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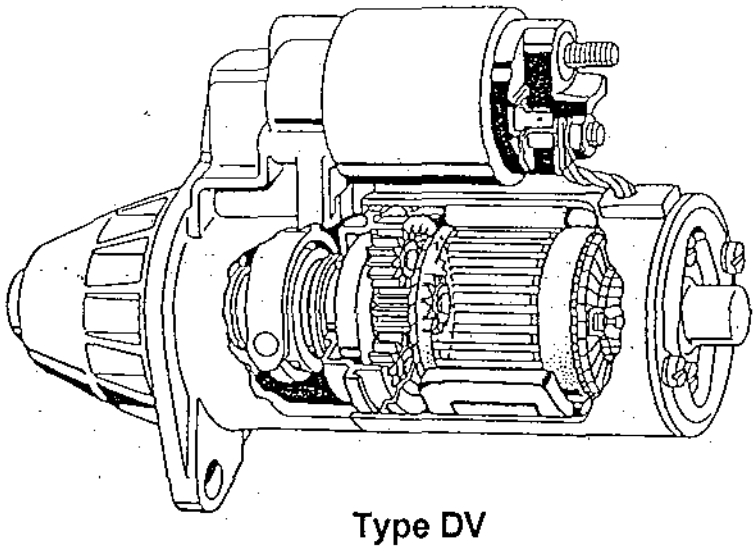
NEW STARTER MOTOR WITH PLANETARY DRIVE AND WOUND FIELD COILS



Description Type DV

The new DV starter motor incorporates planetary drive and wound field coils, it has higher power output and is lighter in weight than previous models.

The coaxial design of the DV starter allows it to directly replace conventional starters having the same mounting and pinion specifications.

The drive end housing locates the planetary gear train which comprises of an outer gear hub, 3 needle roller idler gears attached to the output shaft and the armature with the input gear which passes through the cover plate on the main gear hub to form the complete assembly. The now familiar plastic fork lever and bearing block is used in the DV starter.

Dismantling the starter motor:

Clamp the starter motor in the vice using using Bosch clamp KDAW 9999 or soft jaws. Do not over tighten as this may cause distortion to the pole housing.

Removal of solenoid switch:

Disconnect the main braided cable from the short threaded terminal(13mm spanner). Remove the 3 mounting screws withdraw the solenoid, disengage the plunger from the fork lever and remove complete with the plunger and spring. **Note solenoid position.**

Removal of Drive end housing:

Loosen and remove through bolts(7mm socket). Withdraw the housing complete with the planetary gear assembly, drive assembly and fork lever from the armature gear taking care not to disengage the cover plate.

Removal of drive assembly:

Clamp the mounting lug of the drive end housing in the vice using soft jaws, remove the rubber block. Withdraw the planetary drive assembly and fork lever, ease fork lever from the drive assembly. In order to avoid damage to the planetary gears when removing the stop ring use Bosch fixture **KDAL 5047** this supports the output shaft and prevents the shock being absorbed by the planetary gear hub. Using Bosch striking sleeve **KDAL 5028** and a non metallic hammer, with a sharp tap drive back the stop ring retainer. Using a pair of circlip pliers expand the stop ring and remove it from the output shaft. Carefully remove any burrs from the output shaft before removing the drive assembly, failure to do so will damage the pinion bushing.

Removal of the armature:

Clamp the pole housing in a vice using soft jaws or Bosch clamping fixture **KDAL 9999.** Remove the screws and the cover cap from the commutator end cover, also remove the rubber ring, circlip and adjustment washers.
Slide commutator end cover from armature shaft. Using special Bosch tool **KDAL 5048**, slide tool onto the armature shaft until it contacts the face of the commutator. Gently push the tool until the annular flange contacts the brushplate, the armature may now be withdrawn. The tool will support the brushes in their holders until the armature needs to be reinserted.

Inspection of the brush holder:
Ensure that the brushes move freely in their holders, that the brushes are free from chips and burn marks. Check brush minimum length (7mm) if shorter than the minimum, replace the brush set.

Removal and replacement of brushes:

Gently bend back the brush retaining tab until the spring and brush can be removed, (if any tag is broken the whole brush holder must be replaced). Clean the brush holders making sure they are free from carbon deposits and burrs.

Cleaning components:

The following components must not be cleaned with spirit based agents, only clean rags and compressed air must be used, they are **Armature, field coils, solenoid switch and drive assembly.**
All other mechanical components may be cleaned using non volatile or low inflammable agents in a well ventilated area, it is important that the parts are thoroughly dried before assembly, take care not to breath in the vapours.
Please observe the safety regulations and precautions issued by the manufacturer of the cleaning agent in use.

Replacement of positive brushes:

Cut old brush lead about mm away from the field coil connecting strap, tin lead with 60/40 resin cored solder take new brush and position it on the pre-tinned lead with pointed nosed pliers. Solder new brush to the lead.

Replacement of negative brushes(earth):

Cut old brush lead flush with the brush plate, pre-tin the remaining copper lead on the brush plate with 60/40 resin cored solder. Using a pair of pointed nosed pliers position and solder new brushes to the brush plate.

Caution: Ensure that the solder does not run up the lead by capillary action which makes the lead inflexible. Please also note the direction the earth brushes are soldered to the plate.

Testing the field coils:

Test the field coil for short circuits to earth using an insulation tester with a minimum AC voltage of 40volts or Bosch tester **KDAW 9984, KDAW 9985.** Inspect the coils for signs of overheating, if this condition is present they should be replaced.

Removal and replacement of field coils.

The new DV starter uses an interlocked joint in the pole housing, care should be exercised whenever the pole housing is clamped to fit or remove the field coils, it is recommended that a mandrill having a diameter of 52.8+0.2- 0.1mm. x 70mm long be placed inside the pole housing to support the pole shoes whilst the screws are removed. Place the pole housing in a vice or clamping support using a Posidriv No3 bit remove the pole screws, pull the fields out the brush end complete with the mandrill and pole shoes.

Installing the field coils:

Insert the pole shoes into the new field coils and place inside the pole housing, install the pole shoe screws finger tight, now insert the support mandrill to hold and support the fields. Clamp pole housing and tighten the screws to a torque of 20-25 Nm and remove the mandrill. After installation recheck the coils for earths using an insulation tester. A reading of 1 megohm or greater should be expected.

Testing the armature:

The armature should be clean before testing. Check for short circuits using an armature growler or similar tester. Test the insulation resistance to earth using a megger or similar tester. A reading 1 megohm or greater should be expected. The commutator should be examined for any sign of burned or darkened segments as this is usually an indication of open circuited windings.

Machining and undercutting the commutator:

If worn segments are evident on the commutator it must be machined until the working surface is clean, note that the minimum size for the commutator is 31.2mm. When machining the armature it must not be held by the laminations. The Armature must be held at the drive end and supported at the commutator end bearing surface.
It is recommended that the commutator be turned in two stages, that is pre turning and finish turning. In the pre turning stage the commutator is undercut to a maximum depth of 0.8mm. **Please note, it is most important to use dust extraction when undercutting commutators.**

After undercutting the commutator place the armature in the lathe and finish cut using a fine tool. The cut should be no more than 0.03mm. After turning, brush out the commutator slots using a stiff brush and polish surface if necessary.
Runout should be less than 0.1mm for the commutator and 0.5mm for the laminations.

Preparation of sintered bushes:
The bushings used in starter motors are made from porous sintered metal and as such they will hold oil to provide lubrication. It is important that the bushes are pre lubricated prior to fitting. This can be achieved by soaking the bushes over night in mineral oil. If time does not permit over night soaking oil can be forced into the bush by placing a thumb over one end of the bush and filling it with oil. Using the other thumb press firmly until the oil is visiable on the outer surfaces of the bush.

Drive end housing:

Inspect the housing for wear or cracking, examine mounting surfaces and threaded holes for damage, if housing is serviceable using a suitable drift press out old bush and fit a new one.

Commutator end housing:

Inspect the housing for damage. If serviceable press out old bushing and replace with a new one.

Inspection of drive shaft and planetary assembly:

Carefully examine the assembly for signs of wear or cracking. If worn replace the whole planetary drive. The planetary gear hub and bush may be replaced separately if required. To replace the hub remove the circlip and thrust washer and withdraw the planetary shaft. To reassemble reverse the procedure.
Note: The planetary gears are pre lubricated, a small amount of light oil may be used to lubricate the armature spigot bushing prior to reassembly.
The helix for the drive assembly must be lubricated with lithium based grease only.

Drive assembly:

Inspect the pinion for signs of wear or chipped teeth, rotate the pinion by hand and check for any signs of roughness or slipping, examine the pinion bush for wear or scoring, if in doubt replace the drive assembly.

Solenoid testing:

Inspect the solenoid for damage, test the winding dc resistance.
Hold-in Winding 1.16 ... 1.3 Ohms.
Pull-in Winding 0.248 ...0.281 Ohms.
Test temperature +20°C
During hold in and pull in tests the solenoid is held vertically,ie plunger uppermost. It is recommended that a rubber band be installed to prevent the plunger from flinging out during testing.

Testing the pull-in voltage:

Using a power supply capable of supplying 30 amperes , set the voltage to 3.0 volts. A battery and variable resistor may also be used.
Connect the solenoid as per the wiring diagram fig 2.
Connect a 12 volt test lamp between terminal 30 and +12 volt supply and a voltmeter between terminal 50 and ground.
Fully press in solenoid plunger until lamp lights. Allow the plunger to spring out by approximately 8-10mm and hold in this position. Slowly increase the voltage on terminal 50 until the plunger pulls in; note voltmeter reading. At the same time the lamp must light fully. (main contact continuity)
The voltage should be between 3.0v - 6.5 volts.Test duration 2 seconds.

Testing the hold-in voltage:

Set the power supply to 12 volts, connect the positive lead to terminal 50 of the solenoid and connect the negative lead to the case of the solenoid. Press the plunger fully home, it will be held by the hold-in winding. Now decrease the voltage until the winding will no longer hold the plunger.
Note the voltmeter reading, this is the release voltage which should be between 0.2v - 2.0 volts.

Testing the contact burn off reserve:

Press the plunger until the contacts close, this will be indicated when the lamp comes on. It must be possible to push the plunger another 1mm or more towards the magnetic core. If less than 1mm the solenoid must be replaced.

Testing for interwinding short circuits:

A 24 volt supply is required for this test. Apply positive supply to terminal 30 (main battery supply input) and negative to the casing. Press the plunger fully home. Release the plunger, it should return to it's rest position by the action of the return spring. If it does not the windings have interwinding short circuits.
When the solenoid is connected in this way the windings are differentially compounded, that is, their fields are in opposition to each other. See Fig 3.

Mechanical data ,solenoid:

Burn off reserve: 0.8-1.4mm
Pre-stressed tension of reset spring for moving contact. 12$\pm$ 3N
Pre-stressed tension of contact pressure spring. 19N.
Pre-stressed tension of plunger spring with 9mm plunger clearance. 45$\pm$ 7N
Total spring force 113N

Lightly grease the plunger with special grease, Bosch No 5 932 240 150 or equivalent. Do not under any circumstances allow grease on the face of the plunger. If too much grease is applied it may enter the contact chamber and cause contact problems.

Reassembly of starter:

The basic assembly procedure is the reverse of the dismantling process, however the following points should be noted:

- Lubricate lightly as per the appendix attached.
- Ensure the drive shafts are free from burrs.
- Always fit new bushes. (bushes must be pre-lubricated)

Assembly:

1 Refit planetary gear shaft to outer gear hub and secure shaft with washer and circlip.Install drive assembly on shaft, fit stop ring and retainer ring to groove in shaft. Using Bosch tool **KDAL 5484** in vice, support stop ring and press shaft downwards to engage ring into stop ring. Using Bosch tool **KDAL 5487** calk stop ring. Test drive to ensure it moves freely on the shaft, check clutch action.

2 Fit fork lever and pivot to drive assembly. Install planetary gear shaft into opening in drive end housing, placing the flat on the gear hub towards the opening for the solenoid. Slide the assembly into position allowing the fork lever pivot to enter the housing. Install the sealing rubber behind the pivot with the groove towards the housing.

3 Assemble the motor unit. First fit the armature into the pole housing, if brush tool **KDAL 5048** was used during the dismantling process fit commutator shaft into the tool carefully push the armature until the brushes engage the commutator fully. Remove the tool. If the tool was not used the tags on the brush plate will need to be released to allow the brushes to move upwards in the holder permitting the armature to engage the brush plate, refit the brush springs close the tags. Fit the thrust washer to armature shaft. Install commutator end cover until the rubber cable grommet is located in position. Refit the thrust washers, circlip and brush plate screws to cover.

4 Take the assembled motor unit and carefully fit the armature shaft into the planetary drive. It may be necessary to turn the pinion to engage the gears. **(do not force entry)** Install through bolts and tighten to correct torque setting.

5 Refit solenoid taking care to properly engage the fork lever. Install the three mounting screws and connect the cable. This completes the assembly procedure

Bench testing starter motor:

Clamp the starter motor securely in a starter test bench. Connect the positive supply to terminal 30 on the starter and negative to earth or the casing.

The test specifications contained herein only apply to bench testing. They cannot be used to test starters which are installed on an engine.

The duration of the test should be as short as possible. The battery must be in good condition and have an SG of at least 1260. The capacity of the battery must be large enough to support lock torque testing and be capable of delivering 900 amperes for the duration of the test.

Refer attached appendix for test data.

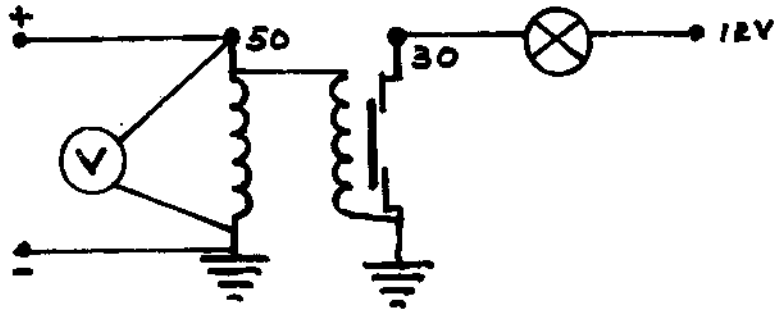
Lubrication guide:

Helix on armature shaft	5 932 240 150	0.8 grams
Helix of drive assy.	5 932 240 150	0.5 grams
Cover cap Comm end	5 700 082 005	0.5 grams (Shell MDL2)
Bushes, pinion track	5 692 260 605	0.15 ml. (Shell Tellus Oil)

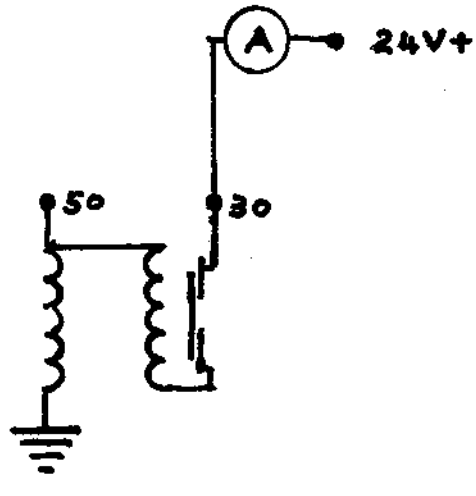
Important: Keep brushes and commutator free from oil.

Bosch Service tools:

KDAL 5028	Mounting sleeve 12mm
KDAL 5047	Mounting base (planetary drive)
KDAL 5048	Assembly tool (brush plate)
KDAL 5487	Calking tool stop ring
KDAL 5484	Support tool stop ring



Testing pull in voltage
Figure 2



Testing for inter winding shorts
Figure 3

Bosch Part Number			9 000 061 000	9 000 061 001	9 000 061 002	9 000 061 003	9 000 061 004	9 000 061 005	9 000 061 006	9 000 061 007	9 000 061 008	9 000 061 009	9 000 061 010
Model			DV-12V-1.4kW	DV-12V-1.4kW	DV-12V-1.4kW	DV-12V-1.4kW	DV-12V-1.4kW	DV-12V-1.4kW	DV-12V-1.4kW	DV-12V-1.4kW	DV-12V-1.4kW	DV-12V-1.4kW	DV-12V-1.4kW
Free Run Test		Volts	11.5	11.5	11.5	11.5	11.5	11.5	11.5	11.5	11.5	11.5	11.5
		Amperes	120	120	120	120	120	120	125	125	125	125	125
		RPM	4000	4000	4000	4000	4000	4000	5300	5300	5300	5300	5300
Lock Torque Test		Volts	4.00	4.00	4.00	4.00	4.00	4.00	4.00	4.00	4.00	4.00	4.00
		Amperes	800	800	800	800	800	800	740	740	800	740	740
		Nm	20	20	20	20	20	20	20	20	20	20	20
Nominal Running Test		Volts	7.7	7.7	7.7	7.7	7.7	7.7	7.7	7.7	7.7	7.7	7.7
		Amperes	400	400	400	400	400	400	390	390	400	390	390
		RPM	900	900	900	900	900	900	1300	1300	900	1300	1300
		Nm	10	10	10	10	10	10	10	10	10	10	10
Armature End Play		mm	0.05-0.3	0.05-0.3	0.05-0.3	0.05-0.3	0.05-0.3	0.05-0.3	0.05-0.3	0.05-0.3	0.05-0.3	0.05-0.3	0.05-0.3
Commutator Diameter	New	mm	32.3	32.3	32.3	32.3	32.3	32.3	32.3	32.3	32.3	32.3	32.3
	Minimum	mm	31.2	31.2	31.2	31.2	31.2	31.2	31.2	31.2	31.2	31.2	31.2
	Undercut depth	mm	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8
Carbon Brush Length	Minimum Length	mm	7	7	7	7	7	7	7	7	7	7	7
Tightening Torques	Solenoid Fixing Screws	Nm	5.5	5.5	5.5	5.5	5.5	5.5	5.5	5.5	5.5	5.5	5.5
	Solenoid Terminal Studs	Nm	9	9	9	9	9	9	9	9	9	9	9
	Through Bolts	Nm	7.5	7.5	7.5	7.5	7.5	7.5	7.5	7.5	7.5	7.5	7.5
	Cover Cap Screws	Nm	1.4-2.0	1.4-2.0	1.4-2.0	1.4-2.0	1.4-2.0	1.4-2.0	1.4-2.0	1.4-2.0	1.4-2.0	1.4-2.0	1.4-2.0
	Pole Shoe Screws	Nm	25	25	25	25	25	25	25	25	25	25	25
Drive Assembly	Overrunning Torque	Nm	0.12-0.18	0.12-0.18	0.12-0.18	0.12-0.18	0.12-0.18	0.12-0.18	0.12-0.18	0.12-0.18	0.12-0.18	0.12-0.18	0.12-0.18
	Maximum runout	mm	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1
Solenoid	Pull-in 20 C	V	6.00	6.00	7.80	7.80	7.80	7.80	6.00	7.80	6.00	7.80	7.80
	100 C	V	8.00	8.00	10.30	10.30	10.30	10.30	8.00	10.30	8.00	10.30	10.30
		A	30.00	30.00	42.00	22.00	22.00	22.00	22.00	22.00	30.00	22.00	22.00
	Hold-in Winding	A	15.00	15.00	15.00	15.00	15.00	15.00	15.00	15.00	15.00	15.00	15.00
		V	12.00	12.00	12.00	12.00	12.00	12.00	12.00	12.00	12.00	12.00	12.00
	Release voltage	V	4.00	4.00	4.00	4.00	4.00	4.00	4.00	4.00	4.00	4.00	4.00