CHAPTER 3

Starter Motor Circuit

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3.1 INTRODUCTION

For more than twenty years the 430 series vehicles utilised No 3, Mk 1 or Mk 2 CAV Axial starter motor.

This has now been superseded by the S152 Co-axial starter motor.

It is possible that the Axial starter may still be in use on some vehicles. Both are covered in these notes.

The circuit serving the motors is the same for both types.

2.4 STARTER NO 3 MK 1 AND MK 2 (CAV AXIAL)

A two stage solenoid switch is housed within the commutator end cover. The solenoid is energised when the starter switch is pressed via a relay in the DLB.

The motor is completely sealed and waterproof. It is an insulated return unit, having no internal connections to the frame.

At rest the armature is offset from the centre of the field and is held in that position by a coil spring at the commutator end of the armature.

When the field windings are energised, the armature is attracted and moves into the centre of the field, carrying the pinion with it into engagement with the starter ring.

The field system has four poles on which are wound two main series coils, two auxiliary series coils and two auxiliary shunt coils.

The auxiliary coils achieve the engagement of the pinion and the initial rotation. The main series coils produce the torque to turn the engine.

Between the armature and the pinion sleeve is a disc plate type of clutch which transmits the motor torque to the pinion but which will slip in the event of a backfire.

If the pinion should remain in mesh after the engine has started, the drive will be reversed, the clutch will disengage and the pinion will rotate freely, preventing excessive armature speeds.

The earlier (Mk 1) starter is fitted with a thermal switch which opens at 135°C if the starter is overheated, to open circuit the solenoid switch circuit.

The later (Mk 2) starter has greater heat tolerance and is not fitted with a thermal switch.

Operation. When the starter button is pressed the solenoid switch operates and closes the first contacts (a mechanical latch prevents the second contacts closing).

Current flows from battery positive, through the first contacts, the auxiliary series field coils and the armature to battery negative and through the auxiliary shunt coils to battery negative.

The armature rotates with little torque being produced, and, at the same time, the magnetic field set up between the pole shoes pulls the armature core into line with the poles, and with it the pinion into engagement with the starter ring, against the pressure of the return spring.

The longitudinal movement of the armature causes a trip plate, mounted at the commutator end of the shaft, to lift a trigger of the mechanical latch, and allow the second contacts of the solenoid switch to close.

The second contacts short out the relatively high resistance auxiliary series field coils and energise the main series field coils. Maximum torque is produced.

When the engine fires, the armature speed increases with a corresponding increase in back emf, the current through the motor falls, but the pinion is held in engagement by the auxiliary shunt coils until the starter switch is released.

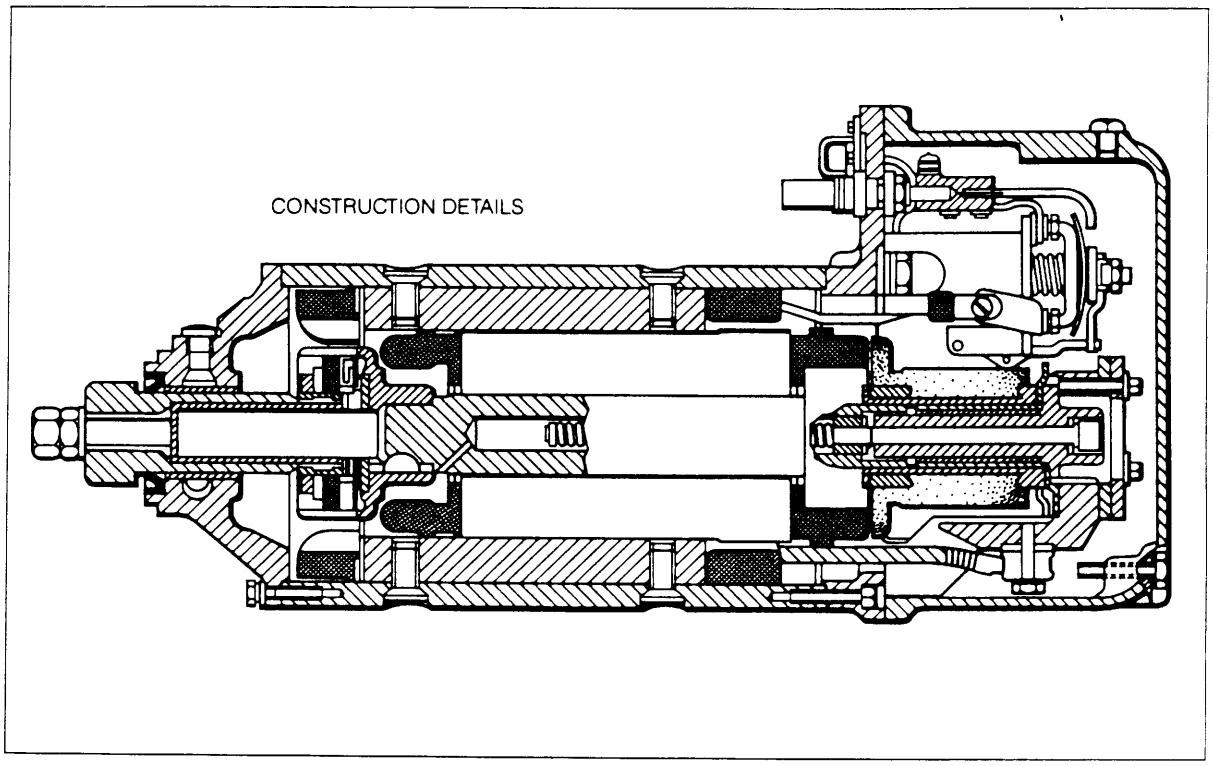


Fig 3.1 Axial Starter Motor — Construction Details

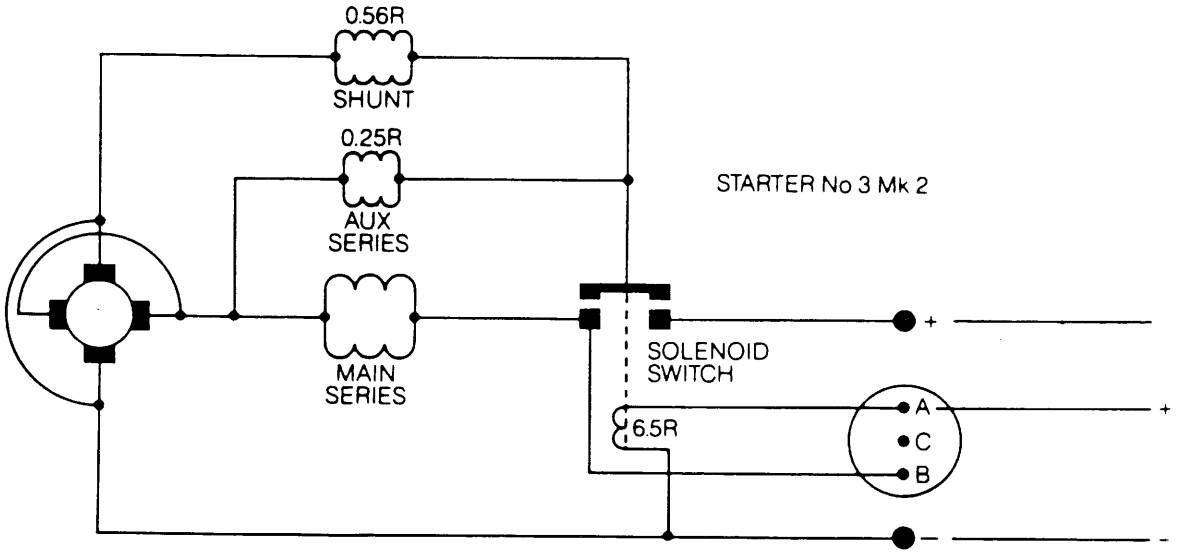


Fig 3.2 Axial Starter Motor — Internal Connections

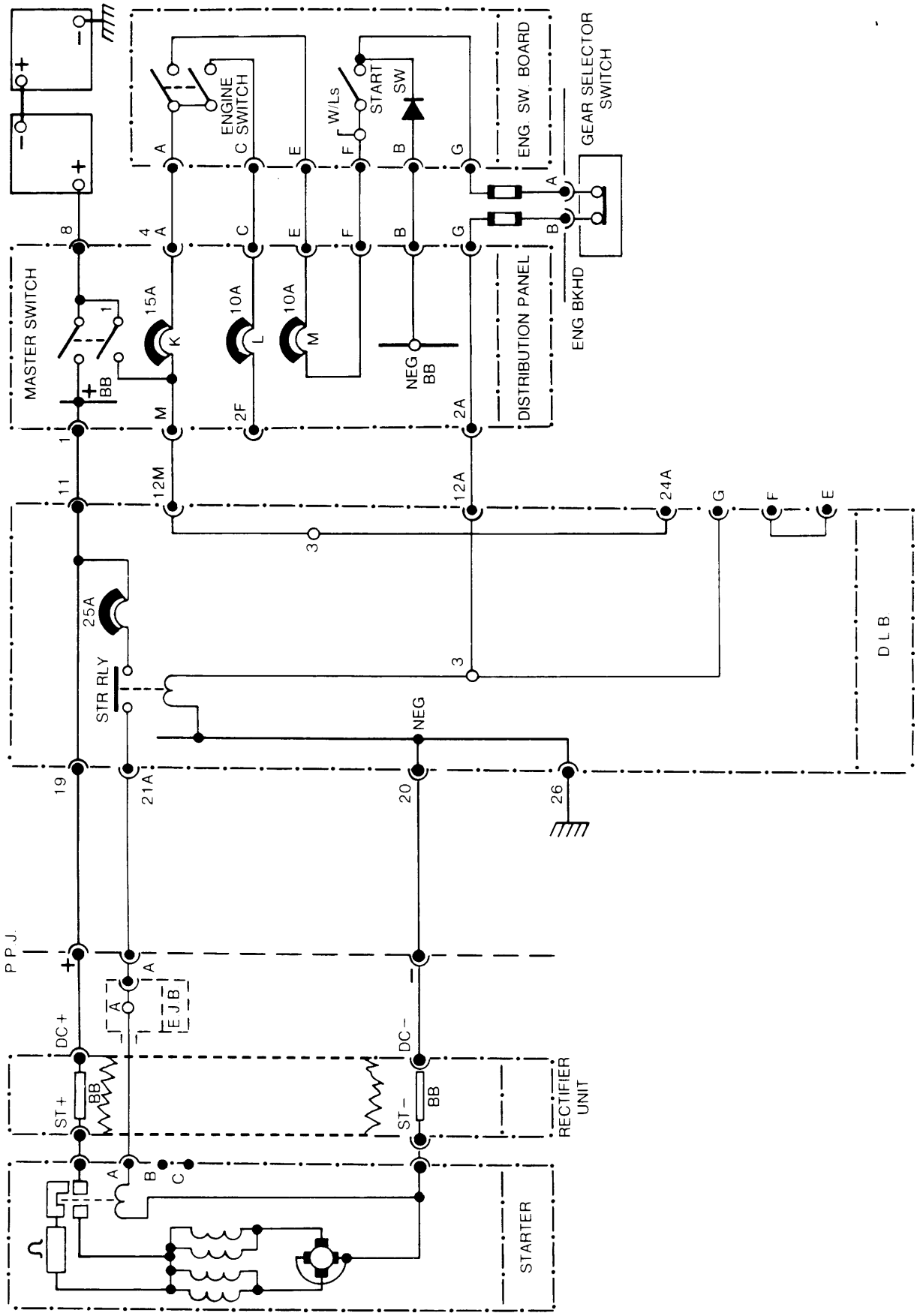
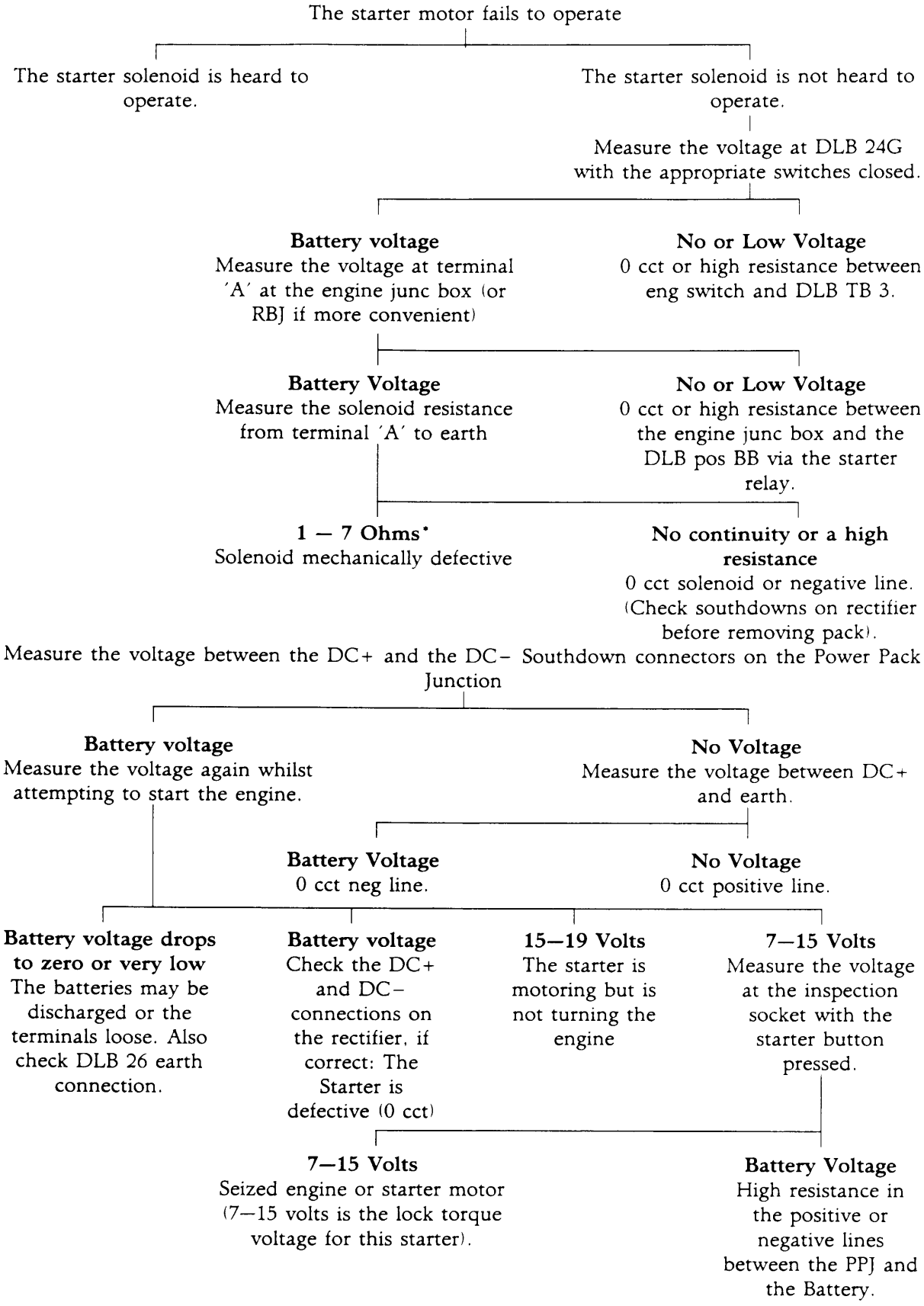


Fig 3.3 Starter Circuit (except 433 and 434)

3.3 FV 432 STARTER CIRCUIT FAULT FINDING (BOTH TYPES)



*S152 — 1 to 1·5 ohms
Axial — 7 ohms

3.4 STARTER S152 CO-AXIAL

See Fig 3.4.

The starter is a co-axial type and incorporates a two-stage solenoid switch unit (6) mounted internally around the armature shaft (16). The brush gear (11) is carried in the commutator end bracket which, together with a drive end bracket is secured to the yoke by through bolts.

The starter is so designed that pinion (3) engagement occurs under reduced power and full power is only applied when the pinion is fully engaged. The pinion locks in the fully engaged position to prevent premature disengagement.

To prevent rapid acceleration of the armature by the engine when it starts, a ratchet device (10) is included which allows the armature shaft to overrun independently of the armature.

In addition an overspeed device comprising steel balls (8) housed in the pinion sleeve and a locking collar (14) prevents the armature (12) from being driven at excessively high speeds by the engine.

The starter is wired for insulated return.

The main terminals (5) are permanently connected to the battery supply, operation of the starter being controlled by the application of battery power to the solenoid terminals (7).

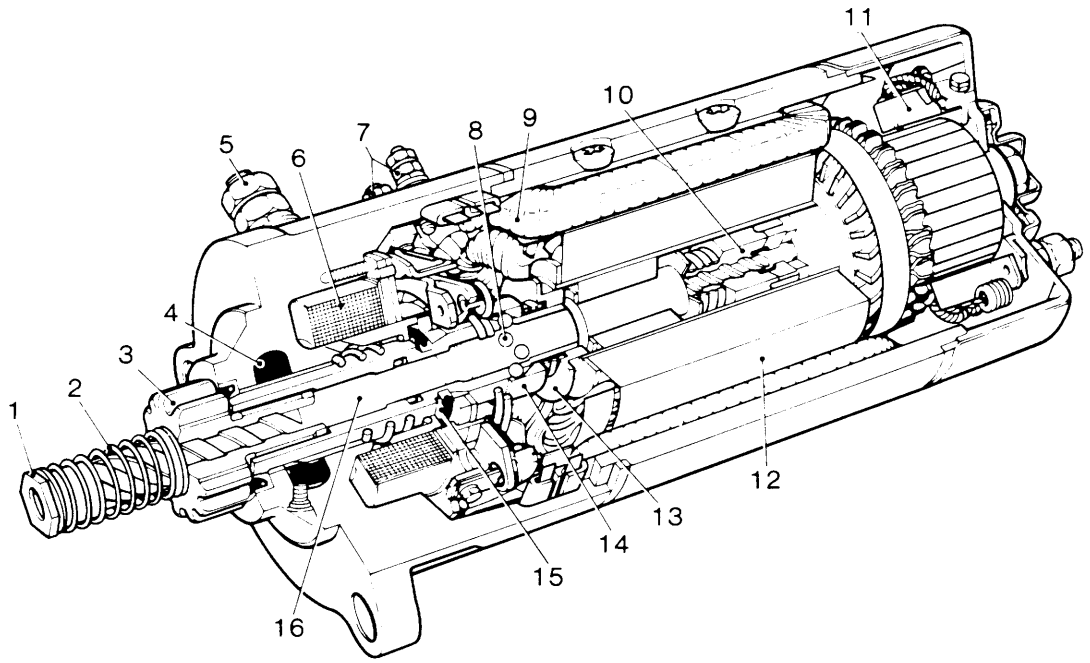
3.5 OPERATION — S152

When the starter solenoid is energised, its plunger moves towards engagement. Four spring-loaded steel segments (15) in the plunger bear against a shoulder on the pinion sleeve and move the pinion sleeve and integral pinion to its first position. At the same time, the first stage contacts close and current is applied to the starter windings via a build-in resistor. The armature rotates under reduced power and the pinion is driven into engagement by means of the armature shaft helix.

When the pinion is almost fully engaged, the second stage contacts close, shorting out the resistor and applying full battery power to the starter windings. When the pinion sleeve is fully engaged it is locked in position by four balls located in the sleeve which drop into an annular groove in the armature shaft. A spring-loaded sleeve slides over the balls to keep them in position.

As the pinion sleeve moves into full engagement, a ramp on the sleeve forces the four spring-loaded segments outwards where they are held in position by the magnetic field of the solenoid.

When the engine starts, the pinion is rapidly accelerated by the engine flywheel. The ratchet device now operates and allows the pinion to accelerate at a faster rate than the heavier armature. When the armature reaches the same speed as the pinion, the ratchet ceases to operate.



1. **Pinion Stop Nut**
2. **Pinion Return Spring**
3. **Pinion**
4. **Lubricating Felt Wick**
5. **Main Terminal**
6. **Solenoid Switch Assembly**
7. **Solenoid Terminals**
8. **Lock Balls**
9. **Field Coils**
10. **Ratchet Helix Sleeve**
11. **Brush Gear**
12. **Armature**
13. **Trip Plate**
14. **Lock Collar**
15. **Segment Set**
16. **Armature Shaft**

Fig 3.4 Sectional view of S152 Starter

3.6 OVERSPEED PROTECTION

Should the engine start to drive the armature at a speed in excess of the permitted maximum, then the overspeed device will operate. This consists of four additional steel balls housed in the pinion sleeve. At speeds of between 10 000 and 13 000 rev/min they move outwards under centrifugal force against a ramp on the locking collar. The locking collar is forced back against its spring thus releasing the four locking balls from the annular groove in the armature shaft. The pinion is now driven back along the helix to its original position; the shoulder passing through the four steel segments which are being held out by magnetic force. The starter will continue to run unloaded until switched off.

If the starter is switched off before the overspeed device has operated, the solenoid plunger, in moving back, pushes the locking collar backwards and releases the locking balls thus enabling the pinion sleeve to return to its original position.

3.7 CAUTION – BENCH TESTING

If the starter motor has been removed from the engine and is to be subjected to a simple motoring test, there will be no flywheel to engage, the pinion will not be restrained from rotating in the initial stage, it will not complete the forward movement necessary to trip the second contacts, the torque limiting resistor will remain in the circuit and may carry current for a longer period than intended.

Such tests, therefore, should be limited to a period of five seconds.

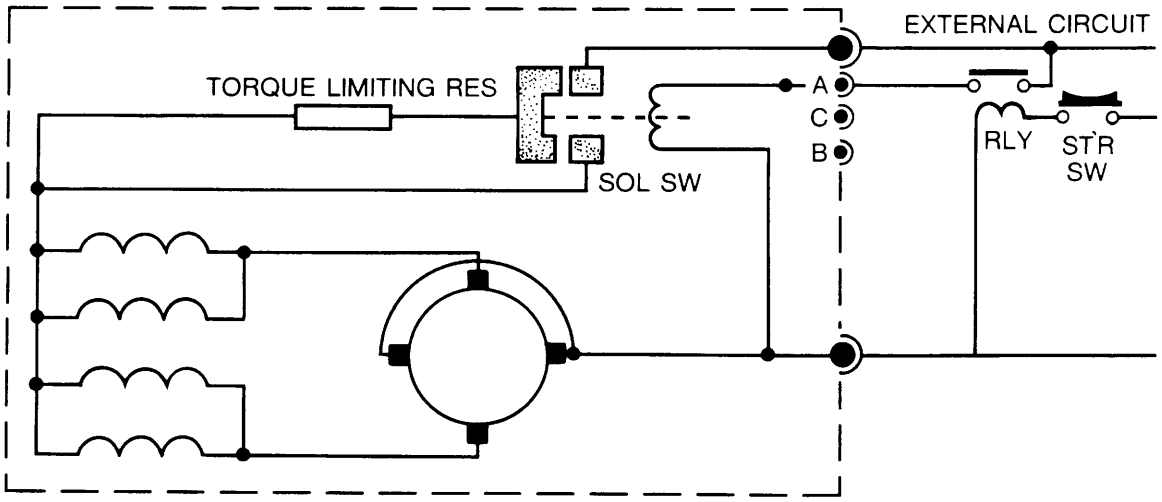


Fig 3.5 Internal Circuit — S152

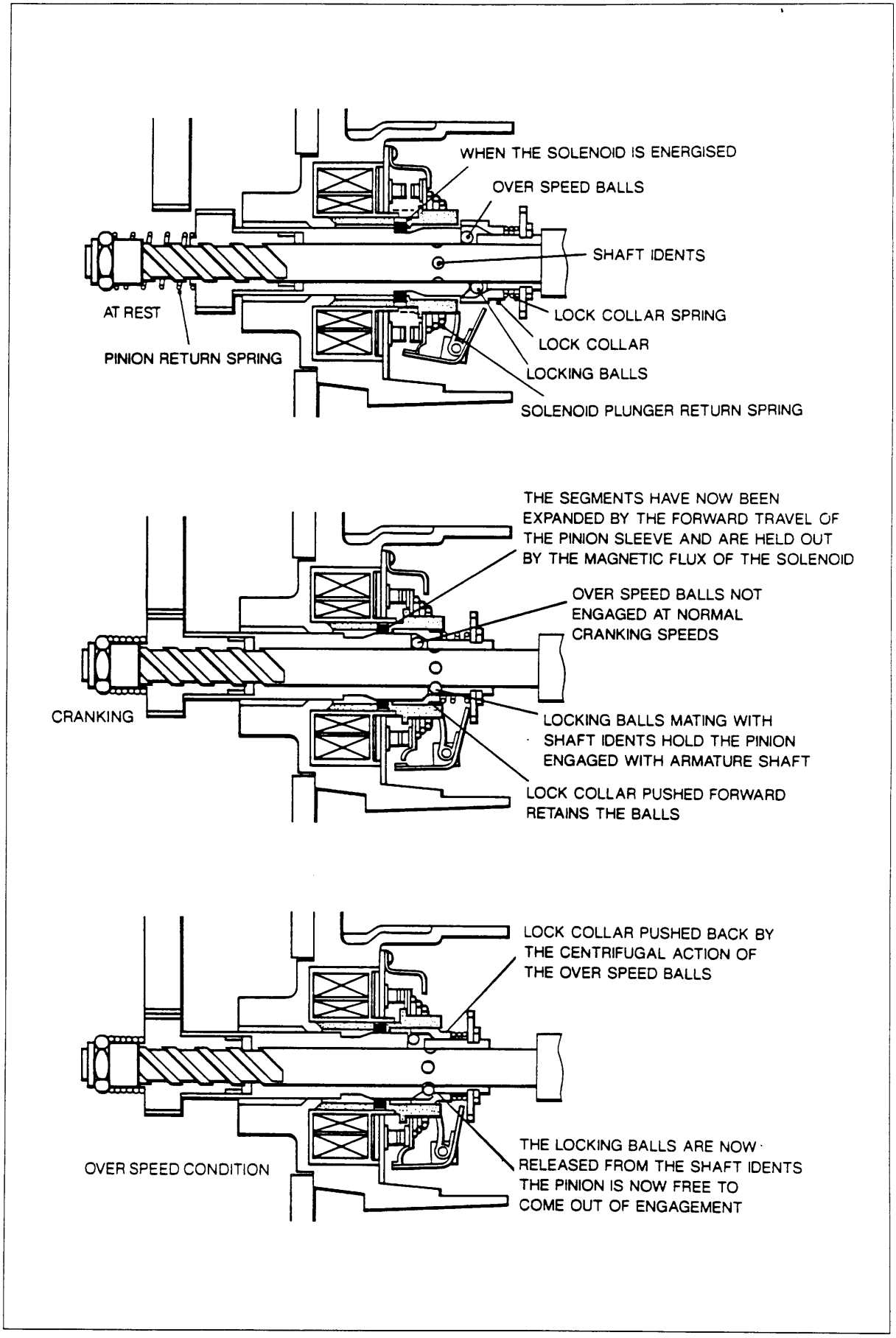


Fig 3.6 Starter S152 Over-Speed Protection

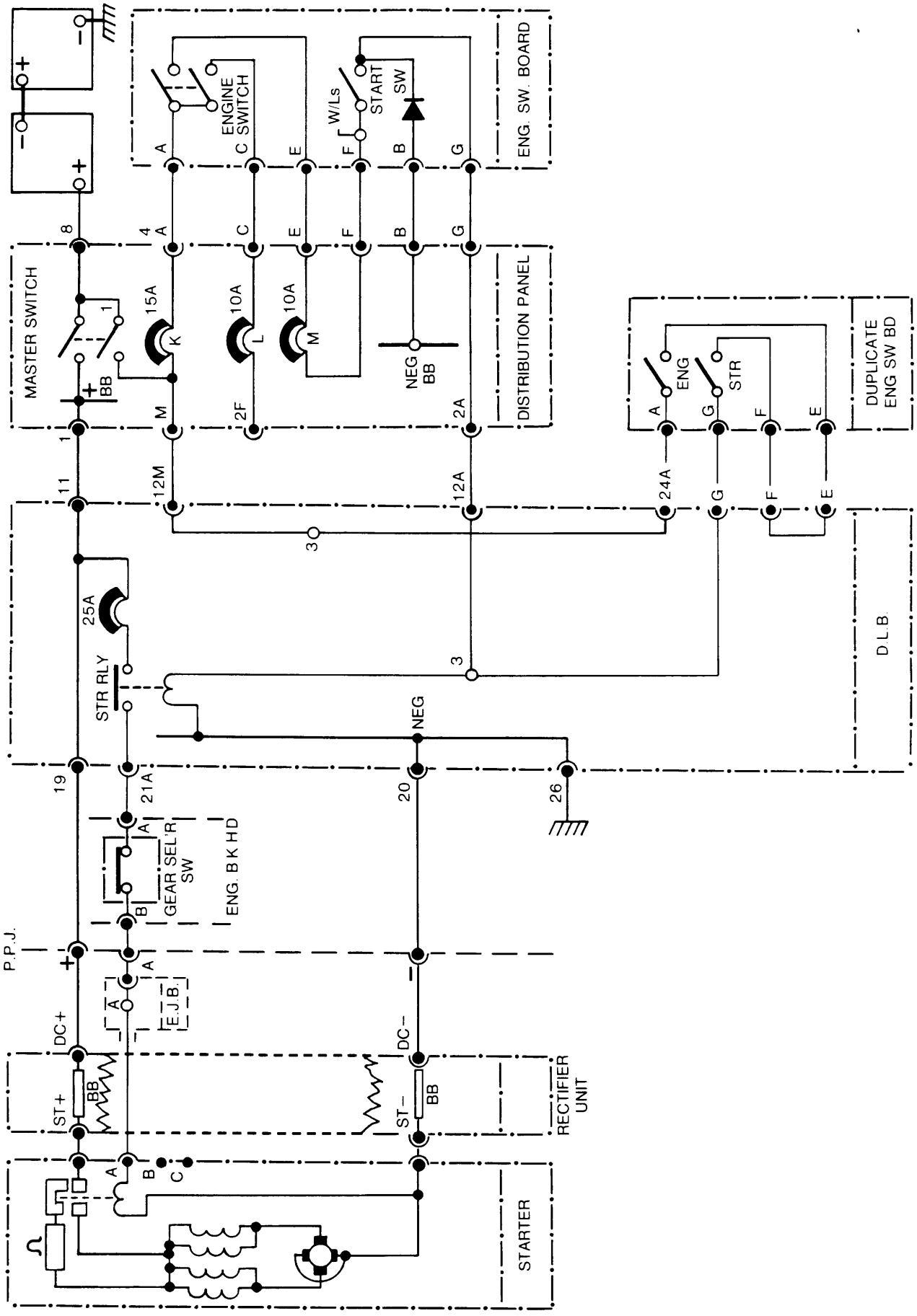


Fig 3.7 433 and 434 Starter Circuit Diagram

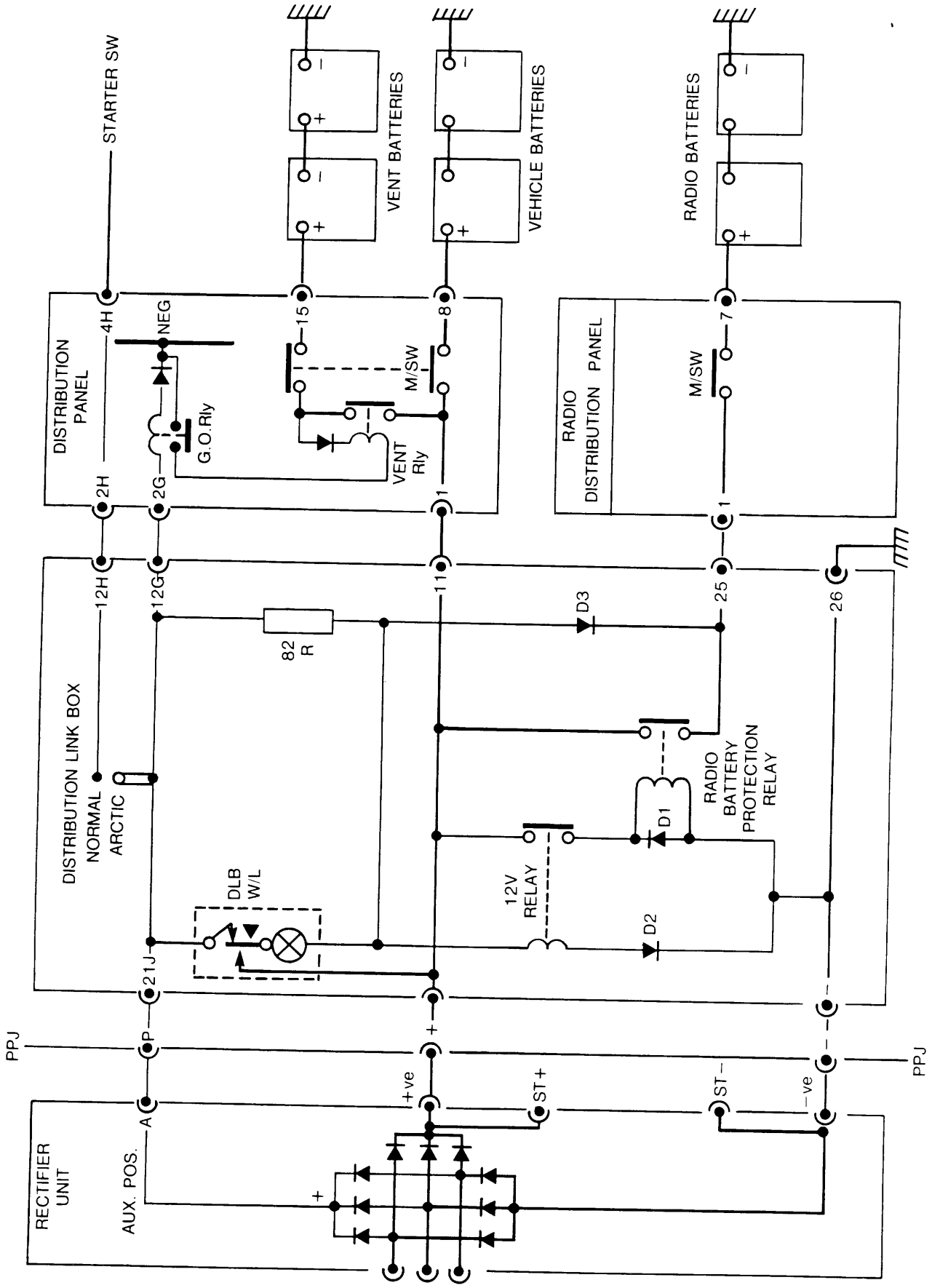


Fig 3.8 Paralleling the Batteries for Arctic Starting

3.8 ARCTIC LINK

See Fig 3.8

This is a facility to provide better starting under extremely cold conditions. A cable marked 12H on TB3 in the DLB is connected to a terminal marked "NORMAL". In Arctic conditions this cable is moved to an adjacent terminal marked "ARCTIC". When the starter switch is closed with the cable in the "ARCTIC" position, automotive battery voltage is applied to the "generator only" line causing the radio battery protection relay to close, and also operating the "gen only" relay in the distribution panel. The "gen only" relay allows the ventilation battery protection relay to close. All three sets of batteries are, therefore, connected in parallel and will provide better starting.

CAUTION – *This facility must not be used on FV 433. Failure to observe this warning may result in damage to the RBJ cords due to the passage of the high starting current.*