

# Mitsubishi Electric Corporation (MELCO)

## Service Bulletin ME003-P

### STARTER MOTORS (105P70)

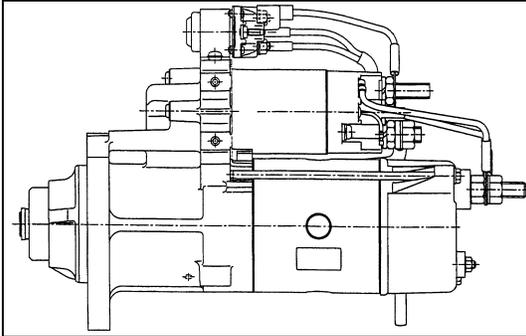


Figure 1 - 105P70 STARTER

A starter is one of the parts installed to the flywheel housing. MELCO's 105P70 starter uses the planetary gear reduction system, actualizing a compact and high-power starter. This starter weighs approximately 30 pounds (13.5 kg), extremely lightweight, and excels in handling.

In addition, this starter uses an overhung mechanism in the output shaft supporting structure designated to protect the inner starter parts from dust or water/oil splash.

#### 1. Principle of operation

- \* When handling the starting system, be sure to refer to the wiring diagrams issued by the vehicle manufacturer to insure an understanding of the whole starting circuit.

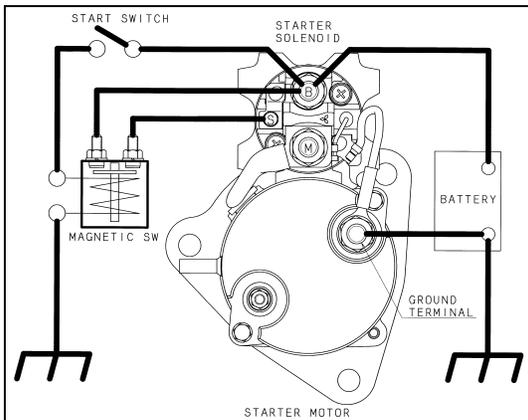


Figure 2 - BASIC STARTING CIRCUIT (GROUND-FLOAT TYPE)

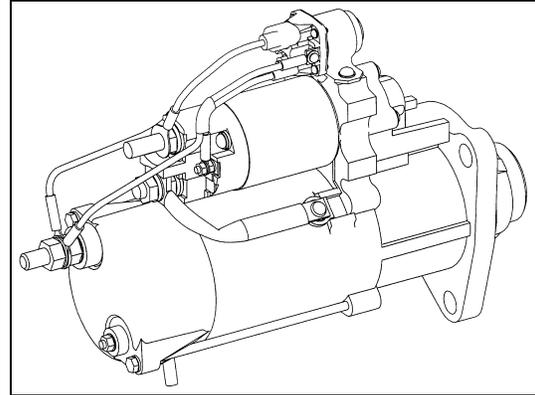


Figure 2 shows the circuit diagram for the 105P70 Ground-float type (sometimes referred to as Insulated or Isolated Ground).

The circuit diagram contains a start switch, a magnetic switch, and a starter solenoid.

When the start switch is closed, the current flows through the magnetic switch windings. The magnetic switch contacts are closed, enabling the current to flow through the windings in the starter solenoid. The clutch is thrust forward with the movement of the plunger and the lever (shown in figures 3), the pinion starts to rotate slowly by the above-mentioned current to engage with the ring gear. When the secure engagement is made, the main contacts in the starter solenoid are closed, and cranking takes place.

When the engine does not start during the initial cranking attempt, the start switch must be turned off within 30 seconds to protect the starter from excessive heat. If the starter motor is operated continuously for 30 seconds, it is necessary to allow the starter motor to be cooled off for at least 2 minutes before the next operation.

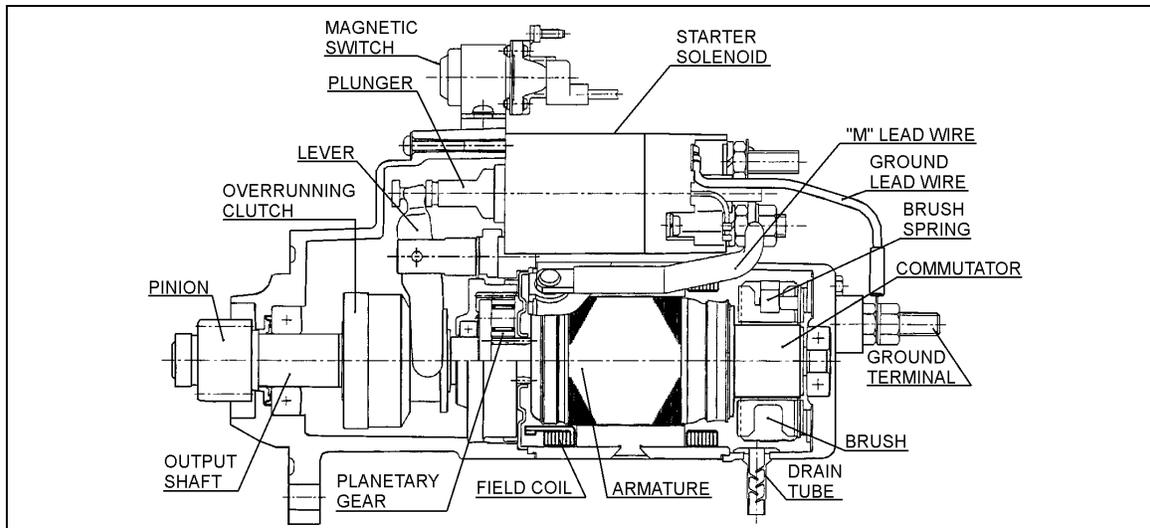


Figure 3 - CROSS-SECTIONAL VIEW (GROUND-FLOAT TYPE)

When the engine starts, the clutch prevents excessive overrun of the armature. Because the clutch is for a short-time rating, the start switch must be turned off immediately after the engine starts.

## 2. Troubleshooting the starting circuit

If the starting system is not functioning correctly, the following checks will assist in determining which part of the circuit is at fault.

### 2.1 Battery

To determine the condition of the battery, follow the testing procedure specified by the vehicle manufacturer. Ensure that the battery is fully charged. (If the battery is faulty, the other starting systems cannot be checked.)

### 2.2 Wiring

Inspect the wiring relating to the starting system for damage. Inspect all connections to the battery, start switch, magnetic switch, and starter solenoid for contact failure due to looseness or rust.

### 2.3 Magnetic switch (Directly attached to the starter)

Inspect the magnetic switch for its function with the start switch closed (i.e. key switch in the start position) by measuring the voltage between the S-terminal in the starter solenoid and the ground. The switch should

not be closed for more than 3 seconds. If this time is exceeded, the starter solenoid may be damaged.

### 2.4 Ring gear and pinion

If the battery, wiring, and magnetic switch are in satisfactory condition, it is assumed that a "stuck" condition may be found (this condition is the phenomenon caused when the pinion is caught by the ring gear, thereby resulting in neither pinion rotation nor thrust movement). This only occurs in very rare cases when the ring gear and pinion teeth are damaged on their end faces. Therefore, remove the starter and check the end faces on the ring gear and pinion for damage (burr). If necessary, replace the ring gear and starter.

### 2.5 Starter

#### 2.5.1 Pinion movement and starter solenoid operation test

As described in figure 4, inspect that the pinion advances forward (no rotation will occur) when a voltage of 16 to 24 V is applied to between the S-terminal in the starter solenoid and the ground. Inspection must be done within 3 seconds for voltage application. If the pinion does not advance forward, replace the starter. The P-coil in the starter solenoid may be layer-shortened, or the pinion sliding area may be clogged.

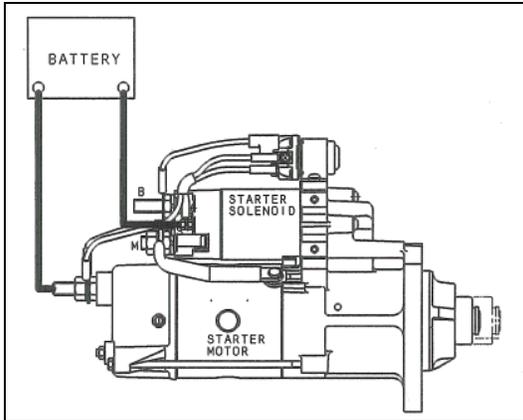


Figure 4 - TESTING PINION MOVEMENT AND PULL-IN WINDINGS (GROUND-FLOAT TYPE)

For the starter switch coils, refer to the switch circuit diagrams for the ground-wire type (ground-float type) shown in figures 5.

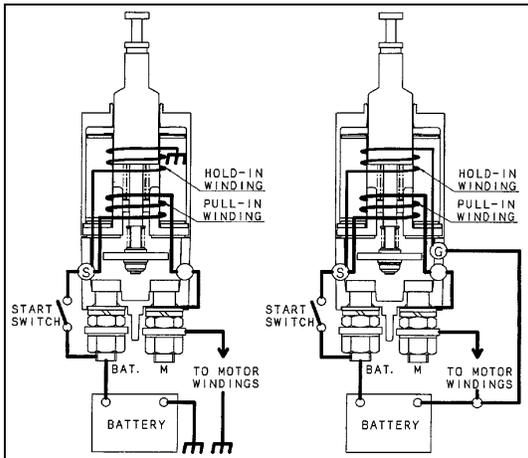


Figure 5 - SOLENOID CIRCUIT (GROUND-FLOAT TYPE)

If the pinion is performing properly, follow the procedure as described below to inspect the H-coil in the starter solenoid.

Remove the M-terminal nut as described in figure 6 and keep the lead wire end in contact with the M-terminal. Apply voltage between the S-terminal and the ground to let the pinion advance forward. Immediately after that, separate the lead wire from the M-terminal and check if the pinion stays in the advanced forward position while voltage is applied to the H-coil only. If the pinion returns, replace the starter. The H-coil is assumed to be layer-short.

\* M-terminal nut tightening torque: 20 to 30 N·m

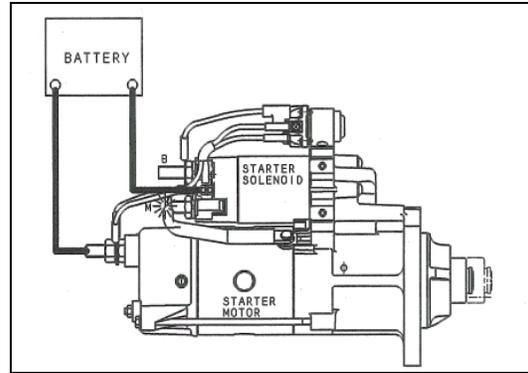


Figure 6 - TESTING HOLD-IN WINDINGS (GROUND-FLOAT TYPE)

Below are the resistance values for the P- and H-coils for reference.

| Coil   | Resistance (reference) |
|--------|------------------------|
| P-coil | 0.072ohm at 68° F      |
| H-coil | 1.300 ohm at 68° F     |

### 2.5.2 No-load test

The no-load test makes it easy to inspect the starter for functional failure without disassembling. This test can also identify an open/short circuit that is difficult to check when disassembled.

As shown in figure 7, connect the starter, fully charged battery, ammeter, and voltmeter. If possible, connect a resistor suitable for voltage control in parallel with the battery. In addition, use an rpm indicator to measure the revolution speed of the output shaft.

**Note:** Attention should be given to the output shaft which advances forward to approximately 0.8" (20 mm) and rotates at that position when the starter is operated.

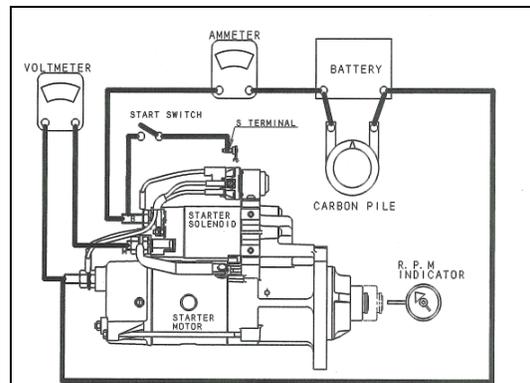


Figure 7 - NO-LOAD TEST CIRCUIT (BODY-GROUND TYPE)

- \* If the output shaft does not move, stop voltage application. If voltage continues to be applied, excessive heat will occur in the starter solenoid and give thermal damage to the coil, thereby making it unserviceable.

Inspect that the current and revolution speed satisfy the following standards when the start switch is closed.

| Voltage | Current    | Speed         |
|---------|------------|---------------|
| 23.5 V  | 125 A max. | 3000 rpm min. |

It is not necessary to adjust the voltage to the exact value of 23.5 V. If the voltage is slightly higher, the rpm will be proportionately higher, while if the voltage is lower, the rpm will be proportionately lower. The current is independent of the voltage, and can be judged using the above standard.

- \* Note that the starter solenoid will not operate unless the voltage between the S-terminal and the ground exceeds 16 V.

Test result and possible cause

1. Rated current draw and revolution speed indicate normal condition of the starter.
2. Low revolution speed and high current draw indicate:
  - a. Too much friction inside starter motor such as clogging, dirt, wearing, faulty bearings
  - b. Shorted circuit inside starter
3. No revolution of the output shaft indicates:
  - a. Grounded M-lead wire or field coils
  - b. Frozen bearings
4. No current draw indicates:
  - a. Open field coils
  - b. Open armature coils
  - c. Broken brush springs, worn brushes, or high insulation resistance between brushes and commutator
5. Extremely low revolution speed and low current draw indicate:
 

Poor connection between M-terminal and lead wire, or between bracket and brush holder screws (body-ground type only), damaged M-lead wire, damaged

brush pig tails, or poor contact between commutator and brushes

6. High revolution speed and high current draw indicate:

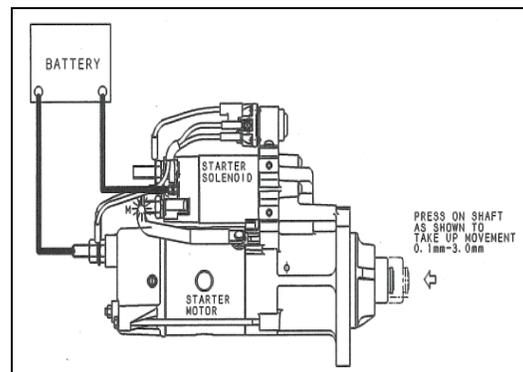
Shorted field coils

- \* In case of symptoms 2 to 6, replace the starter, because of the possible failures mentioned above.

2.5.3 Output shaft play

Before reinstalling the starter to the engine, follow the procedure below to inspect the output shaft clearance.

1. Remove the M-terminal nut and keep the lead wire end in contact with the M-terminal.
2. Apply voltage to between the S-terminal and the ground to let the pinion advance forward. Immediately after that, separate the lead wire from the M-terminal. The pinion stays in the advanced forward position until the battery is disconnected.
3. As described in figure 8, measure the distance between the shaft pressed-in and pulled-out positions. The play should be within 0.004" to 0.118" (0.1 to 3.0 mm). If the measured value does not satisfy the standard, replace the starter.



**Figure 8 - CHECKING OUTPUT SHAFT CLEARANCE (GROUND-FLOAT TYPE)**