 Spacer sleeve
5 Buffer block
6 Support
7 Connecting pin
8a, 8b Backing washers
9a, 9b, 9c, 9d Rubber rings
10a, 10b Washers
11a, 11b Sleeves
13a, 13b Compensating washers
14 Splined bolt
18 Circlip
20 Groove

48. Press or drive the sleeve (11 b) onto the connecting pin (7). Push the washer (10 b) and the backing washer (8 b) onto the connecting pin in such a way that the beveled face points away from the circlip groove.

    Then put in the circlip (18) (see Fig. 35—4/14).

49. Grease the connecting pin and push it through from the rear in such a way that the face for the splined bolt points downward.

    Press out the assembly bolt with the connecting pin and push in the two rubber rings 9 b and 9 c over the shoulder of the axle tube eyes.

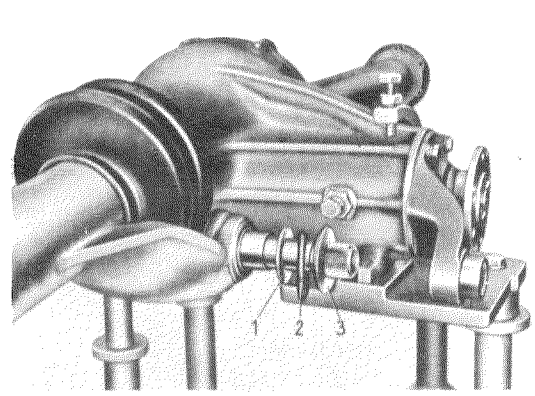


Fig. 35 — 4/15

1 Washer (10a)
2 Rubber ring (9a) } in Fig. 35—4/14a
3 Backing washer (8a)

50. Push the sleeve, the washer (1), the rubber ring (2) and the backing washer (3) onto the connecting pin (see Fig. 35 — 4/15).

Caution: The beveled face of the backing washer (3) must point toward the rear in the direction of the axle tube.

51. Push the rubber cuff onto the rear axle housing and connect it to the rear axle housing and the axle tube with the hose strap and the hose clamp.

52. Slide the support for the rear axle suspension, together with the fitted — but not yet tightened — buffer block, into position and drive through the connecting pin toward the front.

When the buffer block is being **installed** in the support, care must be taken to ensure that the end of the sleeve which projects 6 mm, points toward the rear (Fig. 35—4/16).

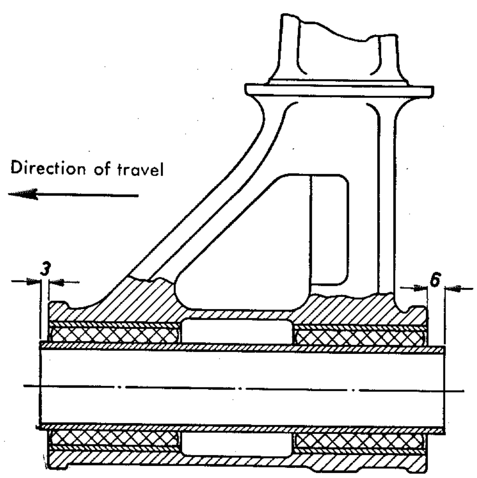


Fig. 35—4/16

53. Turn the connecting pin to the point where the groove (20) is exactly horizontal (see Fig. 35—4/14 a).

Note: This is necessary in order to allow the splined bolt to be installed properly (Fig. 35—4/17).

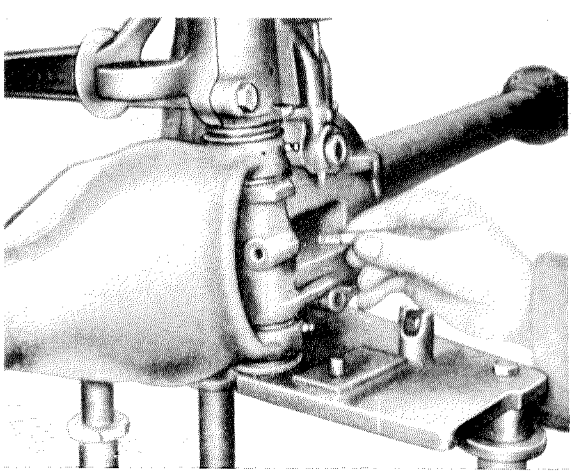


Fig. 35—4/17

54. Drive the splined spacer sleeve (4) toward the rear onto the connecting pin and into the cover (3) and put on the locking plate. Screw on the hexagon screw (1) and tighten up with a tightening torque of 10—12 mkg and then slacken it again (see Fig. 35—4/14 a).

55. Drive in the splined bolt (14), put on the hexagon nut (16) with lock washer (15) and tighten up (see Fig. 35—4/14). Put on the rear rubber ring (9 d) between the backing washer (8 b) and the axle tube eye (see Fig. 35—4/14 a).

56. Re-tighten the hexagon screw (1) with a torque of 10—12 mkg. Then lock the hexagon screw by tapping the locking plate over (see Fig. 35—4/14 a).

57. Adjust the distance between the face of the joint flange and the front edge of the cup (1) which is welded to the support for the rear axle suspension, using Adjusting and Checking Device 180 589 04 23 (Fig. 35—4/19).

Note: The distance between the face of the joint flange and the axis of the support for the rear axle suspension should be 131 ± 1 mm (Fig. 35—4/18).

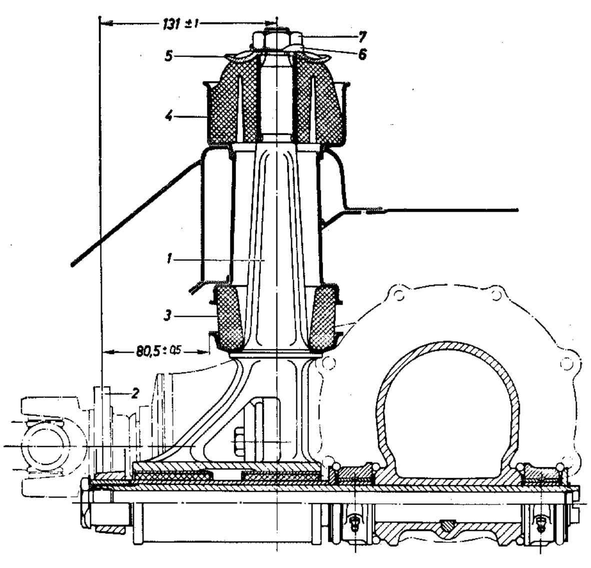


Fig. 35—4/18

1 Support
2 Joint flange
3 Lower rubber ring
4 Upper rubber ring
5 Tightening washer
6 Locking plate
7 Hexagon nut

Since this distance is difficult to measure in practice, the adjusting and checking device is held against the joint flange (2) and the front edge of the cup (1) (Fig. 35—4/19).

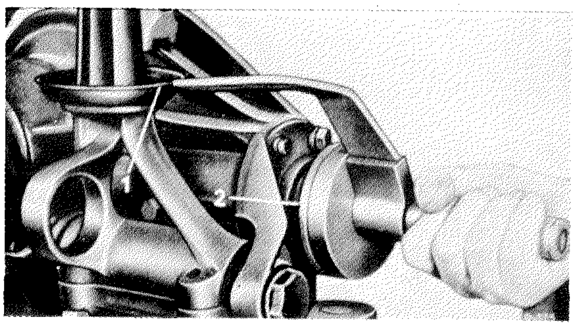


Fig. 35—4/19

1 Cup
2 Joint flange

This distance should be 80.5 ± 0.5 mm. The more recent version of the adjusting and checking device has been altered to this dimension. The older versions are 23 mm longer because on the earlier rear axle suspension the cup (1) was not welded on and therefore measurements could be taken with the adjusting and checking device as far as the mounting of the cup on the support. This dimension is 103.5 ± 0.5 mm. If the older version of the adjusting and checking device is still used, it must be shortened by 23 mm to the measuring dimension of 80.5 mm.

This distance can be corrected by moving the support on the buffer block, after loosening the two clamping screws of the support.

58. Check the angle between the support and the left axle tube. The support for the rear axle suspension must form a right angle with the left axle tube, seen in the direction of travel.

    If this is not the case, the support should be turned into the correct position after slackening the two clamping screws (see Fig. 35—1/7). When this is done, the support must not be displaced in the axial direction.

    Then tighten up the two clamping screws of the support.

59. Install the right rear axle shaft (see Paras. 19 to 27).

D. Removal, Installation and Adjustment of Gear Train

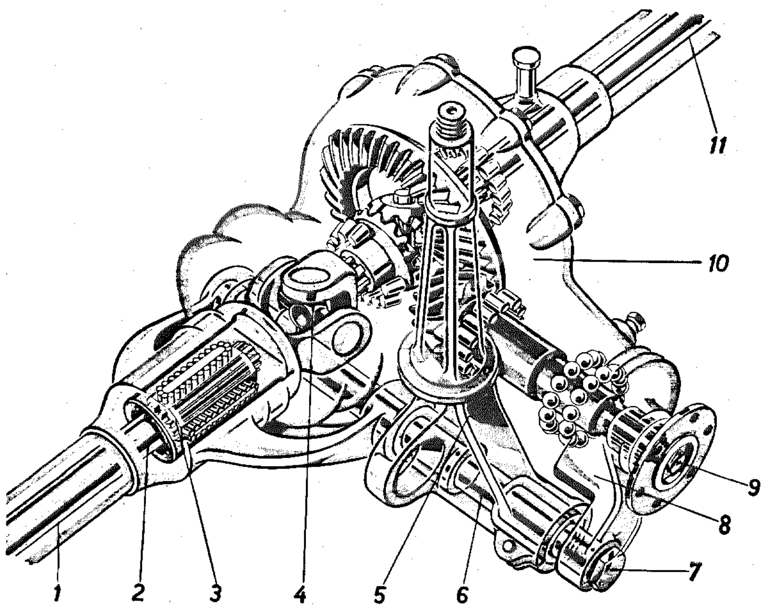


Fig. 35 — 4/20

1 Right axle tube
2 Right rear axle shaft
3 Sliding sleeve
4 Slip coupling with universal joint spider
5 Support for rear axle suspension
6 Connecting pin
7 Hexagon screw for connecting pin
8 Cover with eye for connecting pin
9 Drive pinion shaft
10 Rear axle housing
11 Left axle tube

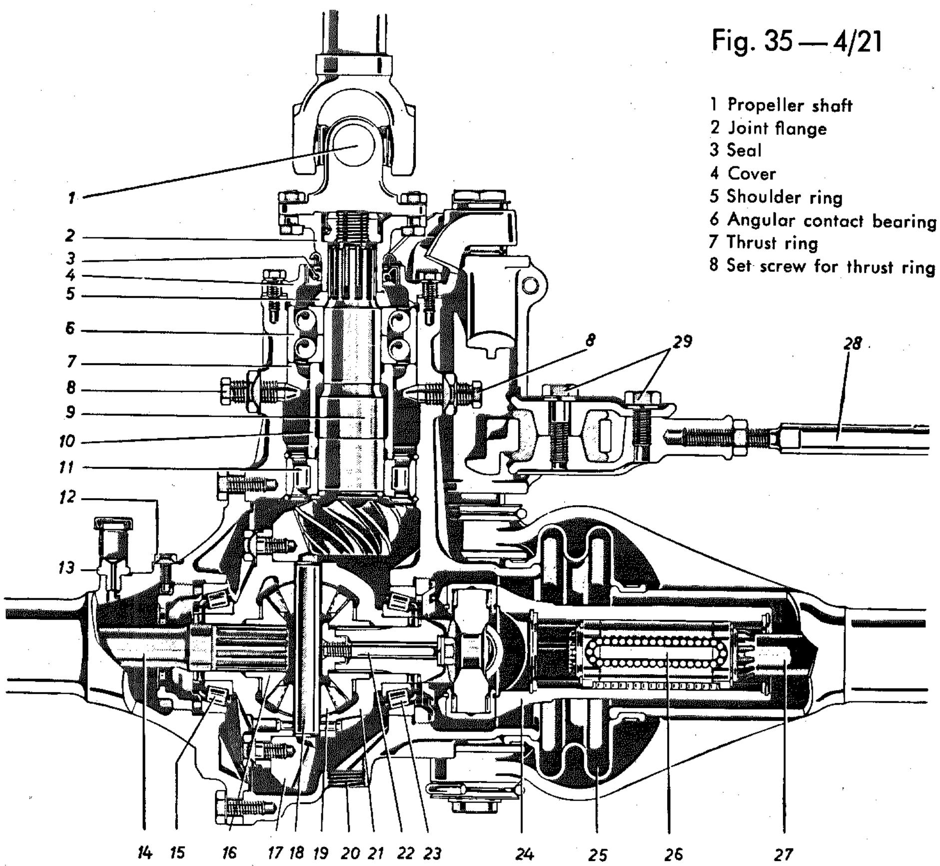


Fig. 35 — 4/21

1 Propeller shaft
2 Joint flange
3 Seal
4 Cover
5 Shoulder ring
6 Angular contact bearing
7 Thrust ring
8 Set screw for thrust ring
9 Drive pinion shaft
10 Spacer sleeve
11 Cylindrical roller bearing
12 Lock screw for threaded ring
13 Bleed screw for left axle tube
14 Left rear axle shaft
15 Taper roller bearing
16 Differential side gear, left
17 Ring gear
18 Differential pinion shaft
19 Differential pinion gear
20 Oil filler plug
21 Differential housing
22 Clamping screw
23 Taper roller bearing
24 Slip coupling
25 Rubber cuff
26 Sliding sleeve
27 Right rear axle shaft
28 Cross strut with link
29 Fixing screw for cross strut

Disassembly:

60. Remove the right rear axle shaft (see Paras. 1—6).

61. Remove the right axle tube (see Paras. 35—42).

62. Hold the left rear axle shaft and the flange of the drive pinion shaft, in order to loosen the clamping screw (22). Then unscrew the clamping screw (22) which fixes the slip coupling (24) to the right differential side gear and take out the slip coupling with compensating washer (Figs. 35—4/21 and 35—4/22).

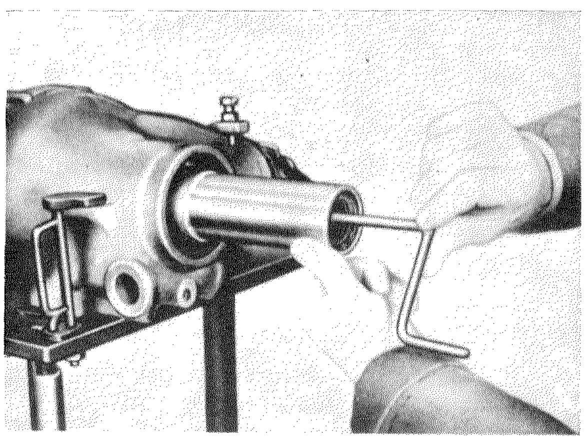


Fig. 35—4/22

63. Remove the left rear axle shaft (see Paras. 1—6). Then unscrew the left axle tube from the rear axle housing and take out the differential housing with ring gear.

64. Press the seal (2) out of the left axle tube with a screwdriver (Fig. 35—4/23).

    Unscrew the bleed screw (13) and the lock screw (12) for the threaded ring (see Fig. 35—4/21).

    Use Pin Wrench 180 589 02 07 on the threaded ring to press out the outer race of the taper roller bearing (15) (see Fig. 35—4/21).

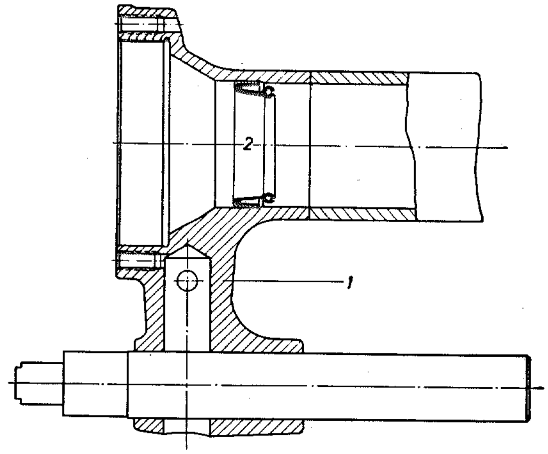


Fig. 35—4/23

1 Axle tube
2 Seal

65. Set up the rear axle housing on the assembly stand for the rear axle:

Note: The assembly stand for rear axle housings (according to Drawing BE 9891 a) with Assembly Plate BE 11 175 a, can be made in the workshop with the drawing as a guide. If necessary, the rear axle housing can also be disassembled on a shop bench.

66. Unlock the two set screws (8) for the thrust ring of the angular contact bearing and back out the two screws.

    Unscrew the hexagon screws at the cover (4) of the rear axle housing. Then pull out the drive pinion shaft (9), together with the joint flange (2), the cover (4), the seal (3), the angular contact bearing (6), the spacer sleeve (10) and the cylindrical roller bearing (11) (see Fig. 35—4/21).

67. After tapping up the locking plate (4), unscrew the two hexagon screws for the lock (3) of the threaded ring in the rear axle housing and screw out the threaded ring (2) (Fig. 35—4/24). Use Pin Wrench 180 589 00 07 for the threaded ring. Then press out the outer race of the taper roller bearing toward the inside (Fig. 35—4/24).

68. Remove the two snap rings (15) for the outer race of the cylindrical roller bearing (2) and drive out the race with Assembly Arbor 120 589 00 39 (see Fig. 35—4/26).

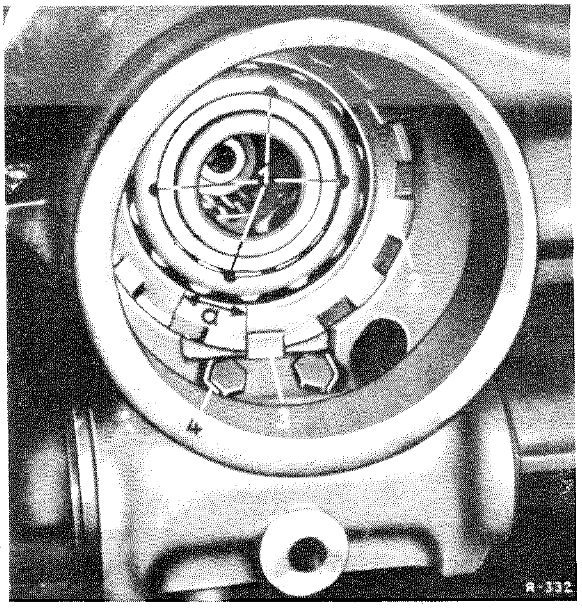


Fig. 35—4/24

1 The 4 recesses in the roller cage for Special Pin Wrench 180 589 14 07
2 Threaded ring
3 Lock
4 Locking plate
a = one notch

Reassembly:

69. Insert the snap ring (2) in the rear axle housing. Make sure that it is properly positioned in the annular groove!

    The hook of the snap ring must rest in the cast groove in the housing (Fig. 35—4/25).

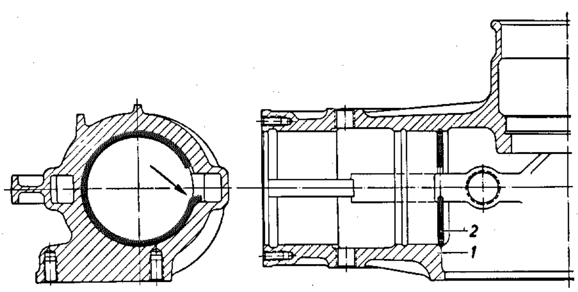


Fig. 35—4/25

1 Rear axle housing
2 Snap ring

70. Press in the outer race of the cylindrical roller bearing (2) with Assembly Arbor 120 589 00 39 and insert the front snap ring (15). Make sure it is properly positioned in the annular groove! (Fig. 35—4/26).

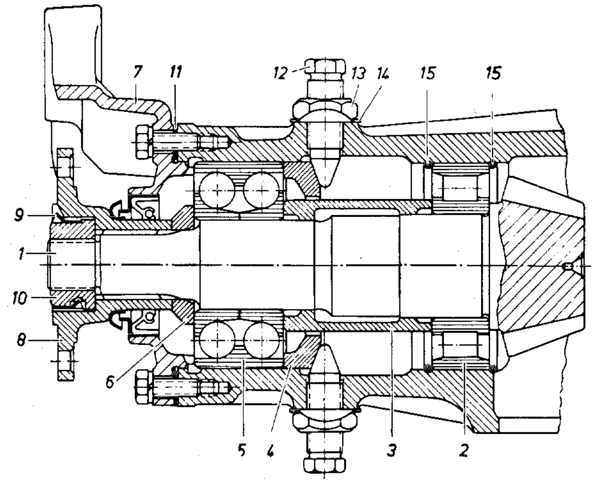


Fig. 35—4/26

1 Drive pinion shaft
2 Cylindrical roller bearing
3 Spacer sleeve
4 Thrust ring
5 Angular contact bearing
6 Shoulder ring
7 Cover with pressed-in seal
8 Joint flange
9 Lock
10 Grooved nut
11 Shim
12 Set screw for thrust ring
13 Hexagon nut
14 Locking plate
15 Snap ring

71. Screw the two set screws (12) about halfway in so that when the fitted drive pinion shaft is slid into the rear axle housing, the thrust ring (4) butts against the set screws (12).

72. Place a shim (11) (no specified thickness) on the cover (7) of the rear axle housing and slide the drive pinion shaft, which is fitted ready for installation, into the rear axle housing.

    Screw up the cover (7). Screw in the two set screws (12), a few turns at a time at each screw, until they lie firmly against the thrust ring (4) (Fig. 35—4/26).

    The tightening torque for the two set screws is 2.5 mkg.

73. Screw the right threaded ring three threads into the rear axle housing. Then use Assembly Arbor 180 589 00 39 to press in the outer race of the taper roller bearing (23) until it lies against the threaded ring (see Fig. 35—4/21).

Adjustment of Pinion Drive:

74. When a new gear train is being installed in the rear axle housing, the specified distances between the individual gears and the

specified amount of backlash must be obtained by adjustment. The installation dimensions are stamped on the rear face of the ring gear, the first figures indicating the clearances between the gears and the second figures indicating the amount of backlash required (Fig. 35 — 4/27).

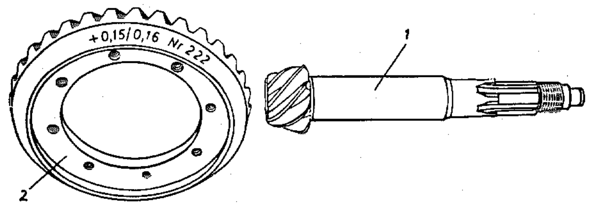


Fig. 35 — 4/27

1 Drive pinion shaft
2 Ring gear

Clearance dimension	=	+0.15 mm
Backlash	=	0.16 mm
Gear train		No. 122

The two dimensions given ensure optimum meshing and operation of the gear train.

75. In order to set the front edge of the drive pinion and the center line of the ring gear to the exact clearance, place the measuring disk (4) (108.00 mm diameter) on Adjusting Device (1) 180 589 01 23 and set it to zero. To do this, screw the adjusting screw (3) of the device either in or out, to the point where the measuring disk (4) can just be turned to and fro with ease. Then lock the adjusting screw with the lock nut (2). No light gap must be visible between the two surfaces (Fig. 35 — 4/28).

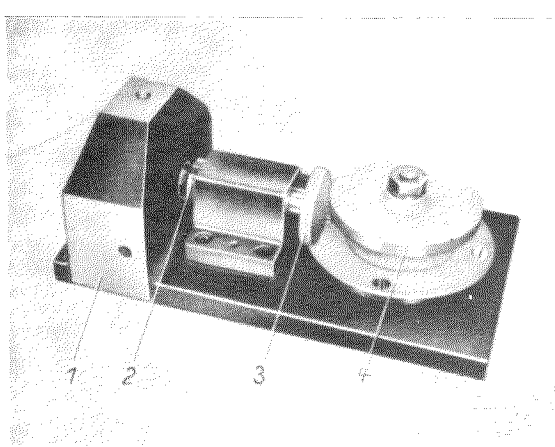


Fig. 35 — 4/28

1 Adjusting Device 180 589 01 23
2 Lock nut
3 Adjusting screw
4 Measuring disk

76. Now replace the measuring disk by the strap (5) with Dial Gage Holder 180 589 00 23 and a Dial Gage 000 589 14 21 and place in Adjusting Device 180 589 01 23. Clamp the dial gage in position under an initial tension of 1 mm. By turning the dial gage holder to and fro, establish the highest point of the face of the adjusting screw and set the dial gage to zero by moving the scale (Fig. 35 — 4/29).

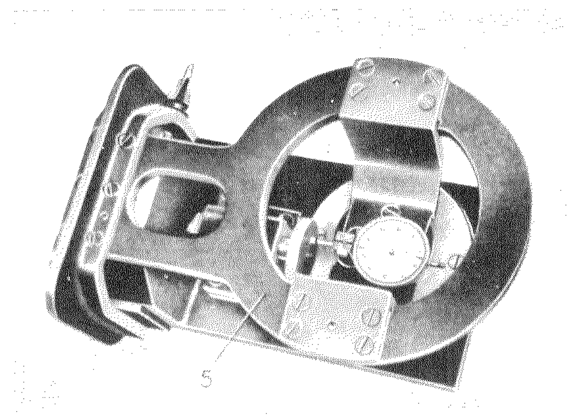


Fig. 35 — 4/29

Strap 180 589 00 23

77. Put the strap with dial gage holder and the dial gage in the rear axle housing (Fig. 35 — 4/30).

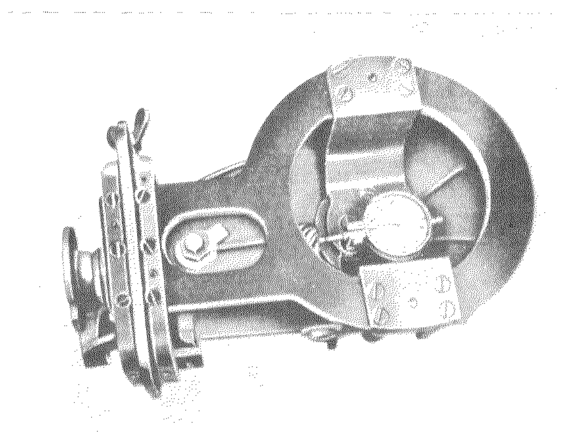


Fig. 35 — 4/30

Note: Recently the adjusting tools described in Paras. 75 — 77, i. e. the

Adjusting Device	180 589 01 23
with Measuring Disk	108 mm diameter
and Strap with Dial Gage Holder	180 589 00 23

have been replaced by the following adjusting tools:

Adjusting Device	136 589 02 23
Strap	180 589 05 23
and Measuring disk	108 mm diameter 180 589 06 23.

If Adjusting Device 136 589 02 23 for adjusting the twin-jointed rear axle is already available, it does not need to be re-ordered (Fig. 35 — 4/28 a).

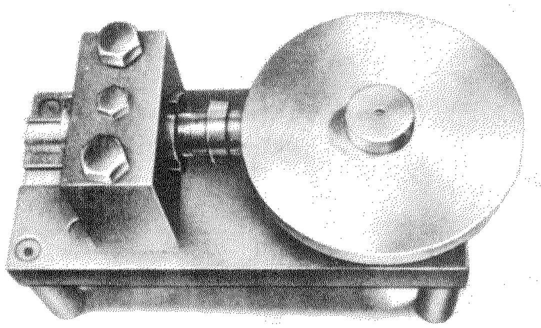


Fig. 35 — 4/28 a

Adjusting Device 136 589 02 23
Measuring Disk 180 589 06 23 108 mm diameter

Adjustment with these tools is done in the same way as described above but with the difference that when the dial gage is adjusted, the strap does not need to be bolted to Adjusting Device 136 589 02 23 (Fig. 35 — 4/29 a).

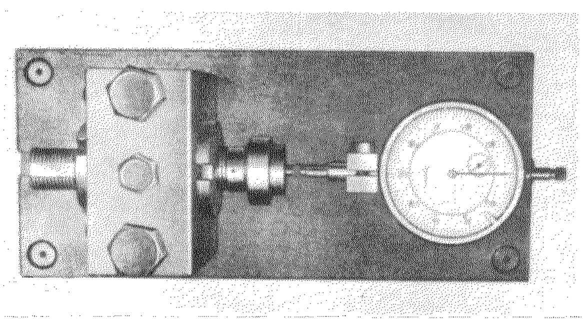


Fig. 35 — 4/29 a

Adjusting Device 136 589 02 23
and dial gage

After the dial gage has been adjusted, the dial gage is placed in the Strap 180 589 05 23 and then the strap, together with the dial gage, is put into the rear axle housing.

78. Adjust to the specified clearance between drive pinion shaft and ring gear (the clearance specified by the works and stamped on the ring gear) by selecting an appropriate compensating washer (11) for insertion between the rear axle housing and the cover (7) (see Fig. 35 — 4/26).

When the dial gage is read off, the original initial tension of 1 mm must be taken into account!

Example 1:

Clearance stamped on ring gear: +0.15 mm (see Fig. 35 — 4/27).

In accordance with the initial tension of 1 mm, the dial gage must show 1.15 mm after the adjustment. (For the + measurement, the pointer of the dial turns in a clockwise direction.)

Example 2:

Clearance stamped on ring gear:
— 0.15 mm.

In accordance with the initial tension of 1 mm, the dial gage must show 0.85 mm after the adjustment. (For the measurement, the pointer of the dial turns in an anticlockwise direction).

For setting to the clearance required, compensating washers are available in a range from 1.0 to 2.0 mm, in steps of 0.1 mm. Compensating washers 2.05 mm thick are also available.

If necessary, a compensating washer should be ground to the appropriate thickness.

The tolerance for this setting is 0 to 0.02 mm.

79. Screw the threaded ring right home into the left axle tube (see Fig. 35 — 4/31). Then press in the outer race of the taper roller bearing, using Assembly Arbor 180 589 04 39.

80. Put the differential housing (21) into the rear axle housing and screw the left axle tube to the rear axle housing (see Fig. 35 — 4/21).

81. Use Pin Wrench 180 589 02 07 to tighten the threaded ring in the left axle tube to the point where there is no further play between the drive pinion and the ring gear. Then turn the threaded ring back 2—3 notches.

Note: The notches (1) of the threaded ring are visible through the bore for the locking screw (Fig. 35 — 4/31).

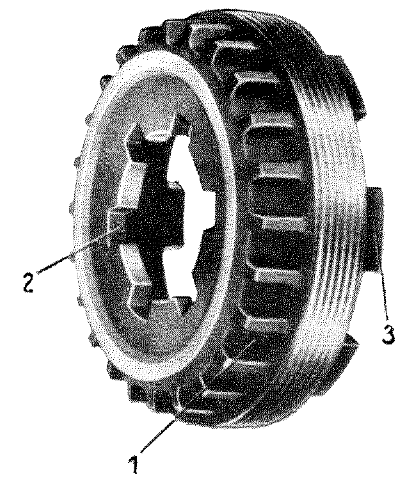


Fig. 35 — 4/31

1 Notches for the locking screw
2 Spaces for Pin Wrench 180 589 02 07
3 Contact surface for outer race of bearing

Pin Wrench 180 589 02 07 can only be inserted in the axle tube **before** the seal has been put in the axle tube.

82. Use a torque wrench and Pin Wrench 180 589 00 07 to tighten the right threaded ring in the rear axle housing to 4.0 mkg.

83. Mount Measuring Gage 180 589 01 21 for measuring the blacklash (Fig. 35 — 4/32).

84. Fix the stop bracket (1) to the rear axle housing.

85. Insert the holder (2) with dial gage in the bore of the differential housing and clamp it in position.

86. Adjust the holder in such a way that the feeler of the dial gage points to the diameter of 176 mm marked on the stop bracket (1).

Note: This is necessary because the backlash reading is in respect of a diameter of 176 mm.

87. Clamp the drive pinion shaft to the joint flange with a screw (3) (see Fig. 35 — 4/32).

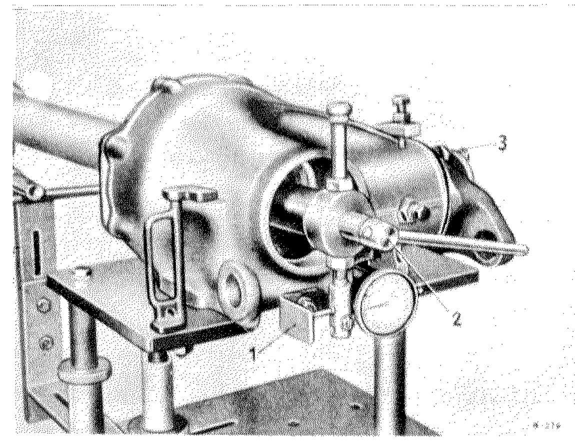


Fig. 35 — 4/32

1 Stop bracket
2 Holder with dial gage
3 Screw

88. Now make the adjustment by screwing the two threaded rings in or out as required until the backlash indicated on the ring gear is obtained. For the left threaded ring, use Pin Wrench 180 589 02 07, and for the right threaded ring, Pin Wrench 180 589 00 07.

    Measurements should be taken at four points on the circumference of the ring gear. The true measurement is the one obtained where the play is smallest.

89. Remove the measuring gage after the adjustment of the backlash has been made.

90. **In order to check the accuracy of the adjustment, it is absolutely necessary to take a wear pattern impression on the flanks of the teeth.**

Note: If the adjusting device for the gear train is not available, the adjustment must be made by means of the wear pattern impression alone. But adjusting by means of the wear pattern impression requires considerable expert knowledge and great experience.

91. In order to take the wear pattern impression, remove the left axle tube again and take out the differential housing.

92. Apply a layer of oil-diluted blue dye to both sides of about 5 of the ring gear teeth. Put the differential housing in position once more and screw on the left axle tube again.

93. Use a crank to turn the joint flange and when turning, brake the ring gear at the same time. Once more remove the differential housing, check the wear pattern impression and if necessary, correct the adjustment.

The following diagrams show the wear pattern impressions for correct and incorrect meshing.

Wear Pattern Impressions on Ring Gear under Load

(Ring gear braked)

Correct meshing

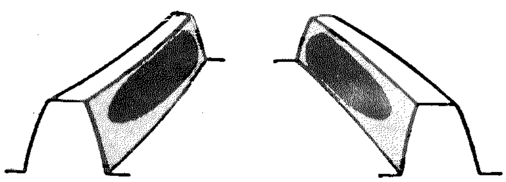


Fig. 35—4/33

As a rule, such an ideal wear pattern impression will not be obtained in practice. It is, however, important to ensure that the outer edge of the tooth flank is not touched at any point.

Contact at addendum (incorrect)

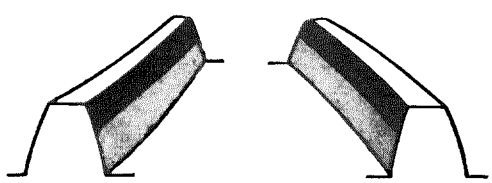


Fig. 35—4/34

Remedy:

Decrease the fitting clearance of the drive pinion and at the same time increase the fitting clearance of the ring gear in order to obtain the correct amount of blacklash.

Contact at dedendum (incorrect)

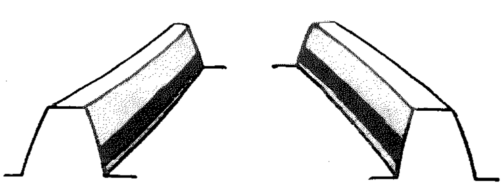


Fig. 35—4/35

Remedy:

Increase the fitting clearance of the drive pinion and at the same time decrease the fitting clearance of the ring gear in order to obtain the correct amount of backlash.

If in spite of the gear train being correctly adjusted, it is impossible to obtain a satisfactory wear pattern impression, the fault must lie in the rear axle housing or in the left axle tube.

In this case, the parts in question must be replaced.

94. After adjusting the pinion drive, loosen the drive pinion shaft (1), pull the drive pinion shaft out a little, apply sealing compound to the compensating washer (11) and slide the drive pinion shaft (1) finally into the rear axle housing and tighten up the cover (7) (Fig. 35—4/36).

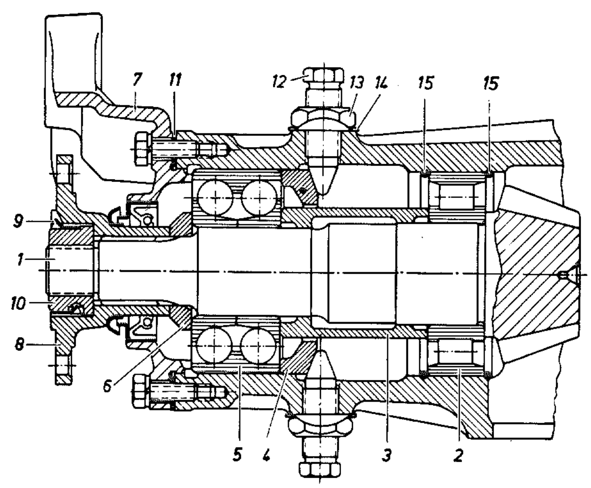


Fig. 35—4/36

1 Drive pinion shaft
2 Cylindrical roller bearing
3 Spacer sleeve
4 Thrust ring
5 Angular contact bearing
6 Shoulder ring
7 Cover with pressed-in seal
8 Joint flange
9 Lock
10 Grooved nut
11 Compensating shim
12 Set screw for thrust ring
13 Hexagon nut
14 Locking plate
15 Snap ring

95. Remove the set screws (12) once more and coat them with sealing compound. Push on new locking plates and again screw in the set screws, a few turns at a time on each one, and tighten to a torque of 2.5 mkg.

Lock the set screws (12) with the hexagon nuts (13) and tap over the locking plates (Fig. 34—4/36).

96. Remove the left axle tube once more and coat the sealing surface of the flange with sealing compound. Re-install the axle tube and tighten up.

97. In order to adjust the taper roller bearing properly, insert Special Pin Wrench 180 589 14 07 in the four recesses (1) in the roller cage of the right taper roller bearing (Fig. 35 — 4/37 and Fig. 35 — 4/38).

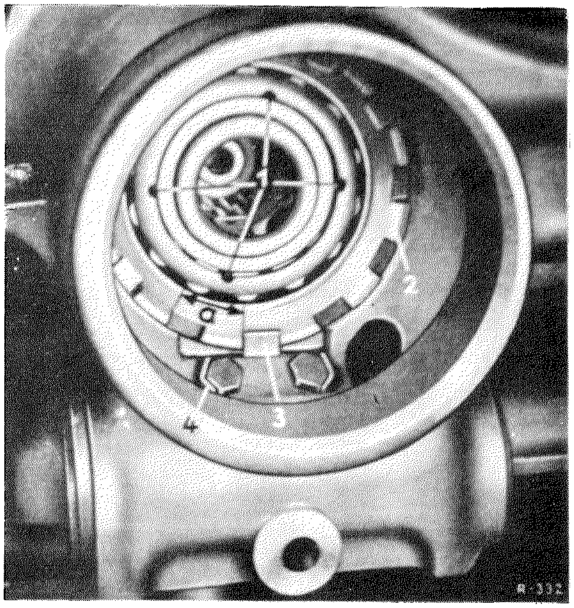


Fig. 35 — 4/37

1 The four recesses in the roller cage for Special Pin Wrench 180 589 14 07
2 Threaded ring
3 Lock
4 Locking plate
a = one notch

Then, with the aid of Special Pin Wrench ([1] in Fig. 35 — 4/38) 180 589 14 07, screw the threaded ring in or out as required until the roller cage can be turned with a torque of 50—80 cmkg.

98. For measuring this torque, put a torque wrench with a range of 0—160 cmkg on Special Pin Wrench 180 589 14 07 (Fig. 35 — 4/38).

Note: It is important that the drive pinion should be continuously turned while the adjustment is taking place and that the inner race should be given a tap or two so that the taper rollers can settle into place properly without any of them being tilted.

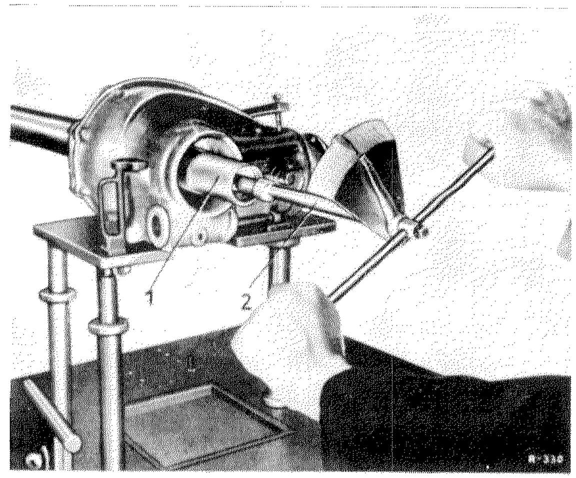


Fig. 35 — 4/38

1 Special Pin Wrench 180 589 14 07
2 Torque wrench 0—160 cmkg with ¼" square drive

The Special Pin Wrench 180 589 14 07 is made in the form of a combination wrench so that the threaded ring can be moved and the torque necessary to move the roller cage can be measured at the same time.

99. After the specified torque value has been obtained, tighten the threaded ring **¾ to 1 notch** (see Fig. 35 — 4/37).

Note: It should be noted that turning the threaded ring one notch corresponds to the lower torque value mentioned above. i. e., at a torque of 50 cmkg = 0.5 mkg the threaded ring must be turned one notch and at a torque of 80 cmkg = 0.8 mkg, it must be turned ¾ of a notch.

This degree of tightening corresponds to an axial movement of the threaded ring of 0.09 to 0.12 mm, the thread dimensions being M 90×1.5.

100. If a taper roller bearing with the four recesses in the cage is not available or if Special Pin Wrench 180 589 14 07 is not available, tighten the right threaded ring to a torque of 4.0 mkg, using Pin Wrench 180 589 00 07.

Note: This new method of adjusting the taper roller bearing must be applied with the utmost care in order to ensure the long life of the taper roller bearings.

This method of adjustment by tightening the right threaded ring to a torque of 4.0 mkg must only be used in emergencies.

101. Lock the right threaded ring with a lock wedge. Five types of this lock wedge are available, the offset of the nose being different in each.

Fix the lock wedge, together with a locking plate, with two hexagon screws and lock the hexagon screws by bending over the locking plate (4) (see Fig. 35 — 4/37).

102. Lock the left threaded ring by screwing in the lock screw (12) into the axle tube and tap over the locking plate (see Fig. 35 — 4/21).

103. Check the backlash again. A departure from the specified backlash of ± 0.02 mm is permissible. **If the backlash has to be corrected, the taper roller bearing must again be adjusted in accordance with paras. 97 to 102.**

Attach the slip coupling (24) with the clamping screw (22) to the right differential (21) (see Fig. 35 — 4/21 and Fig. 35 — 4/39).

104. When tightening up the clamping screw, put in the left rear axle shaft and hold the rear axle shaft and the joint flange steady.

Caution! Make sure that the correct compensating shim is used (see Job No. 35—4, Paras. 122—123).

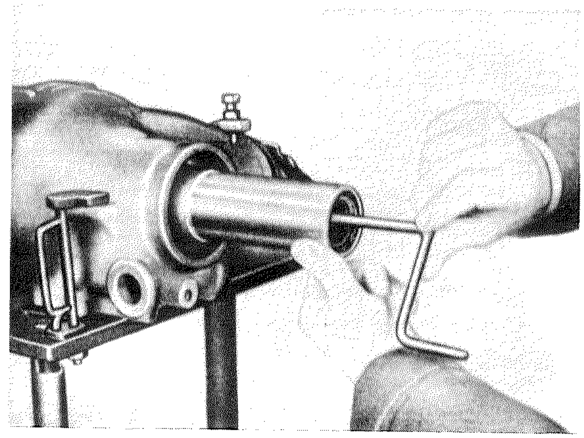


Fig. 35 — 4/39

105. Install the bleed screw (13) in the left axle tube (see Fig. 35 — 4/21). Use Installing Arbor 180 589 03 39 to press or drive a new seal into the axle tube as far as the collar (see Fig. 35 — 4/23).

106. Install the right axle tube (see Paras. 43—59).

107. Install the left and right rear axle shafts (see Paras. 19—26).

108. Put 2.25 liters of Hypoid Oil SAE 90 into the rear axle.

Disassembly:

109. Remove the gear train (see Paras. 60—68).

Differential:

110. Pull the two taper roller bearings off the differential housing with Puller 180 589 01 33 (Fig. 35 — 4/40).

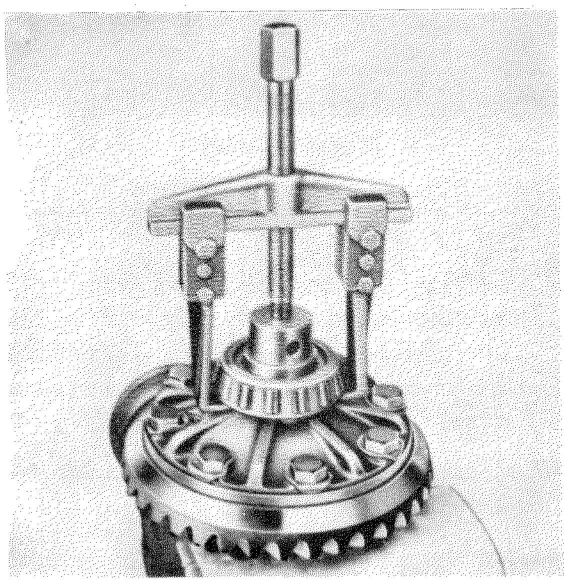


Fig. 35 — 4/40

111. If the ring gear or the differential housing has to be replaced, unlock the hexagon screws and unscrew them. Then press off the ring gear.

112. Counterbore the peened side of the locking pin for the differential pinion shaft with an 8 mm drill and drive out the locking pin (Fig. 35 — 4/41). Then press out the differential pinion shaft and take out the differential pinion gears, the differential side gears, the thrust washers and the dished washers.

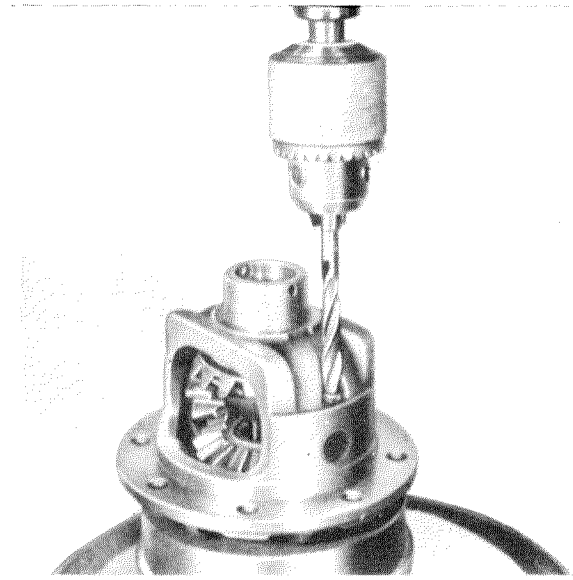


Fig. 35 — 4/41

Drive Pinion Shaft:

113. Fix Retaining Wrench 180 589 09 07 in the vise and put the drive pinion shaft with the joint flange on the retaining wrench (Fig. 35 — 4/42).

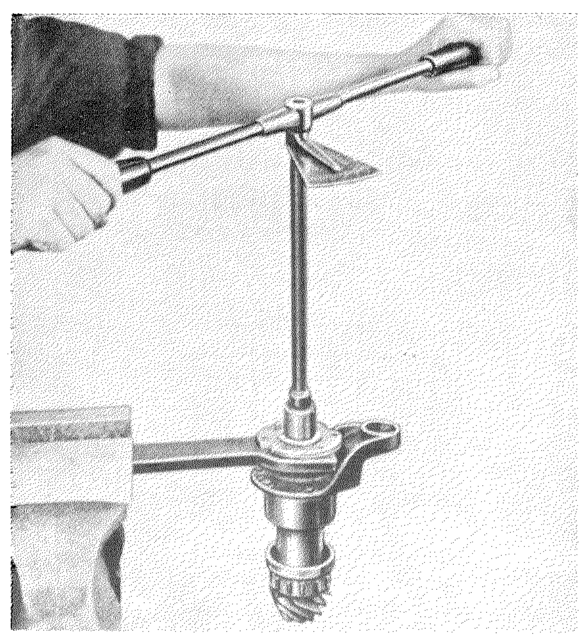


Fig. 35 — 4/42

114. Bend up the lock wedge and unscrew the grooved nut (8) for the joint flange (10), using Pin Wrench 120 589 01 07. Pull off the

joint flange, take off the cover (1) and the shoulder ring (2) (Fig. 35—4/43 and Fig. 35—4/42).

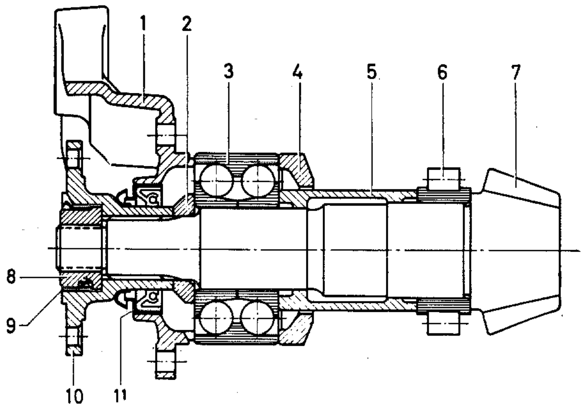


Fig. 35—4/43

1 Cover
2 Shoulder ring
3 Angular contact bearing
4 Thrust ring
5 Spacer sleeve
6 Cylindrical roller bearing
7 Drive pinion shaft
8 Grooved nut
9 Lock
10 Joint flange
11 Seal

115. Press the seal (11) out of the cover (1) (see Fig. 35—4/43).

116. Make in the workshop a jig in the form of a split-ring and a sleeve for pressing off the cylindrical roller bearing (Fig. 35—4/44).

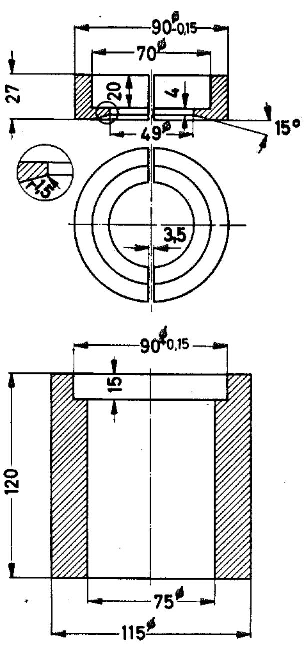


Fig. 35—4/44

Then mount the split-ring in such a way that the inner race of the cylindrical roller bearing is gripped and push the sleeve over the split-ring.

Use a suitable press to press the drive pinion shaft off the cylindrical roller bearing and at the same time off the angular contact bearing (Fig. 35—4/45).

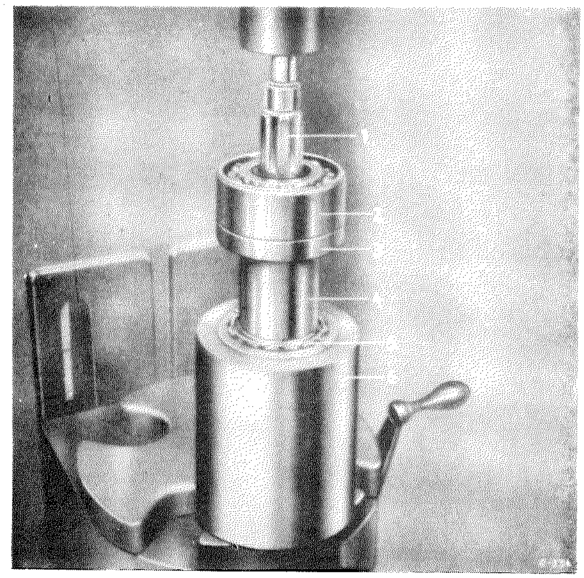


Fig. 35—4/45

1 Drive pinion shaft
2 Angular contact bearing
3 Thrust ring
4 Spacer sleeve
5 Cylindrical roller bearing
6 Auxiliary sleeve fixture

Caution! The angular contact bearing (2) must not be pressed or pulled off by itself since the bearing will not be gripped at the inner race and might be damaged as a result (see Fig. 35—4/45).

117. Check and repair the parts (see Job No. 35—5).

Reassembly:

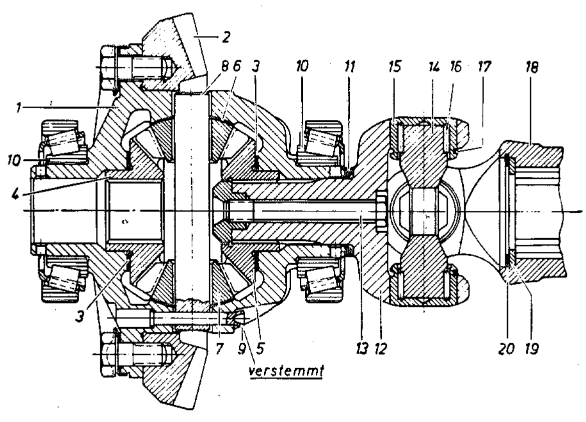


Fig. 35—4/46

1 Differential housing
2 Ring gear
3 Thrust washer
4 Left differential side gear
5 Right differential side gear
6 Dished washer
7 Differential pinion
8 Differential pinion shaft
9 Locking pin
10 Taper roller bearing
11 Compensating washer
12 Inner yoke
13 Clamping screw
14 Joint spider
15 Needle bearing bushing
16 Needles
17 Snap ring
18 Outer yoke
19 Washer
20 Lock washer

Differential:

118. Put the differential side gears (4) and (5) with the thrust washers (3) into the differential housing (Fig. 35—4/46).

Note: The differential side gear fitted with the slip coupling fixing nut is on the right side, seen in the direction of travel (Fig. 35—4/46).

119. Use Assembly Arbor 136 589 13 61 in place of the differential pinion shaft (8), to slide in the differential pinion gears (7) with the dished washers (6) (Fig. 35—4/47 and Fig. 35—4/48).

120. Check whether the differential side gears turn stiffly and without play. If this is not the case, install thicker thrust washers (3).

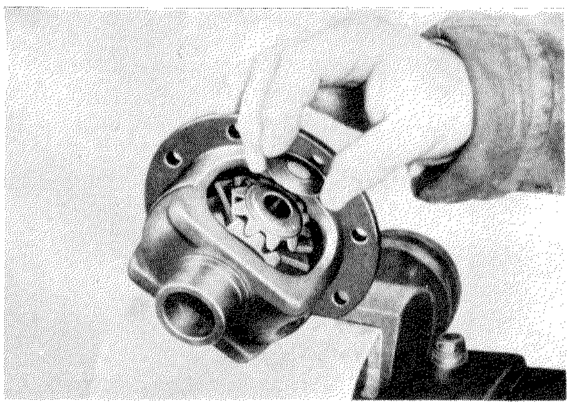


Fig. 35—4/47

The thrust washers are available in thicknesses ranging from 1.3 to 1.7 mm in steps of 0.1 mm.

Slide in the differential pinion shaft (8), install a new locking pin (9) and peen well with a punch at the drilled end (see Fig. 35—4/46).

121. Press the inner races of the taper roller bearings (10) onto the differential housing, using Assembly Arbor 180 589 01 39 (see Fig. 35—4/46).

122. Place a compensating washer (11) on the inner yoke (12) of the slip coupling — the beveled face toward the outer yoke (18) — and fix the yoke to the right differential side gear (5) by means of the clamping screw (13) (Fig. 35—46).

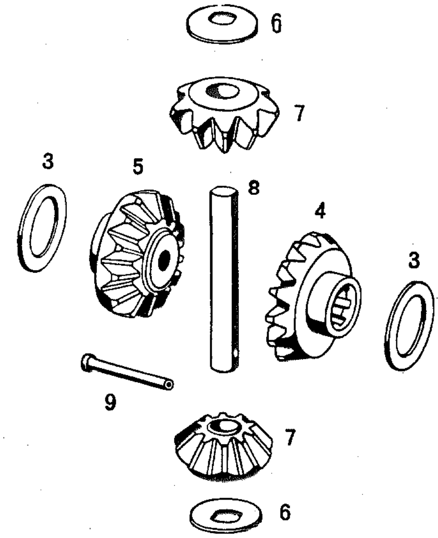


Fig. 35—4/48

3 Thrust washer
4 Left differential side gear
5 Right differential side gear
6 Dished washer
7 Differential pinion gear
8 Differential pinion shaft
9 Locking pin

123. Measure the play between the compensating washer and the differential housing. The play should be 0.05 to 0.10 mm. The correct play is obtained by selecting the appropriate thickness of compensating washer. Compensating washers are available ranging from 1 to 2 mm, in steps of 0.1 mm. After taking the measurement and selecting the correct compensating washer, unscrew the yoke (12) again.

124. If a new ring gear is to be fitted on the differential housing, the bore of the ring gear and the seat on the differential housing must be carefully cleaned.

Then heat the ring gear to approx. 60—70° C. and put it on the differential housing, using the two guide bolts (1) and (2) (Fig. 35—4/49).

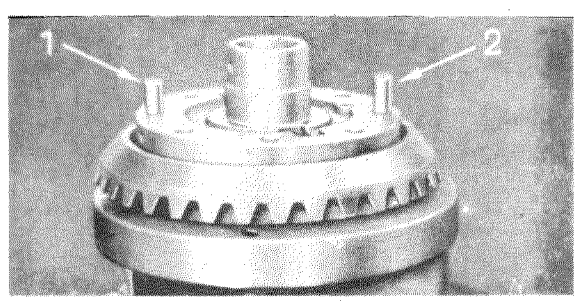


Fig. 35—4/49

Note: If the ring gear does not fall onto the differential housing of its own accord, it should be lightly tapped with a rubber hammer. Care must be taken to avoid chipping when this is done.

125. Tighten the fixing screws for the ring gear in the normal way and then give them a final tightening with a torque of 7—8 mkg (Fig. 35 — 4/50).

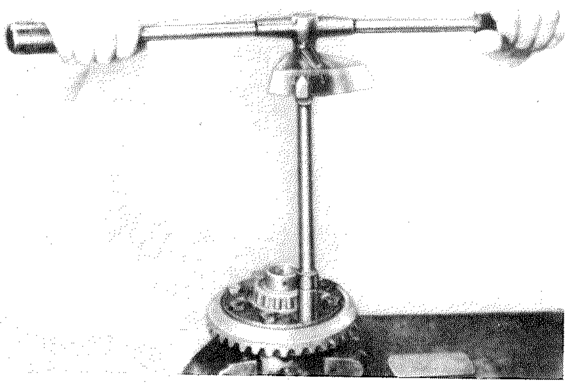


Fig. 35 — 4/50

Drive Pinion shaft:

126. Press the inner race of the cylindrical roller bearing (2) onto the drive pinion shaft (1), using a suitable sleeve. Then put on the spacer sleeve (4) and the thrust ring (3) and press on the angular contact bearing (5) (Fig. 35 — 4/51).

Only exert pressure on the inner race.

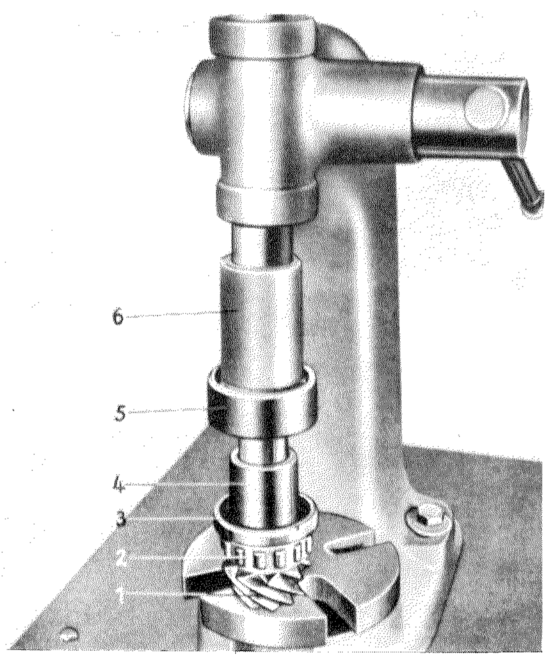


Fig. 35 — 4/51

1 Drive pinion
2 Cylindrical roller bearing
3 Thrust ring
4 Spacer sleeve
5 Angular contact bearing
6 Forcing sleeve

127. Press the seal into the cover (1) of the rear axle housing, having previously coated the sealing lip with grease. Push the shoulder ring (2) and the cover (1) onto the drive pinion shaft (7), having previously coated the splineway of the shaft with anti-friction bearing grease. Then press on the joint flange (10) (see Fig. 35 — 4/43).

128. Screw on the grooved nut together with the lock, using Pin Wrench 120 589 01 07. Place the fitted drive pinion shaft with the joint flange on Retaining Wrench 180 589 09 07 which is clamped in the vise and use Crowfoot Wrench Attachment 120 589 08 07 to tighten the grooved nut to a torque of 14—16 mkg (Fig. 35 — 4/52).

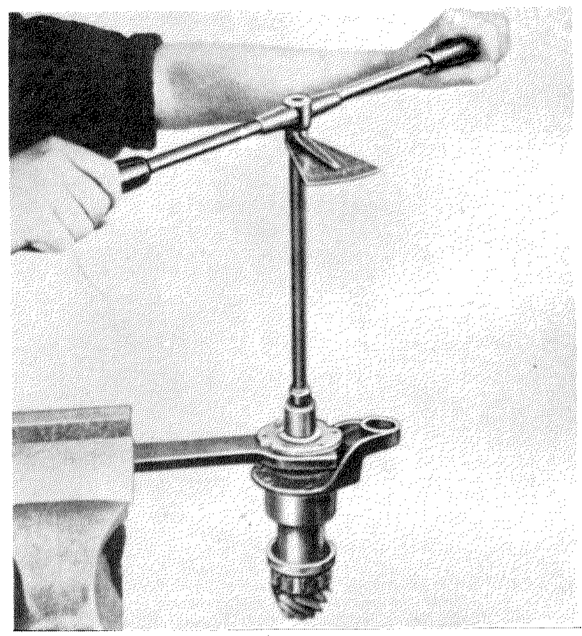


Fig. 35 — 4/52

129. Check the joint flange for lateral deflection. The run-out must not be more than 0.02 mm at the outer diameter.

Note: If the run-out is in excess of this, reposition the joint flange on the serrations and check again.

If no improvement is obtained, the joint flange must be re-turned (see Job No. 35—5, Section F, Para. 3).

130. Peen the locking plate in the groove of the joint flange and of the grooved nut.

131. Install the gear train (see Paras. 69—108).

F. Disassembly and Reassembly of Slip Coupling

Disassembly:

132. Remove the right axle tube together with the rear axle shaft (see Paras. 36 — 42).

133. Hold steady the left rear axle shaft and the flange of the pinion shaft to allow the clamping screw (13) to be loosened.

134. Then remove the clamping screw (13), which fixes the slip coupling to the right rear tube and take out the slip coupling with the compensating washer (Fig. 35 — 4/46 and Fig. 35 — 4/53).

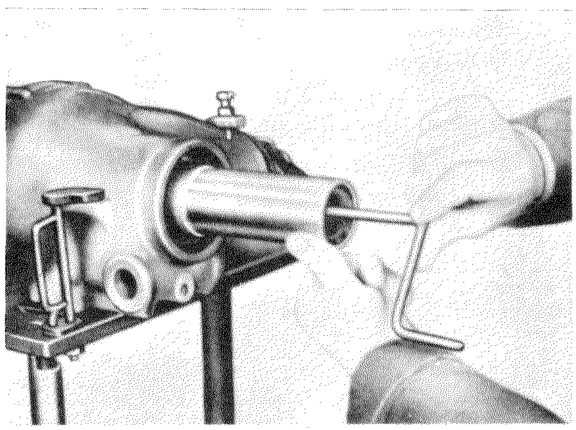


Fig. 35 — 4/53

135. Take the outer circlip (4) and the washer (6) off the outer yoke and carefully pull out the sliding sleeve (1). When this is done, pay attention to the cylindrical rollers (132 in number) (Fig. 35 — 4/54). If necessary, take off the inner circlip and the washer (6).

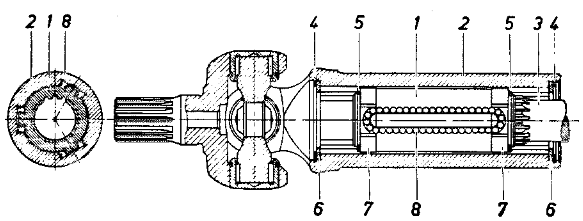


Fig. 35 — 4/54

1 Sliding sleeve
2 Outer yoke
3 Rear axle shaft
4 Circlip
5 Circlip
6 Washer
7 Guide ring
8 Cylindrical rollers

136. Take off the cylindrical rollers (8). Then take off the circlips (5) and pull off the two guide rings (7) by hand (see Fig. 35 — 4/54 and 35 — 4/57).

137. Take the snap rings off the joint spider (Fig. 35 — 4/55).

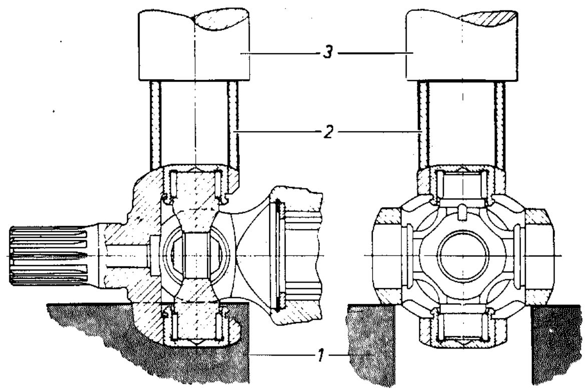


Fig. 35 — 4/55

1 Cradle
2 Sleeve
3 Press

138. Use a suitable sleeve (2) to press the yoke downward to the point where the needle bearing bushings can be taken off (Fig. 35 — 4/55 and Fig. 35 — 4/56).

Note: Make sure that the work is properly set up on a cradle in order to avoid any damage to the yokes.

(Pay attention to the needles; there are 100 needles in a complete set.)

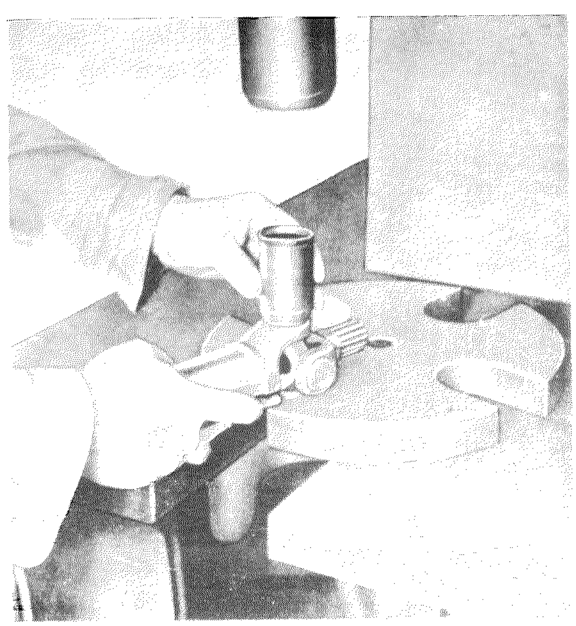


Fig. 35 — 4/56

139. Check the slip coupling, yoke, joint spider, and the needle bearing bushings (see Job No. 35 — 5, Section G).

Reassembly:

140. Place the guide rings (7) on the sliding sleeve (1) and lock by means of the circlips (5) (see Fig. 35 — 4/54).

Caution: Put in the circlips in such a way that the two eyes are opposite a splineway (see arrow in Fig. 35 — 4/57) since otherwise the sliding sleeve cannot be introduced into the yoke.

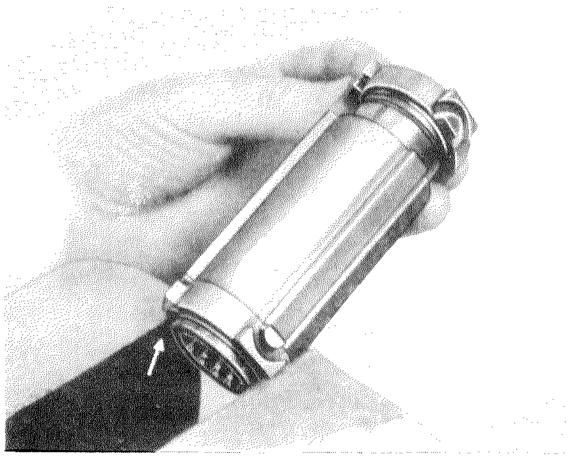


Fig. 35 — 4/57

141. Coat the cylindrical rollers (132 in number, 44 rollers per splineway) with vaseline, place them in position on the sliding sleeve and cover them with Installing Plates 180 589 03 63 (Fig. 35 — 4/58 and Fig. 35 — 4/59).

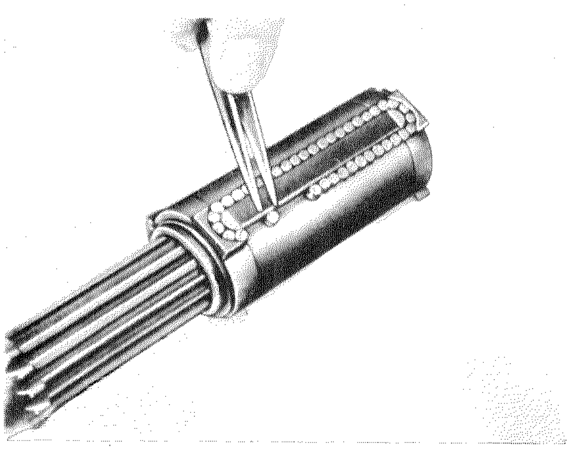


Fig. 35 — 4/58

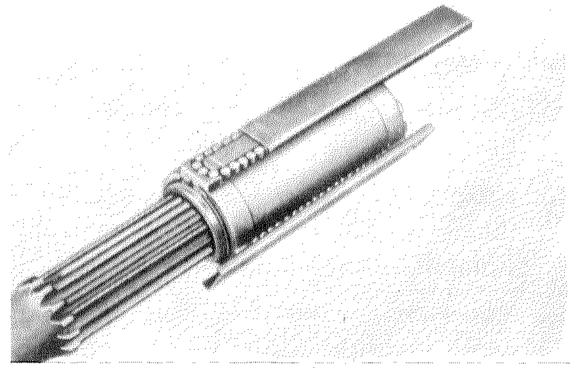


Fig. 35 — 4/59

142. Put the circlip (4) and the washer (5) in the yoke end side of the outer yoke (2) (see Fig. 35 — 4/54).

143. Slide the sliding sleeve into the yoke (Fig. 35 — 4/60); the beveled face of the installing plates must point to the yoke.

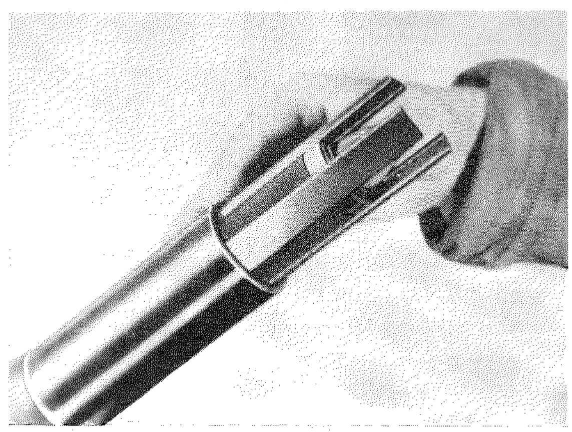


Fig. 35 — 4/60

144. Insert the outer washer (6) and the circlip (4) (see Fig. 35 — 4/54).

145. Coat the needle bearing bushings (2) with vaseline and then insert the needles (3) (there are a 100 in a complete set, 25 per needle bearing bushing) in the needle bearing bushings. Do not use too much grease (see Fig. 35 — 4/62).

Put in the joint spider and very carefully press the needle bearing bushings into the yoke. Make sure that the work is properly set up (Fig. 35 — 4/61 and Fig. 35 — 4/62).

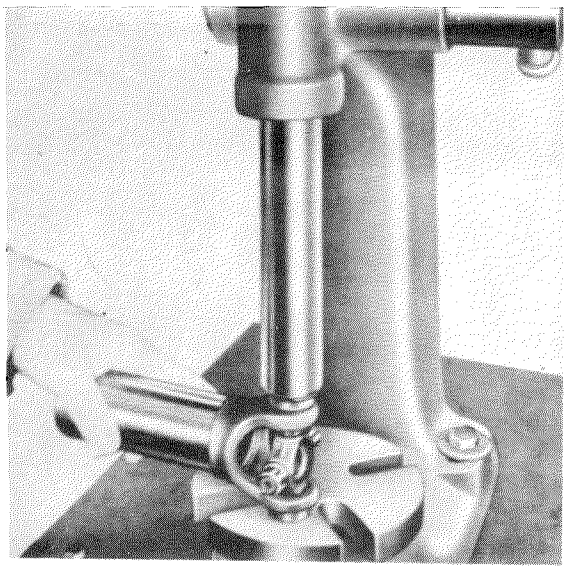


Fig. 35 — 4/61

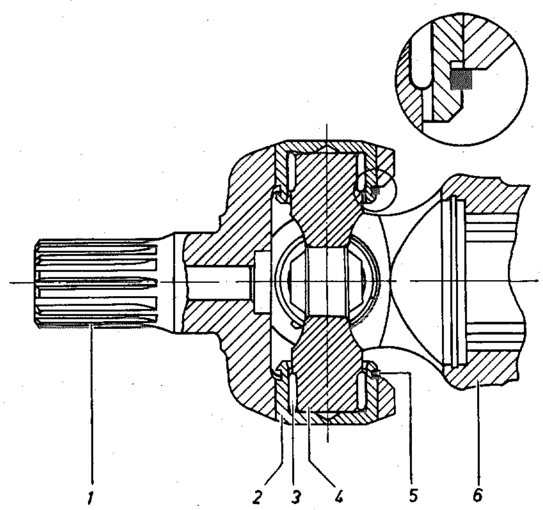


Fig. 35 — 4/62

1 Inner yoke
2 Needle bearing bushing
3 Needle
4 Joint spider
5 Snap ring
6 Outer yoke

146. Insert the snap rings (5) (Fig. 35 — 4/62). The snap rings (5) must be so selected that there is no end play.

The snap rings are available in thicknesses of 2.25 mm, 2.35 mm, 2.40 mm, 2.45 mm, and 2.55 mm.

147. Push the compensating washer (11) onto the inner yoke of the slip coupling (see Fig. 35 — 4/46).

Note: For the selection of the compensating washers see Para. 123.

148. Screw the slip coupling by means of the clamping screw to the right differential side gear in the differential (Fig. 35—4/63).

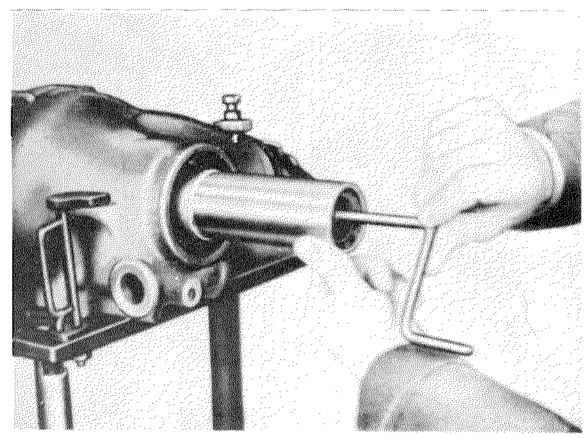


Fig. 35 — 4/63

149. Install the right axle tube together with the rear axle shaft (see Paras. 44—59).

Dished Washers in Differential

The dished washers (6) in the differential (see Fig. 35 — 4/48) are made of polyamide plastic on recent models. When repairs are being carried out on the differential, only this type of polyamide plastic dished washer (Part No. 180 353 00 24) must be installed. When dished washers of this type are used, the thrust washers (3) (see Fig. 35 — 4/48) must be carefully selected so as to ensure that the differential side gears (4) and (5) turn easily, but at the same time are firmly held.

Checking and Repair of Rear Axle

Job-No. 35 — 5

A. General Information on Rear Axle

Gearing	Number of teeth drive pinion: ring gear	Gear ratio	Oil capacity	Length of axle tube		Length of rear axle shaft	
				left mm	right mm	left mm	right mm
Gleason Hypoid	10:41	1:4.10	2.25	599.5 ± 1.0 (see Fig. 35—5/17)	670.5 ± 1.0 to center line of bushing (see Fig. 35—5/17)	693.0	676.0 687.0*

* Rear axle shafts with lock for slip coupling slide unit.

B. Bearings

The following points must be taken into account when judging the serviceability of the bearings:

As a rule, a bearing can still be regarded as serviceable, if the raceways or contact surfaces and the balls or rollers show no visible signs of wear or damage. In order to form a really sound judgement, the bearing must previously be cleaned in gasoline or trichloroethylene until all traces of dirt have been rinsed out of the bearing. A bearing can be considered free from all traces of dirt if there are no binding spots when it is rotated by hand.

A few drops of engine oil or gear oil should be put on the cleaned bearing so that it can be tested for silent running. When this test is made, it should be remembered that even bearings which have only been in operation for a short period of time are appreciably noisier than new bearings but this does not necessarily mean that they are unserviceable.

In order to avoid unnecessary rejection of bearings which are still serviceable, assessment of bearing serviceability should only be done by an expert who is experienced in this work.

Under normal running conditions, the radial play of a bearing should only show a slight increase during its lifetime.

When repairs are being carried out on a vehicle which has covered 100,000 km, the bearings should automatically be rejected even if examination shows that they are still serviceable. This is because their further period of serviceability is an unknown factor. But the decision must depend on whether replacement of the bearings is easy, i. e., on whether it can be done without any considerable disassembly and reassembly work or whether replacement involves considerable preparation.

Dimensions and Tolerances of Bearings

in mm

Function	Designation	Internal diameter	External diameter	Radial play	End play
Annular grooved bearing for rear axle shaft	180 981 00 25 Special purpose bearing 6208 C 4 DIN 625	$\frac{39.988}{40.000}$	$\frac{80.000}{79.987}$	0.032—0.050	approx. 0.32—0.50
Angular contact bearing* with split inner race for drive pinion	000 981 04 27 000 981 07 27 (optional)	$\frac{34.988}{35.000}$	$\frac{80.000}{79.987}$	—	approx. 0.01—0.035
Cylindrical roller bearing for drive pinion	000 981 16 01	$\frac{39.988}{40.000}$	$\frac{80.000}{79.987}$	0.018—0.031	—
Taper roller bearing for differential	30208 DIN 720	$\frac{39.988}{40.000}$	$\frac{80.000}{79.987}$	adjustable	adjustable

* A number of rear axles were fitted with angular contact bearing 3307 DIN 628 with one-piece inner race.

Note: When new, the annular grooved bearing of the rear axle shaft has up to 0.50 mm end play, as indicated above.

When a bearing of this type is being examined for serviceability, the above fact must be taken into account to avoid any unnecessary replacement. In order to ensure that the bearing lies properly against the shoulder of the rear axle shaft, only bearings which have an edge-to-edge dimension of 2+0.7 mm must be used (Fig. 35—5/1). For this reason, only Special Bearings, Part No. 180 981 00 25, must be used.

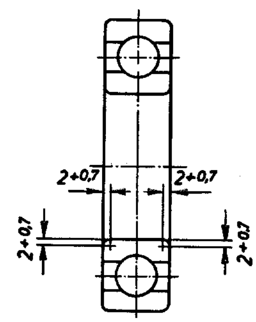


Fig. 35—5/1

C. Rear Axle Shafts

in mm

Rear axle shaft diameter for seal retainer	Seal retainer, internal diameter	Oversize	Rear axle shaft diameter		
			At sealing surface 1	At sealing surface 2	At seat of annular grooved bearing
$\frac{34.059}{34.043}$	$\frac{34.000}{34.025}$	+ 0.018 to + 0.059	$\frac{50.000}{49.840}$	$\frac{37.700}{37.540}$	$\frac{40.013}{40.002}$

1. Check the center bore of the rear axle shaft and, if necessary, grind on a center grinder (Fig. 35 — 5/2).

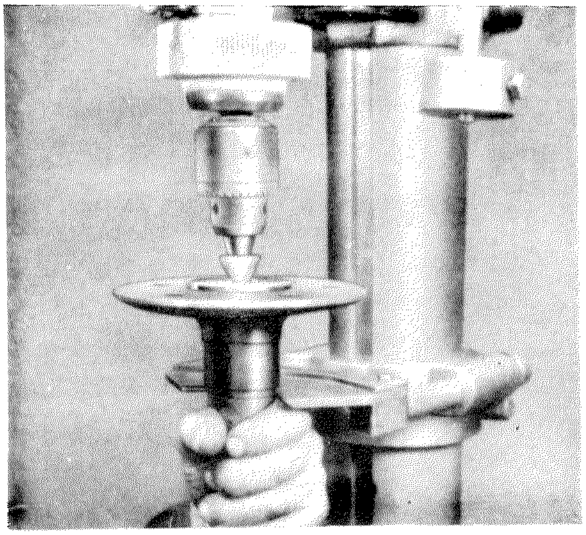


Fig. 35 — 5/2

2. Check the shaft for true run (Fig. 35 — 4/3) and, if necessary, straighten the shaft and re-turn the flange. In order to re-turn the flange, press out the wheel studs. Be careful not to damage the brake drum recess (diameter 66.954 to 67.000 mm) when doing this (Fig. 35 — 5/3).

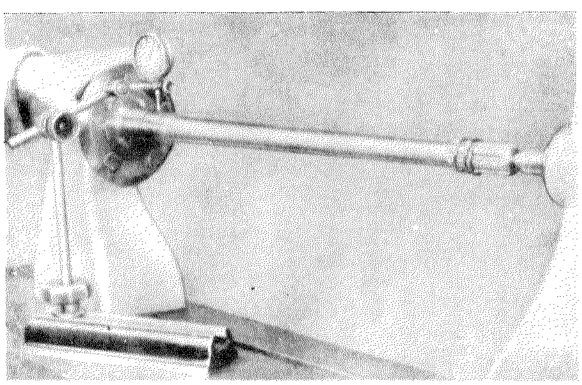


Fig. 35 — 5/3

Note: The permissible run-out at the individual points must not be exceeded (Fig. 35 — 5/4).

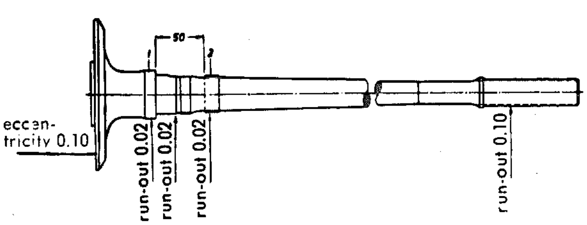


Fig. 35 — 5/4

1 Sealing surface for seal in retainer
2 Seal retainer, at the same time, sealing surface for seal in axle tube

3. Check the sealing surfaces (1) and (2). If they are worn, the diameter (measured from the dimension when new, see Table), may be reduced by 0.5 mm.

Note: The shrinking-on of a ring at the sealing surfaces should only be undertaken in an absolute emergency.

4. After reconditioning, turn a new thread-pattern on the sealing surfaces — a right-hand thread-pattern on the left rear axle shaft and a left-hand thread-pattern on the right rear axle shaft.

   Caution! Under no circumstances must there be any confusion of the thread-patterns.

5. The thread-pattern is made by means of a piece of wood which has the shape of a flat file and is faced with emery cloth No. 80.

   Hold the wood at an angle of approx. 45° to the shaft and file in the direction of the arrow — always toward the splined end. Lift the file (wood) for the return stroke (Fig. 35 — 5/5 and Fig. 35 — 5/6).

Left rear axle shaft with right-hand thread-pattern

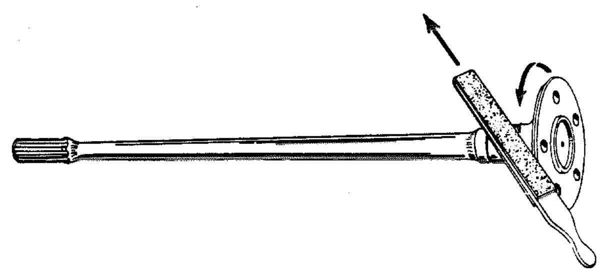


Fig. 35 — 5/5

Flange of rear axle shaft pointing to tailstock

Right rear axle shaft with left-hand thread pattern

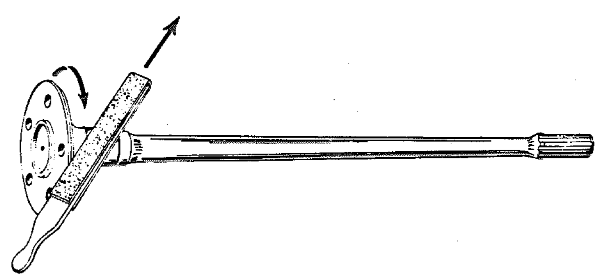


Fig. 35 — 5/6

Flange of rear axle shaft pointing to headstock

Note: The shaft must be rotated toward the lathe-operator in both cases. In order to make the thread pattern more pronounced, a soft rubber pad of approx. 3 mm thickness is placed between the wood and the emery cloth. The lathe should be run at a speed of approx. 150 r. p. m.

Before turning the thread pattern, the shaft must be thoroughly cleaned of all traces of oil. The thread pattern must be made with smart, vigorous movements (approx. 80 file-strokes per minute). The surface-finish, or depth, of the thread pattern is 0.003 to 0.006 mm.

The grooves must run parallel and must not be interrupted by any transverse lines.

6. Check the seat of the annular grooved bearing on the rear axle shaft. If the diameter is smaller than the specified diameter (see Table on Page 35 — 5/2), the rear axle shaft must be replaced.

Note: The annular grooved bearing should be mounted on the rear axle shaft with an oversize of 0.01—0.015 mm.

7. If the wheel studs were pressed out, press new wheel studs in and stake.

Caution: The wheel studs must make an absolutely tight fit.

D. Axle Tubes

1. Thoroughly clean the axle tube at the flange for fixing the brake anchor plate and also the ball bearing seat.

2. Fix the axle tube in a vise and use a suitable internal micrometer to measure the diameter of the annular grooved bearing seat for the rear axle shaft.

   The diameter must be 79.985—80.004 mm.

3. Check the depth of the annular grooved bearing seat in the axle tube, using a depth gage or a micrometer depth gage.

   The dimension should be 20.00 + 0.1 mm.

   When the outer race of the annular grooved bearing is installed, there must be no axial play between the bearing seat in the axle tube and the seal retainer.

   In order to check, place the seal (3) and the annular grooved bearing (2) on the seal retainer and use a depth gage or a micrometer depth gage to measure the distance between the outer race of the annular grooved bearing and the separating surface of the seal retainer (Fig. 35 — 5/7).

   If this distance is smaller than the dimension obtained above, the seal retainer must be re-turned at the separating surface (4). If the distance is greater, the seal retainer must be re-turned at the shoulder (5) for the annular grooved bearing.

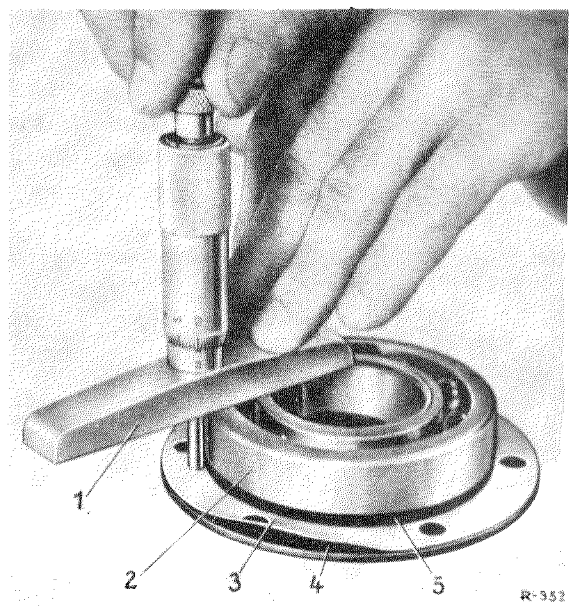


Fig. 35 — 5/7

1 Micrometer depth gage
2 Annular grooved bearing
3 Seal
4 Separating surface of seal retainer
5 Shoulder for annular grooved bearing

4. Check the parallelity of the axis of the axle tube and the center line of the supporting tube. To do this, insert the measuring spindle (2) of Axle Tube Checking Device 180 589 09 21 for Single-jointed Swing Axle in the bearing bore of the axle tube. The gage arm (1) of the checking device must slide onto the measuring spindle (2) and the supporting tube (4) without forcing (Fig. 35 — 5/8).

If the gage arm cannot be slid on or can only be slid on by forcing, the supporting tube must be replaced (see Para. 14).

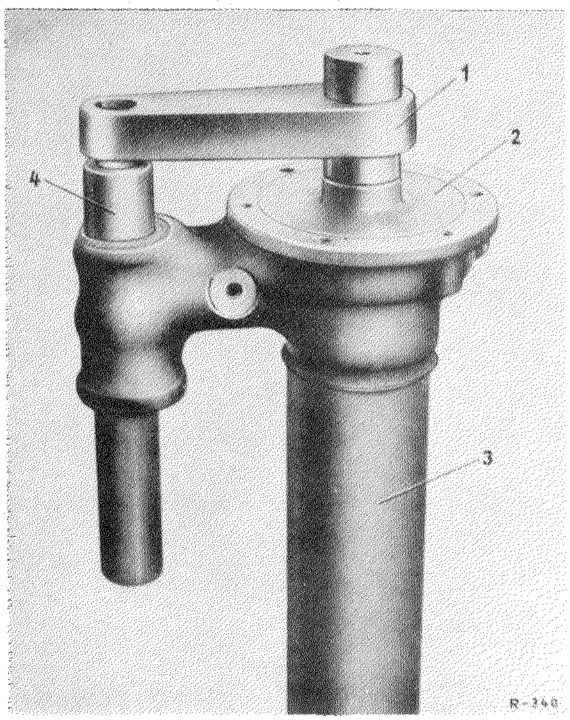


Fig. 35—5/8

1 Gage arm
2 Measuring spindle
3 Axle tube
4 Supporting tube

Note: The Axle Tube Checking Device 180 589 09 21 for Single-jointed Swing Axle consists of the following parts:

The holding fixture,
the gage arm,
the measuring spindle,
the dial gage holder, and
the measuring bolt.

5. Fix the left axle tube in a vise and use a suitable internal micrometer to measure the diameter of the differential taper roller bearing mounting.

   The diameter must be 79.985—79.999 mm.

Checking Axle Tubes for Distortion:

6. Set up the left axle tube on the holding fixture (1) of Axle Tube Checking Device 180 589 09 21 and mount the dial gage holder (2) with dial gage on the checking device. Run the feeler of the dial gage around the bolt hole circle of the flange and in this way test the parallelity of the two flanges (Fig. 35—5/9).

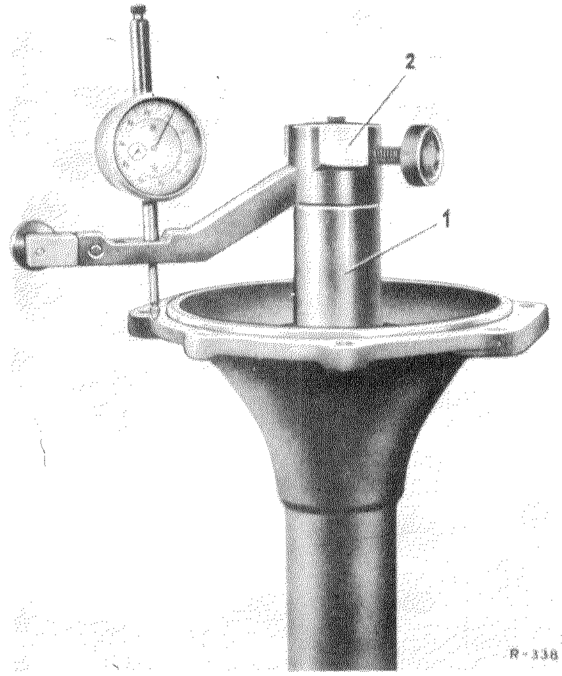


Fig. 35—5/9

1 Holding fixture
2 Dial gage holder

Note: The left axle tube can also be set up in a lathe with the aid of two turning arbors and the two flanges can be checked for true run (Fig. 35—5/9 a).

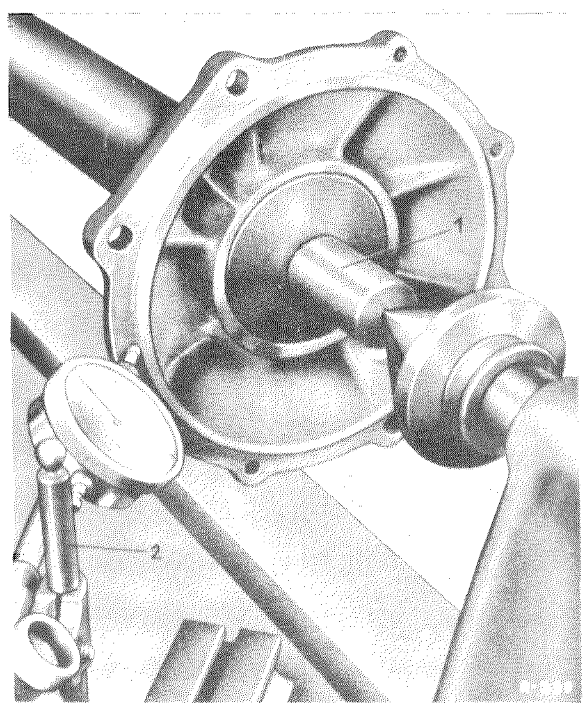


Fig. 35—5/9 a

1 Turning arbor
2 Holder with dial gage

A departure from parallelity of up to 0.1 mm is permissible.

If the departure from parallelity is between 0.1 mm and 1.0 mm, the axle tube must be straightened in a press.

If the departure from parallelity is greater than 1 mm, the axle tube must be replaced.

7. Press out the two bushings in the right axle tube (Fig. 35 — 5/10).

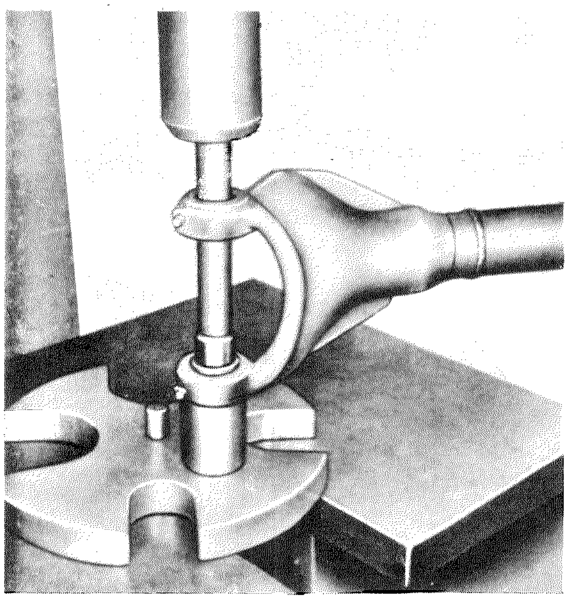


Fig. 35 — 5/10

8. Set up the right axle tube in the holding fixture (1) of Checking Device 180 589 09 21 (Fig. 35 — 5/11).

9. Push the measuring bolt (3) of the checking device through the base bores of the two eyes of the axle tube. Put the dial gage holder (2) on the holding fixture and ascertain the difference between the dimensions at the left and at the right.

Note: A difference of 0.2 mm is permissible. If the difference is up to 1 mm, the axle tube must be straightened in a press.

If the difference is greater than 1 mm, the axle tube must be replaced.

10. Press in new bushings, making sure that the bore in the bearing bushing and the bore for the pinion rim grease fitting correspond.

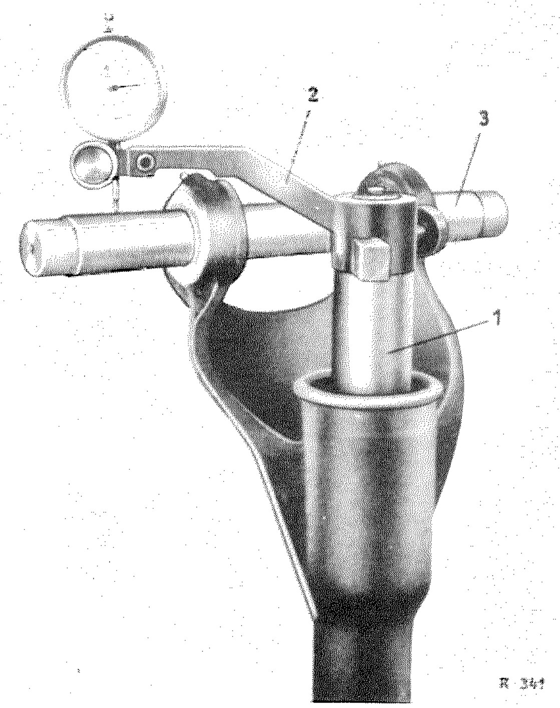


Fig. 35 — 5/11

1 Holding fixture
2 Dial gage holder
3 Measuring bolt

11. After pressing in the bushings, ream out to finished size if necessary, using Reamer 000 589 06 53.

Always center the reamer with a tapered sleeve on the opposite side (Fig. 35 — 5/12).

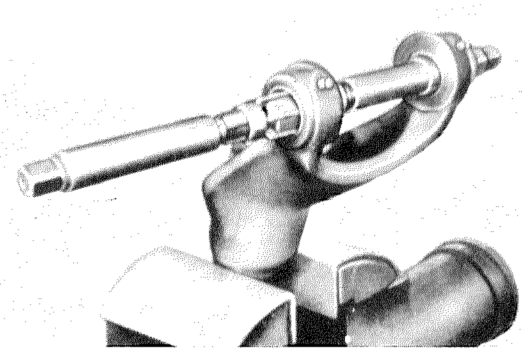


Fig. 35 — 5/12

Dimensions and Tolerances in mm

Base bore in fork diameter	Bushing in fork		Oversize
	External diameter	Internal diameter	
38.000 / 38.025	38.059 / 38.043	33.000 / 33.025	+ 0.018 to + 0.050

Note: The tolerances must be strictly maintained. The dimensions and tolerances of the connecting pin and the sleeve between the connecting pin and the bushing in the fork are indicated in Section "H. Connecting Pin".

12. If necessary, the inner surfaces of the eyes at the fork should be reconditioned, using End Milling Cutter 180 589 01 51 and the Cutting Arbo: 180 589 00 66 which belongs to it (Fig. 35—5/13).

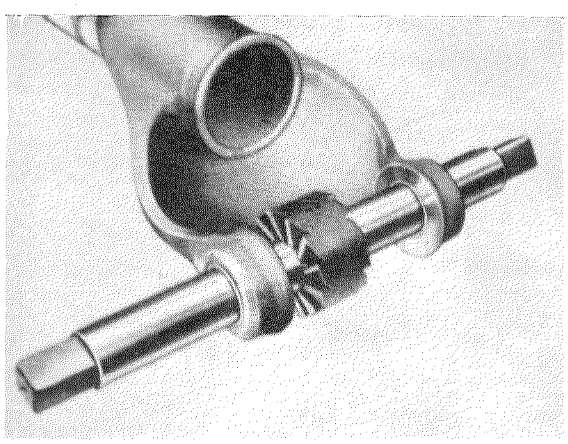
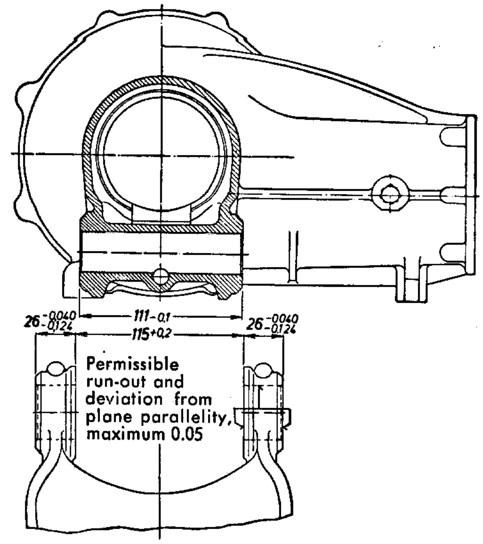


Fig. 35—5/13

The stock reduction at the inner surface must not be more than 0.3 mm at one side. For dimensions when new, see Fig. 35—5/14.

The surfaces must be accurately milled. The maximum permissible run-out and deviation from plane parallelity is 0.05 mm.



13. For checking the parallelity of the two surfaces and the angular accuracy of the surfaces in relation to the bores, Testing Plug Gage with Level Ring 180 589 04 21 should be used. Apply a little oil-diluted blue dye to the level ring so that any unevenness of the surface can be easily seen (Fig. 35—5/15).

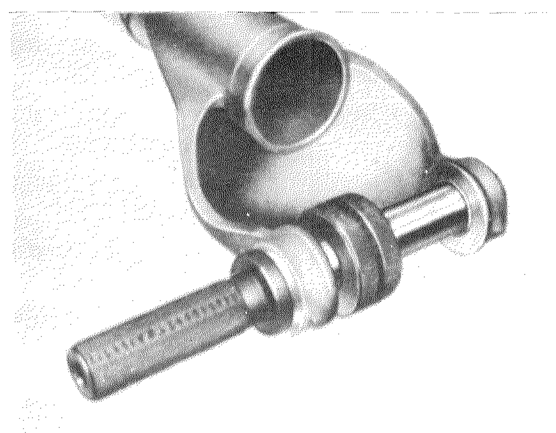


Fig. 35—5/15

14. Press the supporting tube out of the axle tube (Fig. 35—5/16).

Note: This procedure is only necessary if the supporting tube is damaged.

15. Measure the external diameter of the supporting tube and the bore in the axle tube.

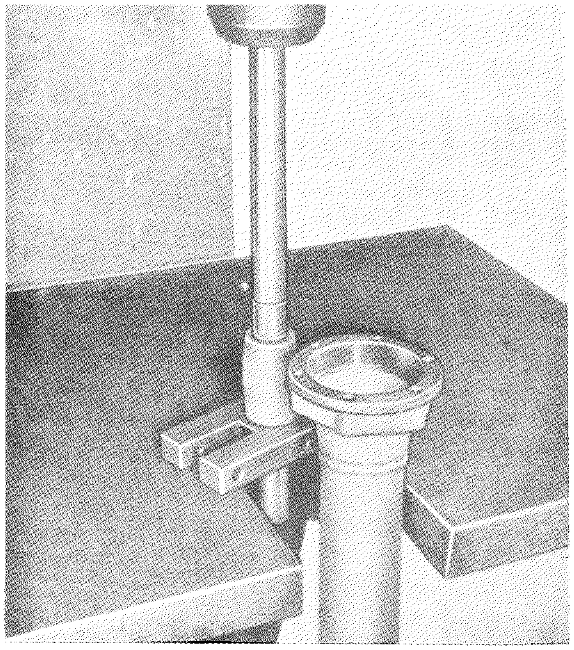
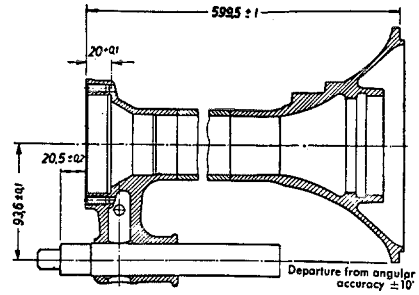


Fig. 35 — 5/16

Bore in axle tube diameter mm	Supporting tube external diameter mm	Oversize mm
26.000 / 26.021	26.048 / 26.035	+ 0.014 to + 0.048

16. Rub tallow on the new supporting tube and press the supporting tube in. When pressing in, care must be taken to ensure that the end of the bolt is not damaged (Figs. 35 — 5/16 and 35 — 5/17).

Left axle tube



Right axle tube

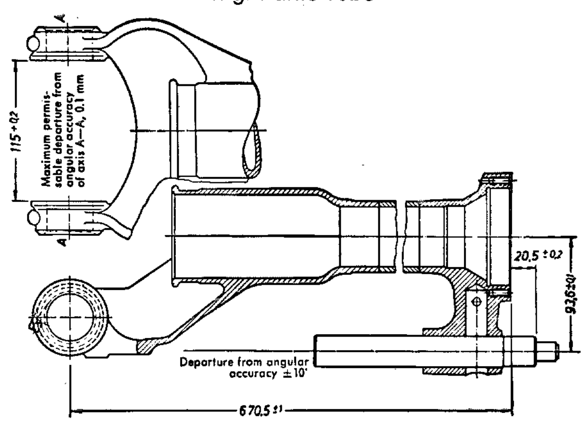


Fig. 35 — 5/17

17. Use Checking Device 180 589 09 21 to check the parallelity of the axis of the axle tube and the supporting tube which has been pressed in (see Section D. Axle Tubes, Para. 4).

E. Rear Axle Housing

Dimensions and tolerances of rear axle housing

in mm

Function	Designation	Outer race of bearing diameter	Bearing seat in housing diameter	Force-fit dimension (+) or clearance (—)
Angular contact bearing with split inner race for drive pinion	000 981 04 27 000 981 07 27 (optional)	80.000 / 79.987	79.994 / 80.013	— 0.026 to + 0.006
Cylindrical roller bearing for drive pinion	000 981 16 01	80.000 / 79.987	79.985 / 80.004	— 0.017 to + 0.015
Taper roller bearing for differential	30208 DIN 720	80.000 / 79.987	79.985 / 79.999	— 0.012 to + 0.015

1. Check the bores for pits or scoring. The bores must not be re-machined. If necessary, the rear axle housing must be replaced.

2. Check the contact surfaces for the eyes of the right axle tube at the rear axle housing. If the surfaces are damaged or worn, they should be reconditioned in the same way as the eyes of the right axle tube (see Section D and Fig. 35—5/13, Fig. 35—5/15 and Fig. 35—5/19).
A stock reduction of up to 0.3 mm on each side is permissible. The diameter of the bore is 27.983—27.996 mm.

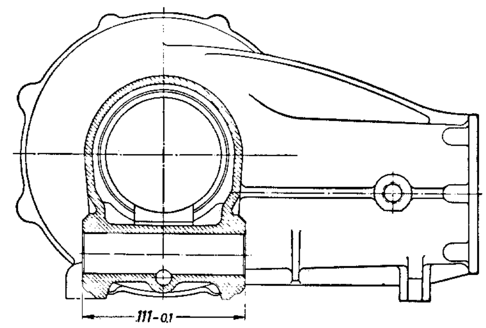


Fig. 35—5/19

F. Gear Train

Drive Pinion Shaft:

1. Check the drive pinion shaft for run-out. If the permissible run-out is exceeded at the various points (Fig. 35—5/20), the drive pinion shaft must be replaced.

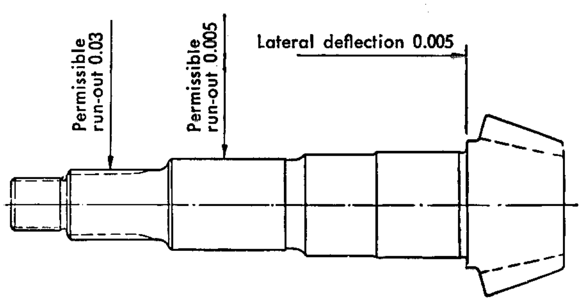


Fig. 35—5/20

Note: The drive pinion shaft must only be replaced together with the ring gear.

2. Check the bearing seats (dimensions and tolerances, see Table).

When pressing the bearings onto the drive pinion shaft, be careful to avoid chipping.

Pressure must only be exerted on the bearings at the inner race.

Dimensions and tolerances of drive pinion shaft in mm

Designation of bearing	Inner race of bearing diameter	Bearing seat on the drive pinion shaft diameter	Force-fit dimension (+) of clearance (—)
Cylindrical roller bearing 000 981 16 01	39.988 / 40.000	40.013 / 40.002	+ 0.002 to + 0.025
Angular contact bearing 000 981 04 27 000 981 07 27 (optional)	34.988 / 35.000	35.006 / 34.995	— 0.005 to + 0.018

Joint Flange:

3. Check the joint flange for lateral deflection. The deflection, measured at the outer diameter, must not be more than 0.02 mm.

If, after repositioning on the splines, the deflection is still greater than 0.02 mm, the joint flange can be turned down to 5.7 mm thickness. Otherwise, the joint flange must be replaced. If the sealing surface for the seal at the joint flange is worn, the sealing surface can be reconditioned, removing up to 0.5 mm of stock. When the sealing surface is new, the diameter is 34.840 to 35.000 mm. After reconditioning, the sealing surface should once more be marked with a left-hand thread pattern (see Section C, Fig. 35—5/6).

Differential:

4. Check the differential pinion shaft and the bores for the differential pinion shaft in the differential housing (Fig. 35—5/21).

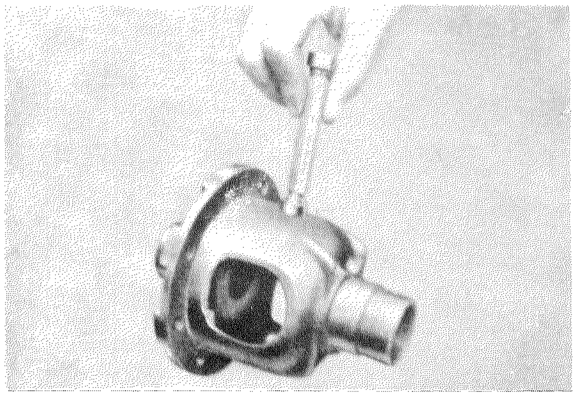


Fig. 35—5/21

If the bores in the differential housing are worn or damaged, the housing must be replaced.

5. Selective assembly is specified for the differential pinion shaft. The differential pinion shaft must be so selected that the specified force-fit dimension in the differential housing (0.002—0.023 mm) is obtained (see Table).

Dimension and tolerances for the differential pinion shaft in mm

Type	Color code	Differential pinion shaft diameter	Bore in differential housing	Force-fit dimension
I	white	17.023 / 17.012	17.000 / 17.010	+ 0.002 to + 0.023
II	blue	17.034 / 17.023	17.011 / 17.021	+ 0.002 to + 0.023

6. Check the differential pinions and the differential side gears and their bores in the differential housing.

Note: Differential pinion gears, thrust washers and dished washers which have been overheated or have become scored, must always be replaced.
The diameter of the bearing journals of the differential side gears is 35.450—35.475 mm and the bore in the differential housing 35.500—35.525 mm (clearance, 0.025 to 0.075 mm). The two differential pinion gears have a bore diameter of 17.07—17.12 mm which results in a play on the differential pinion shaft of 0.036 mm to 0.108 mm.

7. If the ring gear has to be replaced, check the seating on the differential housing and the ring gear bore (Dimensions and tolerances, see Table. Replacement, see Job No. 35—4, Section "E. Disassembly and Reassembly of Gear Train").

Dimensions and tolerances of seating and bore of ring gear in mm

Diameter, differential housing	Bore in ring gear	Force-fit dimension
107.035 / 107.013	107.000 / 107.013	0.000 to + 0.035

8. Measure the lateral and radial deflection of the differential housing at the contact surface for the ring gear.
Maximum permissible lateral deflection 0.005 mm
Maximum permissible radial deflection 0.01 mm
The permissible deflection must not be exceeded.

9. Check the seating of the taper roller bearings on the differential housing.
Under no circumstances must the inner race of the taper roller bearing turn on the differential housing (Dimensions and tolerances, see Table).

Dimensions and tolerances of seating and bore of taper roller bearings in mm

Designation of bearing	Inner race of bearing diameter	Bearing seating at differential housing diameter	Force-fit dimension
Taper roller bearing 30 208 DIN 720	39.988 / 40.000	40.014 / 40.030	+ 0.014 to + 0.042

G. Slip Coupling

1. Check the roller raceways in the outer yoke and also the sliding sleeve for any signs of wear or roller impressions.

Note: If the roller raceways show considerable signs of wear or roller impressions, the whole slip coupling assembly must be replaced.

2. Examine the serrations of the sliding sleeve which engage with the rear axle shaft for wear and burrs.

   The sliding sleeve must move easily, but without play, on the rear axle.

3. The cylindrical rollers must not be replaced individually. If a cylindrical roller is damaged, or has been lost, the whole set of rollers (132 in number) must be replaced.

4. Check the joint spider, the needle bearing bushings and their bores in the yokes for wear and burrs.

5. If new needle bearing bushings are used, care must be taken to ensure that the specified force-fit dimension is strictly adhered to (see Table).

Note: Selective assembly is specified for the needle bearing bushings (for further details. see Table).

6. The needles must not be replaced individually. If a needle is damaged or has been lost, the whole set of needles (100 in number) must be replaced.

Dimensions and tolerances of needle bearing bushings, yokes and joint spider in mm

Type	Color code	Needle bearing bushing, external diameter	Bore in yokes	Force-fit dimension (+) or clearance (—)	Needle bearing bushing, internal diameter	Trunnion diameter	Clearance
I	1 white dot	29.502/29.512 previously: 29.522/29.515	29.500/29.510	— 0.008 to + 0.012 previously: + 0.005 to + 0.022	22.641/22.620	17.600/17.589	0.02 to 0.05
II	2 white dots	29.513/29.523 previously: 29.528/29.523	29.511/29.521	— 0.008 to + 0.012 previously: + 0.002 to + 0.017			

H. Connecting Pin

1. Check the connecting pin, sleeves, compensating washers and backing washers, rubber rings and splined bolt for wear and damage.

   Worn sleeves, compensating washers and backing washers and also damaged rubber rings must always be replaced.

2. Check the connecting pin (2) for true run. If the pin is supported at the ends during this test, the run-out must not be more than 0.10 mm. Selective assembly is specified for the external diameter of the connecting pin and the internal diameter of the sleeves (11 a) and (11 b) which are fitted on the connecting pin (see Fig. 35—5/22 and Table).

Excessive play between the connecting pin and the sleeves or between the sleeves and the bushings in the eyes of the axle tube will result in metallic knocking noises when the car is travelling.
Inadequate play tends to cause rumbling of the rear axle.
It is therefore important that the tolerances indicated in the Table should be strictly adhered to.

Dimensions and tolerances of the connecting pin and the sleeve in mm

Type	Color code	Connecting pin, external diameter	Bore in the sleeve	Force-fit dimension
I	white	28.000 / 27.994	27.983 / 27.989	+ 0.005 to + 0.017
II	blue	27.993 / 27.987	27.976 / 27.982	

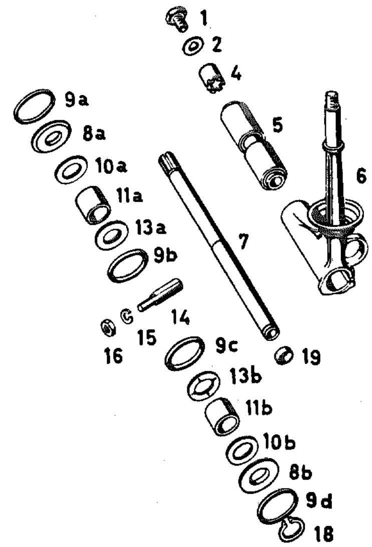


Fig. 35—5/22

1 Hexagon screw
2 Locking plate
4 Spacer sleeve
5 Buffer block
6 Support
7 Connecting pin
8a, 8b Backing washers
9a, 9b, 9c, 9d Rubber rings
10a, 10b Washers
11a, 11b Sleeves
13a, 13b Compensating washers
14 Splined bolt
15 Lock washer
16 Hexagon nut
18 Circlip
19 End plug

I. Support of Rear Axle Suspension

1. Check the buffer block in the support and if necessary, replace it.

   When pressing a new buffer block into the support, care must be taken to ensure that the end which protrudes 6 mm, is pointing toward the rear (Fig. 35—5/23).

2. Check the M 22×1.5 thread at the top of the support and if necessary, re-tap it.

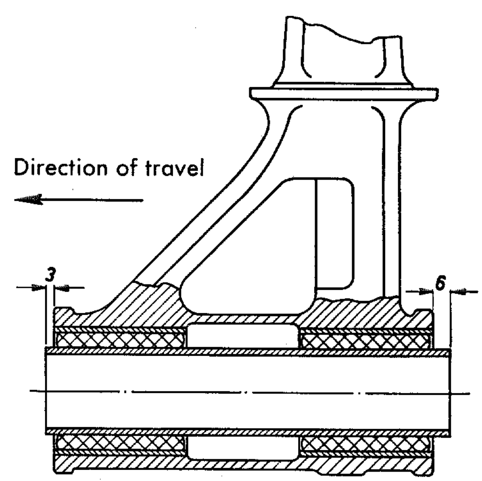


Fig. 35—5/23

Wheels and Tires
Adjustment of Wheels

40

Wheels and Tires - Adjustment of Wheels
Group 40

Job No.	Operation	Page
40—0	**Wheels and Tires**	40—0/1
	A. Wheels	40—0/1
	B. Tires	40—0/2
40—1	**Fitting of Tires**	40—1/1
	A. Normal Tires	40—1/1
	B. Tubeless Tires	40—1/1
40—2	**Balancing of Wheels with Tires fitted**	40—2/1
40—3	**Adjustment of Wheels**	40—3/1
	A. General	40—3/1
	B. Terminology and Methods of Adjustment	40—3/2
	C. Wheel Adjustment Values	40—3/12
	D. Tire Wear	40—3/13
	E. Preparation for Measurement	40—3/15
	F. Measurement Charts	40—3/15
	G. Measurement with an Optical Axle Gage	40—3/16
	H. Measurement with Mechanical Gages	40—3/16

Wheels and Tires

A. Wheels

The standard Model 190 is fitted with 13″ disk wheels. 15″ disk wheels can also be fitted as optional equipment on export models.

The rim type numbers are
standard version 4½ K × 13—B,
modified version, optional, SA 10 174/1 4½ K × 15—A.

The type number is made up as follows:

4½ = Rim width in inches
K = Shape of wheel flange
× = Well base rim
13 or 15 = Diameter of rim in inches
A = Symmetrical rim
B = Asymmetrical rim

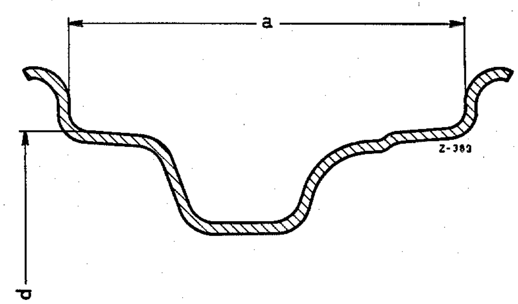


Fig. 40—0/1

a = Rim width
d = Diameter

Recently, in order to avoid any confusion of the two types, the model number of the car has been stamped on the wheel in addition to the rim type number. This stamping is on the bolt hole circle.

The standard rim 4½ K × 13—B can be used for all tires in the special range 6.40—13 and 6.70—13, in addition to the standard 6.40—13 tires, 4-ply. In the case of 6.40—15 tires, type 4½ K × 15—A rim should be fitted (see also Section B. Tires).

Test Values for the Wheels in mm

Rim size	Rim width a	Rim diameter d	Measured circum-ference $\pi \cdot d$	Permissible eccentricity	Permissible run-out	Permissible unbalance
4½ K × 13—B (standard)	114.3 ± 1	328.7	1032.6 ± 1	1.5	1.5	750 cmg
4½ K × 15—A (optional SA 10 174/1)	114.3 ± 1	379.5	1192.2 ± 1.2	1.5	1.5	750 cmg

The wheel consists of the dished wheel disk and the rim which are welded together.

When testing the disk wheels, particular care must be taken to ensure that the rims, and in particular the edges of the rims, are not damaged. Slight imperfections at the outer edge can be put right by reshaping. But if there is any extensive damage or an abnormal degree of run-out or eccentricity, considerable ovality etc., the wheels must be replaced. Distorted rims must not under any circumstances be straightened. If damaged wheels have been repaired, they must in all cases be tested for eccentricity and run-out.

B. Tires

A) General

The following tires can be fitted to Model 190:

Standard:	Low-pressure tire 6.40 — 13, 4-ply
Optional (SA 887/1 — 120):	Low-pressure tire 6.40 — 13, 6-ply
Optional (SA 10 215):	Low-pressure tire 6.70 — 13, 4-ply
Optional (SA 10 135/1):	Low-pressure tire 6.70 — 13, 6-ply
Optional (SA 10 173):	Low-pressure tire 6.70 — 14, 6-ply — transport type —
Optional (SA 10 174/1):	Low pressure tire 6.40 — 15, 4-ply

The type number is made up as follows:

6.40 or 6.70 = Rated width of tire in inches
13 or 15 = Rim diameter in inches.

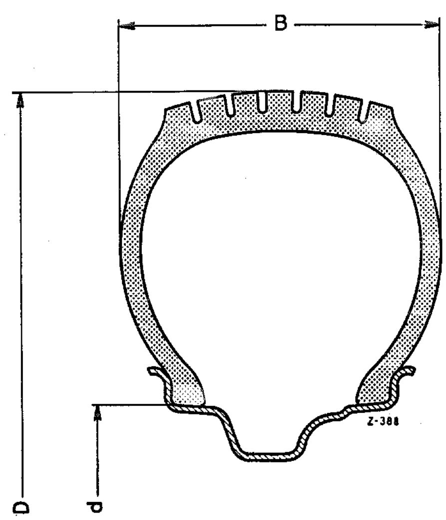


Fig. 40 — 0/2

B = Rated width of tire
D = Tire diameter
d = Rim diameter

The figures given for the rated width B and the diameter D refer to tires which are inflated but not under load.

In addition to these values the effective radii, both static and dynamic, are usually given.

The effective static radius is understood to be the distance from the center of the wheel to the plane surface on which the wheel is standing, when the tire is carrying the maximum permissible load and is inflated to the specified air pressure for this load.

The effective dynamic radius is determined by dividing the distance travelled per revolution of the wheel at a speed of 60 km/h by 2π. Again the tire must be carrying the maximum permissible load and must be inflated to the specified air pressure.

At higher speeds the effective dynamic radius is increased, due to the expansion of the tire resulting from the centrifugal force and the heat developed.

Effective Dynamic Radius for Tire Size 6.40 — 13:

effective radius, dynamic, at 60 km/h = 299 mm ± 3
effective radius, dynamic, at 100 km/h = 305 mm ± 3
effective radius, dynamic, at 140 km/h = 314 mm ± 3

Effective Dynamic Radius for Tire Size 6.70 — 13:

effective radius, dynamic, at 60 km/h = 307 mm ± 3
effective radius, dynamic, at 100 km/h = 313 mm ± 3
effective radius, dynamic, at 140 km/h = 319 mm ± 3

Effective Dynamic Radius for Tire Size 6.40 — 15:

effective radius, dynamic, at 60 km/h = 326 mm ± 3
effective radius, dynamic, at 100 km/h = 331 mm ± 3
effective radius, dynamic, at 140 km/h = 338 mm ± 3

Permissible Axle Load for various Types of Tire:

Type of tire	Permissible axle load kg	Specified tire pressure atm.
6.40 — 14, 4-ply	approx. 880	1.9
6.40 — 13, 6-ply	approx. 900	2.0
6.70 — 13, 4-ply	approx. 950	1.8
6.70 — 13, 6-ply	approx. 1000	2.0
6.70 — 13, 6-ply — transport type —	approx. 1100	2.25
	approx. 1150	2.50
	approx. 1200	2.75
	approx. 1250	3.00
6.40 — 15, 4-ply	approx. 900	1.7

b) Tire Pressures

The maintenance of the tire pressures as specified by us is of considerable importance for the preservation of the tires and also for the riding qualities of the car. Tire pressures are usually given for cold tires. The kneading action of the tires increases the temperature and also the pressure. Thus, when checking tire pressures with the tires warm, the pressures must not be decreased to the pressures specified for cold tires.

Specified Tire Pressures

	For normal driving			For continuous fast freeway driving	
	Cold tires	Increases after prolonged city driving or limited highway travel to	Increases after fast highway travel to	Cold tires	Increases after fast freeway travel to
Front wheels	1.7 atm.	1.8 atm.	1.9 atm.	1.9 atm.	2.1 atm.
Rear wheels and spare wheel	1.8 atm.	2.0 atm.	2.1 atm.	2.0 atm.	2.3 atm.
Note: If the car is fully loaded (6 persons and luggage), the rear wheel tire pressure must be increased to 1.9 atm. with tires cold. The tire pressure for special tires with increased load is shown in the Table in Section a) Tires.					

Tire-pressure checking, at least once a week and particularly before starting on a long journey, is of considerable importance. If the pressure of the cold tire decreases by more than 0.2 atm. within the space of a week, there is leakage at the valve or in the inner tube and this must be put right at once. The regular checking of tire pressures goes a long way toward preventing sudden tire trouble whilst on a journey. At the same time, it helps to prevent damage to inner tubes and covers and to reduce the possibility of accidents. If a nail penetrates the tire, it does not often lead to sudden, complete loss of pressure because the inner tube hugs the nail and very little air escapes from the tire. It is only after a prolonged period of travel that the kneading action of the tire increases the damage so that the tire can go down suddenly.

In order to maintain the exact tire pressures specified by us, service station air pressure gages should be regularly checked with a master air pressure gage and if necessary, re-calibrated.

In order to obtain equal wear on all tires, and to make sure that the tires last as long as possible, the wheels, including the spare, must be interchanged on the rotation principle (Fig. 40—0/3) every 8,000 km. In abnormally hot weather and if the car is normally driven very fast, the wheels should be interchanged every 4,000 km.

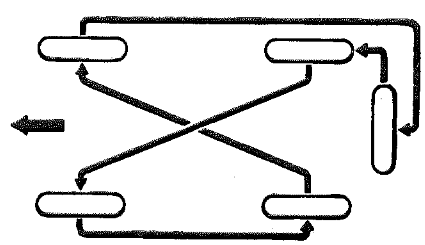


Fig. 40—0/3

c) Approved Makes of Tire

Normal Tires

The makes of tire approved by us are always published in the service bulletins. The Central Service Department (Abteilung Zentralkundendienst) should be consulted when in doubt.

Tubeless Tires

If required, cars can be supplied from the Sindelfingen works, already fitted with tubeless tires. These tubeless tires can also be fitted subsequently without any difficulty.
The difference between tubeless tires and the hitherto conventional tires is in the construction of the beads which are forced against the wheel flange and the shoulder of the rim by the air pressure in the tire. The main seal is formed by the bead and the shoulder of the rim. On both the bead and the inside surface of the tire an elastic layer of rubber is vulcanized to prevent the air from escaping.
The advantage of tubeless tires is that the air cannot suddenly escape if the tire is damaged by the penetration of any foreign body (for example, a nail).

The tubeless tires approved by us are also published in the service bulletin. In cases of doubt, the Central Service Department (Abteilung Zentralkundendienst) should be consulted.

Winter Tires

When advising customers about tires for use in winter, it should be noted that special winter tires (M u. S = slush and snow tires) have no particular advantages under normal snow and ice conditions. It is only on roads which are deep in snow that the M u. S tires are a satisfactory substitute for snow chains.

The "All-weather, Snow and Ice" Wyresoles tires, apart from being suitable for general winter conditions, have good anti-skid qualities on roads made slippery by snow and ice. The Wyresoles tire has a steel wire spiral vulcanized into the surface which bites into the ice on the road. But these tires can only be made by resoling the tire.

Approved winter tire types are also published in the service bulletins.

d) Snow chains

Snow chains are to be recommended when deep snow is lying, grades have to be negotiated and normal winter tires are inadequate. Only fine-link track chains which ensure a good edge-grip, should be used. Snow chains should be fitted and checked over before they are actually needed.

Fitting of Tires

Job No.
40 — 1

A. Normal Tires

1. Before the tire is fitted, it must be evenly dusted with talc on the inside.
2. Inflate the inner tube a little and place it in the tire. The tube must lie snugly in the tire without creases. The valve must be located at the part of the tire marked with a red spot.
3. Press the lower bead of the tire into the rim all the way round. Use a tire lever to lift the last part of the tire over the rim edge. Use only well-rounded tire levers which are in good condition.
4. Screw an extension piece onto the valve.
5. Then press the upper bead into the rim opposite the valve and hold it in this position. Now use the tire lever to force the tire over the rim edge a little at a time at the left and at the right.
6. Remove the extension piece and install the fixing nut. Then inflate the tire and screw on the valve dust cover.

B. Tubeless Tires

1. Clean the wheels with the aid of a wire brush (Fig. 40 — 1/1). The shoulder of the rim, the wheel flange and the valve hole must be completely free of dirt and rust.
2. Check the rim for damage. Slight dents at the wheel flange can be straightened out. If there are any chatter-grooves resembling file cuts at the balancing-weight slots and at the wheel flange, or if there is any major damage to the wheel flange itself, the wheel must be replaced.
3. Smear the rubber valve (snap-in valve) with a soap solution and use a special tool or a valve puller chain to force the valve into the rim from the inside (Fig. 40— 1/2).

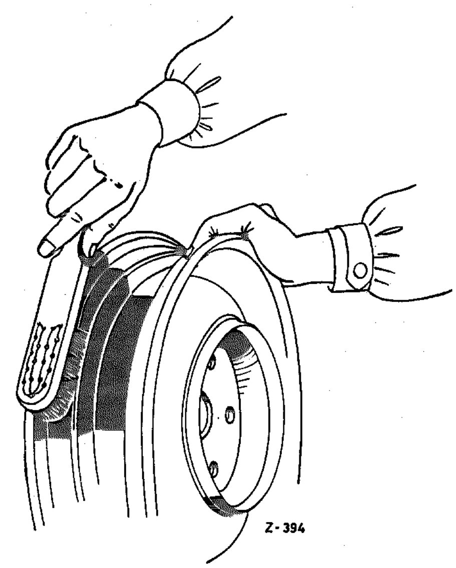


Fig. 40 — 1/1

Note: Only rubber valves, so-called snap-in valves, must be used. These valves consist of a mushroom rubber head with a metal neck vulcanized onto it.

4. Fit the tire onto the rim in the usual way and wet the beads with water. Do not use talc!

5. Hold the tire vertically and inflate until the tire bead snugs against the wheel flange. Before inflating, remove the valve insert so that the air can rush unimpeded into the tire, thus assuring a snug fit of the tire beads against the shoulder of the rim and the wheel flange. To facilitate this, the tire can be placed under constant tension, using a tensioner (Fig. 40—1/3).

Note: It is absolutely necessary to have the tire standing vertical since otherwise it cannot be inflated. If the tire is horizontal, the tire beads do not form a seal.

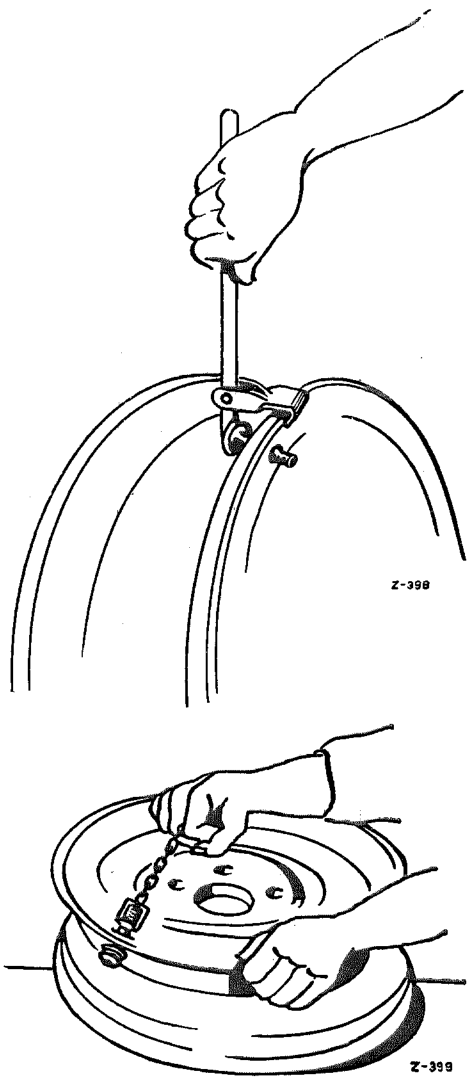


Fig. 40—1/2

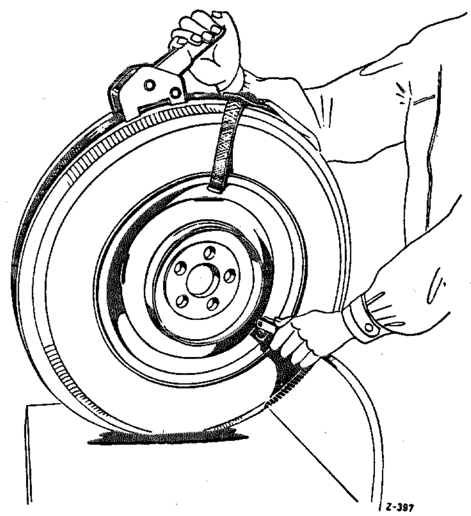


Fig. 40—1/3

6. Then screw in the valve insert and inflate to normal pressure, hammering with a rubber hammer on the side wall of the tire at the same time—especially in the neighbourhood of the balancing slots — so that the centering ring which is vulcanized into the tire remains at the same distance from the wheel flange all the way round.

7. Put the fitted tire into a water bath and test it for leakage. After the tire has been in use on the car for 24 hours, the air pressure in the tire must not have decreased.

8. The instructions for fitting published by the makers of the tire should in any case be observed.

Balancing of Wheels with Tires fitted

Job No.
40—2

In the manufacture of wheels and tires, the occurrence of unbalance is unavoidable. In order to eliminate the detrimental effects of static and dynamic unbalance on steering characteristics and the wheel bearings, it is the general practice today to balance the wheels with tires fitted. Wheel balancing for high-speed vehicles is particularly important, and must therefore be carried out with particular care.

Unbalance is understood to mean an unequal mass distribution in a revolving body.

Static unbalance arises in a wheel with the tire fitted, when mass distribution about the axis of rotation is uneven. This kind of unbalance manifests itself in wheel shimmy or wheel-bouncing when the car is in motion.

Dynamic unbalance is present when mass distribution, seen from the central plane of the wheel, is uneven. This kind of unbalance manifests itself in wheel tramp, when the car is in motion. Balancing of wheels must be carried out carefully in order to achieve smooth steering. Excessive unbalance leads to premature destruction of the wheel bearings and premature wear in the steering assembly units, particularly at high speeds.

The generally adopted method of clamping weights between the tire and the wheel flange is not permissible for reasons of safety.

For this reason, balancing weights in Model 190, as in other Mercedes-Benz models, are fitted and locked in slots on the wheel disk. This method of attachment is the surest method of preventing the balancing weights from working loose. On the circumference of each wheel disk are four slots, situated at 90° intervals.

It is extremely rare that the angle of unbalance happens to coincide with one of the four wheel-disk slots.

Any force which is determined by angle and magnitude, can, however, be resolved, in a very simple manner, into two related components, at 90° to each other. This resolution of forces is also applied in this case by resolving the magnitude of unbalance into the two vertical components which pass through the slots in the wheel disk. This practice, which is common in mathematics, is used in correcting both static and dynamic unbalance. The magnitude and angle of static and dynamic unbalance can be determined together or separately, depending on whether the balancing machine which is available determines the static and dynamic unbalance together, or separately in two planes. For this reason, the four slots are situated on both sides of the wheel disks. It is advisable to follow the instructions supplied by the manufacturer of the balancing machine.

The large Schenk balancing machine resolves angle and magnitude of unbalance automatically into the components corresponding to the two slots.

If no fully-automatic machine is available, it is necessary first of all to determine the angle and magnitude of unbalance by some other method. To resolve the unbalance a so-called polar diagram is employed (Fig. 40—2/1).

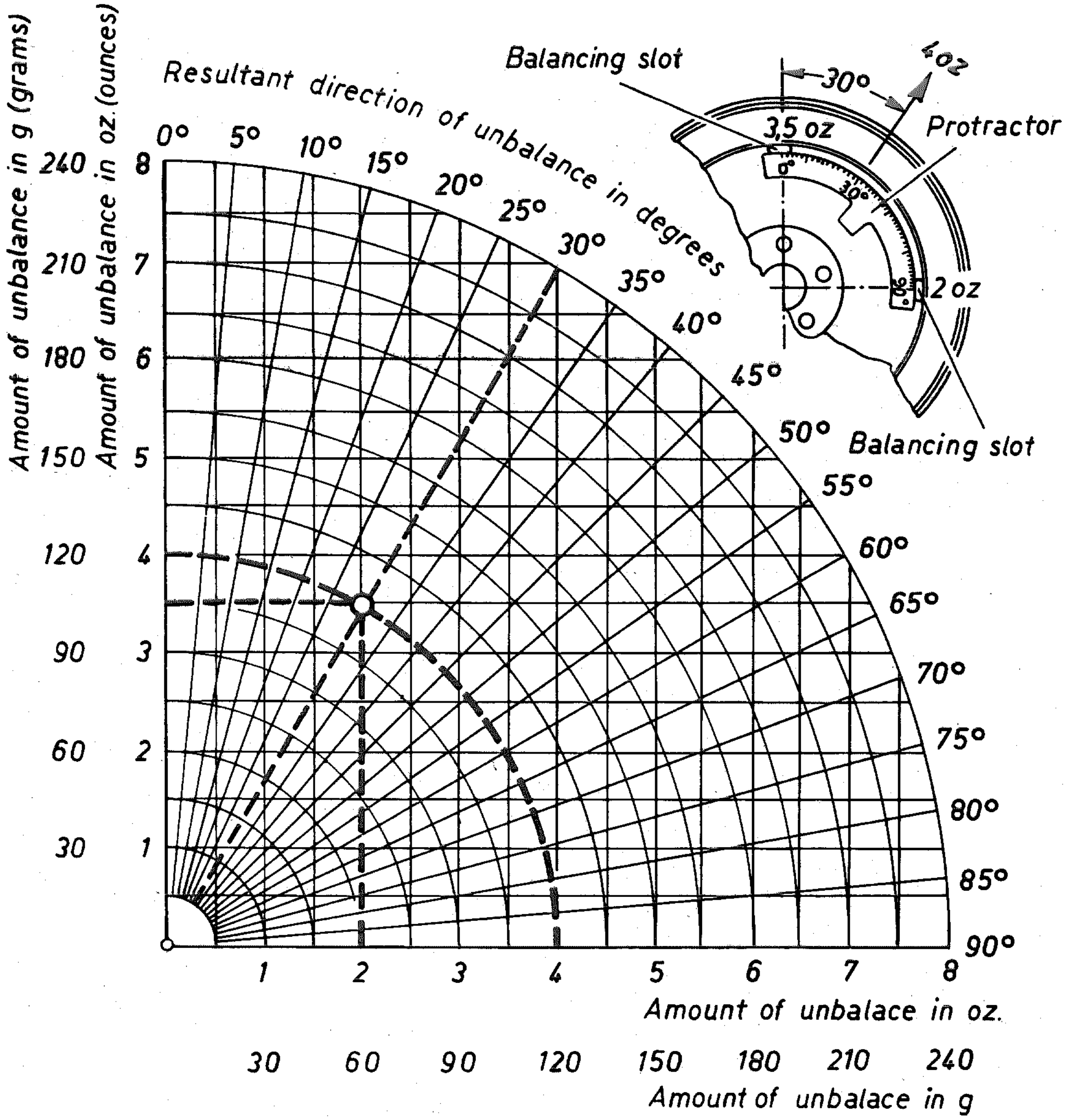


Fig. 40 — 2/1

The following procedure should be adopted:

1. The angle of unbalance must be marked on the tire or the rim and measured in degrees with a protractor (see Fig. 40 — 2/1). Place the protractor in position so that the 0 mark is lined up with one balancing slot and the 90 mark is lined up with the other.

Note: If a regular protractor is not available one can very easily be made in the workshop.

2. Example:

   Unbalance = 80 g.
   Angle = 30°.

   Now find on the polar diagram the intersection of the arc for an unbalance of 80 grams with the 30° radial.

   Proceeding from the point of intersection, the component for the 0° slot is seen on the vertical axis scale to be 70 grams, and on the horizontal axis scale the component for the 90° slot is 40 grams (see Fig. 40—2/1, thick lines).

3. After the value of the components has been established on the polar diagram, use a standard commercial tire clamp to fit the appropriate weights into the balancing slots. In doing this, use the tire clamp to press the tire off the rim and insert the sprung steel blade of the weight into the slot and lock it in position (Fig. 40—2/2).

   The balancing weights are available in a range from 25 grams to 155 grams in steps of 10 grams. If a weight is required which lies between these values, take the next heaviest balancing weight and reduce it to the requisite weight.

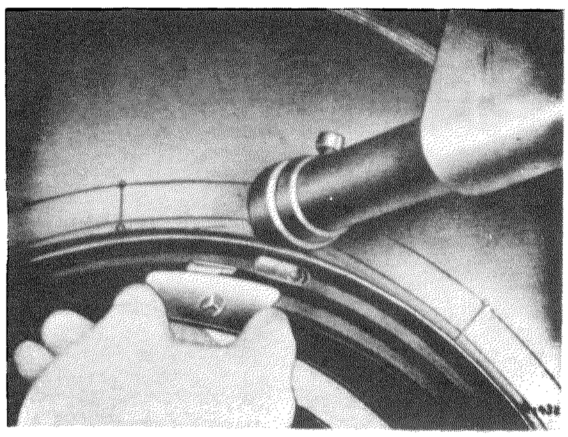


Fig. 40—2/2

Note: A polar diagram is attached to some balancing machines to facilitate rapid determination of the weights to be inserted into two of the slots.

Always wash the wheels with tires fitted before balancing.

Adjustment of the Wheels

Job No.
40—3

A. General

The correct positioning of the four road wheels of the car relative to each other and to the surface of the road is the decisive factor for good road-holding qualities, satisfactory steering, and normal tire wear. Model 190, like all our other passenger models, has independent front and rear suspension.

The values indicated for the wheel adjustments on Model 190 are the result of extensive tests and represent an optimum with regard to road holding qualities and steering characteristics.

If irregularities occur in the car's steering characteristics, road holding qualities, or tire wear, it must be borne in mind that factors other than wheel adjustment play a part.

The following conditions must be fulfilled:

a) Correct tire pressure

b) Good tread on tires (as evenly worn as possible)

c) Perfectly balanced wheels

d) Springs which are functioning perfectly

e) Shock-absorbers which are functioning perfectly

f) Steering assembly units and wheel bearings with a minimum of play.

Since the position of the moving car relative to the road surface is dependent on road conditions, speed of travel and loading and consequently varies at all times, values for wheel adjustment are given for the cars when normally loaded and also when in curb condition.

Car in Curb Condition = Car in working order, with oil and water + full fuel tank + spare wheel + tool kit, but without passengers and luggage.

Car Normally Loaded = Car in curb condition + 6 × 65 kg load on the seats + 45 kg luggage in the trunk.

The car should be loaded with sandbags. The sandbags should not weigh more than 22 kg as heavier sandbags are awkward to handle.

Distribute the sandbags on the individual seats so that at both the front and the back there is 3 × 65 kg; in doing this, adjust the front seats to the central position (do not put the sandbags on the floor of the car).

Distribute the weight in the trunk compartment evenly (45 kg).

If the fuel tank is not full, additional weights must be put in the trunk to compensate for this (1 liter fuel = 0.750 kg).

Measurements for cars which have been involved in an accident or cars where irregularities in the road-holding qualities or tire wear are observed, should be carried out with the vehicle in both curb condition and loaded condition.

When carrying out routine checks it is generally sufficient to take measurements with the car in curb condition.

The measurement and the evaluation of the measurement requires expert knowledge and experience. For this reason only specially trained mechanics should be permitted to carry out this job.

B. Terminology and Methods of Adjustment

a) Camber

Camber is the term used to designate the angle which the wheel plane forms with a line drawn at right angles to the road surface. If the wheels are inclined outward at the top the camber is said to be positive (+) and if the wheels are inclined inward at the top the camber is said to be negative (—) (Fig. 40—3/1).

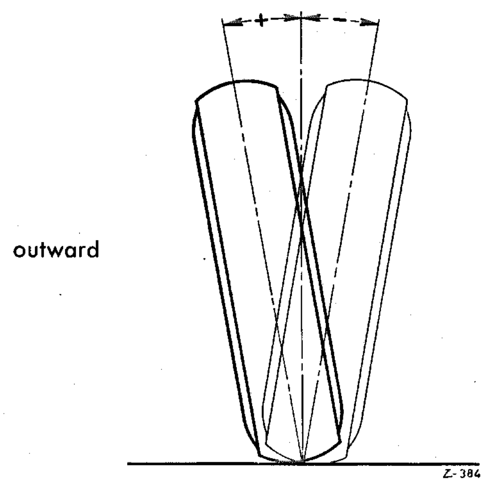


Fig. 40—3/1

Front Axle

The front wheels are adjusted to a positive camber. Positive camber together with king pin inclination ensures stable and smooth steering. With the low-pressure tires which are in general use today, the front wheel camber must not be too great, because this causes increased wear at the outside shoulder of the tire. The camber at the left and the right should be as nearly identical as possible. If there is a considerable discrepancy between the left and the right, the car tends to veer to the side at whichever wheel the camber is greatest. Camber is adjusted so that the least possible variation in camber results when the springs are fully depressed, with the car in normally loaded condition.

A camber of $\pm$ 0° to + 1° is permissible with the car in normally loaded condition, and a camber of + 0° 20′ to 0° 40′ should be aimed at. The difference between the camber at the right and the left should be as slight as possible; however, a maximum difference of $\pm$ 0° 30′ is permissible.

Adjustment of camber is carried out by turning the eccentric bolt (7) (Fig. 40—3/2). To do this, first back out the hexagon screw (13) and the lock washer (12) and remove it together with the locking plate (11). After unscrewing the hexagon nut (10), camber can be adjusted to the prescribed value with the aid of an SW 19 box wrench.

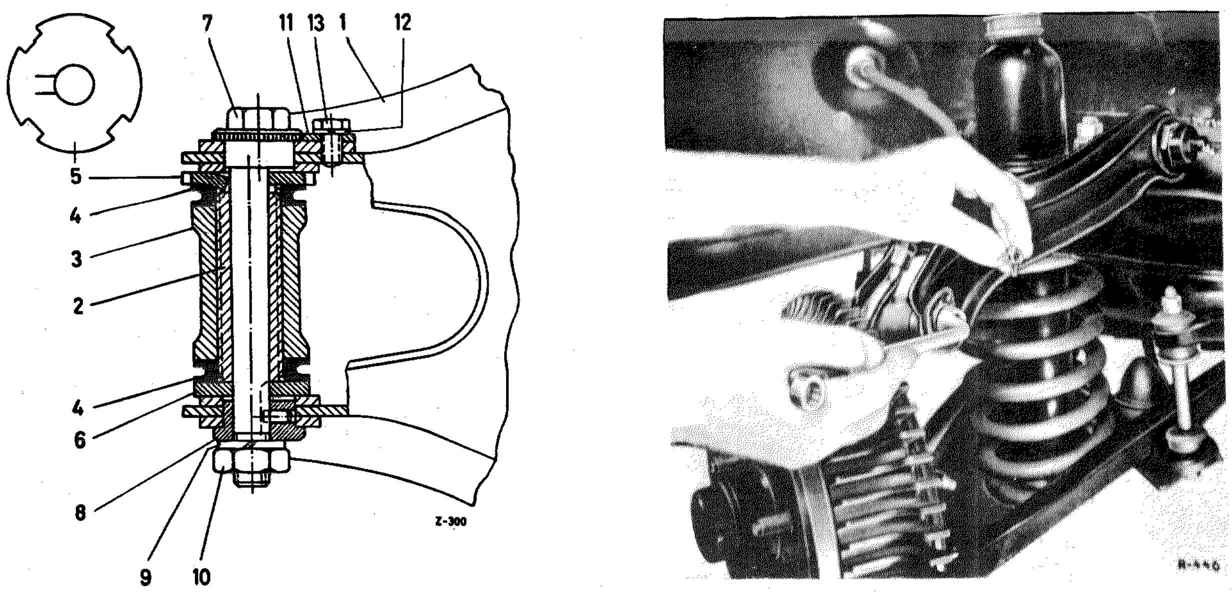


Fig. 40—3/2

1 Upper left control arm
2 Threaded bushing
3 King pin
4 Sealing ring
5 Adjusting washer for caster adjustment
6 Washer
7 Eccentric bolt for camber adjustment
8 Eccentric bushing
9 Lock washer
10 Hexagon nut
11 Locking plate
12 Lock washer
13 Hexagon screw

From the neutral position an adjustment of ± ½° is possible. **If in special cases the camber adjustment is not sufficient to achieve uniform camber at the left and the right, pivot pins can be installed on the upper control arms, whose fixing bores are offset ± 2 mm compared with the standard version.**

Offsetting the bores by —2 mm yields an alteration in the camber of approx. —½°; offsetting by + 2 mm yields an alteration of approx. + ½°. Pivot pins are obtainable as part No. 120 333 03 30 for the shorter version and as part No. 120 333 04 30 for the longer version.

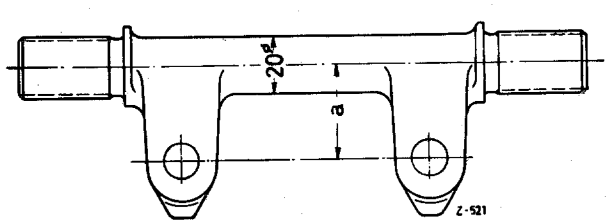


Fig. 40—3/2a

a = 35 mm standard version
a = 33 mm shorter version
a = 37 mm longer version

Rear Axle

The rear wheel camber varies according to the load, since the axle tubes swing about a common fulcrum. Variation in camber is, of course, less in the case of the single-jointed swing axle than in the case of the twin-jointed swing axle.

The rear wheels also assume a negative camber with increasing load.

It is advisable to adjust the rear wheel camber with the car in curb condition. In consequence of the difference in length of the axle tubes when the car is standing in a horizontal position, the camber is greater at the right than at the left. With the car in curb condition the difference amounts to approx. 0° 15′, and with the car in normally loaded condition to approx. 0° 30′.

To achieve optimum road-holding qualities the rear wheel camber should be adjusted to approx. + 1° 30′, with the car in curb condition.

With the car in normally loaded condition, the camber at the left is from —2° 30′ to —3° 30′, and at the right from approx. —3° to —4°. The relatively high tolerances with the car in loaded condition arise because of the tolerances in the rear axle suspension and because of the rubber buffers which extend the action of the springs.

Care must be taken to ensure that, when the car is in normally loaded condition, the camber never reaches a greater negative value than —4° since otherwise the upward spring deflection is too small and moreover there arises the danger of increased wear at the inside shoulder of the tire. Before the measurements are taken, the rubber buffers must be checked to ensure that they are in perfect condition. The camber of the rear wheels is adjusted by turning the spring plate (5) (Fig. 40 — 3/3). The spring plate can be turned to four notch positions; turning the spring plate one further notch causes an alteration of wheel camber of approx. 0° 10′. If it is not possible to adjust the camber sufficiently by turning the spring plate (5) an attempt may be made to adjust the camber to the specified value by adding or removing compensating rubber rings (9). (For further details see Job No. 32—5).

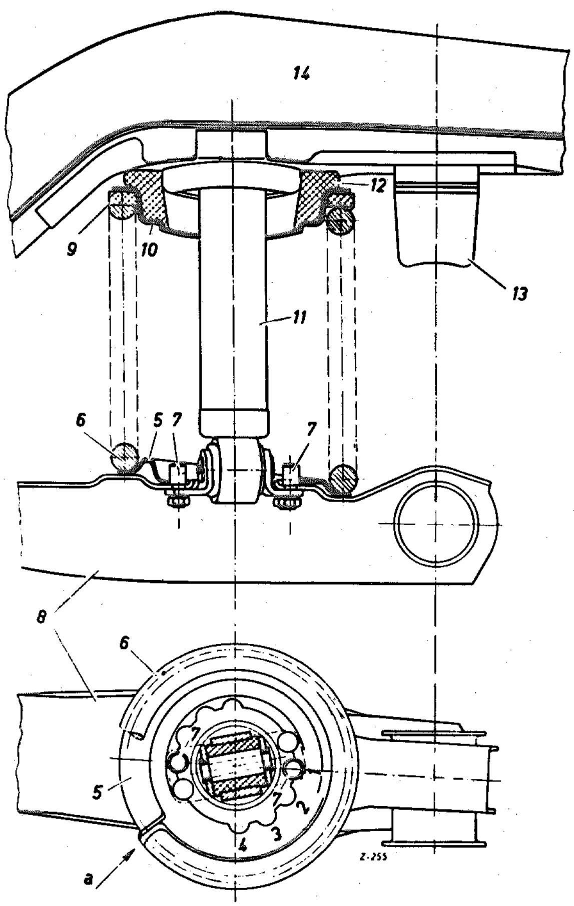


Fig. 40 — 3/3

1—4 Notch position
5 Lower spring plate
6 Spring
7 Cheese head screw
8 Torque arm
9 Compensating ring
10 Upper spring plate
11 Shock absorber
12 Rubber mounting
13 Rubber buffer stop
14 Chassis base panel
a = distance between the end of the spring and the heel of the spring plate

b) King Pin Inclination

The term king pin inclination designates the angle which the king pin forms with a line drawn at right angles to the surface of the road. This is measured by producing the center line of the king pin to meet a line drawn at right angles to the direction of travel and to the surface of the road.

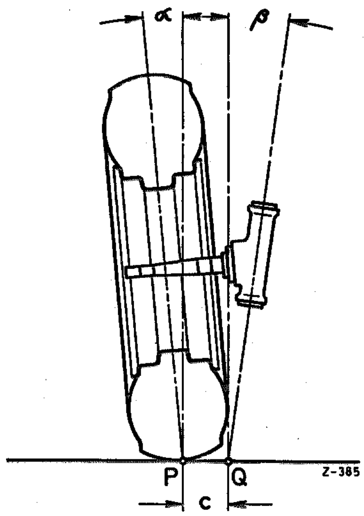


Fig. 40—3/4

a Camber in degrees
b King pin inclination in degrees
c Effective rolling diameter in mm
P Point of contact of the tire with the surface of the road
Q Point of intersection of the center line of the king pin and the surface of the road

The sum of the camber and the king pin inclination is constant, due to the design of the king pin. For this reason when the camber is adjusted, the king pin inclination is automatically adjusted as well.

c) Rolling Diameter

The term rolling diameter (rolling circle diameter) designates the distance (c) between the point of intersection (Q) of the center line of the king pin and the surface of the road and the point of contact (P) of the tire with the surface of the road (see Fig. 40—3/4). The rolling diameter is critical for ensuring easy steering action at low speed, e.g. when parking, since the tire describes a small arc when the steering is locked hard over. The contact surface in modern low pressure tires is so large that steering would be very heavy if the tire had to turn more or less on the spot when parking.

d) Caster

The term caster designates the angle which the axis of the king pin forms (when "produced" upward and rearward) with a line drawn at right angles to the surface of the road (Fig. 40—3/5). To measure this, the central axis of the king pin is produced to intersect with a plane parallel to the direction of travel and at right angles to the surface of the road.

The point of contact S of the tire with the surface of the road thus lies behind the point of intersection R of the axis of the king pin and the surface of the road.

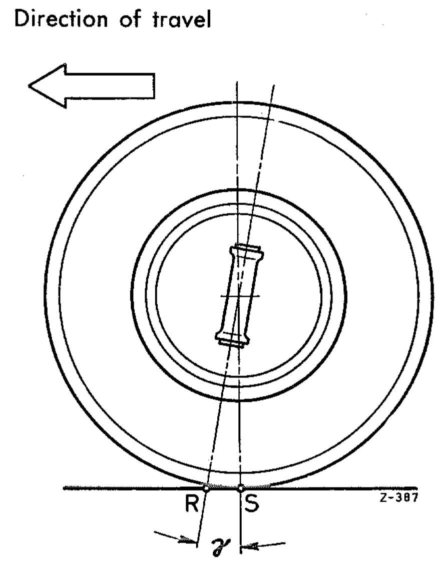


Fig. 40—3/5

γ Caster
S Point of contact of the tire with the surface of the road
R Point of intersection of the axis of the king pin and the surface of the road

Caster facilitates stable steering and automatic return of the road wheels to the straight-ahead position after cornering. The effect of the caster achieved by the angle of the king pin is the same as with the action of an ordinary dinner-waggon.

The magnitude of the caster angle is dependent on the loading of the car. In Model 190 the caster, allowing for all tolerances, is 2° 30′ to 4°, according to the loading of the car. The caster should be as nearly identical as possible between the right and the left. A discrepancy of approx. ½° is, however, permissible.

Caster can be adjusted by turning the threaded bushing (2) (Fig. 40—3/6).

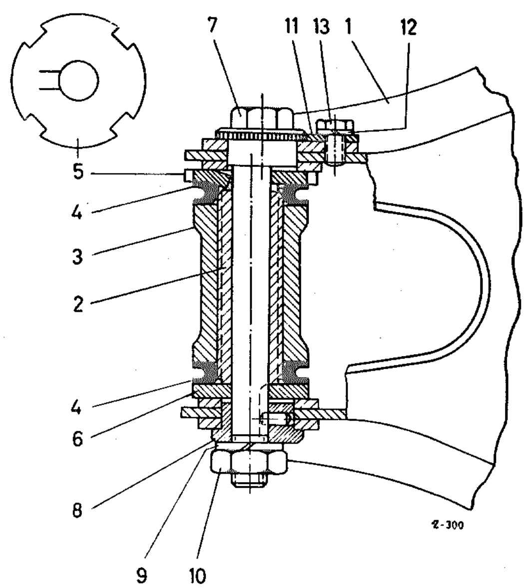


Fig. 40—3/6

1 Upper left control arm
2 Threaded bushing
3 King pin
4 Sealing ring
5 Adjusting washer for caster adjustment
6 Washer
7 Eccentric screw for camber adjustment
8 Eccentric bushing
9 Lock washer
10 Hexagon nut
11 Locking plate
12 Lock washer
13 Hexagon screw

After the hexagon nut (10) has been unscrewed, the threaded bushing (2) can be turned by turning the adjusting washer (5) with the aid of Special Wrench 180 589 00 05 (Fig. 40—3/6).

When the threaded bushing is in the neutral position, an adjustment of 1.5 mm in both directions is permissible. This allows a variation in caster of ± 0° 20′. A greater amount of adjustment is not permissible, since on the one side the rubber ring would be crushed and on the other it would no longer make a perfect seal.

A further limited adjustment of caster can be made by turning the upper control arm pivot pin one turn to the right or to the left from the neutral position. To do this it is necessary to take off the front wheel and remove the shock absorber. Then use Spring Tensioner 120 589 01 31 to compress the front spring so that the upper pivot pin is not under load and can be screwed off the front axle support.

e) Toe-in and Toe-out

The term toe-in (or toe-out) designates the difference in the distance between the wheel rims, at the front and at the rear of the wheels. Measurement for this is taken at a point level with the wheel centers, with the wheels set in the straight-ahead position (Fig. 40 — 3/7).

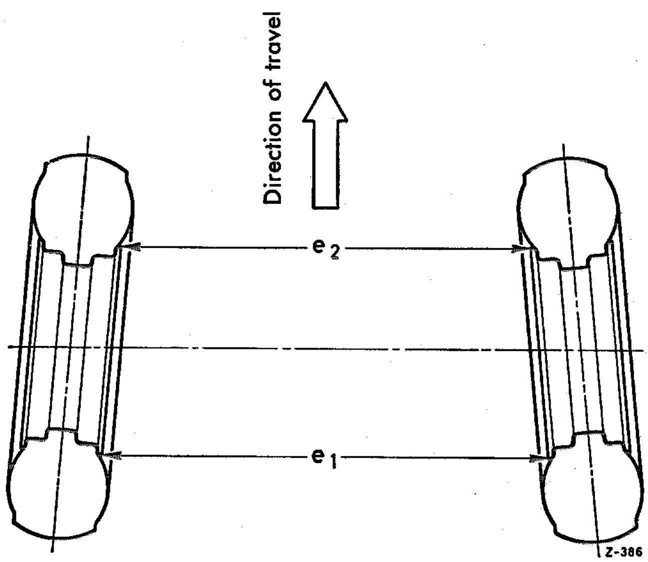


Fig. 40 — 3/7

$e_1 - e_2$ = toe-in (e_1 larger than e_2)
$e_2 - e_1$ = toe-out (e_2 larger than e_1)

Front Axle

Toe-in counteracts the tendency of the front wheels to spread — a tendency caused by the camber. Furthermore, owing to the slippage, lateral forces are brought into play which allow the vehicle to maintain a steady course.

Without toe-in, it is only with a greater angle of "yaw" that lateral forces come into play, so that the car would not maintain a steady course when travelling straight ahead. However, toe-in must not be excessive. If this is the case, considerable tire wear results. Toe-in for Model 190 is 0—2 mm.

When measuring toe-in, the front wheels must not be pressed toward each other at the rear. Toe-in must be measured with the car in normally loaded condition.

Toe-in can be altered by adjusting the lengths of the two tie-rods. To do this, the locking plate (3) must be tapped up, the hexagon nut (4) unscrewed, and the lock ring (2) must be tapped off the cone of the tie-rod tube (1) (Fig. 40 — 3/8).

Note: The tie-rod end on the left side of the tie-rods (seen in the direction of travel) has a left-hand thread. For purposes of identification the two tie-rod tubes have a milled edge on the left side.

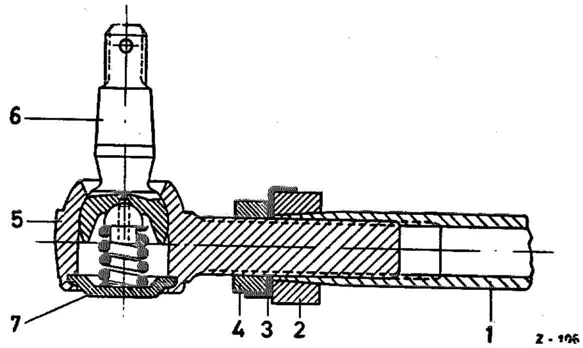


Fig. 40—3/8

1 Tie-rod tube
2 Lock ring
3 Locking plate
4 Hexagon nut
5 Ball head
6 Ball stud
7 Plug

The toe-in can now be adjusted by turning the tie-rod tube (1).

To adjust the toe-in, set the wheels in the straight-ahead position and lock them by means of Center Fixing Screw 186 589 00 23. Toe-in must be distributed evenly between the left and the right wheel. If an optical axle gage is not available, the front wheels must first be lined up parallel to the rear wheels, with the aid of Wheel Base Measuring Gage 136 589 07 21. In the absence of a gage, this alignment can be carried out with the aid of a straight-edge or simply visually.

The wheel base measurement at the left and the right must be equal.

After adjusting toe-in, press the lock rings (2) onto the tie rod tubes (1), tighten up the hexagon nuts (4) and tap over the locking plate (3). When tightening up the hexagon nuts (4), care must be taken to ensure that the ball-heads always rest against the ball pin in the direction of rotation of the hexagon nut. This ensures that the tie-rods are free to turn as required when the car is in motion. If they are incorrectly installed, the danger exists that the tie-rods will bend when the car is being driven. **For this reason it is necessary to carry out a check after adjusting toe-in, by turning the tie-rods to ascertain whether the tie-rod heads can turn to the full extent.**

Rear Axle

Toe-in at the rear axle should be nil. It is not normally necessary to measure toe-in at the rear axle; if, however, rear wheel tire wear is excessive, toe-in at the rear axle must be measured. If the toe-in or toe-out is found to exceed 2 mm, the fault may be bent axle tubes, bent torque arms or faulty seating of the step bearings supporting the torque arms. In the latter case, the rear axle mounting bolt will no longer be perpendicular to the road surface, as in the original design, but will be inclined forward or backward. In this case there will be considerable variation of toe-in, when the springs are fully depressed, and increased tire wear will result.

f) Track Angularity Differential

It is a known fact that when the front wheels turn about a definite angle, the lock of the outside wheel is less than that of the inside wheel, since the outside wheel has to describe an arc of greater diameter. The difference between the angle subtended by the tangent of the arc of the outside wheel and that of the inside wheel is designated the angle of track angularity differential (Fig. 40—3/9).

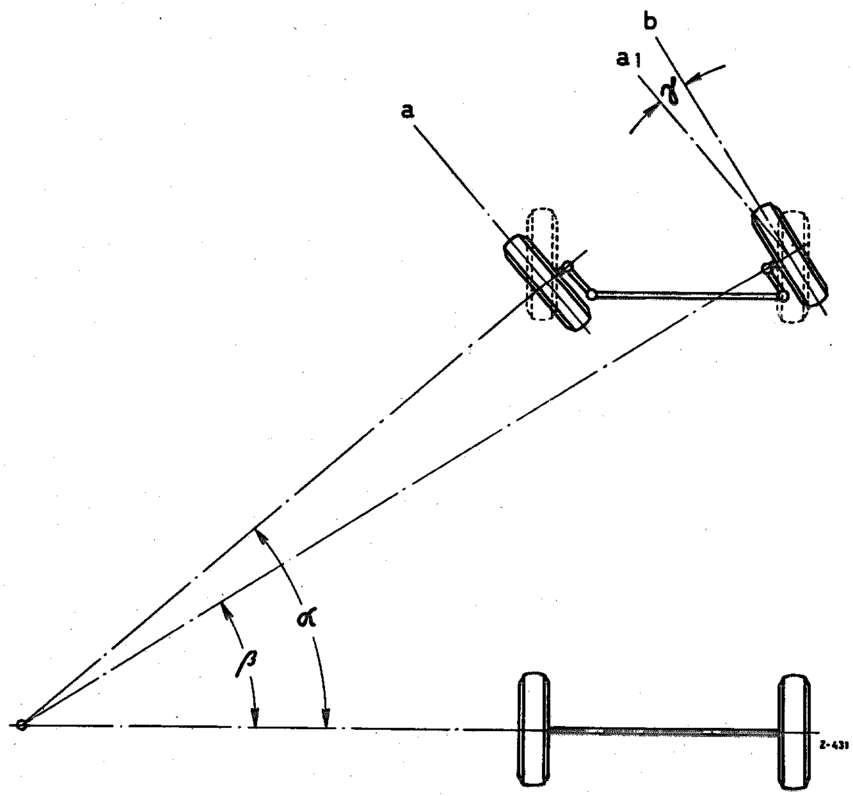


Fig. 40—3/9

a_1 = Parallel to a
γ = Track angularity differential
α = Angle of lock at the inside wheel
β = Angle of lock at the outside wheel

The track angularity differential for Model 190 at an inside wheel lock of 20° is —2° 30′.

In evaluating the track angularity differential, it must be borne in mind that the value indicated is determined geometrically. When the car is in motion considerable slip angles are generated independently of the radius of the curve and speed of travel, so that the track angularity differential most favorable for normal travel can only be ascertained by road tests. Deviations from the value specified are not critical for the behavior of the vehicle and especially not for tire wear. The track angularity differential should nevertheless be as nearly identical as possible on the left and the right locks.

g) Pivot Point Distance

Toe-in should remain constant when the front wheel springs are fully depressed. This is achieved in practice with sufficient accuracy by appropriate relative positioning of the ball pins on the steering gear arm or the steering relay arm, and on the steering knuckle arms (pivot point distance).

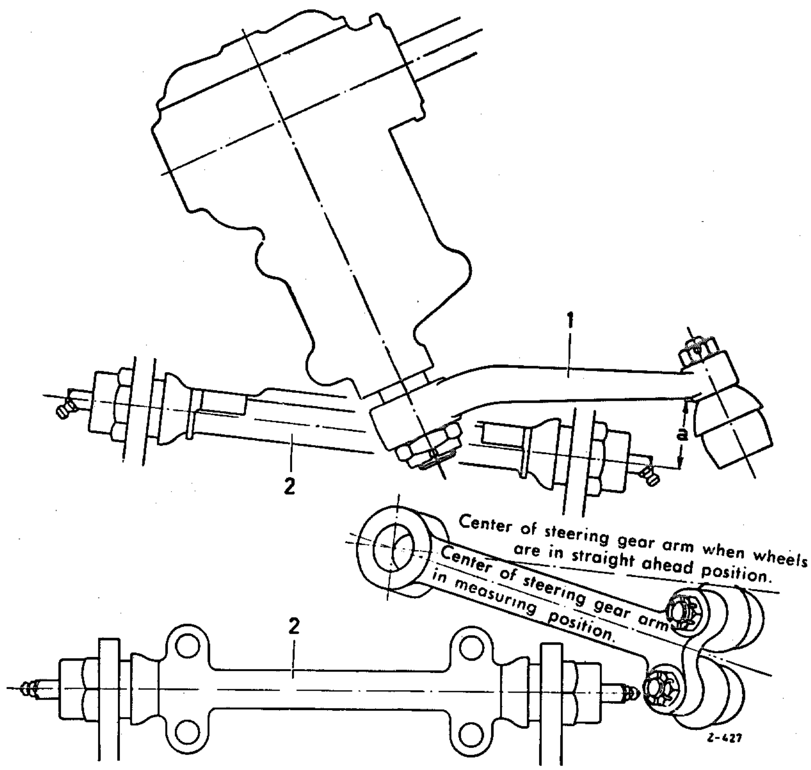


Fig. 40—3/10

1 Steering gear arm
2 Lower control arm pivot pin
a = 34 ± 2 mm

Larger variations in the pivot point distance manifest themselves in variation between toe-in of the wheels with the vehicle in curb condition and toe-in in normally loaded condition. This leads to considerable tire wear and tread defacement on the circumference of the tire.

If, when checking, a variation greater than 2 mm is discovered between the toe-in of the vehicle in curb condition and the toe-in in fully loaded condition, the pivot point distance must be checked.

It is normally sufficient to check the positioning of the ball pins on the steering gear arm and on the steering relay arm. Since in practice the central point of the ball pin cannot be measured, the distance a between the inner pivot pin on the lower control arm and the lower edge of the steering gear arm and steering relay arm must be checked (Fig. 40—3/10). When measurements are taken, the steering must be set in the measuring position. In the measuring position the extension of the pivot pin must be aligned with the measuring spot on the steering gear arm or steering relay arm (Fig. 40—3/10).

If the distance deviates from the prescribed distance, a = 34 ± 2 mm, the steering gear arm must be replaced. If a replacement is not available, the steering gear arm may be straightened cold: **In this case it is essential to carry out a careful check for cracks before reinstalling.**
The steering relay arm can be adjusted for height (see Job No. 46—11, Note: Paragraph 9). The steering gear arm and the steering relay arm must be at the same level when the vehicle is traveling straight ahead, i.e. the tie-rod must be horizontal. A deviation of up to 2 mm is permissible.
If, when the vehicle is in curb condition, the toe-in varies by more than 2 mm from the toe-in when the vehicle is in normally loaded condition, despite correct positioning of the steering gear arm and the steering relay arm, the cause is probably a bent steering knuckle arm. If this is the case, replace the steering knuckle arm.

h) Wheelbase

The term wheelbase designates the distance between the central points of the front and rear wheels (Fig. 40—3/11). The wheelbase at the left should be as nearly identical as possible with the wheelbase at the right. Differences of up to 5 mm between the wheelbase at the left and the right are permissible.

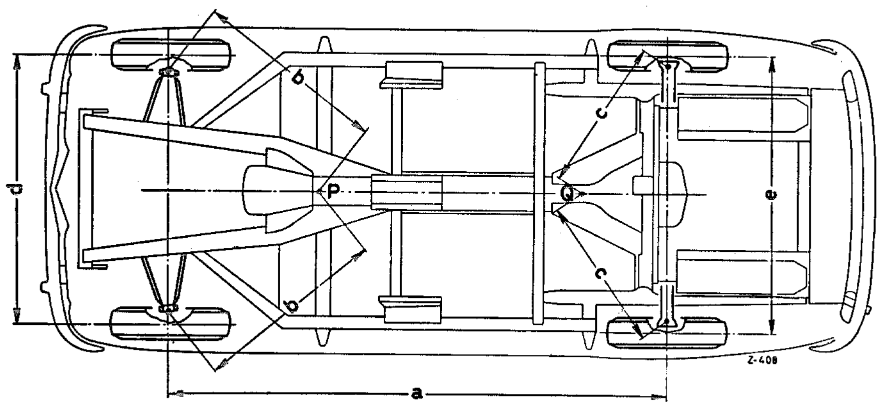


Fig. 40—3/11

P Check bore for front axle positioning distance
Q Check bore for rear axle positioning distance
a Wheelbase
b Front axle positioning distance
c Rear axle positioning distance
d Front axle track
e Rear axle track

i) Axle Positioning Distance

To facilitate adjustment of the front and rear axles, two check bores (P) and (Q) have been made on the chassis base panel along the longitudinal axis of the vehicle (see Fig. 40—3/11). By measuring from these check bores, the position of the front and rear axle can be checked (axle positioning distance b and c). In the case of the front axle a difference of up to approx. 5 mm is permissible. The axle positioning distance cannot be adjusted on the front axle. But a small correction is possible by turning the front axle support, after unscrewing the fixing screws.
Where greater deviations are found, check whether the front axle support is properly fitted, and whether the step-bearings for the front axle support are correctly positioned. Use chassis base panel gage to check the step bearings (see Job No. 61—1, Section B) and use the checking fixture designed for this purpose to check the front axle support (see Job No. 33—8).
A difference of 2—3 mm between the left and the right is permissible on the rear axle. It is possible to carry out a correction by adjustment of the cross strut (see Job No. 35—1).

k) Rear Axle Misalignment

The axle tubes of the rear axle must be perpendicular to the longitudinal axis of the vehicle. If, however, the rear axle becomes turned about the mounting bolt, this results in misalignment and a maximum value of 0° 20′ is permissible (Fig. 40—3/12).

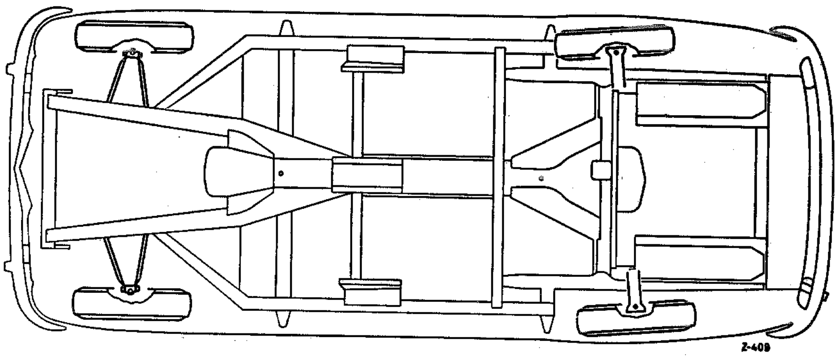


Fig. 40—3/12

If the misalignment is in excess of this value, considerable tire wear results. The rear axle can be straightened by adjusting the cross strut.

l) Lateral Axle Displacement

The term lateral axle displacement refers to the lateral offsetting of the rear axle, relative to the longitudinal axis of the vehicle.
An axle displacement of up to 20 mm is not normally a disadvantage when the vehicle is in motion. If considerable lateral axle displacement is present, the car will veer to the left (with engine pulling) and to the right (with car "driving" engine) or vice-versa, depending on whether the rear axle is offset to the right or to the left. It is usually unnecessary to correct this.

C. Wheel Adjustment Values

vehicle loading	Front axle							Rear axle						Wheel-base permissible difference in mm
	Camber	Toe-in in mm	Track angularity at 20° lock of inner wheel	Caster	King pin inclination	Pivot point distance in mm	Axle positioning distance permissible difference in mm	Camber left	Camber right	Toe-in or Toe-out in mm	Center position permissible deviation in mm	Axle positioning distance permissible difference in mm	Permissible misalignment up to	
curb condition	0° to 1°*	0–2	–	2° 50'* to 4°	5° 20' to 5° 40'	34±2	5	approx. +1° 30'	approx. +1° 45'	0±2	2	3	0° 20'	5
normally loaded	0° to 1°*	0–2	–2° 30'*	3° 10'* to 4° 10'	5° 20' to 5° 40'	34±2	5	–2° 30'** to –3° 30'	–3° ** to 4°	0±2	2	3	0° 20'	5

* This value should be as nearly identical as possible at both sides the maximum permissible difference is 0° 30'. The ideal value for front wheel camber = 0° 20' to +0° 40'.

** At the rear wheels a variation in camber of approx. 0° 30' if the car is in loaded condition, and of 0° 15', if the car is in curb condition, is normal. (The variation in camber at the left and the right arises from the design of the single-jointed swing axle, since the connecting pin of the axle halves lies outside the longitudinal axis of the car. For this reason right wheel camber is greater than left wheel camber).

Car in curb condition = Car in working order, with oil and water + full fuel tank + spare wheel + tool kit, but without passengers and luggage.

Car normally loaded = Car in curb condition + 6 × 65 kg load on the seats + 45 kg luggage in the trunk.

Front axle track	:	1430 mm
Rear axle track	:	1470 mm
Smallest turning circle diameter	:	approx. 10.7 m
Smallest track circle diameter	:	approx. 10.0 m

The smallest **turning circle diameter** is understood to be the diameter of a circle described by the circumferential extremities of the turning vehicle with the steering at full lock.

The smallest **track circle diameter** is understood to be the diameter of the circle described by the outside front wheel (center of tire) when turning with the steering at full lock.

Note: When too great a negative camber is present, particularly in the case of vehicles with special bodies produced by other firms, it is advisable to check the permissible axle load after weighing the vehicle in fully loaded condition, with a full fuel tank and all equipment (see Job No. 32 — 0 and Job No. 40 — 0, Section B). This is carried out by weighing the vehicle on a platform scale twice; the first time with only the front axle on the scale, and the second time with only the rear axle on the scale.
As a check the complete vehicle can then be weighed.

D. Tire Wear

Irregular and extreme tire wear occurs if the wheels are incorrectly adjusted. In many cases it is possible to detect incorrect wheel adjustment without the aid of any measuring device, purely by reference to typical tire wear diagrams. The following diagrams show some such tire wear phenomena and give in each case the cause.

a) Tire Wear Diagrams

(The arrow indicates in each case the direction of travel)

Excessive toe-in

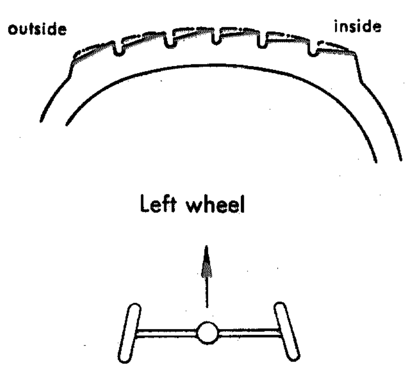


Fig. 40 — 3/14

The fault can occur at both the front and the rear axle.

Excessive toe-out

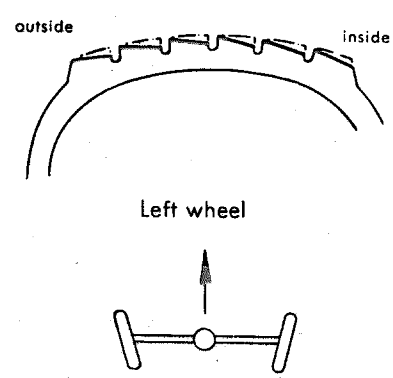


Fig. 40 — 3/15

The fault can occur at both the front and the rear axle.

Rear axle misalignment

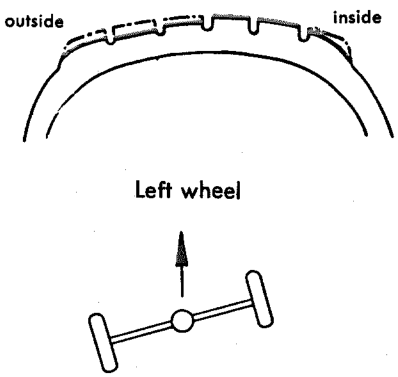


Fig. 40 — 3/16

The rear axle has misalignment but neither toe-in nor toe-out.

Front axle misalignment

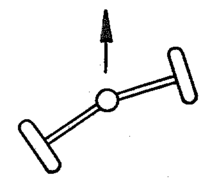


Fig. 40 — 3/17

A tire wear diagram results which is a combination of Fig. 40 — 3/15 and Fig. 40 — 3/16.

Wear at the Shoulder

rear axle front axle

Fig. 40 — 3/18

This tire wear pattern occurs even when driving mainly on freeways or national highways and does not indicate the presence of an adjustment error nor insufficient tire pressure.
The same fault occurs, however, when the vehicle is driven under normal conditions with insufficient tire pressure.
Wear at one shoulder, i.e. the outside shoulder, can occur on the front wheels when camber is excessive. If the tire is not seated firmly on the rim and can thus "wander", wear at the shoulder is especially likely to occur.
Wear at one shoulder occurs less frequently on the rear wheels, since the camber alters constantly when the car is in motion owing to the swinging of the axle tubes.
A certain tendency to wear at the inside shoulder can appear if the vehicle is driven constantly when heavily laden. Here too, perfect seating of the tire on the rim is important. It is therefore important that the interchanging of wheels as recommended is carried out in order to obtain even wear of all tires, including that on the spare wheel.

Flat surfaces

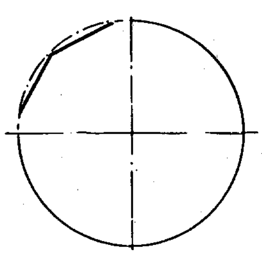


Fig. 40 — 3/19

a) Static or dynamic unbalance, or static and dynamic unbalance.
b) Excessive out-of-round at the rim.

Saw-tooth wear at the outer ribs

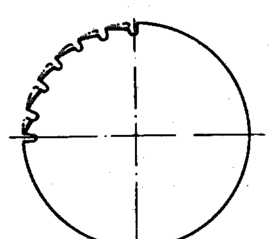


Fig. 40 — 3/20

Saw-tooth wear at the outside ribs is conditioned purely by the type of tread. This type of wear occurs only on front wheels.

In addition to incorrect wheel adjustment, defective shock absorbers can also be partly reponsible for uneven tire wear. If the shock absorbers are defective, the wheels tend to bounce on rough roads. This causes increased general wear and under certain circumstances uneven tire wear along the circumference (polygonal wear).

b) Judgement of Tires

If the tread of a tire is no longer clearly distinguishable along the whole of its surface, the tire is no longer safe. Depth of tread must be a minimum of 1 mm at the most worn point on the tread.

E. Preparation for Measurement

a) When measurements are taken, the tire wear on the left and the right wheels should be as nearly identical as possible. It is not permissible to measure with one very worn tire and one new tire. In such cases it is advisable to use special "measuring wheels", i.e. wheels with new tires, which are used only for this measurement work.

b) The tire pressure should be checked and, if necessary, corrected.

Tire pressure	front	1.7 atmospheres
	rear	1.8 atmospheres

c) The play in the steering units should be checked (see Job No. 46—3). Worn parts should be replaced or repaired.

Note: If an optical axle gage is used, the check for excessive play can also be carried out with this gage.

d) If parts of the front or the rear axle assemblies (e.g. springs or axle halves) or complete assemblies are replaced before the measurement is carried out, it is essential to make a road test beforehand. This is necessary because the sudden stresses which occur whilst the vehicle is in motion cause the replaced parts to alter their position again, so that the measurements taken would be inaccurate.

e) The wheels must be able to settle into position freely whilst under load. This is best done by allowing all four wheels to stand on ball-bearing skid plates. For the front wheels, plates are required which are free to move in all directions; for the rear wheels, it is sufficient to use plates which move laterally. If such plates are not available the car can, if necessary, be measured on fixed plates. The plates used should, however, be "neutrally" positioned under the wheels. The car should also be pushed and rocked to and fro sufficiently before measurement is begun.

It is sufficient to have a level surface if measurements are taken with an optical axle gage.

F. Measurement Charts

Always record all measurements on a measurement chart, which should be kept with the car's papers. This serves to establish whether measurements have altered, e.g. as a result of colliding with the curb when parking or because of an accident.

A measurement chart has been drawn up for use throughout all our branches and workshops and is suitable for use with all our models (see Page 40—3/23). The measurement charts can be obtained from the Central Service Department.

On the back of the measurement chart are listed the adjustment values for all our passenger models.

G. Measurement with an Optical Axle Gage

Measurements should be made wherever possible with an optical axle gage. We recommend for this purpose the Exacta-Gage manufactured by Müller (Heilbronn). When using this gage, the makers' instructions should be observed. However, the method – which is recommended by several of the firms marketing optical gages – of pressing the front wheels in toward each other at the rear, is not permissible for our cars. The correct method is to measure toe-in with the vehicle loaded and the wheels "rolled", not pressed in. The term "rolled" means that before measurements are taken, the car should be forcibly pushed to and fro and rocked by hand, so that the wheels can settle into a position of minimum stress.

H. Measurements with Mechanical Gages

For smaller workshops we have developed a number of mechanical gages, with which measurements can be made which are in general sufficiently accurate for practical purposes.

As is the case with an optical gage, measurement should be commenced at the rear axle, since all further measurements or adjustments are dependent on both the correct positioning of the rear axle relative to the longitudinal axis of the vehicle and the camber of the rear wheels.

a) Rear Axle Center Position and Axle Positioning Distance

The axle is in **center position** when the connecting pin, which is the fulcrum of the two axle halves, is parallel to the longitudinal axis of the car at a certain distance from it.

Use Master Gage 180 589 08 21 to check the axle for center position. The gage should be placed against the two torque arm mountings on the chassis base assembly (Fig. 40—3/21). If the center position is correct, the measuring pointer on the gage points to the center of the hexagon head of the connecting pin for the rear axle suspension (permissible lateral divergence 2 mm).

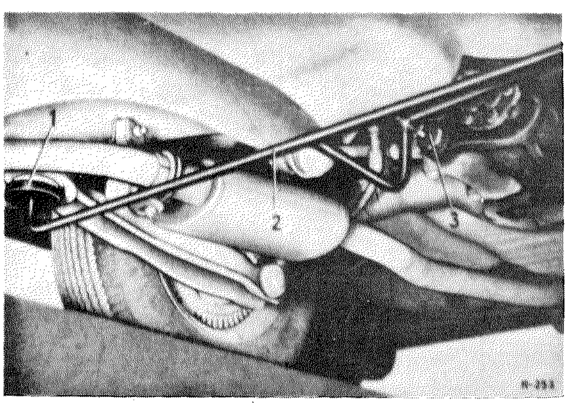
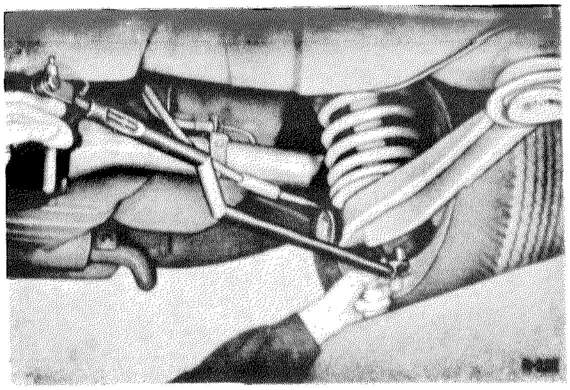


Fig. 40—3/21

1 Cup on torque arm mounting
2 Master Gage 180 589 08 21
3 Connecting pin hexagon screw

After checking the rear axle for center position, the axle positioning distance should be checked. The axle positioning distance should be measured with the aid of Master Gage 180 589 08 23. A measurement should be taken from the check bore on the chassis base to the torque arm fixing screw bores in the bearings of the two support tubes at the rear axle (Fig. 40—3/22).



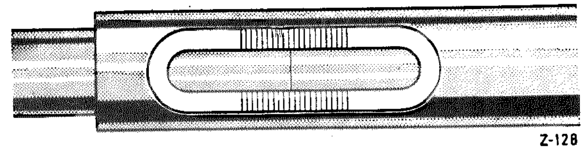


Fig. 40—3/22

For reasons of uniformity, measurement should always be taken first at the left side. The difference in distance (+ or —), as compared with the left side, should be entered on the measurement chart (permissible difference 3 mm). Lateral divergence from center position and rear misalignment can be corrected by adjustment of the cross strut.

b) Rear Wheel Toe-in (Toe-out)

Rear wheel toe-in or toe-out should be measured only if uneven tire wear occurs. If possible it should be nil, although divergences of up to ± 2 mm are permissible. The method of taking measurements is described in Section h) – Front Wheel Toe-in.

c) Rear Wheel Camber

Correct adjustment of rear wheel camber is particularly important for vehicles with independent rear suspension, in order to achieve optimum road holding qualities. Camber should therefore be measured both with the vehicle in curb condition and also in loaded condition. Measurement of camber is carried out with Camber and Caster Gage 180 589 02 21 (Fig. 40—3/23).

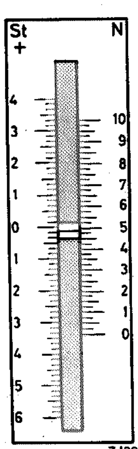
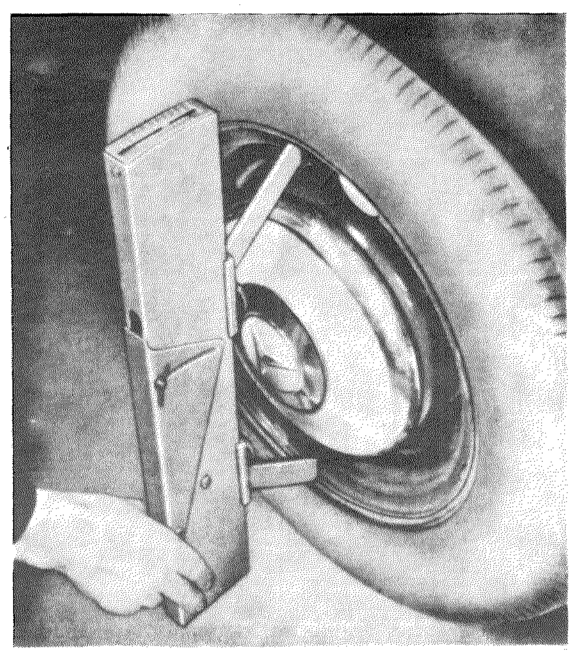


Fig. 40—3/23



Care must be taken to ensure that the measuring surfaces are brought into definite contact with the extreme edge of the rim and that the camber gage is held perpendicular, so that the measuring pendulum can swing freely and does not stick. The camber amount can be read off the left-hand scale on the gage (one graduation = 10′).

To counteract possible rim run-out, an average measurement should be taken by measuring at two opposite points. To do this proceed as follows:

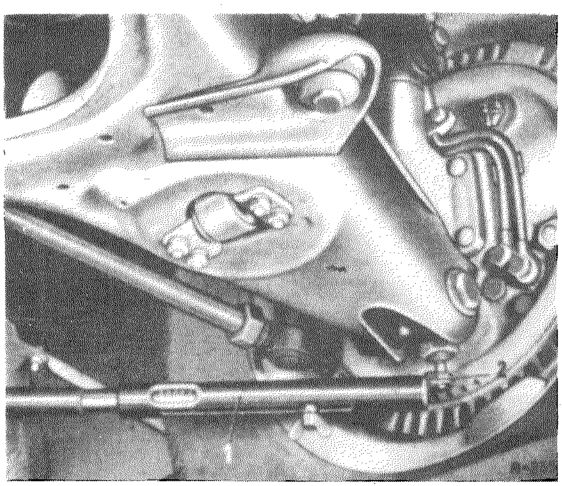
1. Place the gage in position and read off the amount of camber. (Example: + 1° 30′.)
2. Make a chalk mark where the upper tip of the gage touches the wheel.
3. Move the vehicle (in the direction of travel) until the chalk mark is at the bottom of the wheel.
4. Place the gage in position again and read off the amount of camber (Example: + 1° 50′).
5. The actual amount of camber is the mean of the two values read off the gage.

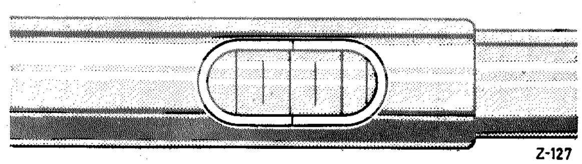
Example: $\frac{1^\circ 30' + 1^\circ 50'}{2} = \frac{2^\circ 80'}{2} = 1^\circ 40'$

The correct camber amounts are given in Section C.

d) Axle Positioning Distance for the Front Axle Halves

Use Master Gage (1) 180 589 02 23 to measure the axle positioning distance of the front axle halves; measurement should be made from the check bore in the chassis base assembly to the centering bores in the two king pins (Fig. 40 — 3/24).





Z-127

Fig. 40 — 3/24

1 Master Gage 180 589 02 23
2 Feeler inserted in the centering bore in the king pin

A difference of 5 mm between the left and the right halves is permissible. The axle positioning distance of the front axle halves cannot be adjusted. A slight correction is possible by removing the fixing screws on the front axle support and turning the support.

If greater divergences are found, a check should be made to see whether the control arms are bent, the front axle support is defective or the step-bearings for the front axle support are incorrectly positioned. Use the chassis base panel gage (see Job No. 61 — 1, Section B) to check the step bearings, and the specially designed checking fixture to check the front axle support (see Job No. 33 — 8).

e) Front Wheel Camber

As with the rear wheels, use the Camber and Caster Gage 180 589 02 21 to measure the front wheel camber. To counteract possible rim run-out, an average measurement should be taken as before (see Section c) Rear Wheel Camber).

f) King Pin Inclination

King pin inclination cannot be measured by mechanical means. It is determined by the design of the steering knuckles and can only be adjusted together with the camber.

g) Caster

The amount of caster is fixed by the design of the car. The adjusting mechanism serves merely to remove slight differences in left and right wheel camber.

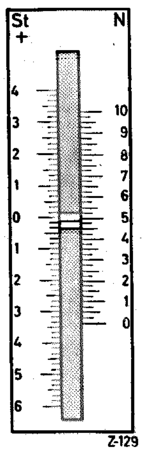


Fig. 40 — 3/25

Caster should be measured (as was the case when using the optical axle gage) by measuring the difference in camber amounts of the front wheels when set at a left and right lock of 20 .
There are two scales on Camber and Caster Gage 180 589 02 21. The left-hand scale gives the camber amount in degrees and minutes and the right-hand scale enables easier measurement of caster to be made. The figures on this right-hand scale, however, do not give the actual caster or camber amount. The caster must be calculated from the difference between the readings taken when the wheels are over at left and right lock (Fig. 40 — 3/25).

When taking measurements proceed as follows:

aa) Set the left wheel in the straight-ahead position; place a rule or draw a chalk line parallel to the road wheel at a distance of 200 mm from it.

bb) Pull out the 20° angle guide of Gage 180 589 02 21.

cc) Place the gage horizontally against the wheel. Now turn the wheel to the left until the rule or chalk line is parallel with the angle guide on the gage (Fig. 40 — 3/26).

dd) Now place the gage against the wheel rim, set it exactly to the vertical position, and read off the value shown on the right-hand scale (one graduation = 15′). Example: 7° 45′ (Fig. 40 — 3/27).

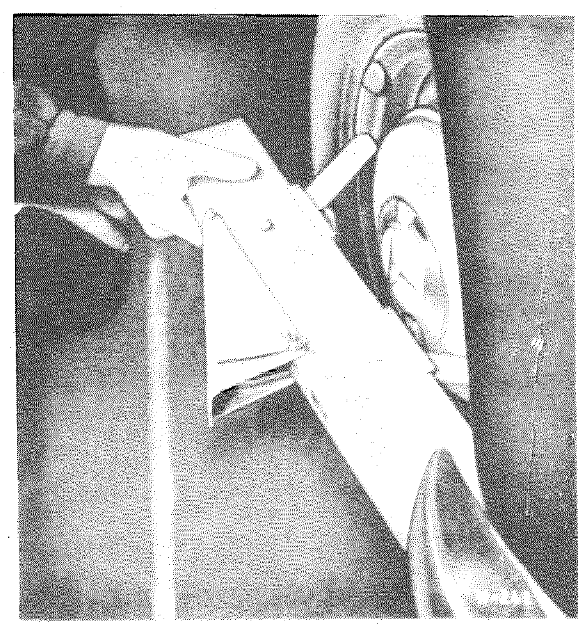


Fig. 40 — 3/26

Measurement at the right wheel

ee) Place the gage horizontally against the left wheel, this time with the gage turned to point in the other direction (i. e. turned through 180°). Now turn the road wheel to the right until once again the rule or the chalk mark is parallel to the angle guide on the gage when in the horizontal position.

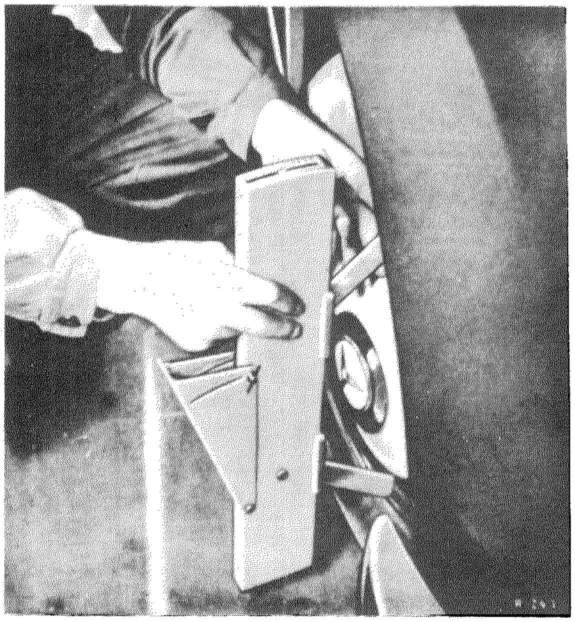


Fig. 40 — 3/27

ff) Place the gage in position as described under point dd) and again read off the value indicated.
Example: 4° 15′.

gg) **The difference between the two values is the caster.**

Example:

Left wheel

Reading at 20° left lock	= 7° 45′
Reading at 20° right lock	= 4° 15′
Difference left wheel caster	= 3° 30′

Note: It should be noted that left wheel caster must be greater when at left lock than at right lock, and right wheel caster must be greater at right lock than at left lock, since the car is designed to have positive caster.

If negative caster is found, there must be a major defect in the front axle (e.g. bent control arm etc.).

hh) Measurement at the right wheel should be carried out in the same way.

h) Toe-in of Front Wheels

The toe-in must be measured at the height of the horizontal diameter of the wheel and with the steering in a straight fore-and-aft position. For this purpose, Center Position Check Screw 186 589 00 23 must be screwed into the steering housing cover instead of the closing plug. When this is done, care must be taken to ensure that the point of the screw enters the centering bore in the steering shaft arm. The toe-in must be equally distributed at the left and right wheels. To ensure this, use should be made of Wheel-base Measuring Gage 136 589 07 21 in order first to line up the front and rear wheels so that they are parallel. If this equipment is not available, the alignment can be made with the aid of a straight-edge or it can be sighted out.

The toe-in must be measured with the vehicle normally loaded. When measuring the toe-in, the front wheels must not be pressed together at the rear.

Measurement is made by means of Track Measurement Gage 000 589 05 21. When measuring, the following procedure should be adopted:

aa) Set the distance between the rims at the front wheels at the rear on the gage. Fix in this position. (Fig. 40 — 3/28).

bb) Make a chalk-mark on the wheel at the point at which measurement is to be made.

cc) In order to obviate any difficulty which might be caused by rim run-out, measurement should be made at two places and the average taken. The vehicle should therefore be moved in the direction of travel a half-turn of the wheels so that the chalkmark is now at the front.

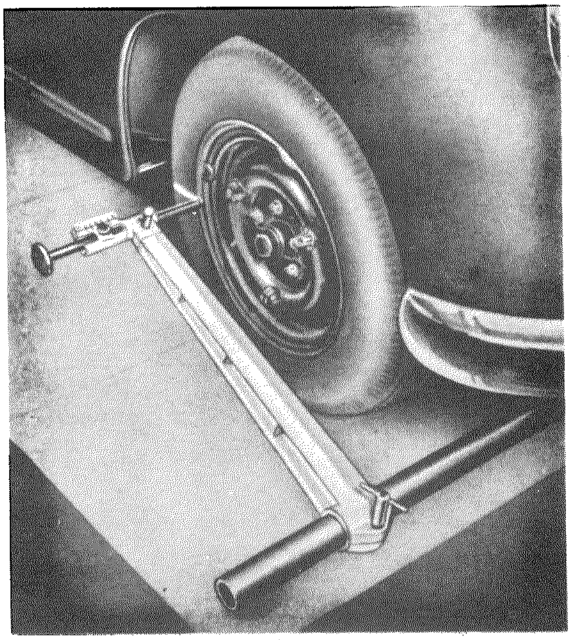


Fig. 40 — 3/28

dd) Now set the distance between the rims at the front on the gage and read off the difference between the distances at the front and at the rear. This measurement is the toe-in of the vehicle in mm.

Note: After adjusting the toe-in, a check must be made to see whether the steering knuckle arm of the left steering knuckle at left lock and the steering knuckle arm of the right steering knuckle at right lock strike against the lower steering knuckle support. The left and right steering locks must be limited by the steering knuckle supports and not by the steering housing (Fig. 40 - 3/29). (For further details see Job No. 33 — 2).

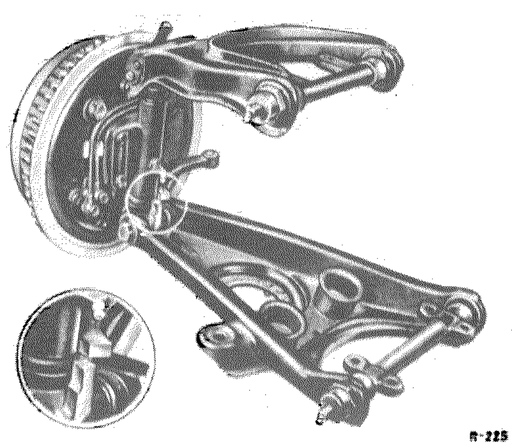


Fig. 40 — 3/29

i) Wheel-base

Measurement of the wheel base is made principally in order to assist in the adjustment of the toe-in of the front wheels. The wheel-base must only be measured when the center position check screw is actually screwed into the steering. Measurement is taken from the center of the rear axle shaft to the center of the front axle stub. Wheel-base Measuring Gage 136 589 07 21 is used (Fig. 40 — 3/30).

1 Centering bore of front axle stub
2 Wheel-base Measuring Gage 136 589 07 21
3 Centering bore of rear axle shaft

Fig. 40 — 3/30

Data Sheet for
Vehicle Measurement

Model: .... Mileage: ....

Chassis No: ....

First Licensed: ....

Owner: ....

Branch/Agent ....

Measured by: .... Date: ....

Customer's complaint: ....

Make of tires, front: rear:

Condition of tires: front, left rear, left
front, right rear, right

Tire pressure checking and correction

Front: atm. rear: atm.

			Measurements: Before correction vehicle, curb condition	Before correction vehicle, normally loaded	After correction vehicle, curb condition	After correction vehicle, normally loaded
Front axle	Wheel bearing play in° (with optical axle gage)	left				
		right				
	Axle positioning distance difference from left to right in mm					
	Pivot point distance in mm	steering gear arm				
		relay arm				
	Toe-in or toe-out*	in °				
		in mm				
	Camber in °	left				
		right				
	Caster Measurement: Reading or camber left	at 20° left lock				
		at 20° right lock				
	Caster Measurement: Caster left	in °				
	Caster Measurement: Reading or camber right	at 20° right lock				
		at 20° left lock				
	Caster Measurement: Caster right	in °				
	Track angularity diff. in ° (with optical axle gage)	left				
		right				
Rear axle	Center positioning or lateral divergence	in mm				
	Axle positioning distance difference from left to right or rear axle misalignment	in mm				
		in °				
	Toe-in or toe-out*	in °				
		in mm				
	Caster in °	left				
		right				
Wheel-base difference from left to right		in mm				

* Toe-in = +, toe-out = −. The toe-in must be measured with the wheels settled in their neutral position. They must not be pressed together. The toe-in must be measured with the wheels in the straight fore-and-aft position. At the same time the steering must be in the center position. Toe-in and camber must be measured on an average of two diametrically-opposed points in order to obviate difficulties caused by any rim run-out.
(For further details on vehicle measurements, see Workshop Manual, Model 190, Job. No. 40–3).

Model		Tire pressure front	Tire pressure rear	Normal load capacity of vehicle in kg	Front axle: permissible wheel bearing play mech. in the axial direction in mm	Front axle: permissible wheel bearing play optical in min	Front axle: permissible axle-positioning distance diff. from left to right in mm	Front axle: Pivot point distance in mm	Front axle: Pivot point distance permissible deviation from steering gear arm to steering relay lever in mm	Front axle: Toe-in in mm	Front axle: Toe-in in °	Front axle: Camber in °	Front axle: Caster in °	Front axle: Track angularity diff. at 20° lock of inner wheel in °	Rear axle: permissible departure from center position in mm	Rear axle: permissible axle positioning distance difference from left to right or permissible rear axle misalignment in mm	Rear axle: permissible axle positioning distance difference from left to right or permissible rear axle misalignment in °	Rear axle: permissible toe-in (+) or toe-out (−) in mm	Rear axle: permissible toe-in (+) or toe-out (−) in °	Rear axle: Camber left in °	Rear axle: Camber right in °	permiss wheel-b differer from l to rig in mm
180 180 D	curb condition	1.7	1.8		0.005	10′	5	34 ± 2	2	0 - 2	0° - 0° 20′	± 0° to + 1° 3)	2°50′ - 4°	approx. −2°30′ 4)	2	3	0°25′	±2	±0°20′	approx. +1°30′	approx. +1°45′	5
	normally loaded			6 × 65 + 45									3°10′ - 4°10′							−2°30′ 5) to −3°30′ 6)	−3° to −4°	
190	curb condition	1.7	1.8		0.005	10′	5	34 ± 2	2	0 - 2	0° - 0° 20′	± 0° to + 1° 3)	2°50′ - 4°	approx. −2°30′ 4)	2	3	0°25′	±2	±0°20′	approx. +1°30′	approx. +1°45′	5
	normally loaded			6 × 65 + 45									3°10′ - 4°10′							−2°30′ to −3°30′ 6)	−3° to −4°	
190 SL	curb condition	1.7	1.8		0.005	10′	5	34 ± 2	2	0 - 2	0° - 0° 20′	± 0° to + 1° 3)	3° - 4°	approx. −2°30′ 4)	2	3	0°25′	±2	±0°20′	+0°30′ to + 1°	+0°45′ to +1°15′	5
	normally loaded			3 × 65 + 30									3°30′ - 4°30′							−2°40′ to −3°30′ 6)	−3°10′ to −4°	
219 220 a 220 S	curb condition	1.6	1.7		0.005	10′	5	30 ± 2	2	0 - 2	0° - 0° 20′	± 0° to + 1° 3)	2°50′ - 4°	approx. −0°30′ 4)	2	3	0°25′	±2	±0°20′	approx. +1°30′	approx. +1°45′	5
	normally loaded			6 × 65 + 45									3°30′-4°10′							−3°15′ to −3°45′ 6)	−3°45′ to −4°15′	
300 b 300 c	curb condition	1.7 1.7	1.9[1] 1.7[2]		0.005	10′	2	20^{+1}_{-3}	2	0 - 2	0° - 0° 15′	± 0° to + 1° 3)	2° - 3°	approx. −2°30′ 4)	2	3	0°25′	±2	±0°20′	approx. +1°15′	approx. +1°30′	5
	normally loaded			6 × 65 + 45									2°15′ - 3°30′							−3° 5) to −3°30′ 6)	−3°30′ to −4°	
300 S 300 S c	curb condition	1.8	2.0		0.005	10′	2	20^{+1}_{-3}	2	0 - 4	0° - 0° 30′	± 0° to + 1° 3)	2° - 3°	approx. −2°30′ 4)	2	3	0°25′	±2	±0°20′	approx. +1°15′	approx. +1°45′	5
	normally loaded			3 × 65 + 30									2°30′ - 3°30′							−1°45′ 5) to −2°15′ 6)	−2°15′ to −2°45′	
300 SL	curb condition	2.0	2.2		0.005	10′	2	18.5±2	2	2 - 4	0°15′ - 0°30′	± 0° to + 1° 3)	3°30′ - 4°30′	approx. −2°30′ 4)	2	3	0°25′	±2	±0°20′			5
	normally loaded			2 × 65 + 25									4° - 5°							−3° to −3°45′	−3° to −3°45′	

) Model 300 b.
) Model 300 c.
) As nearly as possible identical on both sides; permissible maximum difference 30′. The ideal is a camber of + 0°20′ to + 0°40′ with vehicle loaded.
) As nearly as possible identical on both sides at left and right lock. Maximum difference 30′. See also Workshop Manual, Model 190, Job No. 40 — 3.
) On models fitted with double-jointed swing axle, the camber is the same at the left and the right; in each case the camber value given for the left is applicable.
) On models fitted with single-jointed swing axle, the difference in camber between left and right is approx. 0°30′ with vehicle loaded. (The variation in camber left-right results from the design of the single-jointed swing axle where the connecting pin of the axle halves does not lie on the longitudinal axis of the vehicle).

Vehicle in curb condition = vehicle in running order with oil and water + full fuel tank + spare wheel + tool kit but without passengers and luggage.
Vehicle normally loaded = vehicle ready for the road + load according to Table. (The two first figures indicate the load on the seats and the last one the weight in the trunk compartment).

Propeller Shaft

Propeller Shaft — Group 41

Job No.	Operation	Page
41 — 1	**Removal and Installation of Propeller Shaft**	41 — 1/1
41 — 4	**Disassembly and Reassembly of Propeller Shaft**	41 — 4/1
	A. Disassembly and Reassembly of Front and Rear Propeller Shaft	41 — 4/1
	B. Removal and Installation of the Annular Grooved Bearing of the Intermediate Bearing	41 — 4/2
	C. Replacing Universal Joint Spider in Front or Rear Propeller Shaft	41 — 4/4

Removal and Installation of Propeller Shaft

Job No.
41—1

Removal:

1. Unscrew the wing nut for adjusting the hand brake cable.

2. Bend up the locking plates at the joint flange of the rear propeller shaft and disconnect the propeller shaft from the flange of the rear axle.

3. Remove the brake equalizer from the guide grooves along the side of the propeller shaft housing of the chassis base panel and detach the return spring. Pull back the brake equalizer and push it upward outside the housing.

4. Mark the relative position of the slip coupling and the propeller shaft, pull the slip coupling toward the rear and remove (Fig. 41 — 1/1).

Note: It is necessary to mark the relative position of the two parts in order to ensure that on reinstallation the slip coupling is installed in exactly the same position. The propeller shaft and the slip coupling have been balanced together; if their relative position is changed, the result may be increased unbalance and consequently drumming of the propeller shaft.

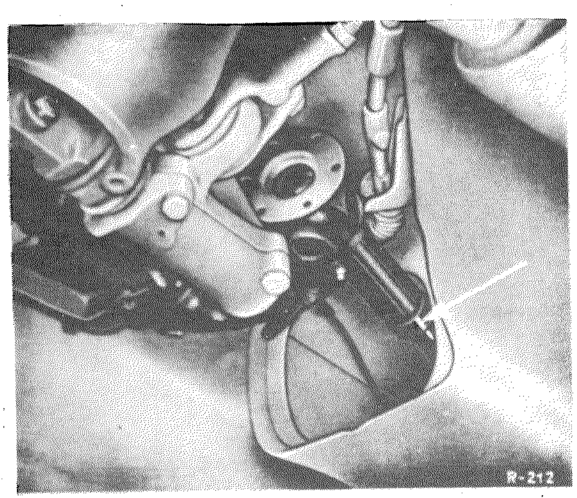


Fig. 41 — 1/1

5. Disconnect the propeller shaft at the transmission flange. The shaft plate remains attached to the transmission.

6. Detach the cover plate for the propeller shaft intermediate bearing.

   Mark the position of the bearing bracket on the chassis base panel (5) and unscrew the two fixing screws (4) for the bearing bracket (Fig. 41 — 1/2).

   Turn the bearing bracket by 180 so that the attaching face points upward.

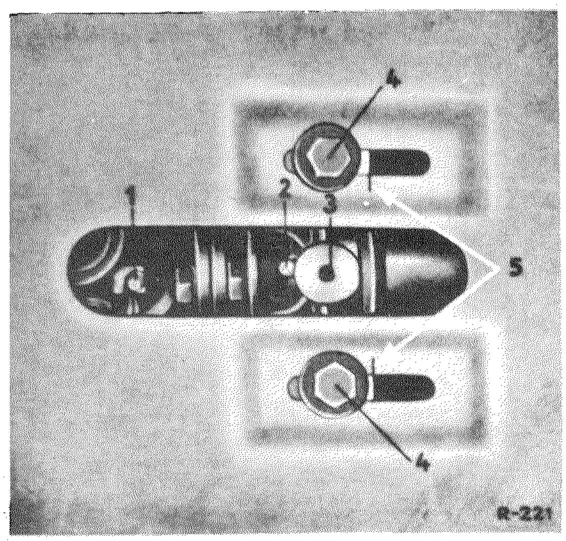


Fig. 41 — 1/2

1 Front universal joint pinion rim grease fitting
2 Pinion rim grease fitting for annular grooved bearing
3 Threaded bore for cover plate fixing screw
4 Fixing screw for bearing bracket
5 Position marking of bearing bracket on chassis base panel

7. Push the propeller shaft into the lower left corner of the housing and remove toward the rear (Fig. 41 — 1/3).

Note: During removal, lift the intermediate bearing and the front propeller shaft by means of Fork 120 589 02 61 in order to prevent the propeller shaft from catching on the ribs in the housing.

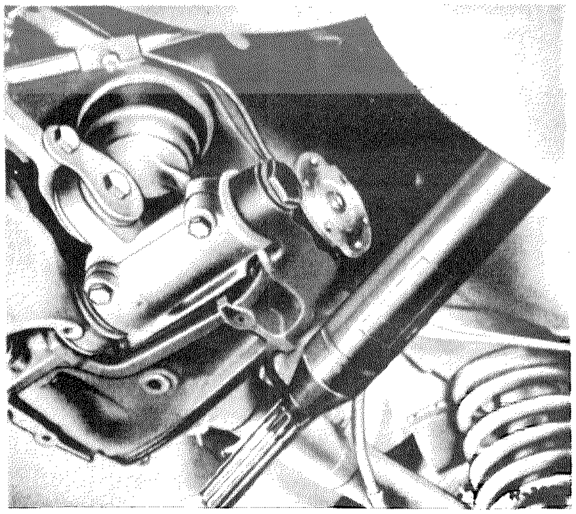


Fig. 41 — 1/3

8. After removal of the propeller shaft check the three-way flange at the transmission for run-out.

   To do this, remove the shaft plate at the transmission and check the run-out by means of Tester 136 589 04 21 (Fig. 41 — 1/4).

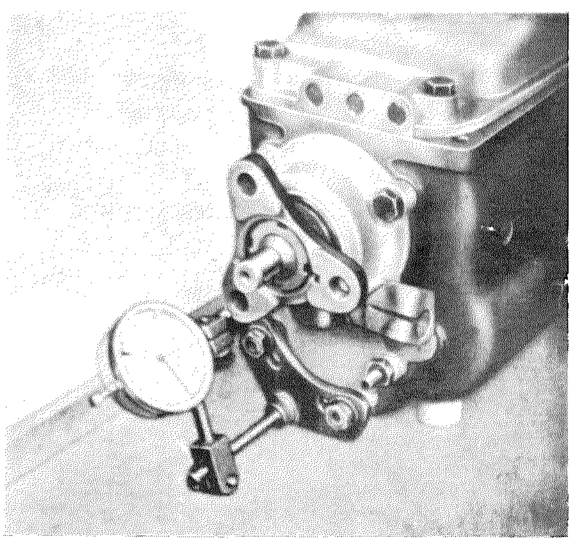


Fig. 41 — 1/4

The run-out is measured at the outside diameter and must not exceed 0.1 mm; if the run-out is greater, change the position of the three-way flange on the splined shaft extension in order to compensate for any additional run-out of the main shaft in relation to the three-way flange. If after that the run-out of the three-way flange still exceeds 0.1 mm the flange can be turned down to a minimum thickness of 8.5 mm. Otherwise the three-way flange must be replaced.

9. In special cases it is advisable also to check the run-out of the circular flange of the rear axle, using Tester 136 589 04 21.

   The run-out is measured at the outside diameter and should not exceed 0.02 mm; if the run-out is greater, change the position of the circular flange on the drive pinion shaft.

   If this does not improve the situation, the circular flange can be turned down to a minimum thickness of 5.7 mm.
   Otherwise the circular flange must be replaced.

Installation:

10. Attach the shaft plate to the transmission three-way flange and cotter the fitted screws. Use the three short fitted screws (see Fig. 41 — 1/5). Install the shaft plate in such a way that the double links are under tensile stress. For this purpose the bores (1) must always be connected to the three-way flange of the transmission (Fig. 41 — 1/4a). On the recent versions of the shaft plate the bores (1) are marked as shown in the picture below (see 'a').

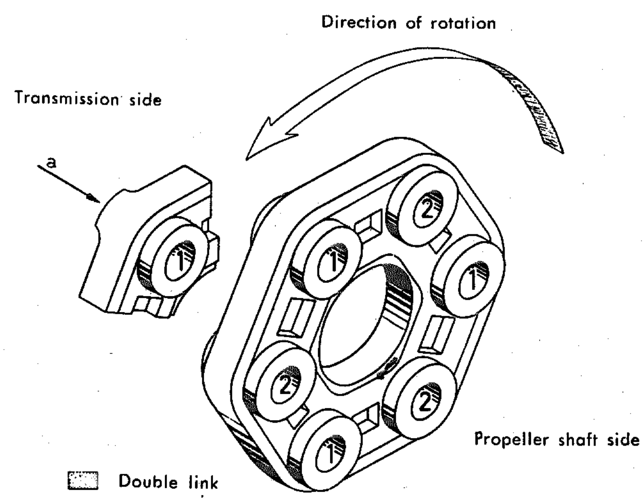


Fig. 41 — 1/4 a

1 Attach to three-way flange of transmission
2 Attach to three-way flange of propeller shaft

On the old type of shaft plate the double links can easily be distinguished by bending the shaft plate at a point between two bores. There is a considerable difference in the degree of stiffness between the double links and the single links. If the shaft plate is not mounted correctly its life will be shortened.

11. Remove the slip coupling from the propeller shaft, if a new shaft is to be installed. Before doing so, mark slip coupling and propeller shaft.

12. Turn the bearing bracket of the propeller shaft intermediate bearing so that the attaching face points upward.

13. Push the brake equalizer upward and slide the propeller shaft into the housing in the chassis base panel past the rear axle on the left.

Note: When sliding in the intermediate bearing and the front propeller shaft, lift them by means of Fork 120 589 02 61 in order to prevent the shaft from catching on the ribs of the housing.

During installation make sure that the brake cable does not wind itself round the propeller shaft.

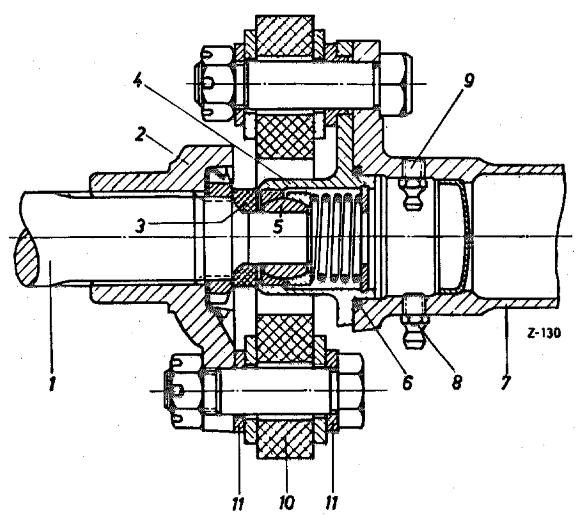


Fig. 41 — 1/5

1 Transmission main shaft
2 Three-way flange on main shaft
3 Sealing ring
4 Center cross
5 Locating ball
6 Sealing ring
7 Propeller shaft
8 Pinion rim grease fitting
9 Relief grease fitting
10 Shaft plate
11 Washer

14. Slide the sealing ring (3) on the journal of the transmission main shaft (1) between the three-way flange (2) and the center cross (4). Do not omit the sealing ring (6) between center cross (4) and propeller shaft flange (Fig. 41 — 1/5).

15. Turn the bearing bracket of the intermediate bearing in such a way that the attaching face points downward again.

16. Install the slip coupling on the splined extension of the propeller shaft, paying attention to the marking (see Fig. 41 — 1/1).

17. Connect the propeller shaft to the flange of the transmission (see Fig. 41 — 1/5).

    To do this install the three long fitted screws through the flange of the propeller shaft and through the shaft plate.

    Install the castle nuts together with the washers and cotter them.

18. Attach the propeller shaft to the flange of the rear axle. Use new locking plates.

19. Attach the propeller shaft intermediate bearing without forcing (see Fig. 41 — 1/2).

    Note the position marked during the removal operation.

20. Attach the brake equalizer and the return spring.

21. Install the brake cable in the brake lever and tighten the wing nut until the hand brake is correctly adjusted (see Job No. 42 — 19, Section C).

22. Apply grease to all lubricating points on the propeller shaft:

a) Pinion rim grease fitting (8) at the front of the propeller shaft, lubricating the center cross and the centering head (see Fig. 41 — 1/5).

Note: The pinion rim grease fitting inside the propeller shaft operates as a relief valve so that the air can escape during lubrication. The lubricating operation is completed as soon as grease emerges from the pinion rim grease fitting.

b) Pinion rim grease fitting (1) at the center universal joint (see Fig. 41 — 1/2).

c) Pinion rim grease fitting (2) for the intermediate bearing (see Fig. 41 — 1/2).

d) Pinion rim grease fitting for the rear universal joint (Fig. 41 — 1/6).

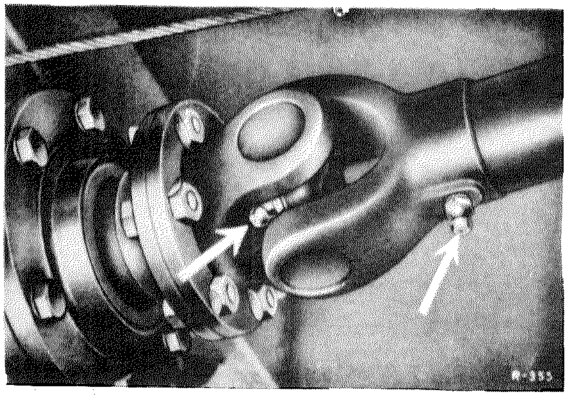


Fig. 41 — 1/6

e) Pinion rim grease fitting on slip coupling (Fig. 41 — 1/6).

Note: The slip coupling must not be overlubricated, since otherwise the propeller shaft would become subject to axial thrust.
On recent models the cover (6) on the splined hub (5) has been provided with a bore (a) and the pinion rim grease fitting (4) has been repositioned (Fig. 41 — 1/7).

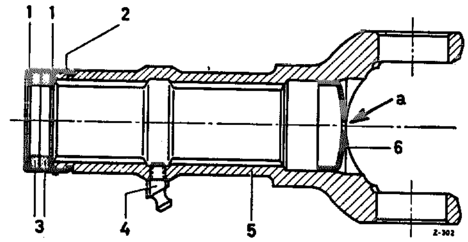


Fig. 41 — 1/7

1 Washer
2 Sealing ring retainer
3 Sealing ring; tallowed wool felt
4 Pinion rim grease fitting
5 Splined hub of universal joint
6 Cover
a Outlet bore diameter 2 mm

During lubrication the air can escape through bore (a). As soon as grease emerges, the lubricating operation is completed.

This arrangement guarantees easy movement of the slip coupling, since no thrust can build up and no grease buffer can form between the front of the splined hub and the cover.

It is impossible to make a corresponding change on older models, since apart from making the bore (a), the pinion rim grease fitting would have to be changed and also the splined hub would have to be altered.

23. After lubrication install the cover plate for the propeller shaft intermediate bearing.

Disassembly and Reassembly of Propeller Shaft

Job No.
41 — 4

Note: As a rule no repairs should be carried out on the universal joints. If the universal joints are damaged in any way, the front or rear propeller shaft should be replaced.

For this reason either the propeller shaft assembly, including the intermediate bearing, or the front or rear propeller shaft, is available as a replacement part. The spiders should only be replaced in exceptional cases, and only if the bores in the shaft yokes are still fully serviceable.

For such cases the spiders are supplied as part No. 180 410 01 31 complete with needle bearing bushings, bearing needles, sealing ring retainer, sealing ring, and pinion rim grease fitting.

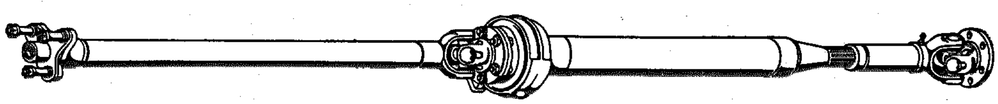


Fig. 41 — 4/1

A. Disassembly and Reassembly of Front and Rear Propeller Shaft

Disassembly:

1. Tap up the locking plates for the fixing bolts at the flange (5) and unscrew the hexagon nuts (Fig. 41 — 4/2).

2. Tap back the hexagon bolts and separate the front and rear propeller shafts (Fig. 41 — 4/2).

3. If the rear propeller shaft or the complete propeller shaft assembly is to be replaced, remove the bearing bracket (3) and the rubber mounting (4) of the intermediate bearing toward the rear (see Fig. 41 — 4/2).

Note: Replacement supply procedures have recently been changed in so far as both the propeller shaft assembly and the rear propeller shaft are supplied without bearing bracket (3) and without rubber mounting (4) (see Fig. 41 — 4/2).

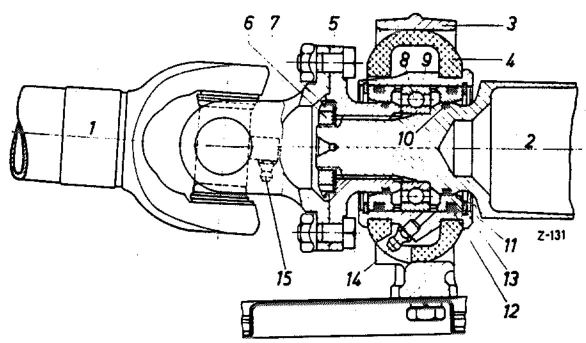


Fig. 41 — 4/2

1 Front propeller shaft yoke
2 Rear propeller shaft
3 Bearing bracket
4 Rubber mounting
5 Flange
6 Grooved nut
7 Locking plate
8 Annular grooved bearing
9 Housing of propeller shaft intermediate bearing
10 Oil ring
11 Spacer ring
12 Rubber sealing ring
13 Snap ring
14 Pinion rim grease fitting for annular grooved bearing
15 Pinion rim grease fitting for universal joint

4. If the front propeller shaft is to be replaced, remove the center cross (4) (Fig. 41 — 4/3).

Note: This is necessary, since the front propeller shaft is supplied without center cross.

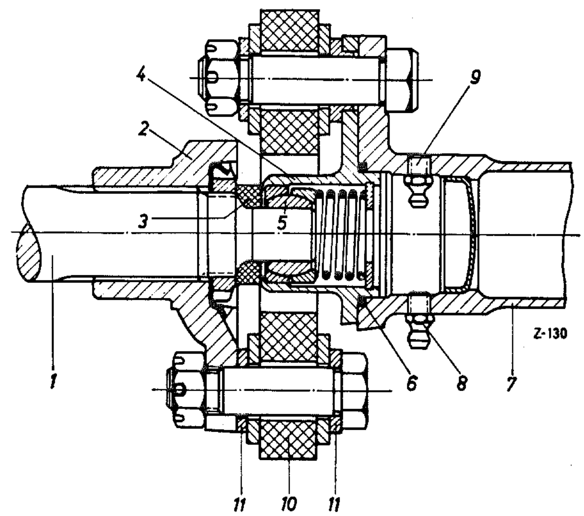


Fig. 41 — 4/3

1 Transmission main shaft
2 Three-way flange on main shaft
3 Sealing ring
4 Center cross
5 Locating ball
6 Sealing ring
7 Propeller shaft
8 Pinion rim grease fitting
9 Relief grease fitting
10 Shaft plate
11 Washer 187 990 14 40

5. Check the center cross (4).
   If the locating ball (5) is worn or if the spring is broken, replace the center cross assembly (see Fig. 41 — 4/3).

Reassembly:

6. Screw the two propeller shaft halves together, using new locking plates.

7. Slide a new rubber sealing ring onto the center cross (see Fig. 41 — 4/3) and insert the center cross in the front propeller shaft.

Note: A pinion rim grease fitting (8) is screwed in at the front of the propeller shaft, lubricating the locating ball (5) and the center cross of the transmission main shaft.

The pinion rim grease fitting (9) inside the propeller shaft operates as a relief valve so that the air can escape during lubrication.

The lubrication operation is completed as soon as grease emerges from the pinion rim grease fitting (9) (see Fig. 41 — 4/3).

B. Removal and Installation of the Annular Grooved Bearing of the Intermediate Bearing

Removal:

8. Pull the slip coupling off the splined journal of the rear propeller shaft.

Note: Both slip coupling and splined journal must be marked before the propeller shaft is removed from the vehicle (see Job No. 41 — 1, Paragraph 4).

9. Tap up the locking plate (7) and unscrew the grooved nut (6) by means of Special Wrench 187 589 06 07 (Fig. 41 — 4/4) and pull off the flange (5).

10. Unscrew the pinion rim grease fitting.

    Then pull out the bearing bracket (3) and the rubber mounting (4) toward the front (see Fig. 41 — 4/4).

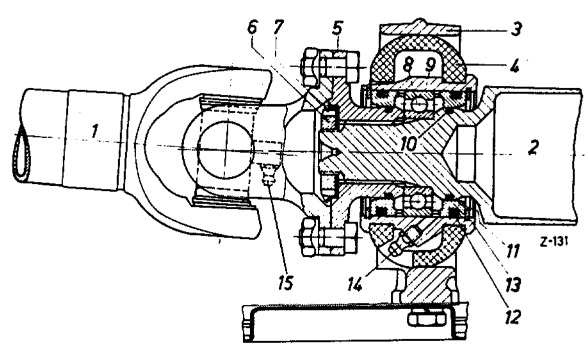


Fig. 41 — 4/4

1 Front propeller shaft yoke
2 Rear propeller shaft
3 Bearing bracket
4 Rubber mounting
5 Flange
6 Grooved nut
7 Locking plate
8 Annular grooved bearing
9 Housing of propeller shaft intermediate bearing
10 Oil ring
11 Spacer ring
12 Rubber sealing ring
13 Snap ring
14 Pinion rim grease fitting for annular grooved bearing
15 Pinion rim grease fitting for universal joint

11. Pull off the housing (9) of the propeller shaft intermediate bearing, together with spacer rings (11) and annular grooved bearing (8), by means of a suitable puller (see Fig. 41 — 4/4).

12. Take the oil rings (10) off the propeller shaft and the flange (see Fig. 41 — 4/4).

13. Remove the snap rings (13) on both sides of the housing (9) and press the two spacer rings (11), together with the annular grooved bearing, out of the housing (see Fig. 41 — 4/4).

14. Remove the two rubber sealing rings (13) from the spacer rings.

Checking:

15. Check the housing (9) for cracks.

16. Check the annular grooved bearing for serviceability.

Note: When new, the annular grooved bearing DIN 6006 — C 3 has a radial play of 0.020 to 0.037 mm and an end play of approx. 0.20—0.37 mm. In judging the serviceability of the bearing, apply the standards laid down in Job No. 35 — 5 for Ball and Roller Bearings.

17. Check the spacer rings (11) for wear (see Fig. 41 — 4/4). Worn spacer rings must be replaced.

18. Check the rubber mounting (4) for cracks. If the rubber mounting is cracked or has deteriorated as a result of contact with grease, it must be replaced.

19. Check the bearing bracket (3) for cracks.

Installation:

20. Insert the front snap ring (13) in the housing (9).

21. Press the spacer ring (11) with a new rubber sealing ring (12) into the housing in such a way that the beveled side points toward the outside (see Fig. 41 — 4/4).

The spacer ring must fit snugly against the snap ring.

22. Press the annular grooved bearing into the housing.

23. Press the second spacer ring (11) with a new rubber sealing ring (12) into the housing in such a way that the beveled side points toward the outside and a recess at the inside of the spacer ring lies above the bore for the grease passage (see Fig. 41 — 4/4).

24. Insert the rear snap ring (13) (see Fig. 41 — 4/4).

25. Install a new oil ring (10) on the propeller shaft and on the flange (see Fig. 41 — 4/4).

26. Carefully tap the housing (9), together with the annular grooved bearing, onto the splined journal of the propeller shaft.

27. Slide the rubber mounting (4) and the bearing bracket (3) onto the housing (9) of the propeller shaft intermediate bearing (see Fig. 41 — 4/4). Screw in the pinion rim grease fitting.

28. Tap the flange (5) onto the splined journal and install a new locking plate (7).

29. Screw on the grooved nut (6) by means of Special Wrench 187 589 06 07 and tighten firmly (Fig. 41 — 4/4).

30. Tap over the locking plate (7) in the direction of the grooved nut and the flange (see Fig. 41 — 4/4).

31. Slide the slip coupling onto the rear splined journal, paying attention to the markings made during removal.

Note: If necessary, replace the felt ring in the slip coupling.

C. Replacing Universal Joint Spider in Front or Rear Propeller Shaft

Disassembly:

32. Press out the four crescent-shaped snap rings (1) from the four needle bearing bushings (2) of the spider (Fig. 41 — 4/5).

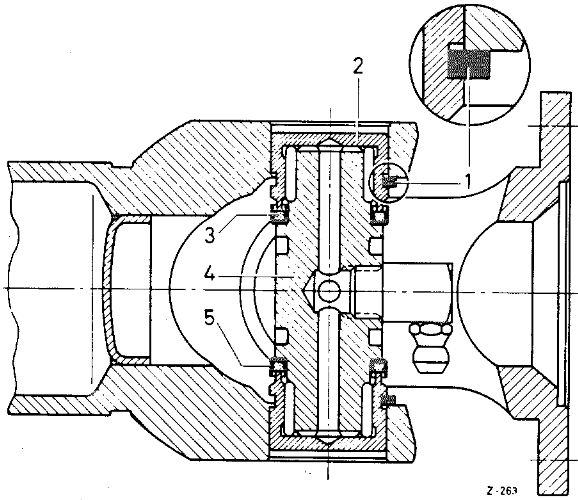


Fig. 41 — 4/5

1 Crescent-shaped snap ring
2 Needle bearing bushing
3 Sealing ring
4 Spider
5 Sealing ring retainer

33. Using a suitable support (2), place the yoke of the joint flange (3) under an arbor press (Fig. 41 — 4/6).

34. Use a suitable sleeve (4) to press the yoke (1) down as far as possible (see Fig. 41 — 4/6), thus pressing out the needle bearing bushing.

35. Turn the yoke over and press the opposite needle bearing bushing out in the same way.

36. Then press the needle bearing bushings out of the other yokes.

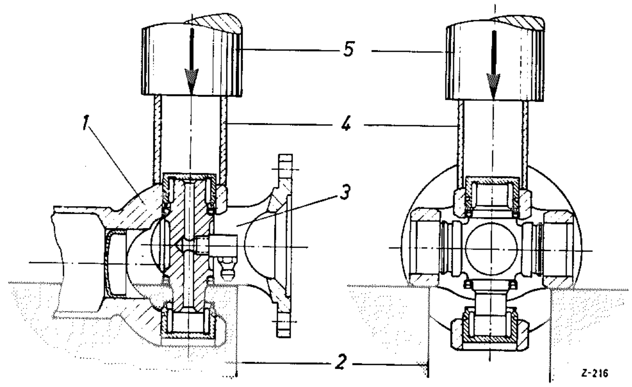


Fig. 41 — 4/6

1 Yoke
2 Support
3 Joint flange
4 Sleeve
5 Arbor

Checking:

37. Check the bores in the yokes. For measurements see Table below. If the bores are worn, the yokes must not be repaired; the front or rear propeller shaft assembly must be replaced.

38. The needle bearing bushings are available in two sizes (see Table below).

Select the needle bearing bushings to comply with the specified oversize fit.

Note: As replacement parts the spiders are supplied complete with needle bearing bushings and needles. When ordering replacements, please indicate whether size I or II is required. It is not permissible to replace individual needles or to replace the needle bearing bushings without a new spider.

Dimensions and Tolerances of Needle Bearing Bushing and Shaft Yoke in mm

Type	Marking	External diameter of needle bearing bushing	Bore in shaft yoke	Force-fit dimension	Internal diameter of needle bearing bushing	Trunnion diameter	Clearance
I	1 white dot	26.015 / 26.022	26.000 / 26.010	+ 0.005 to + 0.022	20.120 / 20.107	15.089 / 15.100	0.02 to 0.05
II	2 white dots	26.023 / 26.028	26.011 / 26.021	+ 0,002 to + 0.017			

Reassembly:

39. Put the yoke on a suitable support and press a needle bearing bushing with needles in slightly more than half its length (Fig. 41 — 4/7).

Note: Make sure that the correct size needle bearing bushing is fitted.

Use as little grease as possible to hold the needles in the needle bearing bushings; the trunnions of the spider should only be given a very light coating of grease.

The 22 needles of a needle bearing bushing must not be installed in another needle bearing bushing.

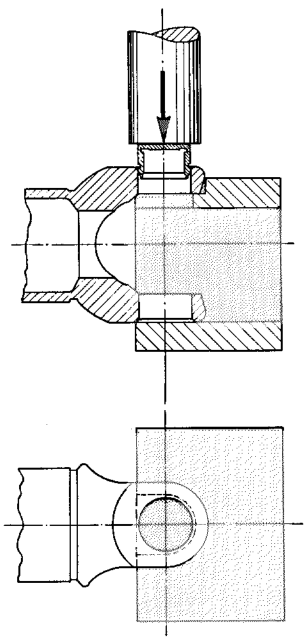


Fig. 41 — 4/7

40. Install the spider, with pinion rim grease fitting screwed in and with new pressed-cork seals (3), into the needle bearing bushing which is pressed in halfway (see Fig. 41 — 4/9).

Note: When installing the slip coupling and the corresponding joint flange, make sure that the pinion rim grease fittings point in the same direction (Fig. 41 — 4/8).

The pinion rim grease fittings of the front propeller shaft and of the universal joint must also point in the same direction.

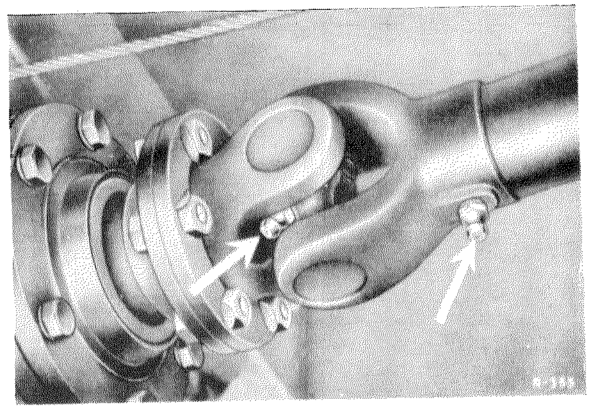


Fig. 41 — 4/8

41. Press the needle bearing bushing home and install the crescent-shaped snap ring (1) (Fig. 41 — 4/9).

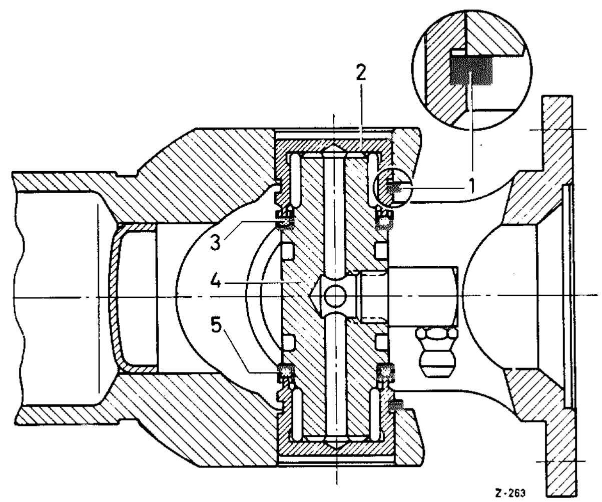


Fig. 41 — 4/9

1 Crescent-shaped snap ring
2 Needle bearing bushing
3 Sealing ring
4 Spider
5 Sealing ring retainer

42. Put in the opposite needle bearing bushing and press it in.

43. Install a crescent-shaped snap ring (1) in the second needle bearing bushing (see Fig. 41 — 4/9).

44. Then put the yokes on a support and relieve the stresses by a tap with a plastic hammer.

Note: The yoke must slowly drop by its own weight.

If the universal joints are difficult to move, install thinner crescent-shaped snap rings. If the joints move too freely, install thicker crescent-shaped snap rings. The crescent-shaped snap rings are available in the following thicknesses:

1.6 mm	Part No. 180 994 09 34
1.65 mm	Part No. 180 994 08 34
1.7 mm	Part No. 180 994 10 34

This check must be made with the utmost care since the universal joints become noisy on a change-over from pushing to pulling if they have too much axial play. If the joints do not move easily, the needle bearings tend to become scored.
For the same reason it is necessary to ensure that on reassembly a minimum of grease is used, since otherwise it becomes impossible to rely on experience when determining the axial play.

45. The other needle bearing bushings are installed in the same way.

Brakes

42

Brakes — Group 42

Job No.	Operation	Page
42—0	**The Brake System**	42—0/1
	A. General	42—0/1
	B. Description of the Brake System	42—0/3
42—1	**Bleeding and Flushing-out of Brake System**	42—1/1
	A. General	42—1/1
	B. Bleeding the Brake System without Special Equipment	42—1/3
	C. Bleeding the Hydraulic System with ARC 50 Power Bleeder	42—1/5
	D. Bleeding the Hydraulic System with ATE Filler and Bleeder AW 34 204	42—1/6
	E. Flushing Out the Hydraulic System with Special Flushing Equipment	42—1/8
42—2	**Checking the Brake System**	42—2/1
42—3	**Removal and Installation of Brake Master Cylinder**	42—3/1
42—4	**Disassembly and Reassembly of Brake Master Cylinder**	42—4/1
42—5	**Removal and Installation of Front Wheel Brake Cylinder**	42—5/1
42—6	**Removal and Installation of Rear Wheel Brake Cylinder**	42—6/1
42—7	**Disassembly and Reassembly of Brake Wheel Cylinders**	
	A. Front Brake Wheel Cylinder	42—7/1
	B. Rear Brake Wheel Cylinder	42—7/2
42—8	**Removal and Installation of Front Brake Shoes**	42—8/1
42—9	**Removal and Installation of Rear Brake Shoes**	42—9/1
42—10	**Disassembly and Reassembly of the Automatic Adjustment**	42—10/1

Job No.	Operation	Page
42—11	**Replacement and Resurfacing of Brake Linings**	42—11/1
	A. Replacement of Brake Linings	42—11/1
	B. Reconditioning Brake Linings	42—11/2
42—12	**Reconditioning the Brake Drums**	42—12
42—13	**Brake Lines**	42—13/1
42—14	**Removal and Installation of ATE Power Brake T 50**	42—14/1
42—15	**Subsequent Installation of ATE Power Brake T 50 (Optional Extra SA 10/143)**	42—15/1
	A. Installation	42—15/1
	B. Maintenance of ATE Power Brake	42—15/5
42—16	**Trouble Shooting Hints for the Brake System**	42—16/1
42—18	**Ratchet and Brake Lever of Pistol-Grip Hand Brake**	42—18/1
	A. Removal and Installation of Hand Brake Ratchet	42—18/1
	B. Removal and Installation of Hand Brake Lever	42—18/2
42—19	**Center and Rear Brake Cables**	42—19/1
	A. Replacement of Center Brake Cable	42—19/1
	B. Replacement of Rear Brake Cable	42—19/2
	C. Adjustment of the Hand Brake	42—19/3

The Brake System

Job No.
42 — 0

A. General

The efficacy and dependability of the brake system of a vehicle are of particular importance for traffic safety. The chief function of the brakes is to absorb the kinetic energy of the moving vehicle. The kinetic energy is converted into heat. The efficacy of a brake system is judged by the mean deceleration attainable. In the relevant German road traffic law the following values are laid down for passenger cars:

Specified mean deceleration
for the service brake: = 2.5 m/sec/sec
for the hand brake: = 1.5 m/sec/sec

The mean deceleration can be computed from the initial velocity of the vehicle and the stopping distance. The stopping distance is the distance the vehicle travels from the moment the brakes are applied until it comes to a stop.

The mean deceleration can, however, also be determined from the initial velocity and the stopping time.

For any given vehicle the stopping distance is dependent on the following factors (assuming that the pedal force applied remains constant):

1. Type and condition of the brake
2. Weight of the vehicle
3. Speed at the moment of brake application (Initial velocity)
4. Condition of the tires
5. Condition of the road surface

Computation of the Stopping Distance

In accordance with basic mechanical formulae, the stopping distance is given by the following equation:

$$s = \frac{v \times t}{2} = \frac{b \times t^2}{b} = \frac{v^2}{2 \times b} \text{ (m)}$$

where

s = stopping distance in m
v = velocity in m/sec
t = stopping time in sec
b = deceleration in m/sec/sec

If the velocity is to be expressed in km/h, the equation is

$$s = \frac{v^2}{26 \times b} \text{ (m)}$$

or for the mean deceleration

$$b = \frac{v^2}{26 \times s} \text{ (m/sec/sec)}$$

The mean deceleration can be determined from the initial velocity and the stopping time by means of the basic equation

$$b = \frac{v}{3.6 \times t} \text{ (m/sec/sec)}$$

The best method of determining the mean deceleration is to measure the stopping distance and to measure the initial velocity with the help of a calibrated speedometer. However, the stopping distance cannot be measured with sufficient accuracy by measuring the tire marks since at the beginning of the braking operation there are no visible tire marks on the road surface. For accurate measurements, therefore, paint markers are used which mark the road surface with a spot of paint at the beginning and at the end of the braking operation.

For practical purposes it is sufficient to determine the mean deceleration by means of a commercial decelerometer. The decelerometer, however, does not indicate the mean deceleration but the maximum deceleration attained during the braking opération. As a rule it can be assumed that when the brakes are fully applied at medium speed (approx. 70—80 km/h), the mean deceleration is roughly 0.8 times that of the maximum deceleration indicated by the decelerometer, which means that the indicated value must by multiplied by 0.8.

The specified deceleration values must be attained on a dry level road, at normal pedal load, with the vehicle fully loaded and the brake drums warmed up, (also at maximum speeds) without the vehicle beginning to skid.

Stopping Distance "s" (in m) and Stopping Time "t" (in sec)
on dry concrete roads (freeways) exclusive of the "scare second"

Deceleration	Speed in km/h																					
	40		50		60		70		80		90		100		110		120		130		140	
	s	t	s	t	s	t	s	t	s	t	s	t	s	t	s	t	s	t	s	t	s	t
1.5	41	7.46	64.1	9.3	92.3	11.19	125.6	13	164	14.92	207.7	16.8	256.4	18.6	310.2	20.5	369.2	22.38	433.3	24.2	502.5	26
2	30.8	5.6	48.1	7	69.3	8.4	94.2	9.8	123.2	11.2	156.6	12.6	192.4	14	232.7	15.4	277.2	16.8	325	18.2	376.8	19.6
2.5	24.8	4.48	38.5	5.6	55.8	6.72	75.4	7.6	99.2	8.96	125.1	10.08	154	11.2	186.2	12.3	223.2	13.44	260	14.6	301.6	15.2
3	20.4	3.72	32.1	4.7	45.9	5.58	62.8	6.5	81.6	7.44	103.5	8.4	128.4	9.4	155.1	10.3	183.6	11.16	216.6	12.1	251.2	11.2
3.5	17.6	3.2	27.5	4	39.6	4.8	53.8	5.6	70.4	6.4	89.1	7.2	110	8	133	8.8	158.4	9.6	185.7	10.4	215.2	13
4	15.2	2.8	24	3.5	34.2	4.2	47.1	4.9	60.8	5.6	77.4	6.3	96	7	116.3	7.7	136.8	8.4	162.5	9.1	188.4	9.8
4.5	13.6	2.48	21.4	3.1	30.6	3.72	41.9	4.4	54.4	4.96	69.3	5.58	85.6	6.2	103.4	6.8	122.4	7.44	144.4	8	167.6	8.8
5	12.4	2.24	19.2	2.8	27.9	3.36	37.7	3.9	49.6	4.48	62.1	5.04	76.8	5.6	93.1	6.2	111.6	6.72	130	7.3	150.8	7.8
5.5	11.2	2.04	17.4	2.54	25.2	3.06	34.2	3.6	44.8	4.08	56.7	4.59	69.6	5.08	84.6	5.6	100.8	6.12	118.1	6.6	136.8	7.2
6	10.4	1.86	16	2.3	23.4	2.79	31.4	3.3	41.6	3.72	53.1	4.2	64	4.6	77.6	5.1	93.6	5.58	108.3	6.1	125.6	6.6
6.0	9.6	1.72	14.8	2.15	21.6	2.58	28.9	3	38.4	3.44	48.6	3.87	59.2	4.3	71.6	4.7	86.4	5.16	100	5.6	115.6	6
7	8.8	1.6	13.7	2	19.8	2.4	26.9	2.8	35.2	3.2	44.1	3.6	54.8	4	66.5	4.4	79.2	4.8	92.9	5.2	107.6	5.6

In computing the stopping distances given in the above table, the "scare second" has not been taken into account. Many tests have confirmed the general experience that the driver of a motor vehicle needs just about one second, the so-called "scare second", until he is in a position effectively to brake his vehicle. The "scare second" comprises the recognition time, the reaction time proper, the brake actuating time, and the brake response time. During the whole of this one second the vehicle travels on at undiminished speed. For this reason the actual stopping distance is much longer when the "scare second" is taken into consideration. In the following diagram the stopping distances are given on the basis of one "scare second".

Stopping Distance (Including 1 Scare Second)

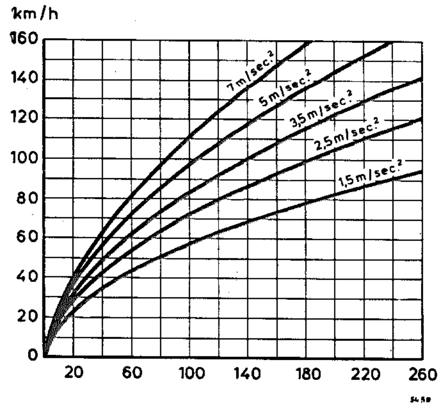


Fig. 42 — 0/1

The deceleration values attained by modern vehicles are considerably higher than the legal minimum values when the cars are braked at medium speeds.
Under very favorable conditions ,the following mean deceleration values can be expected:

dry concrete (freeways)	7 m/sec/sec
dry asphalt and macadam	5 m/sec/sec
wet asphalt and macadam	3.5 m/sec/sec
icy roads	1.5 m/sec/sec

B. Description of the Brake System

a) Vehicle without ATE Power Brake A 50

General:

The service brake is of the hydraulic type. It consists of a brake master cylinder which produces the hydraulic pressure,

the brake wheel cylinders inside the brake drums which transmit this pressure and press the brake shoes against the brake drums,

the network of brake lines and brake hoses which provide the connection between brake master cylinder and brake wheel cylinders, and

the fluid reservoir which maintains a constant volume of brake fluid.

The hydraulic brake operates in accordance with Pascal's Law which states that the pressure exerted on an enclosed liquid is transmitted equally in all directions.

When the brake pedal is depressed, the piston in the brake master cylinder is pushed forward and the displaced brake fluid passes through the brake lines and brake hoses to the brake wheel cylinders. The brake fluid enters the brake wheel cylinders, pushing their pistons outward against the brake shoes and thus forcing these shoes against the brake drums. (For a diagrammatic illustration of the brake system see Fig. 42 — 0/2).

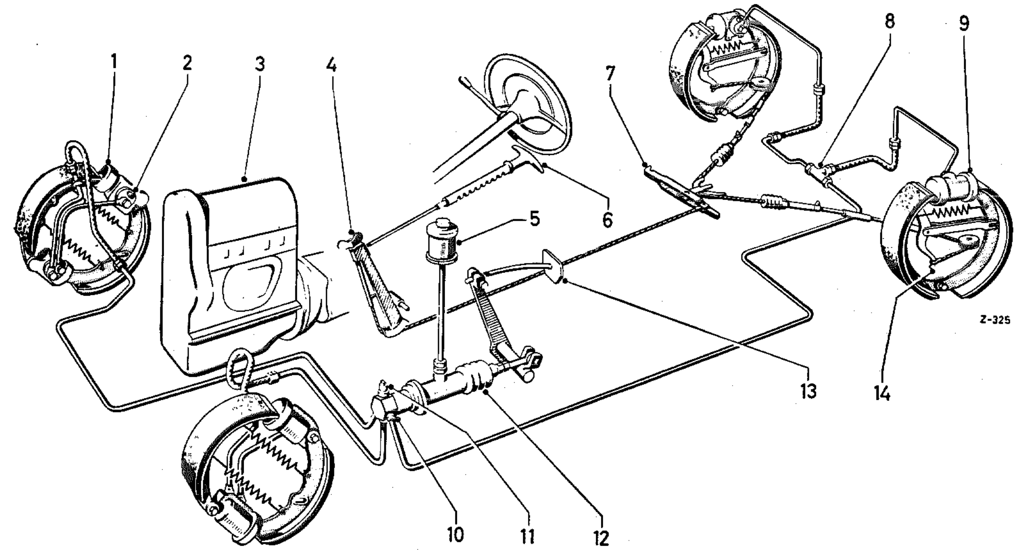


Fig. 42 — 0/2

1 Brake wheel cylinder
2 Bleed screw
3 Engine
4 Brake lever
5 Fluid reservoir
6 Hand brake
7 Equalizer
8 Distributor fitting, rear
9 Brake wheel cylinder
10 Distributor fitting, front
11 Stop light switch
12 Brake master cylinder
13 Brake pedal
14 Brake lever

When the pedal load is increased, the pressure within the brake wheel cylinders is also increased and consequently also the force acting on the brake shoes. The pressure is transmitted in accordance with the pedal load applied.
When the brake pedal is released, the return springs pull the brake shoes and the pistons of the brake wheel cylinders back into their initial position and force the brake fluid back to the brake master cylinder.
However, to ensure instant response of the brake, a small residual pressure of 0.4 — 0.8 atm. is left in the line system even when the brake is released.
On the front wheels the brakes have two leading shoes in each drum, and each brake shoe has its own brake wheel cylinder (Duplex brake) (Fig. 42 — 0/3). This arrangement of two leading shoes, each actuated by a brake wheel cylinder, results in a high degree of self-energization of the brakes, which is produced by the rotating brake drum which tends to drag the brake shoes along with it; as a result, the brake shoes are forced against the brake drum.

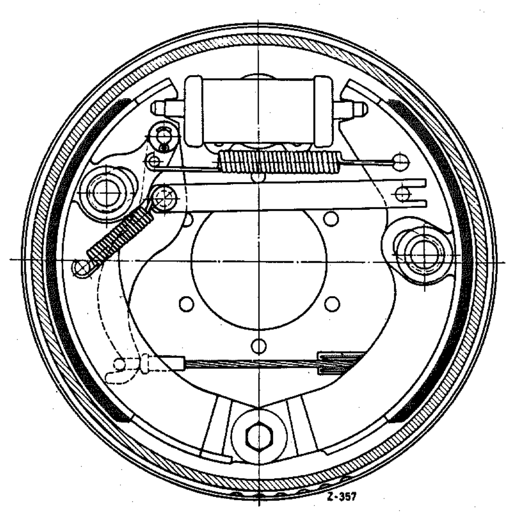


Fig. 42 — 0/3

Front wheel brake left

On the rear wheels, the two brake shoes have a common brake wheel cylinder with two pistons (Simplex brake) (Fig. 42—0/4). In this case the brake shoe which rotates about its pivot in the same sense as the brake drum is the leading or primary shoe, which is pressed against the brake drum when the brake is applied, and consequently exerts an additional force as in the case of the front wheel brake.

The braking force of the second brake shoe, the trailing or secondary shoe, which is moved inward by the sense of rotation of the drum, is considerably smaller.

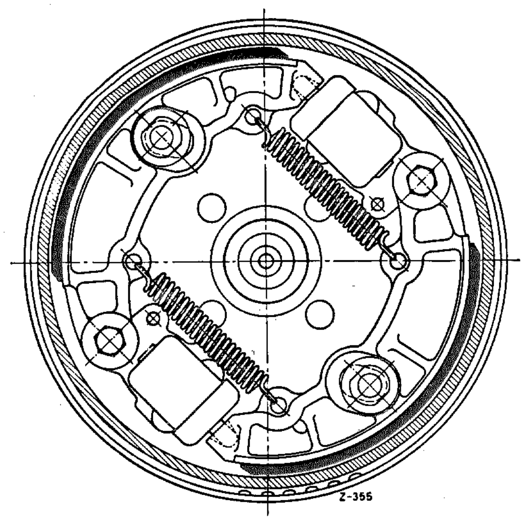


Fig. 42—0/4

Rear wheel brake left

Brake Master Cylinder

The brake master cylinder refills automatically, that is, it contains an automatic control device which ensures constant fluid volume and constant pressure in the brake lines.

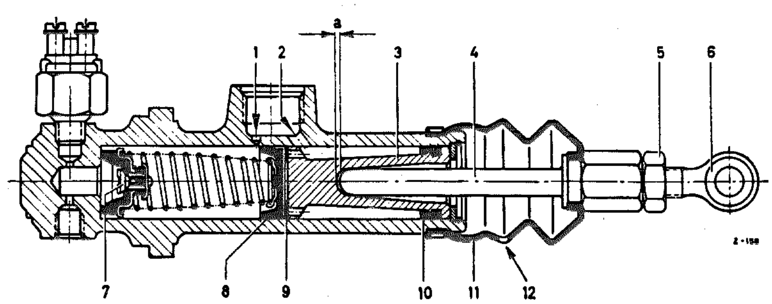
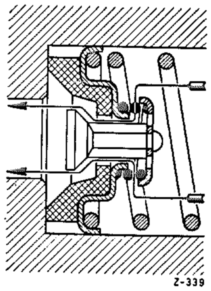


Fig. 42—0/5

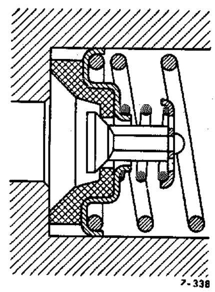
a = 1 mm	7 Check valve
1 Compensating port	8 Primary cup
2 Connecting port	9 Piston cup washer
3 Piston	10 Secondary cup
4 Piston push rod	11 Boot
5 Hexagon nut	12 Vent hole
6 Piston push rod end	

The fluid contained in the brake master cylinder, in the brake lines, and in the brake wheel cylinders is subject to temperature influences, with the result that the enclosed brake fluid expands under the influence of heat and contracts under the influence of cold. Volume compensation is effected via the compensating port (1). When the fluid volume expands, the excess can flow back from the pressure chamber of the brake master cylinder into the fluid reservoir; on the other hand, if the fluid volume is deficient, fluid can flow from the fluid reservoir via the compensating port (1) into the pressure chamber of the brake master cylinder. **In order to ensure that the compensating port can fulfil its highly important task, the compensating port must always be kept open when the brake is in its non-applied position.** When the brake pedal is adjusted, it is therefore very important to ensure that there is a clearance of a = approx. 1 mm between the piston push rod (4) and the piston (3) (see

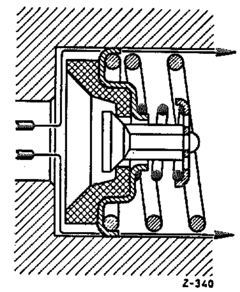
Fig. 42—0/5). If the compensating port is closed, the brake fluid cannot flow back when it expands under the influence of heat. The result would be drum-shoe contact and a constant dragging of the brake shoes.
In addition to the compensating port, a check valve (7) in the brake master cylinder is necessary to provide for the fluid exchange between fluid reservoir, brake master cylinder, and the brake line system (Fig. 42—0/5 and Fig. 42—0/6).



Applied position



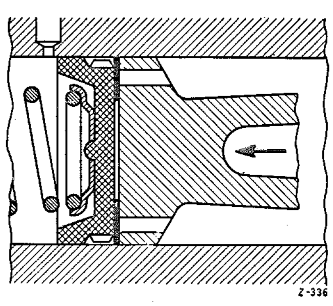
Non-applied position



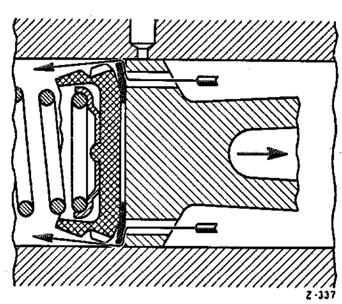
Release position

Fig. 42—0/6

The check or relief valve is arranged at the bottom of the brake master cylinder, that is, between the pressure piston of the brake cylinder and the line system.
Its function is to provide for pressure equalization between brake master cylinder and the line system when the brake fluid expands or contracts. In addition, it maintains a slight residual pressure of 0.4—0.8 atm. in the line system when the brake is released. This ensures that the line system is always completely filled with fluid, so that the brake can respond evenly and quickly.
During the braking operation or if, because of fluid contraction, the pressure in the line system is lower than in the pressure chamber, the inner valve opens and admits brake fluid (Fig. 42—0/6, Applied position).
When the brake is released, or if, because of fluid expansion, the pressure in the line system is higher than in the pressure chamber, the check valve lifts from its seat so that brake fluid can flow back to the fluid reservoir through the pressure chamber of the brake master cylinder (Fig. 42—0/6, Release position).
The pressure spring in the brake master cylinder is so designed that the check valve lifts when the pressure reaches 0.4—0.8 atm.; this ensures the maintenance of the required residual pressure in the line system (Fig. 42—0/6, Non-applied position).
In order to prevent air from being sucked in when the brake cylinder piston returns to its initial position quickly, a ring-shaped fluid chamber is arranged behind the primary piston cup which is supplied with brake fluid via the connecting port (2) (see Fig. 42—0/5).



Applied position



Releasse position

Fig. 42—0/7

When the brake is applied, the sealing lip of the primary cup seals off the pressure chamber, the piston cup washer presses against the bores which are arranged in a circle around the piston, thus preventing damage to the primary cup by the connecting ports (Applied position, Fig. 42—0.7). When the brake is released, the primary cup folds up, and the piston cup washer moves away from the piston head. Thus, the brake fluid can flow from the fluid chamber in the piston through the connecting ports into the pressure chamber (Release position, Fig. 42—0/7).

The interaction of compensating port, check valve, and primary cup definitely prevents the entrance of air into the brake system.

Brake Wheel Cylinders

It is the function of the brake wheel cylinders, which are attached to the brake anchor plates, to transmit to the brake shoes the pressure produced in the brake master cylinder.

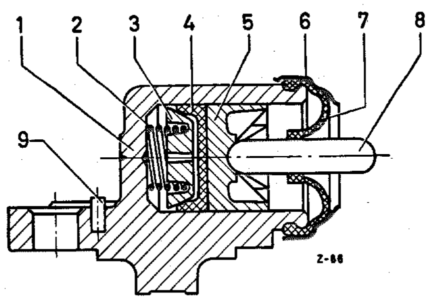


Fig. 42—0/8

Front wheel brake cylinder

1 Brake wheel cylinder
2 Stop spring
3 Piston cup expander
4 Cup
5 Piston
6 Metal boot
7 Rubber boot
8 Actuating pin
9 Notched pin

The front wheel brake cylinder contains the piston (5), the cup (4), the cup expander (3), and the stop spring (2). The stop spring together with the cup expander serves to press the cup against the cylinder wall. The contact between the piston and the brake shoe is established by the actuating pin (8). In order to prevent dirt and moisture from entering the bore of the brake wheel cylinder, a rubber boot (7) covers the brake wheel cylinder and the actuating pin. An additional metal boot (6) is added in order to protect the rubber boot from hot abrasive particles.

When the brake is applied, the brake fluid displaced in the brake master cylinder is pressed into the brake wheel cylinders. The pressure of the brake fluid moves the cup and the piston outward and the actuating pin forces the brake shoe against the brake drum.

A bleed screw is mounted at the highest point of the brake wheel cylinder. This bleed screw is opened when the brake system is filled and bled in order to provide an escape for any air that may have entered. For this purpose, the bleeder valve is so arranged that it is not covered by the cup even when the brake is released.

The rear wheel brake cylinder (Fig. 42—0/9) is designed on the same principle with the difference that it has two pistons, two cups, and two cup expanders. The contact between pistons and brake shoes is again provided by two actuating pins. Metal boots are not required on the rear wheel brake because it is subject to less strain than the front wheel brake.

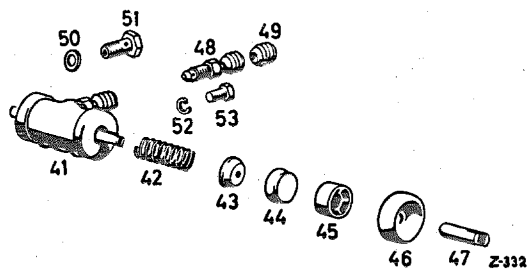


Fig. 42—0/9

Rear wheel brake cylinder

41 Brake wheel cylinder
42 Stop spring
43 Piston cup expander
44 Piston cup
45 Piston
46 Rubber boot
47 Actuating pin
48 Bleed screw
49 Rubber boot
50 Sealing ring A 10×14 copper
51 Hollow screw
52 Lock washer
53 Hexagon screw

Brake shoes

The arrangement of the brake shoes, the brake wheel cylinders, and the return springs is shown in Figs. 42—0/10 and 42—0/11.

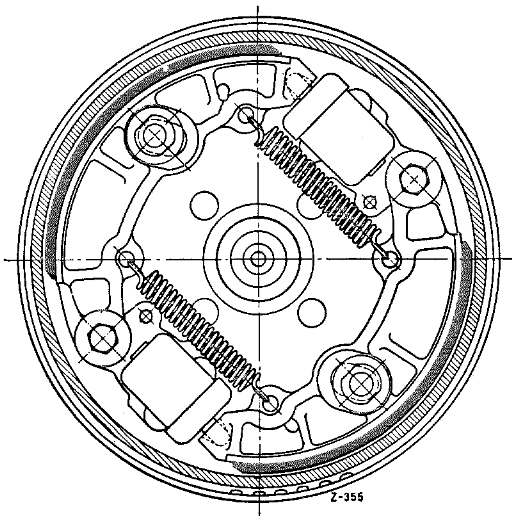


Fig. 42—0/10

Front wheel brake left

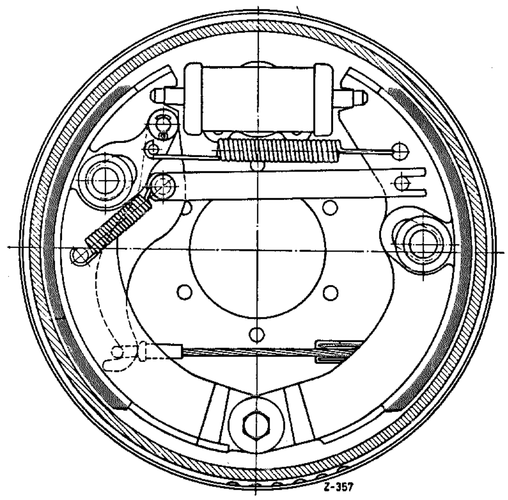


Fig. 42—0/11

Rear wheel brake left

The brake linings are bonded to the brake shoes by a special process. This bonding of the brake linings has the advantage that the brake lining snugly fits the brake shoe without any hollow spots. Since rivets are not used, the effective brake area is larger than in the case of a riveted lining of equal size. An additional advantage is that because of the absence of rivets the brake lining can be worn down to a thickness of approx. 1.5 mm.

Automatic Brake Adjustment

Both the front wheel brakes and the rear wheel brakes adjust themselves automatically to the degree of wear of the linings.

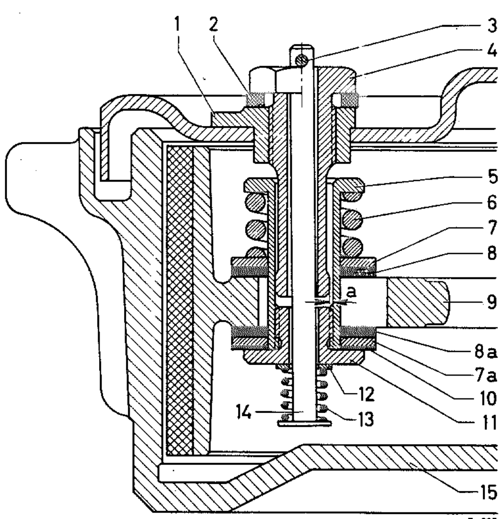


Fig. 42—0/12

Front wheel brake

1 Collar bushing
2 Lock washer
3 Cotter pin 3 × 15
4 Pin
5 Adjusting sleeve
6 Pressure spring
7 and 7a Thrust washer (steel)
8 and 8a Friction washer
9 Brake shoe
10 Washer
11 Tensioning screw
12 Washer
13 Pressure spring
14 Guide pin
15 Brake drum
a = clearance

The automatic adjustment operates as follows:

The adjusting sleeve (5), together with the tensioning screw (11), is arranged in the slotted hole of the brake shoe (Fig. 42—0/12). The pressure spring (6) presses the two friction washers (8 and 8a) against the web of the brake shoe. The pin (4), which is screwed into the brake anchor plate, projects into the adjusting sleeve (5). The guide pin (14) which passes through the hollow pin (4) and is secured at the brake anchor plate by means of a cotter pin, provides an axial guide for the brake shoe. The pressure spring (13) presses the brake shoe against the contact plates of the brake anchor plate.

Between the adjusting sleeve (5) and the pin (4) there is a radial clearance of 0.8 mm in the case of the front wheel brake and of 1 mm in the case of the rear wheel brake (Fig. 42—0/12).

When the brake is released, the return spring pulls the brake shoe inward to the point where the adjusting sleeve comes to rest against the pin. On account of the available clearance, the brake wheel cylinder can easily press the brake shoe against the drum when the brake is applied. If in the course of time the brake lining is worn down, the adjusting sleeve rests against the pin before the brake shoe comes to rest against the drum.
The pressure exerted by the brake wheel cylinder now overcomes the pressure of the friction washers and thus readjusts the brake shoe where it contacts the brake drum. When the brake shoe is thus automatically adjusted, the adjusting sleeve, which is held by the pin, shifts in the slotted hole of the brake shoe.

The contact pressure of the friction washers must be kept within limits so that it can be overcome by the braking pressure, whereas the return spring must not be able to pull the brake shoe inward beyond the specified clearance.

Hand Brake

The hand brake is a conventional cable brake, acting on the rear wheels. The hand brake is adjusted by means of a wing nut at the brake lever which is arranged at the chassis base panel under the engine hood.

The hand brake must be so adjusted that braking begins when the hand brake lever is pulled out to the third or fourth notch.

b) Vehicles with ATE Power Brake T 50

In order to reduce the pedal force required for braking, the vehicle can be provided with an ATE Power Brake T 50 as an optional extra. The power brake is a vacuum-assisted hydraulic braking device which utilizes the pressure difference between engine intake manifold vacuum and atmospheric pressure for its operation. The power unit increases the pressure created physically in the brake master cylinder so that the same braking effect can be produced with considerably less expenditure of effort. With the Power Brake T 50 installed, the pedal force required for braking is about half the force otherwise required. However, it is not possible to obtain a greater mean deceleration. The power unit is mounted in the hydraulic line between the brake master cylinder and the brake wheel cylinders. A vacuum hose connection is made from the power brake unit to the engine intake manifold (Fig. 42—0/13).

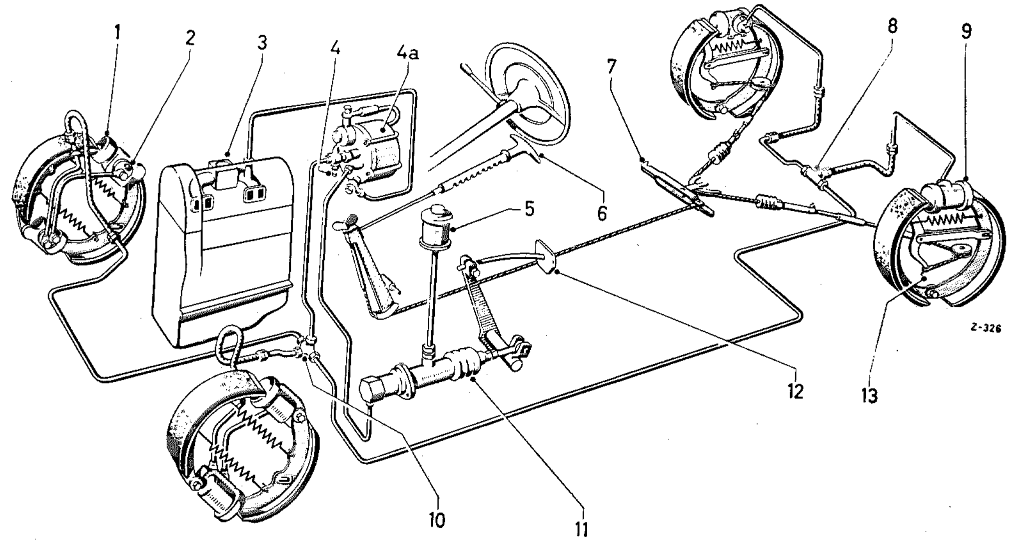


Fig. 42—0/13

1 Brake wheel cylinder
2 Bleed screw
3 Intake manifold
4 Stop light switch
4a ATE Power Brake
5 Fluid reservoir
6 Hand brake
7 Equalizer
8 Distributor fitting, rear
9 Brake wheel cylinder
10 Distributor fitting, front
11 Brake master cylinder
12 Brake pedal
13 Brake lever

Description and Operation of the ATE Power Brake T 50

The ATE Power Brake consists of the following three main sections:

1. Vacuum power cylinder
2. Hydraulic slave cylinder
3. Hydraulically actuated control valve

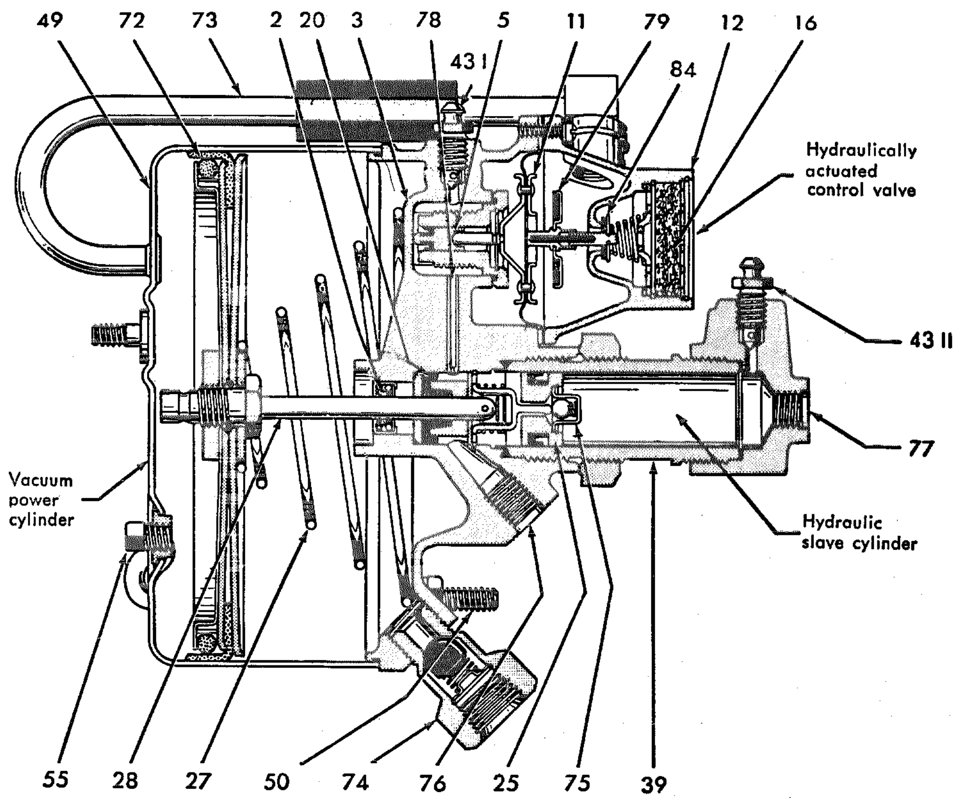


Fig. 42—0/14

Cross-Section of Power Brake ATE 50

2 Vacuum seal
3 End-plate assembly
5 Control valve piston
11 Valve diaphragm
12 Control valve cover
16 Air cleaner element
20 Rubber cup (push rod)
25 Hydraulic slave cylinder piston
27 Power piston return spring
28 Push rod
39 Cylinder tube
43 Bleeder valve
49 Vacuum cylinder (metal shell)
50 Hook bolt (4 fitted)
55 Plug
72 Vacuum power piston
73 Control tube
74 Vacuum connection with check valve
76 Threaded union (intake)
75 Ball check valve in hydraulic slave piston
77 Threaded union (output)
78 Connecting passage
79 Vacuum poppet
84 Atmosphere poppet

Vacuum Power Cylinder

The vacuum power cylinder consists of the cylinder shell (49) with piston (72), piston return spring (27), and push rod (28), and is clamped to the end plate (3) by means of four hook bolts (50) (Fig. 42—0/14).

The control tube (73) connects the left chamber of the vacuum power cylinder with the right side of the diaphragm assembly (11) of the control valve, while the right chamber of the vacuum power cylinder is connected with the vacuum inlet and the check valve (74), and the check valve is connected with the intake manifold. The right chamber of the vacuum power cylinder is also connected with the left chamber of the diaphragm assembly (11).

Hydraulic Slave Cylinder

The hydraulic slave cylinder consists of a cylinder tube (39) and a piston (25) which is pinned to the push rod (28) and is provided with a ball check valve (75).
A hydraulic rubber cup (20) and a vacuum seal (2) are provided in the end plate to seal the push rod. The hydraulic line from the brake master cylinder is attached at (76) and the hydraulic line to the wheel cylinders at (77). The passage (78) in the end plate connects the slave cylinder chamber at the left of the piston (25) with the left side of the control valve piston (5).

Control Valve

The control valve contains the piston (5) which is in contact with the diaphragm (11). The valve cover (12) contains the vacuum poppet (79) and the atmosphere poppet (84) together with the air cleaner (16).

For bleeding purposes, one bleed screw each (43) is placed at the top of the end plate (3) and in the slave cylinder end cap. The vacuum power cylinder is lubricated through an opening at the end of the vacuum power cylinder which is provided with a plug (55).

Principle of Operation

The hydraulic line from the brake master cylinder is attached at (76) (Fig. 42—0/15). Brake fluid passes through the passage (78) behind the valve piston (5) of the control valve, and past the ball check valve (75) of piston (25) into the slave cylinder chamber (80). Vacuum is transmitted through the vacuum check valve (74) to the cylinder chamber (81) and the valve chamber (82) on the one hand, and via the diaphragm (11) and the vacuum poppet (79) to the valve chamber (83) on the other hand. The atmosphere poppet (84) is held on its seat by the spring (13) and by the atmospheric pressure, thus shutting off the valve chamber (83) from the atmosphere. The valve chamber (83) is connected to the cylinder chamber (85) by the control tube (73) so that there is an equal degree of vacuum on both sides of the piston (72).

In the release position (Fig. 42—0/15) the piston (72) is held to the left in the vacuum cylinder by the piston return spring (27). In this position the yoke (86) of the hydraulic slave piston (25) is against the piston stop washer, and the ball of the check valve (75) is lifted from its seat. The valve piston (5) is at its extreme left position, thus separating the poppet (79) from its seat at the diaphragm (11).

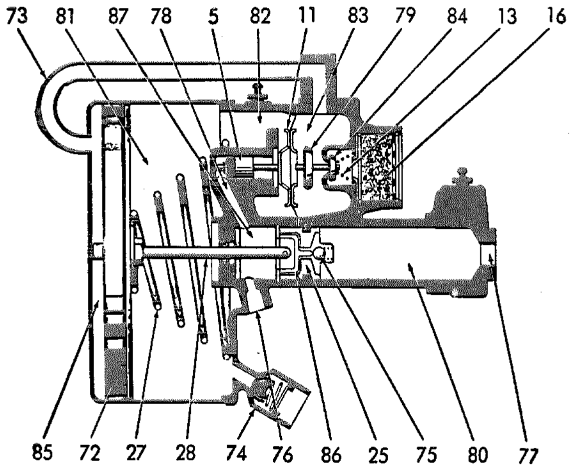


Fig. 42 — 0/15

Power Brake T 50 in release position

5 Control valve piston
11 Valve diaphragm
13 Atmosphere poppet spring
16 Air cleaner element
25 Hydraulic slave cylinder piston
27 Vacuum power piston return spring
28 Push rod
72 Vacuum power piston
73 Control tube
74 Vacuum connection with check valve
75 Ball check valve in hydraulic slave piston
76 Threaded union (intake)
77 Treaded union (output)
78 Connecting passage
79 Vacuum poppet
80 Cylinder chamber in front of hydraulic slave piston
81 Cylinder chamber in front of power piston
82 Valve chamber behind diaphragm
83 Valve chamber in front of diaphragm
84 Atmosphere poppet
85 Cylinder chamber behind vacuum power piston
86 Yoke for piston check valve
87 Cylinder chamber behind hydraulic slave piston

When the brake pedal is applied, fluid under pressure by-passes the ball check valve (75) and is transmitted to the slave cylinder chamber (80) and to the brake wheel cylinders. At the same time pressure is built up at the left of the valve piston (5), moving the piston to the right. As a result, the piston (5) presses against the diaphragm (11) and moves the diaphragm to the right until it comes to rest against the vacuum poppet (79). Any further movement to the right opens the atmosphere poppet (84) (Fig. 42 — 0/16).

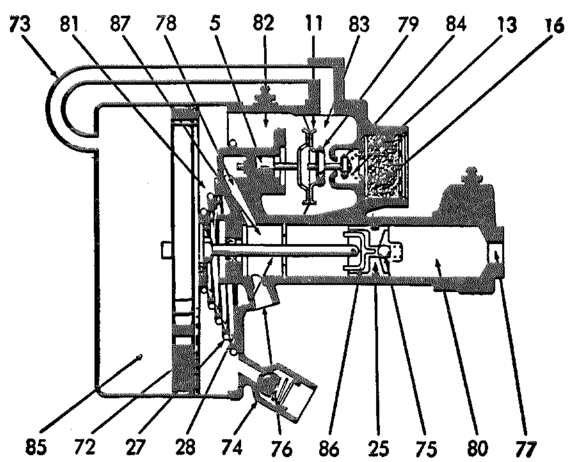


Fig. 42 — 0/16

Power Brake T 50 in applied position

5 Control valve piston
11 Valve diaphragm
13 Atmosphere poppet spring
16 Air cleaner element
25 Hydraulic slave cylinder piston
27 Vacuum power piston return spring
28 Push rod
72 Vacuum power piston
73 Control tube
74 Vacuum connection with check valve
75 Ball check valve in hydraulic slave piston
76 Threaded union (intake)
77 Threaded union (output)
78 Connecting passage
79 Vacuum poppet
80 Cylinder chamber in front of hydraulic slave piston
81 Cylinder chamber in front of power piston
82 Valve chamber behind diaphragm
83 Valve chamber in front of diaphragm
84 Atmosphere poppet
85 Cylinder chamber behind vacuum power piston
86 Yoke for piston check valve
87 Cylinder chamber behind hydraulic slave piston

Atmosphere now enters the valve chamber (83) through the air cleaner (16) past the opened poppet (84) and through the control tube (73), enters the cylinder chamber (85), moving the power piston (25) to the right, compressing the return spring (27). With this movement of the slave cylinder piston (25) the ball of the check vale (75) can be pressed onto its seat by the valve spring because the yoke (86) is then at the left, with the result that the brake fluid is trapped in the cylinder chamber (80) and pressure is transmitted to the brake wheel cylinders.

The vacuum differential (difference between the pressure in the right and the left chamber) across the piston (72) is the same as that across the diaphragm (11). The diaphragm is balanced by the master cylinder pressure on the left side of the valve piston (5). The pressure produced in the slave cylinder chamber (80) is equal to that produced by the piston (72) plus the pressure produced by the brake master cylinder.

After the desired degree of brake application has been obtained, the control valve part of the Power Brake T 50 will reach a "lap" or "holding" position in which the vacuum poppet (79) rests against the diaphragm (11) and at the same time the atmosphere poppet (84) rests against the valve cover. The hydraulic pressure at the left of the valve piston (5) is balanced by the vacuum differential across the diaphragm (11).
Any increase or decrease of the pedal pressure at the brake master cylinder will cause a corresponding increase or decrease in the vacuum differential and consequently in the hydraulic pressure in the brake wheel cylinders.

When the Power Brake T 50 is fully applied (see Fig. 42—0/16), the valve piston (5) is completely to the right against its stop and the atmosphere poppet (84) is lifted from its seat. The cylinder chamber (85) is then completely exposed to atmospheric pressure and the maximum possible differential exists across the vacuum power piston. Any further increase in the pressure existing in the brake wheel cylinders can only be obtained by increasing the pedal pressure.

When the pressure is released from the left side of the piston (5), the piston moves to the left (Fig. 42—0/15). The atmosphere poppet (84) is seated and the vacuum differential pushes the seat on the diaphragm (11) away from the vacuum poppet (79). Vacuum is again transmitted to cylinder chamber (85) through the control tube (73) and the valve chamber (83). The spring (27) then returns the piston (72) and the slave cylinder piston (25) to the release position. The yoke (86) lifts the ball of the check valve (75) from its seat, opening chamber (80) to chamber (87), thus allowing for any fluid expansion or contraction to be compensated for via the brake master cylinder.

If for any reason there should be a vacuum failure,the vehicle can still be braked since in this case the hydraulic pressure is directly transmitted from the brake master cylinder via the open ball check valve (75) to the brake wheel cylinders. However, in this case, a larger pedal force is required corresponding to the force normally applied in a vehicle not provided with a power brake.

When the engine is switched off, the brakes can still be applied several times with power brake assistance since a certain vacuum is stored in the unit by the check valve (74);however, power assistance decreases with every brake application.

c) Hints on Maintenance and Repair of the Brake System

Maintenance and repair of the brake system require very particular care. High standards should be applied in judging the serviceability of all parts.

Particular attention should be paid to the following points:

1. Before starting any work on the brake system, carefully clean your hands to remove all traces of grease and oil. **Grease or oil must on no account get into the line system of the brake.**

2. The brake system must only be filled with the prescribed blue ATE Brake Fluid or in foreign countries with Lockheed Brake Fluid. These two fluids can be mixed with one another.

   Caution! Brake fluid attacks the car finish. The brake linings must not come into contact with the brake fluid. If brake fluid gets into the eyes, they should be immediately rinsed out with water.

3. If through an oversight the brake system is filled with any brake fluid other than those prescribed above, all rubber parts including the brake hoses and the stop light switch must be replaced. To do this, remove the whole brake system, clean according to instructions and flush out.

4. **Only brake fluid or alcohol may be used for cleaning the various parts of the brake system. Do not use gasoline, kerosene, or trichloroethylene!** Mineral oils or related fluids swell the rubber cups and thus render the whole brake system completely inoperative in a very short time.

5. When the brake cylinders are assembled, the cylinder walls and the rubber parts should only be coated with the prescribed brake fluid or with ATE Brake Paste.

   Note: The brake paste may harden if stored too long.

6. The rubber parts can only be stored for a limited period of time. For reasons of brake safety, the rubber cups may not be stored for more than six months and rubber cups installed in brake cylinders for not more than twelve months.

7. The brake system should be checked for correct functioning, leakage, and rubbed spots at the intervals laid down in the 'Service Book Sheets.' Brake hoses should be replaced whenever they show traces of rubbed spots. In addition, the cause of rubbing must be removed. It is imperative that all brake hoses that have become hard, cracked or swollen, should be replaced even if they show no sign of leakage.

   The brake hoses must be carefully covered during any spraying job; care must be taken to ensure that they do not come into contact with gasoline, grease or mineral oil.

8. Regularly check the brake lines for corrosion and rubbed spots. Highly corroded or rubbed lines must always be replaced (see also Job No. 42—2, Paragraph 3).

9. The brake lining surface on both front and rear brakes should be smoothed at regular intervals with emery cloth and the abrasive dust should be blown out with compressed air. Check the lining thickness on the brake shoes. Brake shoes whose linings are worn down to approx. 1.5 mm should, for safety reasons, be replaced. Whenever brake linings are replaced, all linings on the left and on the right should be replaced together.

10. Do not omit to check the rubber boots of the brake wheel cylinders.

11. It is advisable to replace the brake fluid after twelve months of operation. When this is being done, the whole brake system should be flushed out with ATE Blue Brake Fluid or with alcohol.

12. The air cleaner element in the valve cover of the ATE Power Brake T 50 should be replaced every 16 000 km.

    When the vehicle is being driven in very dusty country, it is advisable to check the cleaner element more often. The element must not be clogged or dirty, since otherwise the response of the power brake is retarded.

    The cleaner element must not be washed in gasoline, kerosene, or trichloroethylene, since there is a danger that small particles of the washing fluid may be carried into the power unit by the air and may destroy the rubber parts and cups. In an emergency the cleaner element can be washed with alcohol. In that case it should be thoroughly cleaned with compressed air and allowed to dry completely before it is reinstalled.

A. General

If air has entered the hydraulic brake system, it must be removed, i.e., the brake system must be bled. For the bleeding operation, various types of special equipment are available commercially, such as the ARC 50 pressure bleeder, or the ATE filler and bleeder AW 34 204. When these bleeders are used the instructions issued by the manufacturers should be carefully observed.

For bleeding the brake system it is advisable to use one of these special bleeders; the ARC 50 pressure bleeder is particularly useful and very easy to handle. However, it is also possible to bleed the system without the use of special equipment.

The brake fluid removed during the bleeding operation must be discarded, since otherwise there is a danger of foreign particles getting into the hydraulic system.

The most important bleeding principle is that bleeding should be started at the bleeding point farthest from the master cylinder, which as a rule will be the right rear wheel. **On vehicles equipped with the ATE power brake T 50 the power brake itself must first be bled at the two bleed screws. After that, the brake wheel cylinders are bled in the usual way and finally the power brake has to be bled again.** On later models the distributor fitting for the rear axle brake lines has also been fitted with a bleed screw (Fig. 42 — 1/1).

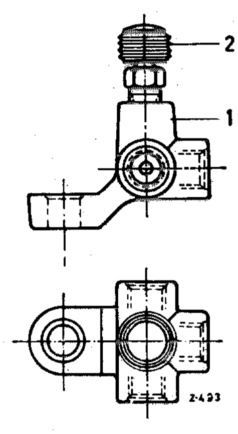


Fig. 42 — 1/1

1 Rear distributor fitting
2 Bleed screw with rubber cap

In addition, also the master brake cylinder is now being provided with a bleed screw (Fig. 42 — 1/2), which makes it possible to bleed the master brake cylinder quickly and satisfactorily.

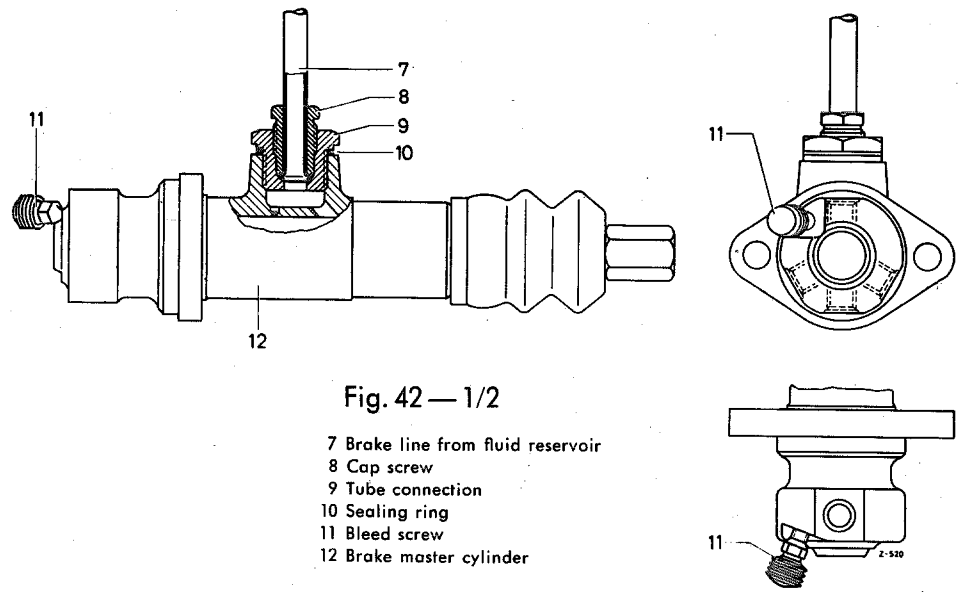


Fig. 42 — 1/2

7 Brake line from fluid reservoir
8 Cap screw
9 Tube connection
10 Sealing ring
11 Bleed screw
12 Brake master cylinder

With the introduction of the new brake master cylinder the previous fluid reservoir of sheet metal has been replaced by a transparent plastic reservoir and the connections of the brake line have been changed both at the master brake cylinder and at the fluid reservoir (see Fig. 42 — 1/2 and Fig. 42 — 1/3).

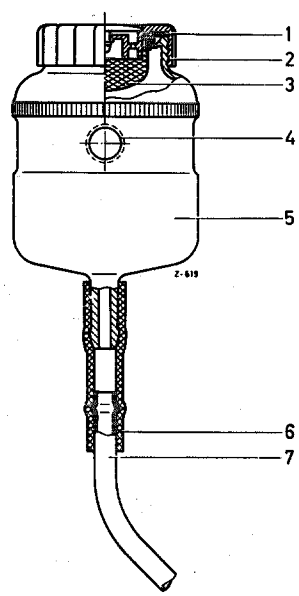


Fig. 42 — 1/3

1 Sealing ring
2 Filler plug
3 Strainer
4 Bracket attaching hole
5 Fluid reservoir
6 Connecting hose
7 Brake line to master brake cylinder

The transparent fluid reservoir has the advantage that the fluid level can be checked readily without removing the filler plug.
The distributor fitting with bleed screw has the additional advantage that the brake system can be quickly filled through the distributor fitting; depending on the type of bleeding equipment used, the brake system can also be bled through this bleed screw.

Only approved brake fluids or alcohol may be used for flushing out the brake system. **Gasoline, solvents, or mineral oils should under no circumstances be used,** since these agents swell the rubber cups and thus make the whole brake system inoperative in a very short time. Before making a complete change of brake fluid always clean the whole line system by means of completely dry, filtered compressed air.
Alcohol should only be used as a flushing fluid in exceptional cases, since it is impossible to remove all traces of alcohol from the hydraulic system. When brake fluid is added, the two liquids mix and the mixture is liable to produce gas bubbles if it is heated up beyond a certain point.

B. Bleeding the Brake System without Special Equipment

1. Remove the filler plug (7) of the fluid reservoir and, if necessary, fill up to the prescribed minimum level (1—2 cm below top edge) Fig. 42 — 1/1).

Note: During the bleeding operation keep a constant check on the fluid level in the reservoir and make sure that it never falls below a depth of 1 cm, since otherwise air will be drawn into the hydraulic system.

2. Bleed the system in the following order:

   a) upper bleed screw (5) at the ATE power brake T 50 (Fig. 42 — 1/4);

   b) lower bleed screw (4) at the ATE power brake T 50;

   c) rear wheel brake cylinder right;

   d) rear wheel brake cylinder left;

   e) front wheel brake cylinder right;

   f) front wheel brake cylinder left;

   g) upper bleed screw (5) at the ATE power brake T 50;

   h) lower bleed screw (4) at the ATE power brake T 50;

   i) brake master cylinder (if provided with bleed screw).

3. To start the bleeding operation remove the rubber protective cap of the bleed screw and fit the bleeder hose over the bleed screw nipple (Fig. 42 — 1/5).

Note: Fig. 42 — 1/5 shows the bleeding operation at the right front wheel.

On the front wheels both brake wheel cylinders are bled through the bleed screw fitted to the upper brake wheel cylinder.

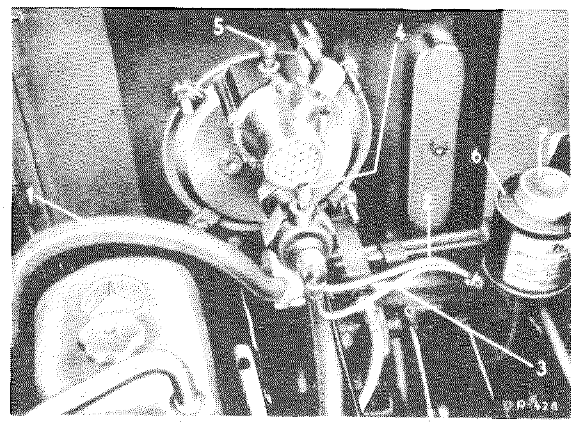


Fig. 42 — 1/4

1 Vacuum tube from engine intake manifold to power brake
2 Brake line from master brake cylinder to power brake
3 Brake line from power brake to distributor fitting
4 Slave cylinder bleed screw
5 Control valve bleed screw
6 Fluid reservoir
7 Filler plug

Immerse the free end of the bleeder hose in a clean glass container partly filled with brake fluid until the end of the bleeder hose is below the fluid level (Fig. 42 — 1/5).

5. Back out the bleed screw about one turn to the left, using box wrench SW 11.

6. Get a second mechanic to depress the brake pedal full stroke and allow it to return

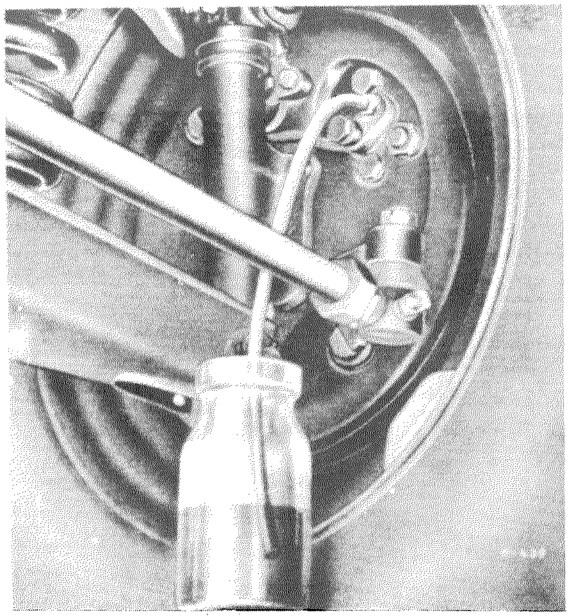


Fig. 42 — 1/5

slowly until the brake fluid in the glass container is free from air bubbles.

During this bleeding operation the fluid reservoir must always contain a sufficient amount of brake fluid, since otherwise air will be drawn into the system (see Note paragraph 1).

7. Then retighten bleed screw using Box Wrench SW 11 or ATE bleeder wrench A 2273.

Note: While the bleeding screw is being tightened the brake pedal must be depressed full stroke and held in this position.

8. Remove the bleeder hose and fit the dust cap on the bleed screw.

9. Bleed at the other points in the same way.

10. After bleeding the system fill the fluid reservoir up to the prescribed level and close by means of the filler plug.

Note: Make sure that the breather port in the filler plug is not plugged.

11. Check the hydraulic system for leaks. For this purpose depress the brake pedal as far as possible for about two minutes and then check the whole system for leaks.

Note: If available, use ATE Pedal Jack AW 35644 (see Fig. 42 — 1/8).

12. Check whether the system is correctly bled by depressing the brake pedal several times.

Note: If despite careful bleeding and a leak-proof hydraulic system the brake pedal is still soft and spongy, the cause may be an air bubble under the stop light switch. This air bubble can be removed in the following way:

Screw out the stop light switch until it is loose in the bore of the brake master cylinder. Then pump the brake pedal until some brake fluid emerges at the switch mounting thread and retighten the stop light switch. This procedure is not necessary if the brake master cylinder is provided with a bleed screw.

C. Bleeding the Hydraulic System with ARC 50 Power Bleeder

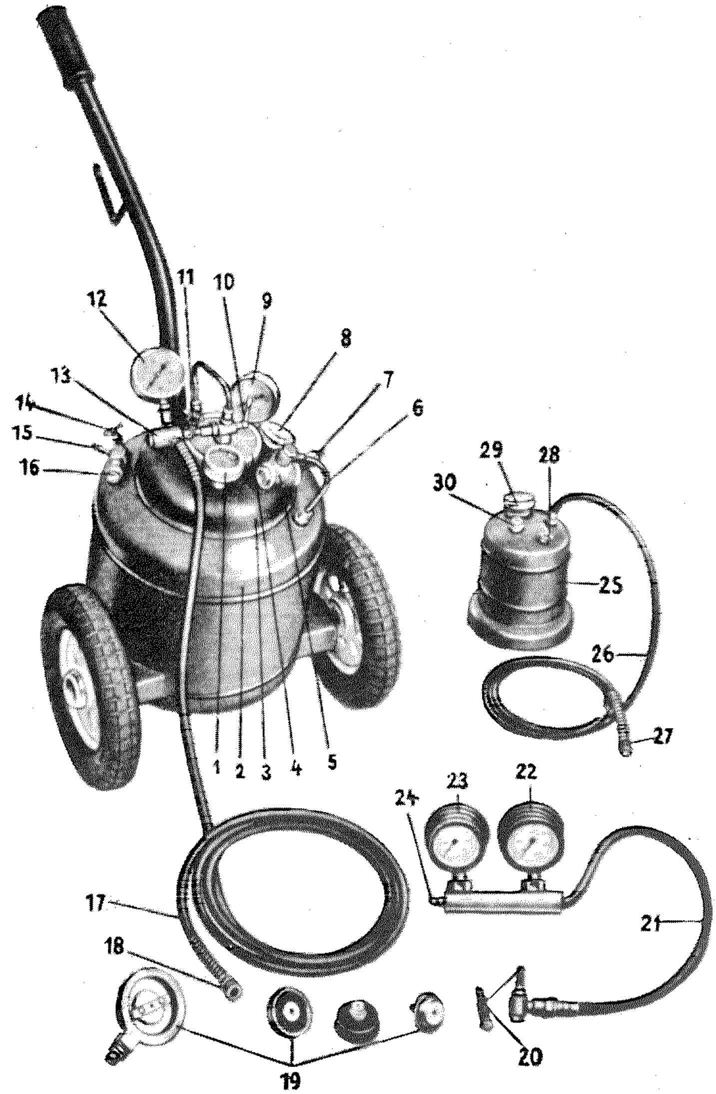


Fig. 42 — 1/6

1 Contents and consumption indicator
2 Compressed air tank
3 Brake fluid tank
4 Cover with switching position
5 Reducing valve
6 Pressure pipe to reducing valve
7 Reducing valve adjusting screw
8 Fluid filler pipe with strainer
9 Air pressure gage
10 Three-way valve
11 Operating valve
12 Bleeder pressure gage
13 Union with strainer
14 Compressed-air valve
15 Compressed-air filler
16 Relief valve
17 Hose
18 Connector
19 Filler hole fittings (various)
20 Special screw(s) for brake wheel cylinder
21 Connecting hose
22 High-pressure gage } combined
23 Residual pressure gage } combined
24 Bleed nipple for pressure gage
25 Flushing unit
26 Flushing hose
27 Connector (like 18)
28 Valve
29 Alcohol filler pipe
30 Union for connection to power bleeder

1. Fill the brake fluid tank (3) with ATE brake fluid through the filler pipe (8) (minimum 3 liters, maximum 6 liters).

2. Put the three-way valve (10) in its vertical position and close valve (11).

3. Fill the compressed-air tank (2) over the filler pipe (15) with completely dry, compressed air until the pressure gage (9) indicates a pressure of approx. 4.5 atmospheres.

4. Close the valve (14) at the compressed-air tank.

5. Remove the filler plug from the fluid reservoir of the brake master cylinder and install a suitable filler hole fitting (19).

6. Connect the hose (17) of the power bleeder to the filler hole fitting (19).

7. Put the three-way cock (10) in its horizontal position pointing to "Füllen und Entlüften" (filling and bleeding) and open valve (11).

8. Adjust the pressure indicated on pressure gage (12) to 2.2—2.5 atmospheres by means of the adjusting screw (7) of the reducing valve (5).

9. Bleed the system in the same order as described in Section B (Paragraph 2).

10. To start the bleeding operation remove the rubber protective cap of the bleed screw and fit the bleeder hose over the bleed screw nipple (Fig. 42 — 1/5).

Note: Fig. 42 — 1/5 shows the bleeding operation at the right front wheel.

11. Immerse the free end of the bleeder hose in a clean glass container partly filled with brake fluid until the end of the bleeder hose is below the fluid level (see Fig. 42 — 1/5).

12. Bleed the system by opening and closing each bleed screw several times until the emerging brake fluid is clear and free from air bubbles.

Note: Open the bleed screws by approx. one turn only and drain sufficient brake fluid to ensure that the system is completely bled.

13. Remove the bleeder hose and put the dust cap on the bleed screw.

14. Open the valve (14) and put the valve (10) in the horizontal position pointing toward "Entleeren" (drain).

15. Remove the filler hole fitting (19) from the fluid reservoir in the vehicle. Allow the brake fluid in the hose to flow back and then put the valve (10) in a vertical position.

Note: In order to ensure that the power bleeder is ready for the next bleeding operation without having to be filled again with compressed air, the new version of the bleeder is supplied with a closing plug for sealing the connector (18). In this case the procedure as outlined under 14 and 15 is changed as follows:

14a. Put the valve (10) in a vertical position and close valve (11).

15a. Unscrew the connector (18) slowly from the filler pipe fitting (19) to allow the compressed air to escape (Caution! Brake fluid is corrosive and attacks the car enamel).
Screw the closing plug into the connector (18).
Then remove the filler hole fitting (19) from the fluid reservoir of the car.

16. If necessary, replenish the brake fluid in the fluid reservoir and install the normal filler plug.

Note: Any air bubbles rising in the fluid reservoir after the power bleeder has been disconnected come from the brake cylinders between the secondary and primary cups and are of no importance and have no influence on brake efficiency.

D. Bleeding the Hydraulic System with ATE Filler and Bleeder AW 34 204

1. Remove the filler plug from the bleeder and fill the fluid tank with 3 to 4 liters ATE brake fluid (Fig. 42 — 1 7).

2. Connect a compressed-air hose to the hose valve of the filler pipe. **The compressed air must be completely dry.**

3. Subject the brake fluid to a maximum pressure of 2.5 atmospheres.

4. Connect the filler hose with its quick action nipple to the bleed screw of the left front wheel brake and open the bleed screw.

Note: In the case of cars with a bleed screw at

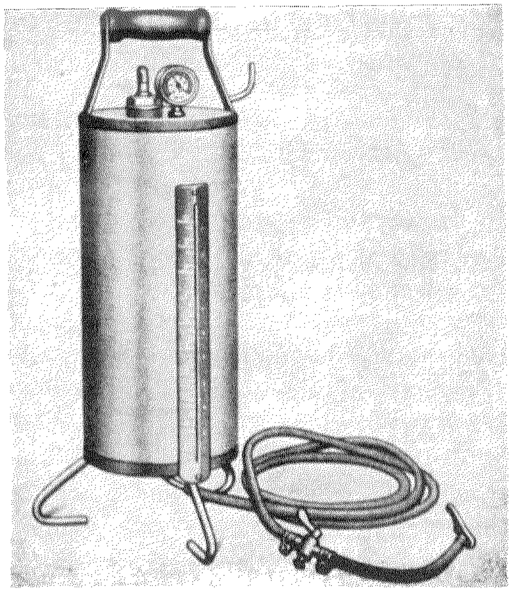


Fig. 42 — 1/7

the rear distributor fitting the filler hose is connected to this bleed screw.

5. Open the shut-off valve in the filler hose and allow brake fluid to run in until the fluid reservoir in the car is filled up to about 2 cm below the edge.

6. Depress the brake pedal by about 2 to 3 cm and block it in this position by means of a pedal jack (Fig. 42 — 1/8).

7. Remove the dust caps from all bleed screws. To bleed the system fit the bleeder hose over the nipple of the individual bleed screws and immerse the free end of the bleeder hose in a clean glass container partly filled with brake fluid. The free end of the hose most be below the fluid level.

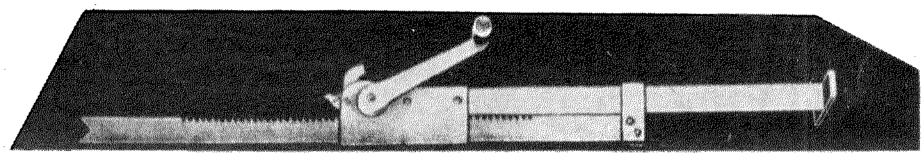


Fig. 42 — 1/8

Pedal Jack AW 35 644 produced by Messrs. Teves
Range 430 to 650 mm

8. Bleed the system by opening and closing each bleed screw several times until the emerging brake fluid is clear and free from air bubbles.

9. Remove the bleeder hose and put the dust cap on the bleed screw.

Note: Proceed in the order outlined above (see B — bleeding the hydraulic system without special equipment, paragraph 2).

10. Close the shut-off valve in the filler hose and remove the filler hose.

11. Install the dust cap and remove the pedal jack.

12. Check the fluid level in the reservoir and, if necessary, top up.

13. Check whether the system is correctly bled by depressing the brake pedal several times.

Note: If despite careful bleeding and a leak-proof hydraulic system the brake pedal is still soft and spongy, the cause may be an air bubble under the stop light switch. This air bubble can be removed in the following way:

Screw out the stop light switch until it is loose in the bore of the brake master cylinder. Then pump the brake pedal until some brake fluid emerges at the switch mounting thread and retighten the stop light switch.

E. Flushing Out the Hydraulic System with Special Flushing Equipment

1. Connect the flushing equipment to the fluid reservoir.

2. Open all bleed screws in the same order as for the bleeding operation and allow brake fluid to run out until it is completely clear and clean. The brake pedal should be pumped during the whole flushing operation.

3. Remove all brake wheel cylinders and the master brake cylinder (see Job No. 42 — 3, Job No. 42 — 5, and Job No. 42 — 6).

4. Disassemble, clean, and check the brake wheel cylinders and the brake master cylinder and reassemble, using new rubber parts (see Job No. 42—4, and Job No. 42—7).

Note:

a) If the car is provided with an ATE power brake T 50 the power brake must also be removed and provided with new rubber parts (see Job No. 42 — 14).

b) The disassembly of the brake cylinders and the ATE power brake T 50 is essential if dirt has got into the hydraulic system or if on older cars the rubber parts are aged or if the rubber parts are damaged through the use of the wrong kind of brake fluid.

c) It is not recommended to flush out the system without removing the brake cylinders, since heavy dirt particles cannot be flushed out through the bleed screw opening which is set high up in the assembly and is constructed on the baffle principle.

5. Clean all brake fluid lines with filtered, completely dry, compressed air.

6. Reinstall the brake wheel cylinders, the brake master cylinder, and, if necessary, the ATE power brake T 50.

7. Fill the hydraulic system with blue ATE brake fluid within a few hours of the flushing operation and bleed the system (see sections B—D).