

**Starting System****26**

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## TECHNICAL DATA

|                                       |            |
|---------------------------------------|------------|
| Manufacturer/Type                     | Bosch DW   |
| Output                                | 1,4 Kw     |
| Number of brushes                     | 4          |
| Brush material                        | Carbon     |
| Min. brush length<br>mm (in)          | 8,0(0,32)  |
| Brush spring<br>pressure gm (oz)      | 1600 (56)  |
| Min. diameter of<br>commutator mm(in) | 32,8(1,29) |
| Armature end float<br>mm (in.)        | 0,3(0,01)  |

## SERVICE AND REPAIR OPERATIONS

### 26 111 0 STARTER MOTOR AND STARTING SYSTEM - TEST

Check that the battery is in an acceptable condition for the purpose of the tests (fully charged with a voltmeter reading of 12,6 volts or above). If not satisfactory, replace with a battery known to be fully charged and in good condition.

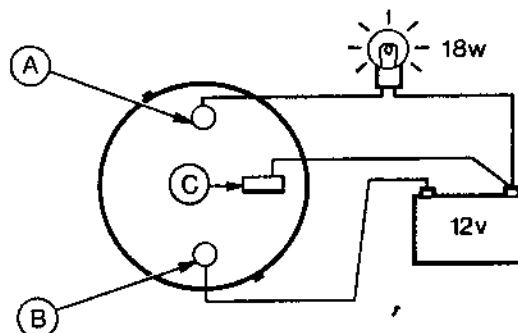
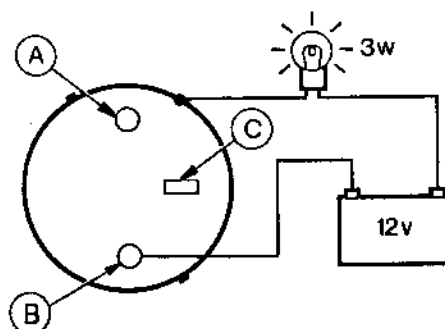
#### Test 1. Starter Solenoid Unit - Check

- A. Disconnect battery earth cable. Remove both cables from solenoid. Check continuity of solenoid windings by connecting a test lamp circuit comprising a 12 volt battery and low wattage (1-3 watts) bulb between starter feed terminal and solenoid body. The lamp should light, Fig.1.
- B. With both solenoid cables still disconnected, connect a new test circuit, (Fig.2.) this time with a high wattage (18 to 21 watts) bulb switched by solenoid main terminals. Energise solenoid by applying 12 volts between spade terminal and starter feed terminal. The solenoid should be heard to operate and test bulb should light fully, indicating closure of solenoid contacts.

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Fig.1. Solenoid winding check.

A - Battery terminal C - Spade terminal  
B - Feed terminal



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Fig.2. Solenoid continuity check.

A - Battery terminal C - Spade terminal  
B - Feed terminal

#### Test 2. Voltage Check at Battery Terminals (On Load)

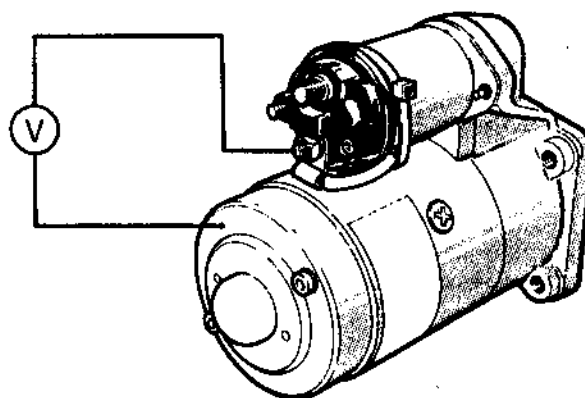
Connect a voltmeter/multimeter directly between battery terminals.

Operate starter with ignition off, i.e. disconnect positive terminal on ignition coil. Voltmeter reading should not be less than 10,5 volts.

#### Test 3. Voltage Check at Starter Main Terminal (On Load)

Connect a voltmeter/multimeter between the starter main terminal and the body of the starter, Fig.3.

Operate starter with ignition off. A reading within 1,0 volt of the readings obtained at the battery should be registered. If a greater voltage drop is measured, the circuit between the battery and starter terminal should be examined.



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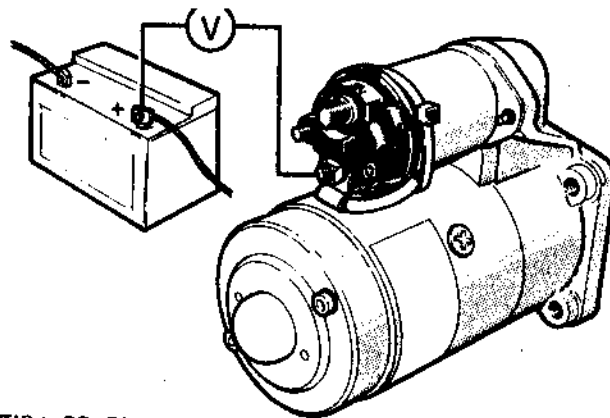
Fig.3. Main terminal voltage check.

26 111 0

## Test 4. Voltage Drop in Main Insulated Line (On Load)

Connect a voltmeter/multimeter between the battery positive terminal and the starter motor main feed terminal, Fig.4.

Operate starter with ignition off for two or three seconds, checking meter readings. Battery voltage should be indicated first and then drop by less than 1,0 volt. Voltage drops above this level indicate a high resistance in the circuit, proceed to Test 5. If the drop is less than 1,0 volt, proceed to Test 6.



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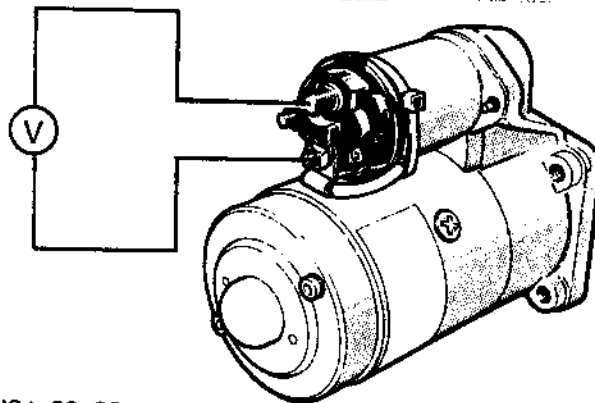
Fig.4. Testing voltage drop in main wiring.

## Test 5. Voltage Drop Across Starter (Solenoid) Switch.

Connect a voltmeter/multimeter between the two main terminal stud connections, Fig.5.

Operate the starter for two or three seconds with the ignition off and note the meter readings.

Battery voltage should be indicated first and then a volt drop of less than 0,5 volts. If not, check for faulty switch or connections. If the reading is acceptable, then any high resistance can be due to either a loose or corroded terminal.



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Fig.5. Testing voltage drop across starter solenoid switch.

## Test 6. Voltage Drop Check on Earth Line (On Load)

Connect a voltmeter/multimeter between the battery negative (earth) terminal and the starter motor main casing.

With the ignition off, operate starter for two or three seconds. If the earth line is satisfactory, the reading should be less than 0,5 volts. A reading of 0,6 volts or more indicates a high resistance somewhere in the earth return side of the circuit.

## Test 7. Battery Earth Connection - Check

A high reading in Test 6 can be due to a dirty or loose connection in the battery earth cable either at the battery or at the location of the earth cable to the engine block.

Check to ensure that all connections are clean and tight.

Clean and re-tighten where necessary and repeat Test 6.

## 26 204 0 STARTER MOTOR ASSEMBLY - REMOVE AND INSTALL

SPECIAL SERVICE TOOLS REQUIRED: NONE

### To Remove

1. Open hood and fit fender covers.
2. Disconnect battery. From underneath vehicle disconnect the main starter motor cable.
3. Disconnect the loom connector from starter motor solenoid.

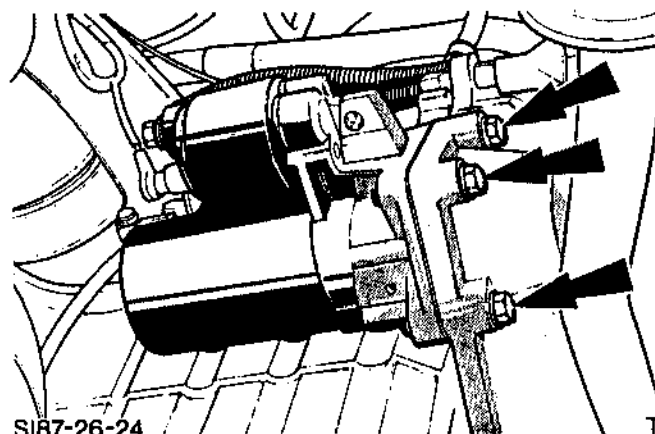


Fig.6. Starter motor in situ.

4. Remove the starter motor securing bolts and support bracket, (where fitted) and guide starter motor clear of the vehicle.

### To Install

5. Align starter motor in position and secure, refitting engine earth strap to top fixing bolt. Refit support bracket bolt, where fitted.
6. Connect main starter feed cable and loom connector.
7. Connect battery and test starter for correct function.
8. Remove fender covers and close hood.

Within the operation 26 204 8 - Starter Motor - Overhaul, various aspects of the Starter Motor mechanical and electrical function should be assessed before the motor is reassembled.

## STARTER MOTOR EXAMINATION AND TESTING

### A. Brushgear.

Check for sticking brushes. If necessary, clean brushes and brush channels with a petrol-moistened cloth.

Check brushes for wear. If brushes are worn to less than minimum dimension shown in the Technical Data, the complete brushplate assembly must be replaced.

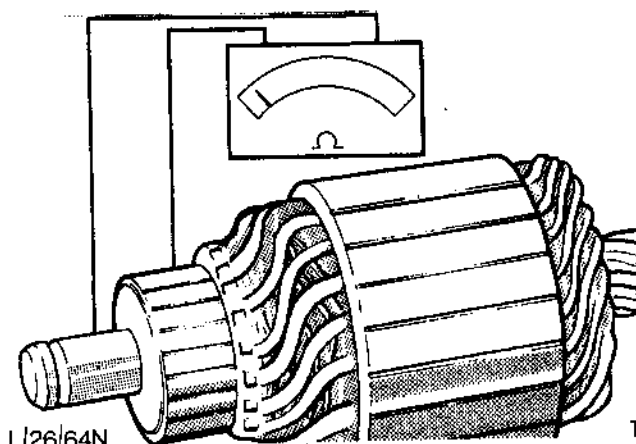


Fig.7. Armature insulation test.

### B. Armature

Face of commutator should be clean and free from burnt spots. If necessary, remove any burnt spots using fine glass paper, (do not use emery cloth), and then clean commutator with a petrol-moistened cloth.

If it is necessary to skim commutator, the minimum permissible diameter to which the armature commutator can be skimmed is specified in Technical Data. The skimming operation should be followed by polishing the commutator surface with fine glasspaper, then wiping clean with a petrol-moistened cloth.

**NOTE: DO NOT CUT INTO THE COMMUTATOR METAL WHEN RECUTTING INSULATION SLOTS.**

Armature insulation can be checked by connecting an ohmmeter/multimeter between a commutator segment and shaft. There should be no reading, Fig.7.

Short-circuited armature windings can only be detected by the use of specialised armature testing equipment. If this equipment is not available, check the armature by substitution.

If there is evidence that armature laminations have been in contact with the yoke or field windings, then the armature bearings are probably excessively worn. First check that the field windings are secure and that the armature runs true in a lathe. If necessary, renew armature bearings.

## STARTER MOTOR EXAMINATION AND TESTING (Cont'd)

## C. Yoke and Field Winding Assembly

A visual check should be made to determine that field magnets are seated correctly and are not damaged.

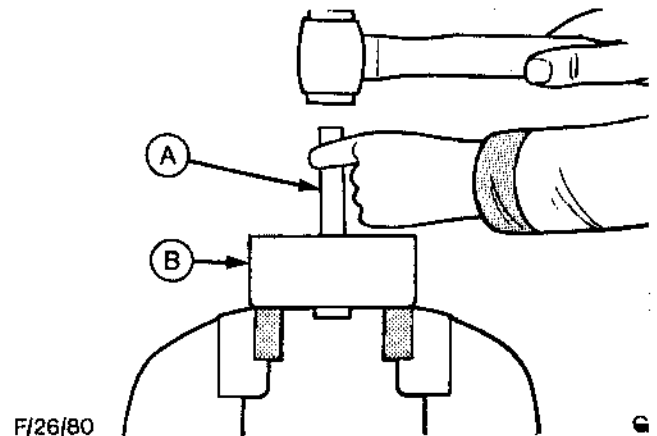


Fig.8. Removing commutator housing bush.  
A - Suitably sized mandrel  
B - Housing

## D. Bearing Bushes

Bearing bushes in both end housings are self lubricating porous bronze.

Renew bushes when excessive armature shaft side-play is evident. Fouling of pole-pieces by armature, or inefficient operation of starter, is likely to occur if armature bushes are excessively worn.

**NOTE:** If the output shaft intermediate bush requires renewal, the complete output shaft/planet gear assembly must be changed.

The commutator end housing bush should be removed by carefully tapping out using a mandrel. Ensure that the end plate is well supported, Fig.8.

The drive end housing bush can be tapped out with a suitably-sized mandrel, Fig.9. after supporting the plate.

New bushes should be pressed into position using a mandrel.

Bushes must not be reamed after fitting, as the self-lubricating qualities will be impaired.

**NOTE:** New bushes must be completely immersed in clean engine oil (SAE 30/40 grade) for at least 20 minutes before being fitted.

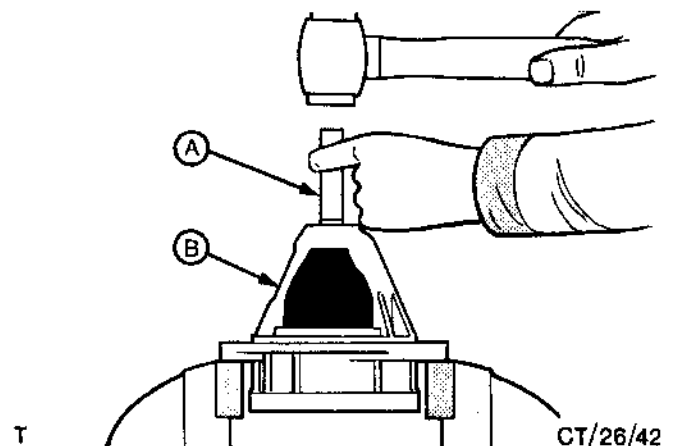
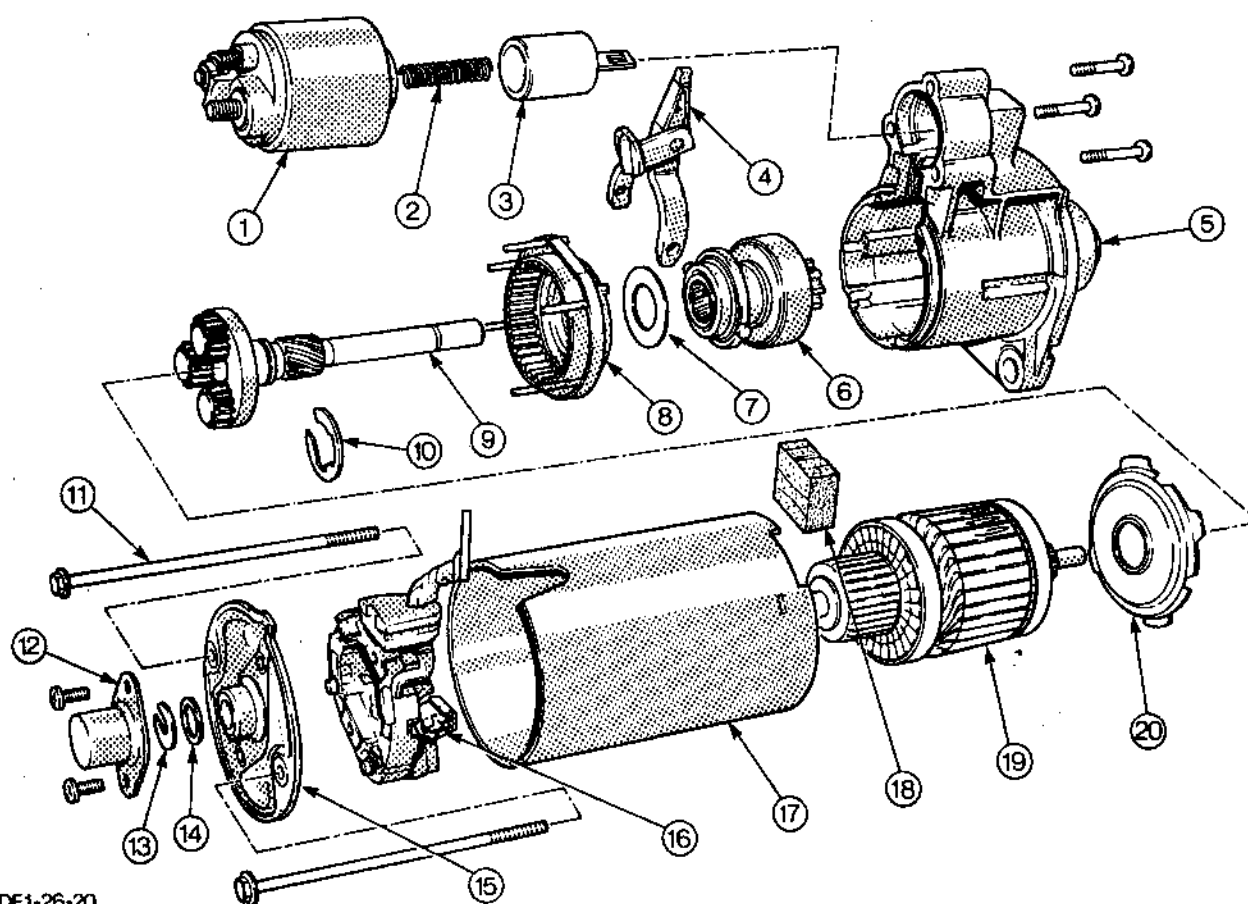


Fig.9. Removing drive end housing bush.  
A - Suitably sized mandrel  
B - Housing



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Fig.10. Bosch DW gear reduced starter motor - exploded view.

- |                              |                                           |                           |
|------------------------------|-------------------------------------------|---------------------------|
| 1 - Solenoid                 | 8 - Ring gear                             | 14 - Spacer               |
| 2 - Solenoid return spring   | 9 - Output shaft and planet gear assembly | 15 - Commutator end plate |
| 3 - Solenoid armature        | 10 - Circlip                              | 16 - Brush plate          |
| 4 - Actuating fork           | 11 - Through bolt                         | 17 - Main housing (yoke)  |
| 5 - Drive end housing        | 12 - End cap                              | 18 - Rubber block         |
| 6 - Pinion and roller clutch | 13 - 'C' clip                             | 19 - Armature             |
| 7 - Spacer                   |                                           | 20 - Retaining plate      |

26 204 8 STARTER MOTOR - OVERHAUL  
(STARTER MOTOR REMOVED)

TYPE: BOSCH DW

SPECIAL SERVICE TOOLS REQUIRED: NONE

To Dismantle

1. Undo two screws and remove armature shaft cover. Fig.11.
2. Remove 'C'-clip and spacer from armature shaft.

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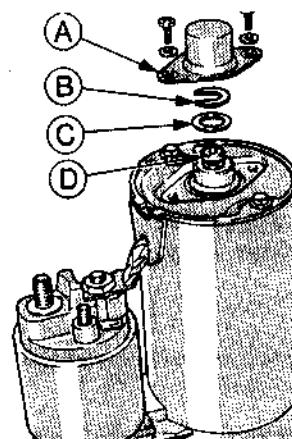


Fig.11. Armature shaft cover.

A - Shaft cover C - Spacer  
B - 'C'-clip D - Shaft

3. Undo two through bolts and lift off commutator end plate. Fig.12.

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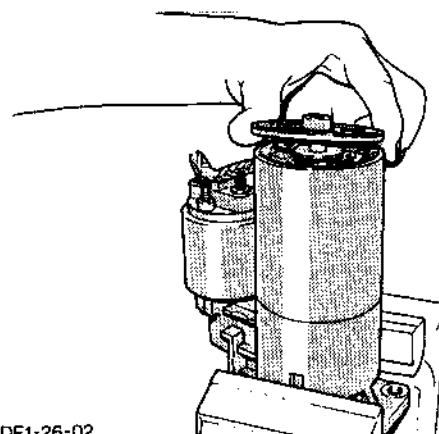


Fig.12. Lift off commutator end plate.

4. Undo nut and remove brush wiring from solenoid terminal.

5. Remove complete yoke and armature assembly from drive end housing. Fig.13.

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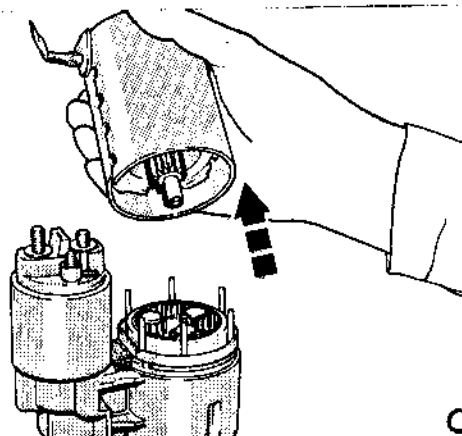
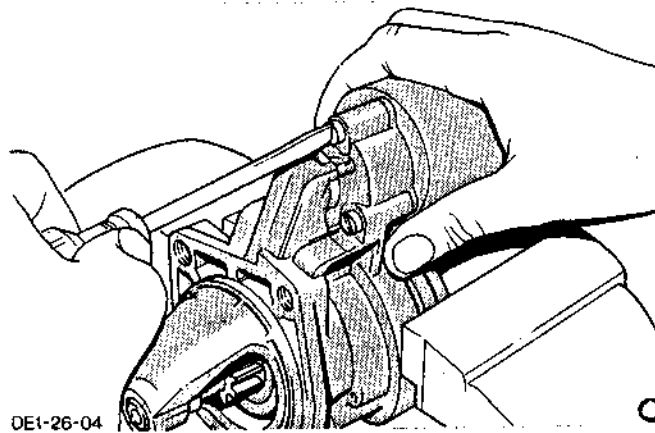


Fig.13. Separate yoke from drive end housing.

6. Release brushes from brushboxes and remove brushplate from armature shaft. Remove armature retaining plate and withdraw armature from yoke housing, overcoming magnetic attraction.

NOTE: Brushes should be released before attempting to remove brush plate, this will prevent accidental damage to brushes.

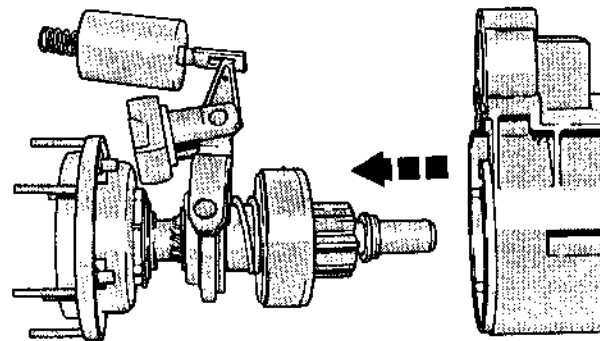
7. Undo three screws and remove solenoid body from drive end housing. Fig.14.



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Fig.14. Remove solenoid body.

8. Remove complete pinion/roller clutch assembly from drive end housing. Fig.15.



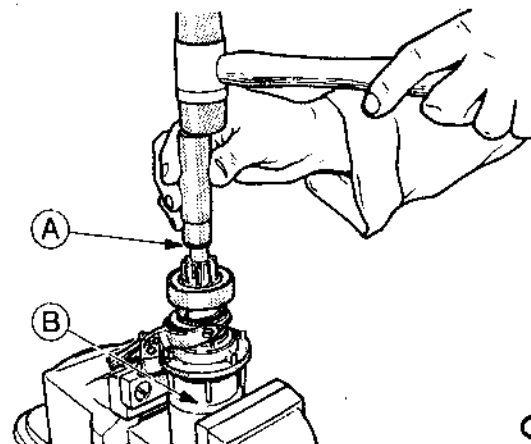
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Fig.15. Separate pinion assembly from drive end housing.

9. Disconnect solenoid armature 'hook' from actuating arm.

10. To remove drive pinion from output shaft, support assembly as shown in Fig.16. and using a suitable sized tube, separate the thrust collar from the 'C'-clip.

NOTE: Do not grip one-way clutch in a vice whilst carrying out this operation as it will be damaged.



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Fig.16. Separate thrust collar from 'C'-clip.

A - Thrust collar  
B - Suitably sized socket

11. Remove the 'C'-clip and slide the drive pinion off the output shaft.

26 204 8

BOSCH DW

To Assemble

12. Slide drive pinion assembly onto output shaft. Fit 'C'-clip and pull thrust collar over 'C'-clip.

13. Refit pinion/clutch assembly into drive end housing ensuring correct location of ring gear carrier. Fig.17. Refit rubber block.

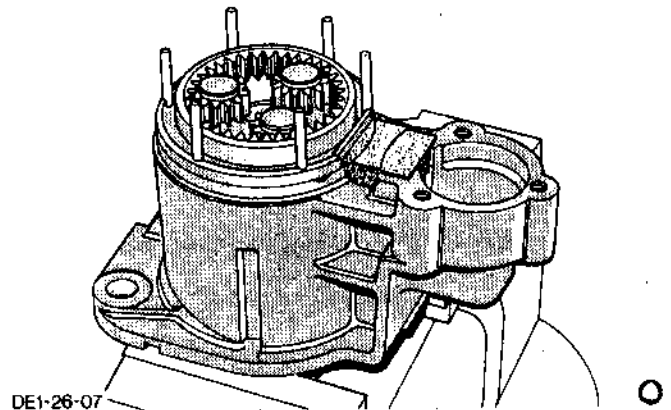


Fig.17. Correct positioning of ring gear carrier.

14. Smear lithium based grease over solenoid armature 'hook' and refit to actuating arm.

15. Refit solenoid spring and body. Secure to drive end housing with three screws. Fig.18.

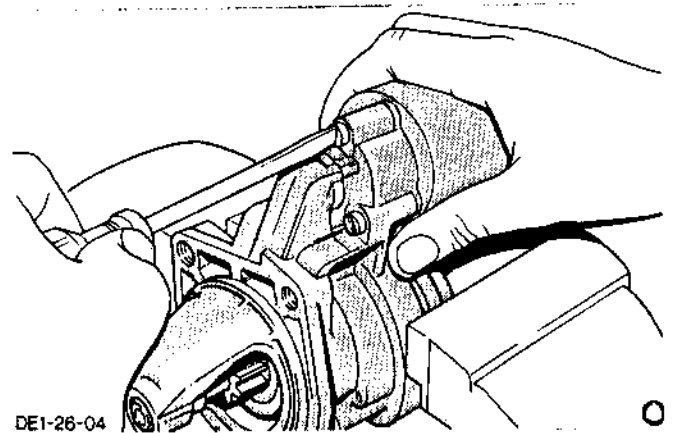


Fig.18. Refit solenoid body.

16. Position brushplate over commutator and assemble brush-boxes, springs and brushes onto brushplate, ensuring that securing lugs on brush-boxes are positively located, Fig.19.

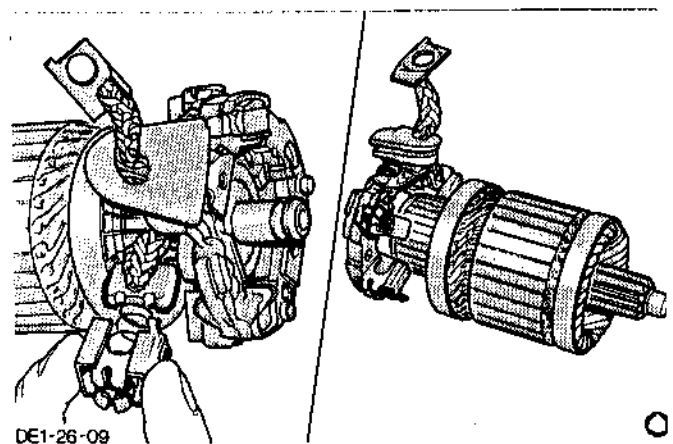


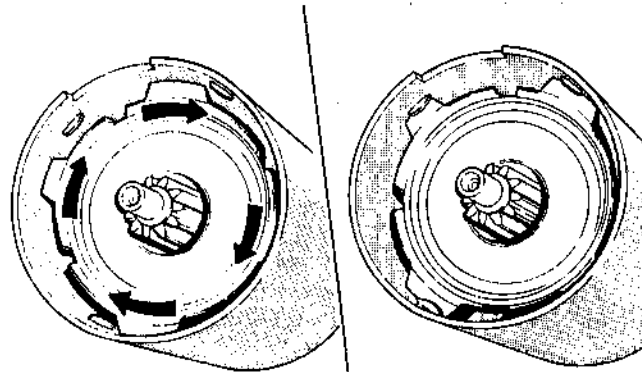
Fig.19. Assembly of brushplate to commutator.

26 204 8

BOSCH DW

17. Insert armature into yoke housing, ensuring brushplate stays in place, and engage rubber insulator with cut-out in yoke.

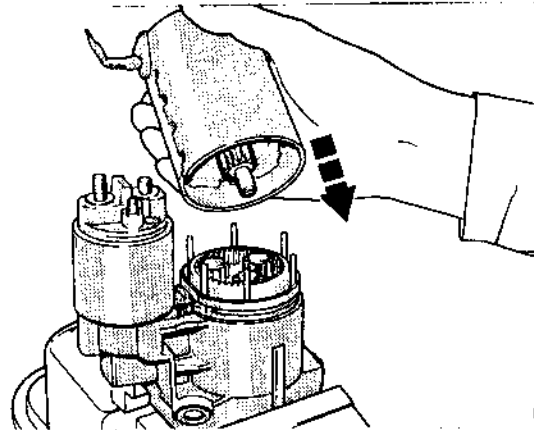
18. Refit armature with retaining plate, ensuring correct positioning, Fig.20.



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Fig.20. Correct armature retaining plate position.

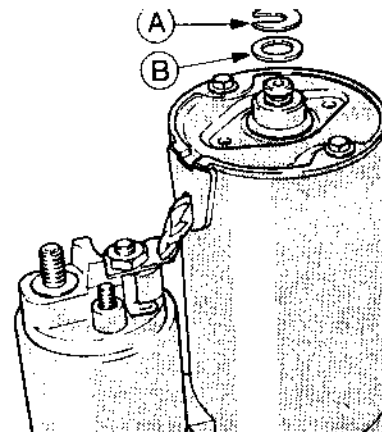
19. Refit yoke and armature to drive end housing, aligning sun gear with planet gears. Refit end cap and retain with two through bolts.



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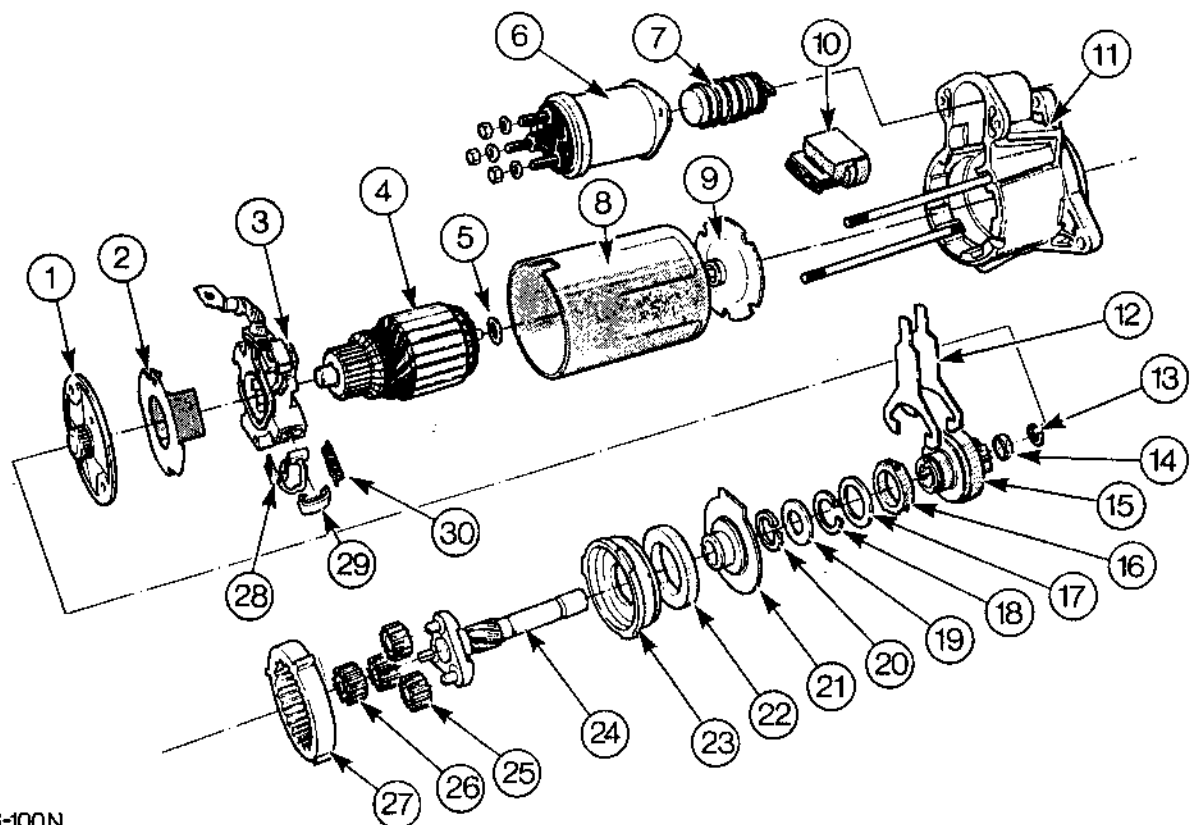
Fig.21. Refit yoke to drive end housing.

20. Refit spacer and 'C'-clip over armature shaft, smear with lithium based grease and fit bearing cap, securing with two screws.



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Fig.22. Refit spacer and 'C'-clip.  
A - 'C'-clip  
B - Spacer



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11

Fig.23. Magneti Marelli M78R starter motor - exploded view.

- |                         |                              |                           |
|-------------------------|------------------------------|---------------------------|
| 1. Commutator end plate | 11. Drive end housing        | 21. Bearing support plate |
| 2. Brush box insulator  | 12. Actuating levers         | 22. Seal                  |
| 3. Brush box            | 13. 'C' clip                 | 23. Support cup           |
| 4. Armature             | 14. Thrust collar            | 24. Output shaft          |
| 5. Spacer               | 15. Pinion and roller clutch | 25. Planet gears          |
| 6. Solenoid             | 16. Carrier                  | 26. Sun gear              |
| 7. Solenoid armature    | 17. Washer                   | 27. Annulus               |
| 8. Main housing         | 18. Circlip                  | 28. Brush                 |
| 9. Bearing plate        | 19. Washer                   | 29. Brush clip            |
| 10. Rubber block        | 20. Circlip                  | 30. Brush spring          |

# 26 204 8 STARTER MOTOR - OVERHAUL (Starter Motor removed)

TYPE: MAGNETI MARELLI M78R

SPECIAL SERVICE TOOLS REQUIRED: NONE

## To Dismantle

1. Clamp starter motor in a vice fitted with protective soft jaws. Disconnect and remove connector link from solenoid.
2. Undo two screws and remove solenoid yoke, Fig.24. Unhook solenoid armature from actuating lever and remove.
3. Remove two through bolt nuts and withdraw main casing, complete with armature, from drive end housing, Fig.25.
4. Undo two screws and remove commutator end plate.
5. Remove bearing support plate, and withdraw armature from the commutator end of the yoke housing, overcoming magnetic attraction.
6. Release brushes from brush boxes and remove brush box and insulator from commutator.

NOTE: Brushes should be released before attempting to remove brush moulding, this will prevent accidental damage to brushes.

7. Remove complete pinion/roller clutch/reduction gear assembly from drive end housing together with the actuating lever and rubber block, Fig.26.
8. Dismantle the gear train and remove the rubber block.

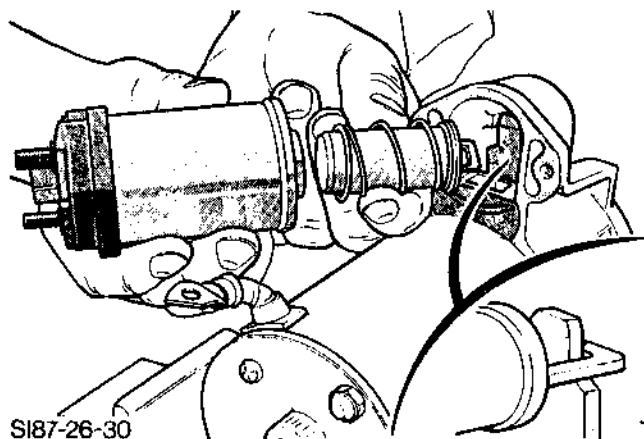


Fig.24. Remove solenoid.

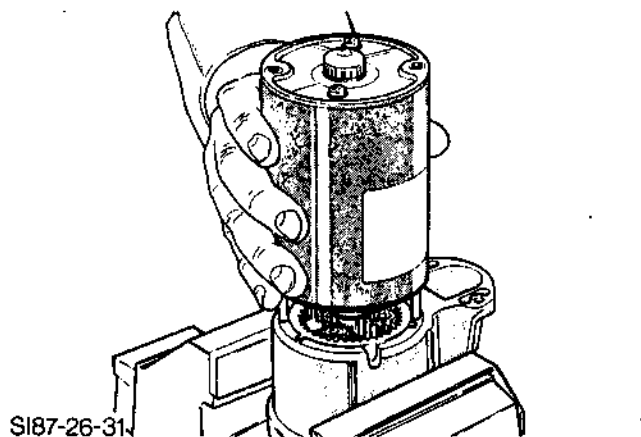


Fig.25. Withdraw main casing from drive end housing.

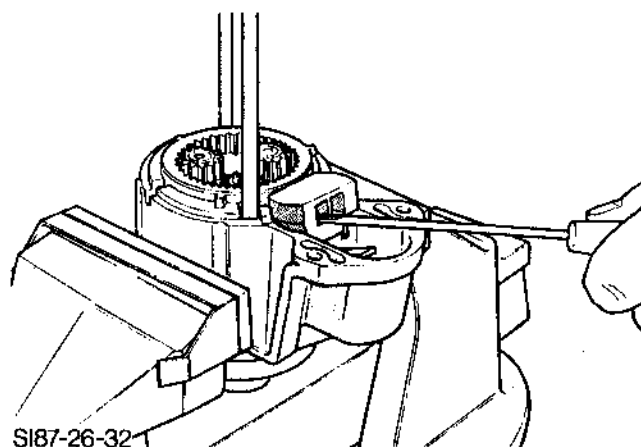


Fig.26. Remove pinion assembly from drive end housing.

9. To remove the pinion from the output shaft, support assembly as shown in Fig.27, using a suitably dimensioned tube e.g. deep socket, to separate the thrust collar from the 'C' clip.

NOTE: Do not grip the one-way clutch in a vice whilst carrying out this operation as it will be damaged.

10. Remove the 'C' clip and slide the drive pinion assembly off the output shaft.

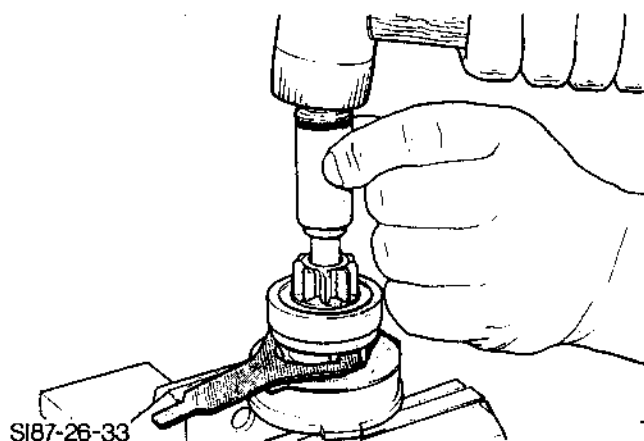


Fig.27. Separate thrust collar from 'C' clip.

11. Remove the circlip, Fig.28, and washer from the drive pinion assembly and slide off the actuating levers and carrier. Remove the actuating levers from the carrier.

12. Remove the circlip and washer from the output shaft and slide off the bearing support plate, seal and plastic support cup.

13. After dismantling, examine all components for wear or damage and replace as necessary.

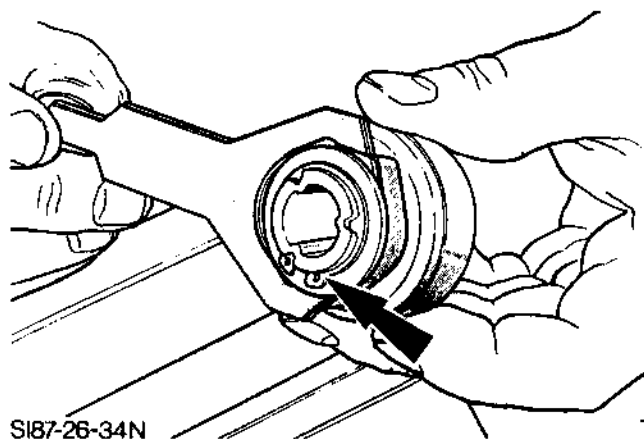


Fig.28. Remove circlip from drive pinion assembly.

#### To Assemble

14. Refit the plastic support cup, seal and bearing support plate to the output shaft and secure with the washer and circlip.

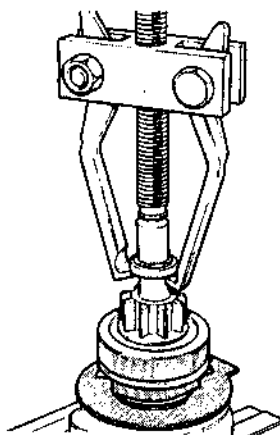
NOTE: Make sure that the seal is correctly located in the support cup.

15. Refit the actuating levers to the carrier. Slide carrier onto the drive pinion assembly. Refit the washer and circlip.

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MAGNETI MARELLI M78R

16. Slide the drive pinion assembly onto the output shaft. Fit thrust collar and 'C' clip, using a suitable puller to locate collar on 'C' clip, Fig.29.



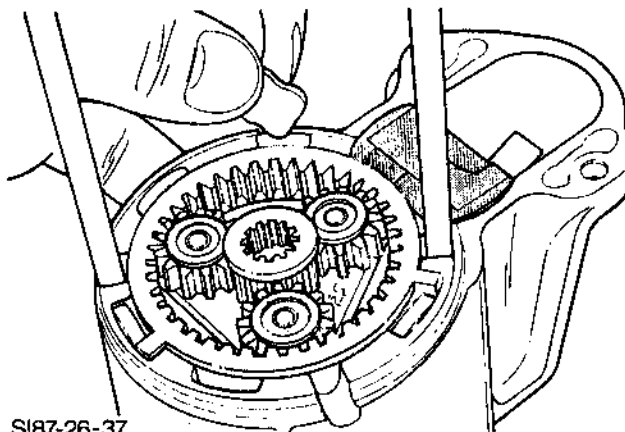
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17. Refit the rubber block to the actuating lever and refit pinion/clutch assembly into the drive end housing ensuring correct location of the rubber block.

Fig.29. Use a suitable puller to locate thrust collar.

18. Reassemble the epicyclic gear train with lithium based grease ensuring correct location of the plastic thrust blocks, Fig.30.

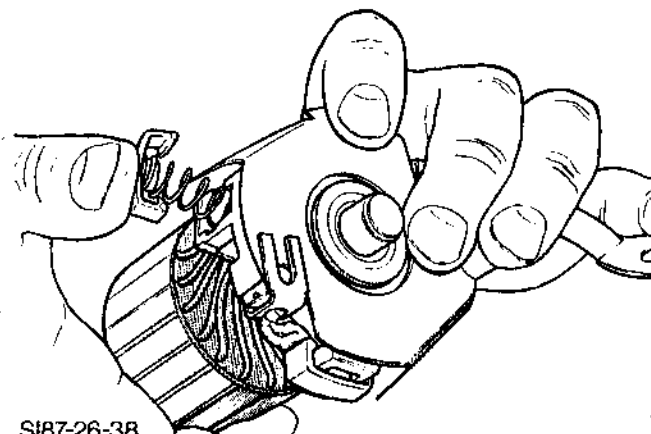


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Fig.30. Correct location of thrust blocks.

19. Assemble the brush boxes on the commutator and refit the insulator, Fig.31.



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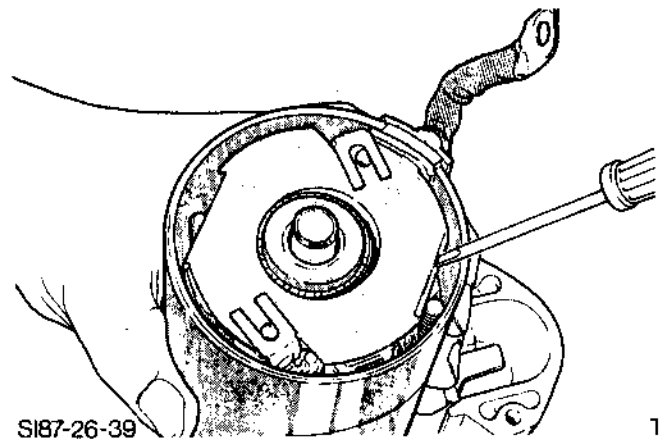
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Fig.31. Assemble brush boxes on commutator.

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MAGNETI MARELLI M78R

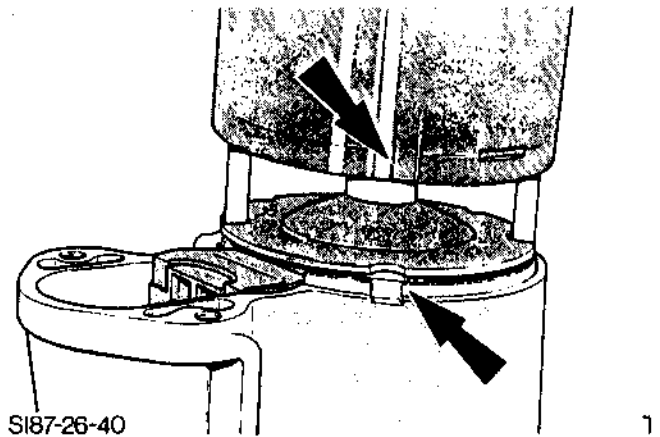
20. Insert the armature into the yoke housing, ensuring correct location of the through bolts and solenoid cable, Fig.32. Refit spacer and bearing plate.



21. Fit the main casing to the drive end housing and align correctly, Fig.33.

Fig.32. Insert armature into yoke housing.

22. Refit commutator end plate and brush assembly retaining screws, secure with through bolt nuts.



23. Smear lithium based grease over solenoid armature 'hook' and refit to actuating arm. Refit solenoid spring and yoke and secure with two screws.

Fig.33. Align main casing with drive end housing.

24. Reconnect cable to solenoid stud.

