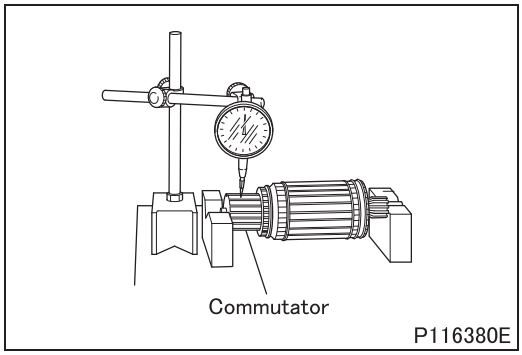
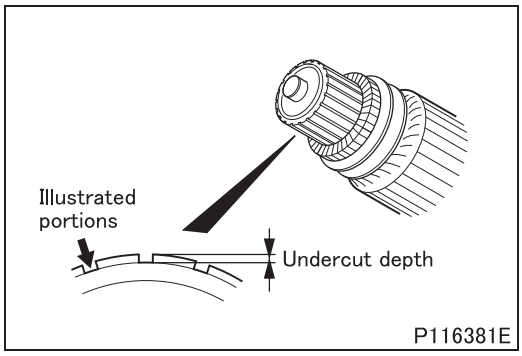


(5) Runout of commutator periphery

- If the reading exceeds the specified limit, rectify the commutator of the armature, making sure the outside diameter stays within specification.

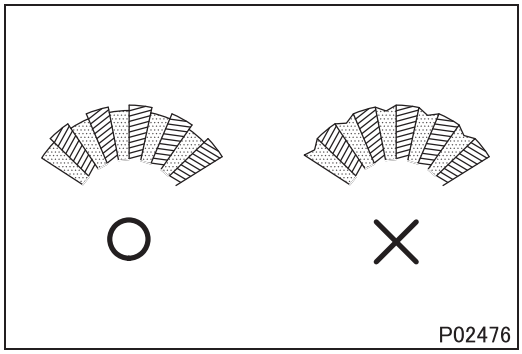
(6) Condition of commutator surface

- If the surface is rough or has stepped wear, rectify it with emery paper (#300 to 500).
- After rectifying the surface, check the extent of commutator runout.



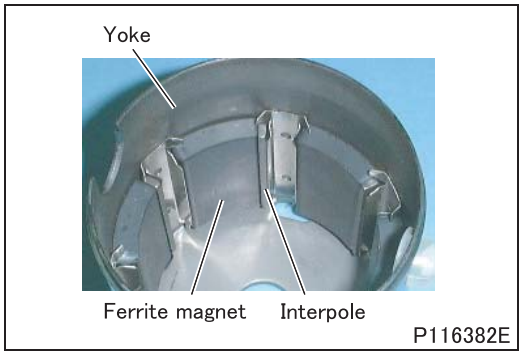
(7) Undercut depth between segments

- If the measurement is lower than the specified limit, rectify or replace the armature.
- To rectify the armature, grind the illustrated portions.



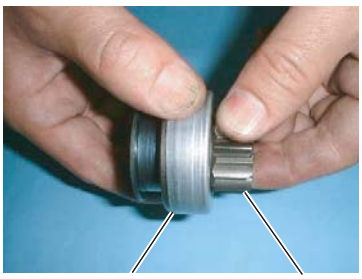
- If the undercut is worn as illustrated, rectify or replace the armature.

○: Acceptable
×: Unacceptable



■ Inspection: Yoke

- Inspect the ferrite magnet in the yoke for damages and cracks. If any fault is found, replace the yoke.



P116383E

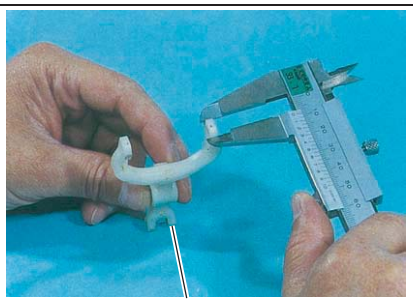
■ **Inspection: Overrunning clutch**

If the following inspections reveal any abnormality, replace the overrunning clutch.

- While holding the housing, give a turn to the pinion. The pinion should not turn at all in one direction but should turn smoothly in the other direction with some resistance felt.
- Confirm that the pinion teeth are free of chips and not abnormally worn.
- Confirm that the pinion metal is not abnormally worn.

CAUTION ⚠

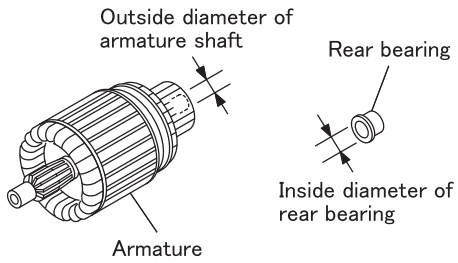
- **The overrunning clutch is filled with grease inside. Do not use immersion cleaning.**



P116384E

■ **Inspection: Lever**

- Measure the overrunning clutch contact surface of the lever to see if it meets the standard value.
- If the measurement is out of the standard value, replace the lever.

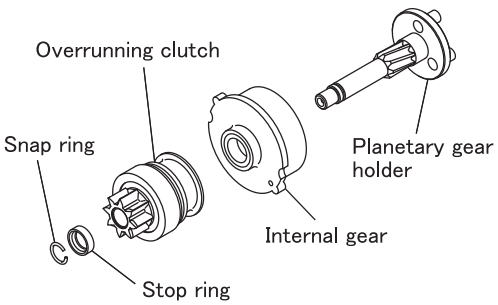


P116385E

■ **Inspection: Rear bearing**

- Confirm that the difference between the inside diameter of the rear bearing and outside diameter of the armature shaft meets the standard value.
- If the measurement is out of the standard value, replace the rear bearing.

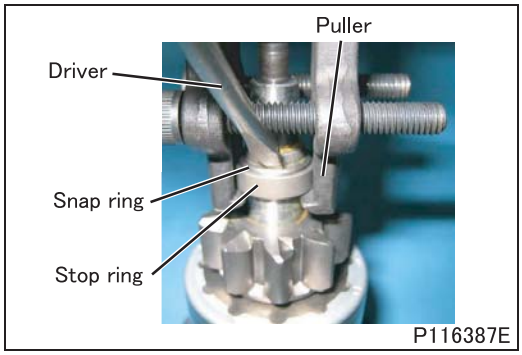
◆Assembly procedure◆



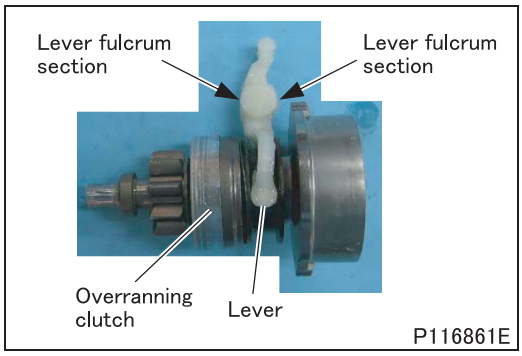
P116860E

■ **Assembly: Planetary gear holder, internal gear and overrunning clutch**

- Install the internal gear, overrunning clutch and stop ring onto the planetary gear holder.

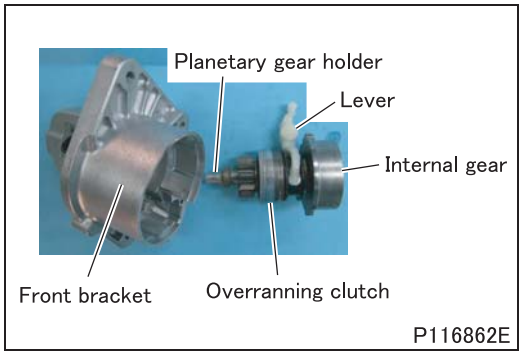


- Set a new snap ring in the groove of the planetary gear holder.
- Using a puller, draw the stop ring toward the snap ring and then fit the snap ring into the stop ring by pressing with a screwdriver.



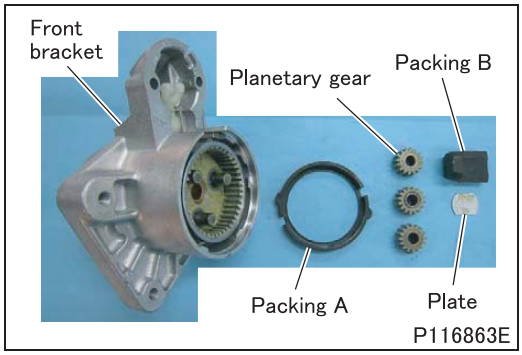
■ Assembly: Lever

- Paying attention to its direction, install the lever onto the over-running clutch.



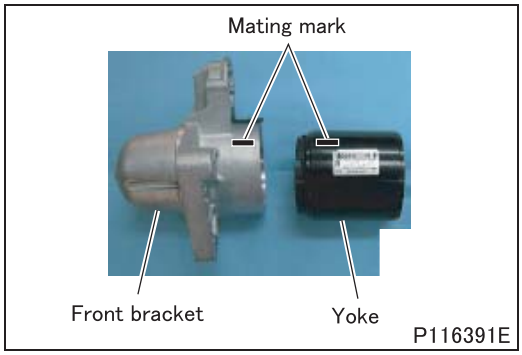
■ Assembly: Front bracket

- Install the planetary gear holder, internal gear, overrunning clutch and lever on the front bracket.



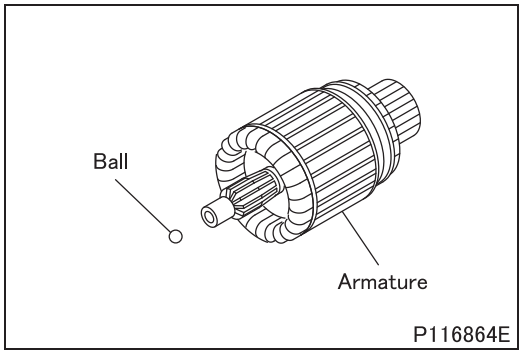
■ Assembly: Packing A, B, plate and planetary gear

- Install in this order: plate, packing B, three planetary gears and packing A.



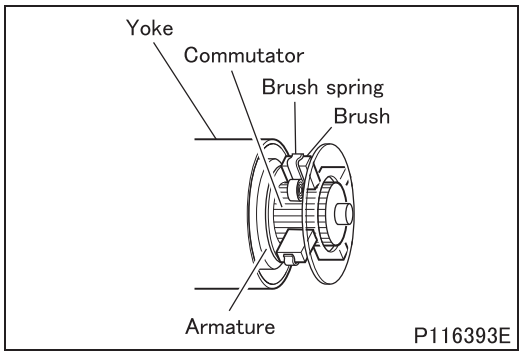
■ **Assembly: Front bracket and yoke**

- Using the mating marks provided before disassembly for alignment, install the yoke to the front bracket.



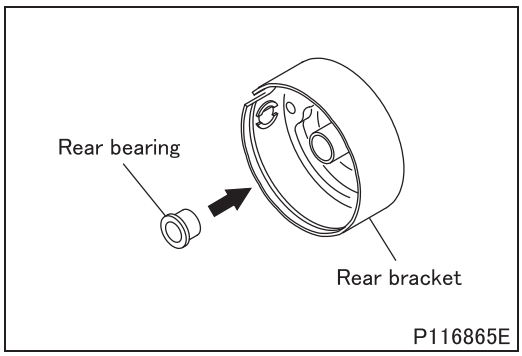
■ **Assembly: Ball and armature**

- Insert the ball, and then install the armature on the planetary gear holder side.



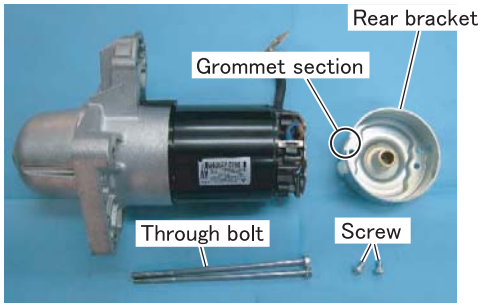
■ **Assembly: Brush holder**

- Install the brush holder on the armature.
- Set the brush springs in the regular state.



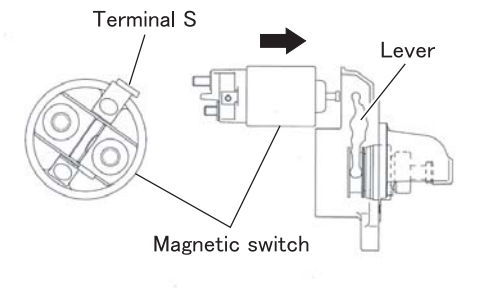
■ **Assembly: Rear bearing and rear bracket**

- Install the rear bearing to the rear bracket.



P116395E

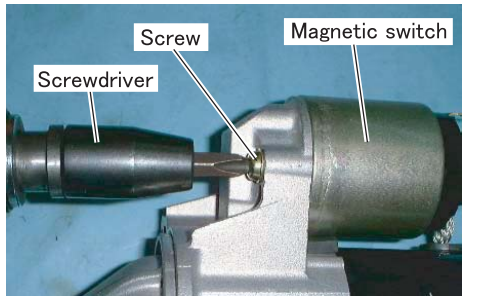
- Install the rear bracket on the yoke. Make sure that the parts are fitted at the grommet section of the rear bracket.
- Tighten the through bolts and screws.



P116396E

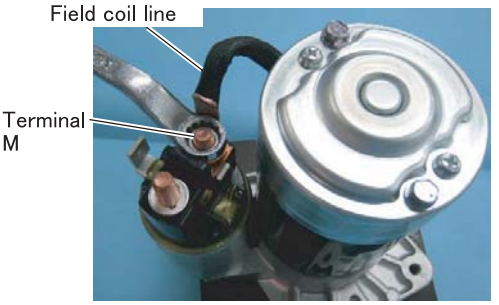
■ **Assembly: Magnetic switch**

- Install the magnet switch onto the lever with its terminal S in the illustrated direction.



P116361E

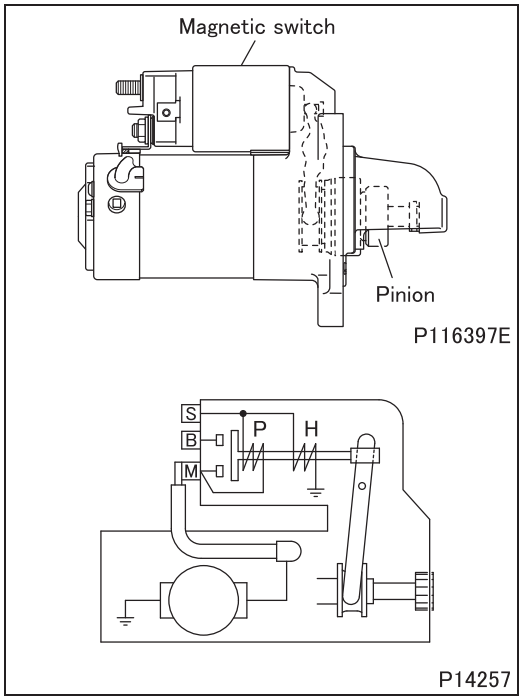
- Tighten the screws.

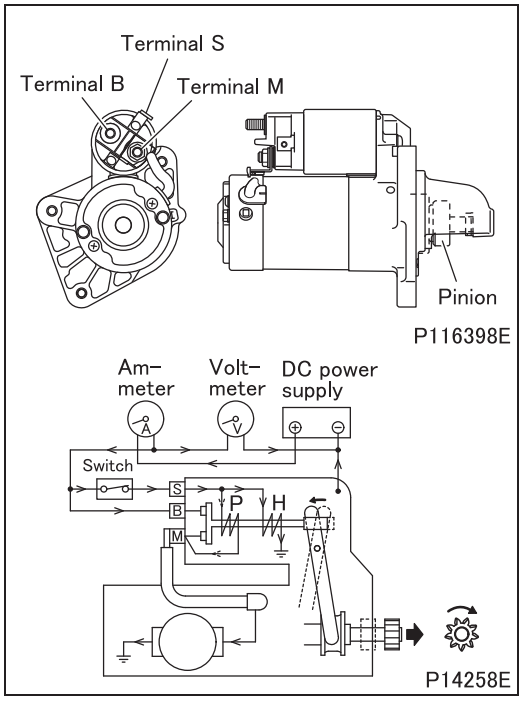


P116360E

- Connect the field coil line to terminal M of the magnet switch, and then tighten the nut.

◆Inspection after assembly◆





■ Inspection: Performance and pinion gap

- After assembling the starter, perform inspections with current supplied to it.

WARNING ⚠

- **When the starter is energized, the pinion will spring out and rotate. Be careful not to touch it with your hands.**
- **The magnetic switch may become very hot during inspections. Be careful when touching it.**

CAUTION ⚠

- **Do not energize the pull-in coil P for longer than 10 seconds, and do not energize the holding coil H for longer than 30 seconds. If these periods are exceeded, the coils may overheat and burn out.**
- **When current is supplied to the starter, a large current (100 A or higher) will flow. For inspection purposes, booster cables or similarly thick cables must therefore be used. It is also important to ensure that all connections are secure.**

(1) Performance test

- Connect the starter as illustrated.
- Set the voltage to 11 volts DC.

CAUTION ⚠

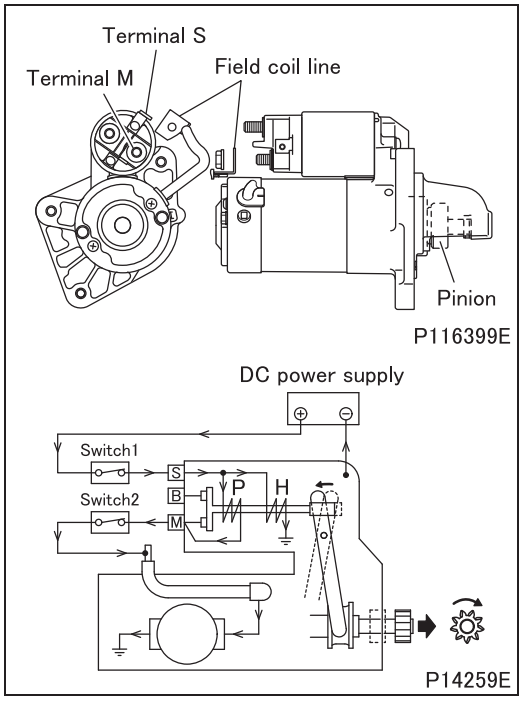
- **The voltage applied must not exceed 12 V.**

- The following operations are performed with current supplied to the starter. Thus, the entire test (consisting of measurement of the current flowing through the starter and measurement of the starter's rotational speed) must be completed within 30 seconds.
  - Turn ON the switch to supply current to the starter. The pinion will spring out and rotate.

CAUTION ⚠

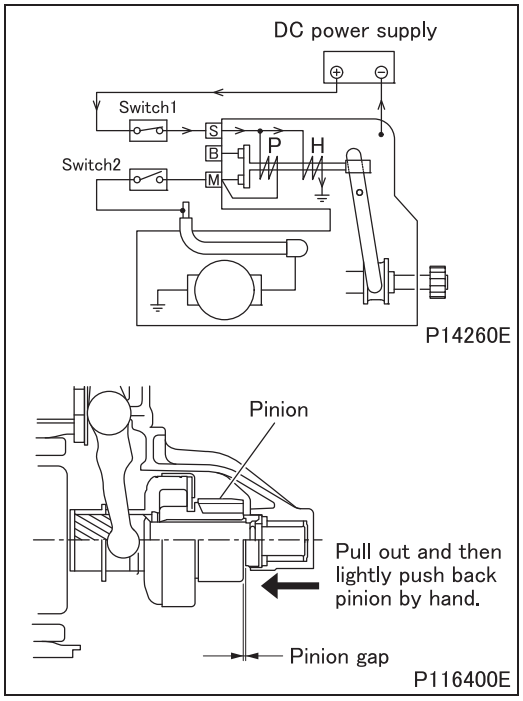
- **When the switch is turned ON, the pull-in coil P and holding coil H are both energized. When the large current from the DC power supply flows from terminal B to terminal M, the supply of current to the pull-in coil P is cut; only the holding coil H remains energized. To prevent the holding coil from burning out, it is essential to complete all operations within 30 seconds.**

  - Measure the current, then measure the starter's rotational speed with a digital tachometer.
  - Turn OFF the switch to de-energize the starter.
- If either measurement is out of specification, disassemble and inspect the starter again.



(2) Pinion gap

- Connect the starter as illustrated.
- The following operations are performed with current supplied to the starter. Thus, the entire procedure for measurement of the pinion gap must be completed within 30 seconds.
  - Turn ON switches 1 and 2 to supply current to the starter. The pinion will spring out and rotate.



  - After the pinion starts to rotate, quickly (within five seconds) turn OFF switch 2 to stop the pinion's rotation.

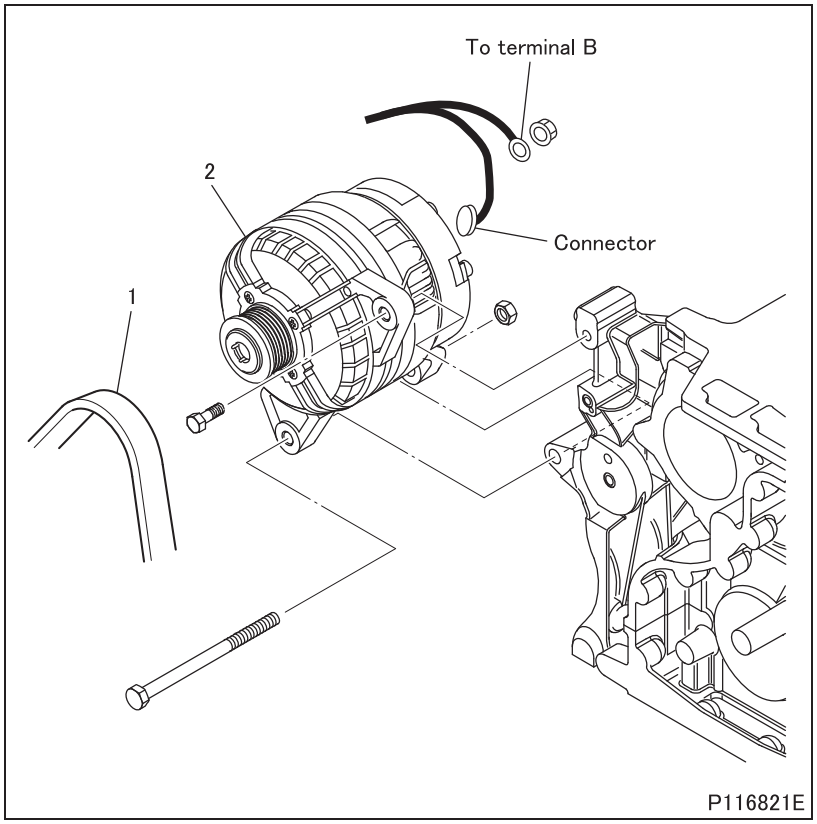
CAUTION ⚠

- **When switches 1 and 2 are turned ON, the pull-in coil P and holding coil H are both energized. The circuit is connected such that no voltage is applied to starter terminal B, so current flows to the pull-in coil while the pinion rotates. To prevent the pull-in coil from burning out, it is essential to turn OFF switch 2 quickly (within five seconds) after the pinion starts to rotate.**

  - Pull out the end of the pinion by hand, and then lightly push it back by hand. Measure the amount of axial movement (pinion gap).
  - Turn OFF switch 1 to de-energize the starter.
- If the measurement is out of specification, replace the lever.

M E M O

#940 ALTERNATOR



● **Removal sequence**

1 Belt
2 Alternator

WARNING ⚠

- **Before removing the alternator, disconnect the (–) battery cable and insulate the cable and the (–) battery terminal with tape.**
- **It is dangerous to leave the (–) battery cable connected since the battery cable voltage is always present at terminal B.**

● **Installation sequence**

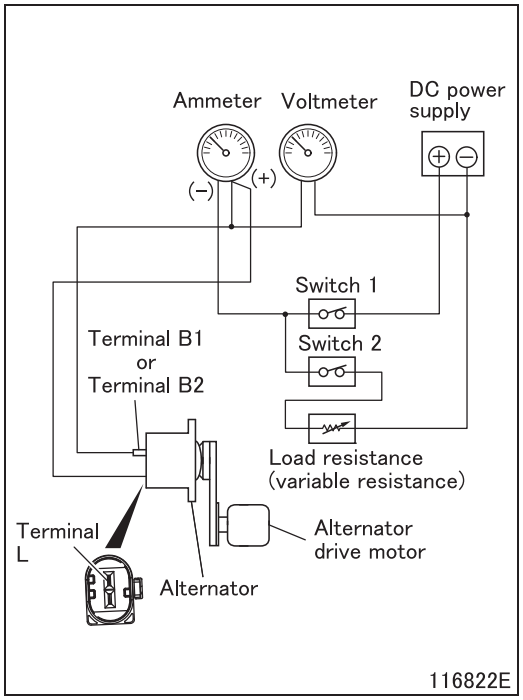
Follow the removal sequence in reverse.

Service standards

Location	Maintenance item			Standard value	Limit	Remedy
2	Alternator output current (*when alternator is hot and producing 13.5 V)	110A	At 1800 rpm	55 A or more	–	Correct or replace
			At 6000 rpm	110 A or more	–	
		140A	At 1800 rpm	75 A or more	–	
			At 6000 rpm	140 A or more	–	
	Adjustment voltage of regulator (at 6000 rpm, 5 A is loaded)			14.5 ± 0.25 V	–	Replace

* The hot condition occurs after the alternator has been running at normal ambient temperature at 6000 rpm and maximum output for 30 minutes.

◆Inspection procedure◆



■ Inspection: Alternator

(1) Alternator output current (bench test)

- Connect the alternator as illustrated.

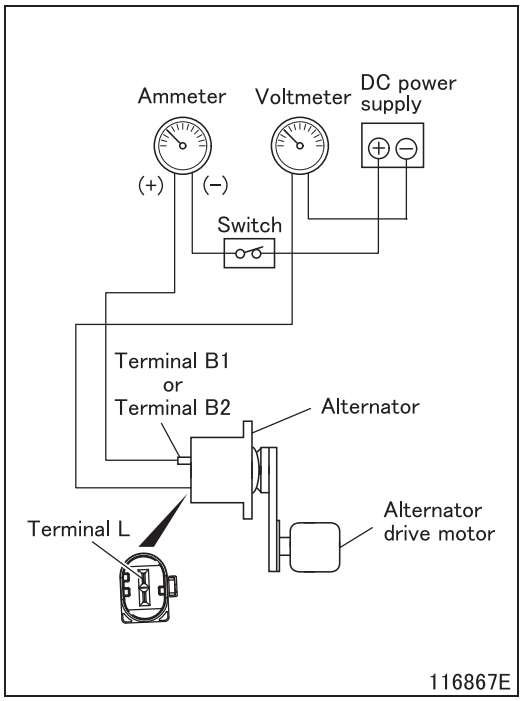
CAUTION ⚠

- **Wires with sufficient thickness should be used for wiring and each connection should be securely fastened.**

- Increase load resistance to the maximum (condition under which the load current hardly flows).
- Turn switch 1 and 2 ON.
- Run alternator at 6000 rpm for 30 minutes by adjusting load resistance so that electric current can conform to the following standard.
  Alternator nominal current

Alternator	Current
110A	Approx. 110A
140A	Approx. 140A

- Measure the current at each specified revolution of alternator.
- If the measured value is lower than the standard value, disassemble and check alternator.

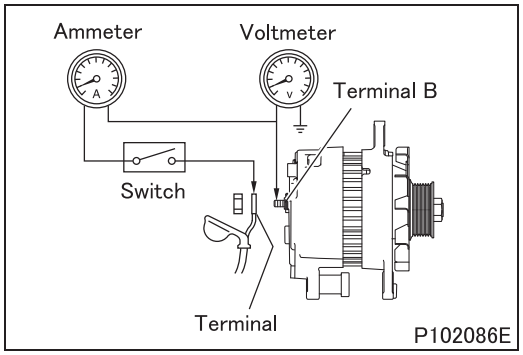


(2) Adjustment voltage of regulator (bench test)

- Connect the alternator as illustrated.
- Turn switch ON.
- Run alternator at low speeds.
- Increase the speed of alternator to 6000 rpm and measure the voltage (adjustment voltage) at this speed. At the same time, make sure that the current is 5 amperes or less at 6000 rpm.
- If the measured value deviates from the standard value, do as follows:
  - If higher than the standard value: Replace the regulator.
  - If lower than the standard value: Inspect the alternator related parts before replacing the regulator.

54-13 ON-VEHICLE INSPECTION AND ADJUSTMENT

#950 INSPECTION OF ALTERNATOR



Performance test

- The on-vehicle inspection is only a simplified check. Use a test bench for accurate checking.
- Connect the meters to the alternator as shown.

WARNING ⚠

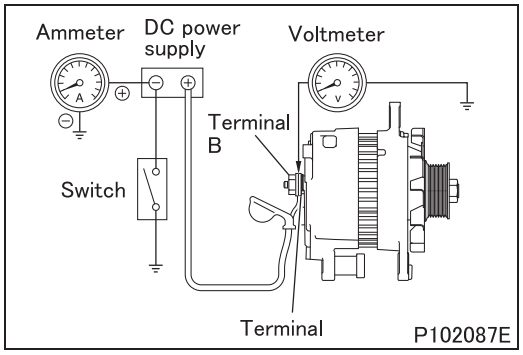
- **To prevent possible injury, be sure to disconnect the negative battery cable and insulate the cable and the negative battery terminal with tape before working on the wiring. With the negative (–) battery cable connected, battery voltage is always applied to terminal B.**
- **To connect to switch, use a lead wire with the same or larger diameter than that of the chassis harness connected to terminal B.**

- Turn on switch and make sure that voltmeter indicates battery voltage.
- Start the engine.
- Immediately turn on the switches for all lamps on the vehicle.
- Immediately accelerate the engine to the speed indicated below and measure the alternator's output current.
  Approx. 2200 rpm
- The alternator is considered to be good if the measured value is 70% or more of the nominal output current.
  Alternator nominal output

Voltage	Output current
12 V	110 A
12 V	140 A

Service standards

Location	Maintenance item	Standard value		Limit	Remedy
–	Adjusting voltage	12V-110A	14.5 ± 0.2 V	–	Replace
		12V-140A	14.5 ± 0.25 V		



- Connect the meters to the alternator as shown.

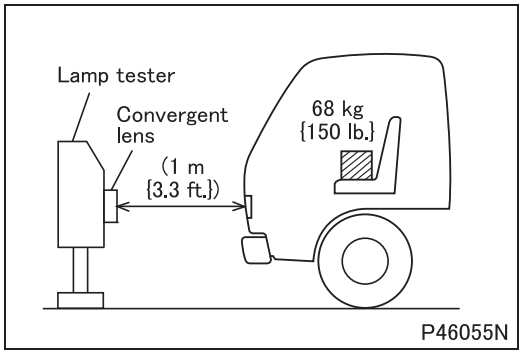
WARNING ⚠

- **To prevent possible injury, be sure to disconnect the negative battery cable and insulate the cable and the negative battery terminal with tape before working on the wiring. With the negative (–) battery cable connected, battery voltage is always applied to terminal B.**
- **To connect to switch, use a lead wire with the same or larger diameter than that of the chassis harness connected to terminal B.**

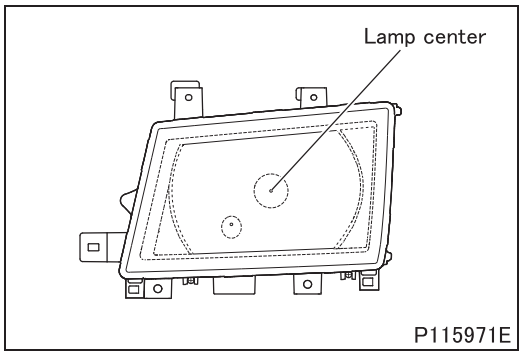
- Turn off the switches for lamps, heater, etc. so that electric loads may not be applied during the inspection.
- Turn on switch and then start the engine.
- If the output current is 5 amperes or less when the engine speed is raised to the appropriate speed indicated below, then measure the voltage at terminal B.
  Approx. 2200 rpm
- If the output current is not less than 5 amperes, the measured value (regulated voltage) will be slightly lower.
- If the output current is 5 amperes or more, do one of the following:
  - Run the engine for a while to charge the battery.
  - Replace the battery with a fully-charged one.
- If the measured value deviates from the standard value, conduct checking again on the test bench.

#960 HEADLAMP AIMING

1. Preparation before Adjustment



- Park the vehicle on a level flat place and apply chocks to the wheels.
- Empty the vehicle.
- Adjust the tire inflation pressure to the specified value.
- Place a mass of 68 kg {150 lb} (corresponding to a mean weight of one man) on the driver's seat.
- On vehicles with headlamp leveling device, set the headlamp leveling switch to 0.
- Start the engine to charge the battery.
- Locate a lamp tester at a place opposite to the vehicle front end face as illustrated.

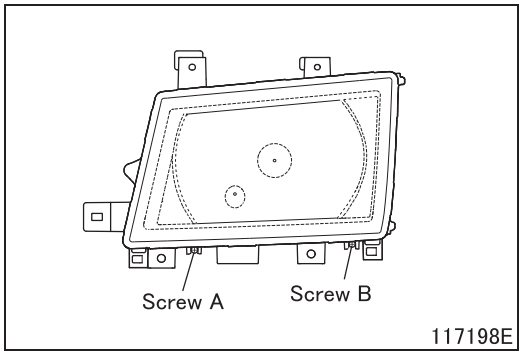


- Turn on the headlamps and aim the headlamps such that the passing beam lamp center is aligned with the beam convergent lens center of the lamp tester. (Shown here is the left-hand headlamp.)
- Mask other lamps than that next subjected to adjustment in such a way that no light may leak.

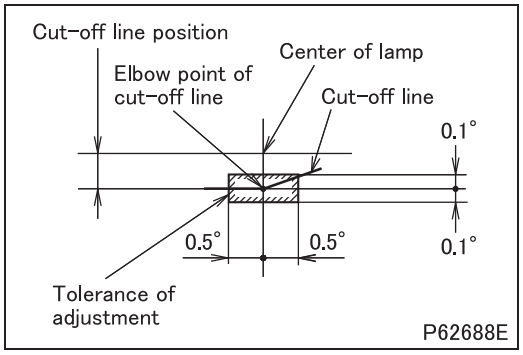
CAUTION ⚠

- **Headlamp lenses are made of plastic. Do not keep the masked headlamps illuminated for longer than 2 minutes. Sustained illumination of these lamps can cause heat generation, possibly resulting in deformed headlamp lens.**

2. Adjustment



- Turn on the passing beam.
- Perform the following procedure to adjust the passing beam such that the elbow point of the cut-off line between the lighted and shaded areas is positioned as shown in the figure:
- Adjustment in vertical direction: Turn screws A and B the same amount in this order.
- Adjustment in horizontal direction: Turn screw B.



- The position of the cut-off line between the lighted and shaded areas must correspond to the adjustment value.

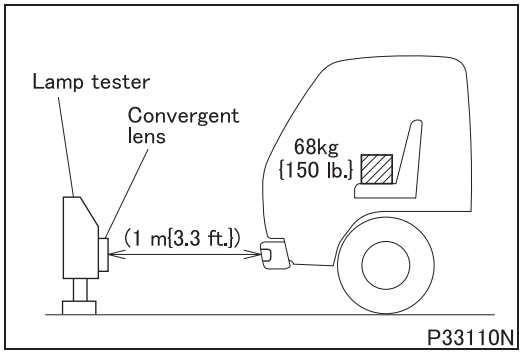
	Adjustment value
Cut-off line position	0.57° <FE>
	0.86° <FG>

	Beam adjustment direction							
	Right-hand headlamp				Left-hand headlamp			
	Up	Down	Left	Right	Up	Down	Left	Right
Screw A	CCW	CW	–	–	CCW	CW	–	–
Screw B	CCW	CW	CCW	CW	CCW	CW	CW	CCW

CW: Clockwise
CCW: Counter-clockwise

#961 FOG LAMP AIMING

1. Preparation before Adjustment

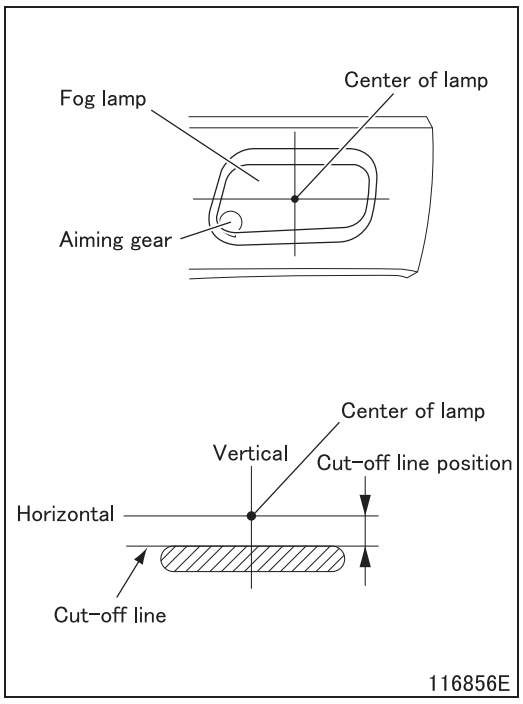


- Park the vehicle on a level flat place and apply chocks to the wheels.
- Empty the vehicle.
- Adjust the tire inflation pressure to the specified value.
- Place a mass of 68 kg {150 lb} (corresponding to a mean weight of one man) on the driver's seat.
- Start the engine to charge the battery.
- Locate a lamp tester at a place opposite to the vehicle front end face as illustrated.
- With the fog lamp turned on, align the center of fog lamp bulb and the center of convergent lens of convergent lamp tester. (Shown here is the left-hand fog lamp.)
- Mask other lamps than that next subjected to adjustment in such a way that no light may leak.

CAUTION ⚠

- **Fog lamp lenses are made of plastic. Do not keep the masked fog lamp illuminated for longer than 2 minutes. Sustained illumination of these lamps can cause heat generation, possibly resulting in deformed fog lamp lens.**

2. Adjustment



- Turn on fog lamp.
- Make adjustment with the aiming gear to bring for lamp cut-off line into the illustrated position.

Cut-off line position	Standard value
	1.5% or less

	Adjusting direction for optical axis	
	Upward	Downward
Screwdriver rotation direction	Clockwise	Counter-clockwise

M E M O

#984 INSPECTION OF IMMOBILIZER

- Since the FUSO diagnostics data are updated from time to time, descriptions or wording may not agree with the workshop manual. The FUSO diagnostics will have the latest data.

1. List of Diagnosis Codes

Code	Message	Warning lamp indication 	Remarks
521742-12	Immobilizer fault	O	
521742-31	Watchdog reset	O	
521743-2	Missing transponder modulation	O	
521744-2	Invalid secret key	O	
521745-2	Bad ECM authentication	O	
521746-2	No ECM challenge/acknowledge	O	
521747-2	Transponder authentication failed	O	
521748-2	Transponder ID table empty	O	
521749-2	Transponder data format error	O	
521750-19	CAN bus performance	O	
521750-31	Lost communication with SAM	O	

2. Details of Diagnosis Codes

521742-12: Immobilizer fault

Generation condition	• Some abnormality has occurred in immobilizer electronic control unit.
Recoverability	• System recovers when relevant diagnosis code is erased.
Control effected by electronic control unit	• Engine is disabled from starting.
Possible causes	• Defective immobilizer electronic control unit

521742-31: Watchdog reset

Generation condition	• CPU has been reset.
Recoverability	• System recovers if no abnormal conditions are present when starter switch is placed in ON again.
Control effected by electronic control unit	• None
Possible causes	• Defective immobilizer electronic control unit

521743-2: Missing transponder modulation

Generation condition	• No communication takes place between transponder key (starter key) and immobilizer electronic control unit.
Recoverability	• System recovers if no abnormal conditions are present when starter switch is placed in ON again.
Control effected by electronic control unit	• Engine is disabled from starting.
Possible causes	• Defective transponder key (starter key) • Defective harness between immobilizer antenna and immobilizer electronic control unit • Defective immobilizer antenna • Defective immobilizer electronic control unit

521744-2: Invalid secret key

Generation condition	• Secret key is not registered in immobilizer electronic control unit.
Recoverability	• None
Control effected by electronic control unit	• Engine is disabled from starting.
Possible causes	• Defective immobilizer electronic control unit

521745-2: Bad ECM authentication

Generation condition	• Collation between engine electronic control unit and immobilizer electronic control unit is not successfully made.
Recoverability	• System recovers if collation is made successfully when starter switch is placed in ON again.
Control effected by electronic control unit	• Engine is disabled from starting.
Possible causes	• Defective engine electronic control unit • Incorrect engine electronic control unit in use • Engine electronic control unit transferred from another vehicle

521746-2: No ECM challenge/acknowledge

Generation condition	• No communication is possible between engine electronic control unit and immobilizer electronic control unit.
Recoverability	• System recovers if normal communication is established when starter switch is placed in ON again.
Control effected by electronic control unit	• Engine is disabled from starting.
Possible causes	• Defective engine electronic control unit • Controller area network communication line is open or short-circuited to power, ground or another circuit. • Incorrect engine electronic control unit in use

521747-2: Transponder authentication failed

Generation condition	• Collation between transponder key (starter key) and immobilizer electronic control unit is made unsuccessfully.
Recoverability	• System recovers if collation is made successfully when starter switch is placed in ON again.
Control effected by electronic control unit	• Engine is disabled from starting.
Possible causes	• Unauthorized transponder key (starter key) is used. • Transponder key (starter key) not registered yet is used.

521748-2: Transponder ID table empty

Generation condition	• Transponder key (starter key) ID is not stored in immobilizer electronic control unit.
Recoverability	• System recovers when initial key registration is executed.
Control effected by electronic control unit	• Engine is disabled from starting.
Possible causes	• Transponder key (starter key) used is not a one registered in immobilizer electronic control unit.

521749-2: Transponder data format error

Generation condition	• Immobilizer electronic control unit has received an implausible data from transponder key (starter key) through communication line.
Recoverability	• System recovers if a plausible data is obtained when starter switch is placed in ON again.
Control effected by electronic control unit	• Engine is disabled from starting.
Possible causes	• Faulty transponder key (starter key) • Faulty immobilizer antenna • Faulty immobilizer electronic control unit

521750-19: CAN bus performance

Generation condition	• Controller area network error message is received.
Recoverability	• System recovers if any normal signal is received when starter switch is placed in ON position.
Control effected by electronic control unit	• None
Possible causes	• Controller area network communication line is open or shorted to power, ground or another circuit. • Faulty controller area network resistor • Faulty signal detect and actuation module • Faulty immobilizer electronic control unit

521750-31: Lost communication with SAM

Generation condition	• No controller area network message is receivable.
Recoverability	• System recovers if any normal signal is received when starter switch is placed in ON position.
Control effected by electronic control unit	• None
Possible causes	• Controller area network communication line is open or shorted to power, ground or another circuit. • Faulty controller area network resistor • Faulty signal detect and actuation module • Faulty immobilizer electronic control unit

3. FUSO Diagnostics Service Data (Measured Values)

• Since the contents of the FUSO Diagnostics are regularly updated, the descriptions and expressions may differ from those given in the service manuals. Check the latest information with the FUSO Diagnostics.

Current Value Group	Description	Value	Explanation
Vehicle key	Number of registered key	0 to 6	Shows the number of registered starter keys (transponder keys) for the engine immobilizer.
	Transponder key type	Registered/Unregistered	Shows the type of the starter key (transponder key) for the engine immobilizer that is currently inserted in the starter switch.
	Ignition status	ON/OFF	Shows the ignition status.
Immobilizer status	Immobilizer mode	Normal mode/ Transponder key ID initial registration mode/ Transponder key ID additional registration mode/ Transponder key deletion mode/ Secret key registration mode	Shows the current state of the immobilizer ECU.
	Immobilizer indicator	ON/OFF	Shows the immobilizer indicator lamp state.
	Immobilizer status	ACTIVE/NOT ACTIVE	Shows the immobilizer system state.

4. Initial Settings of Immobilizer

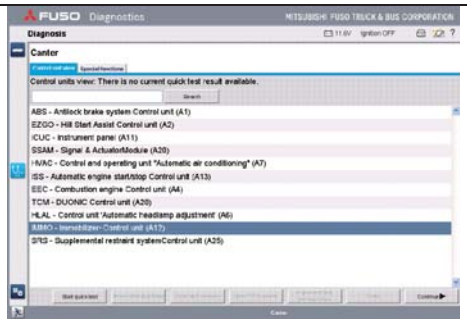
4.1 Connecting the FUSO Diagnostics

CAUTION ⚠

- **The immobilizer can be set with FUSO Diagnostics Ver. FDS-R10-1 or higher.**
- **Display images will be applied to FUSO Diagnostics Ver. FDS-R12-1 or higher. Display images might look different according to the version of FUSO Diagnostics.**

- Connect FUSO Diagnostics. (See Gr54-00A.)

4.2 Selection of the setting of immobilizer



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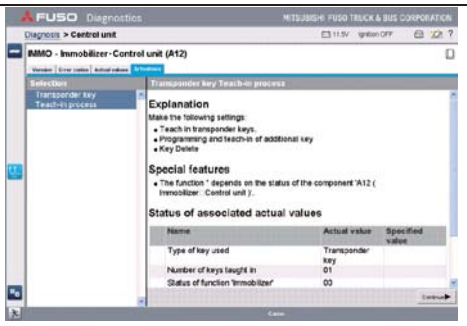
- From the control unit list screen, select [IMMO - Immobilizer Control Unit (A12)].



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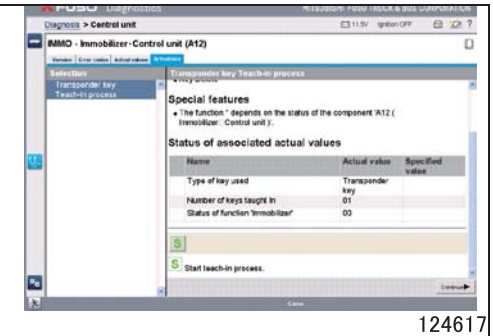
- Select “Actuations” tab.
- Select [Transponder key Teach-in process].



124617

- Press the “S” button of “Start teach-in process”.

4.3 Various operations (initial key registration, additional key registration, secret key registration, key information deletion)

- Details of each function are as follows.

Function	FUSO Diagnostics display	Outline
Initial key registration	Button “R”: Register Initial Key	Used to allow the immobilizer electronic control unit to identify starter key data or to load new data to the memory after replacement of the electronic control unit. (See “(1) Initial key registration”.)
Additional key registration	Button “R”: Register Additional Key	Used to allow the immobilizer electronic control unit to identify starter key data or to load new data to the memory at re-registration of starter key or addition of a new key. (See “(2) Additional key registration”.)
Secret key registration	Button “R”: Perform teach-in process “security code”.	Used to allow the system to collate immobilizer electronic control unit ID with engine electronic control unit ID. (See “(3) Secret key registration”.)
Key information deletion	Button “N”: Delete key.	Used to delete starter key data registered in the immobilizer electronic control unit memory. (See “(4) Key information deletion”.)

CAUTION ⚠

- **The secret key data can be registered in the memory only after the initial key has been previously registered.**

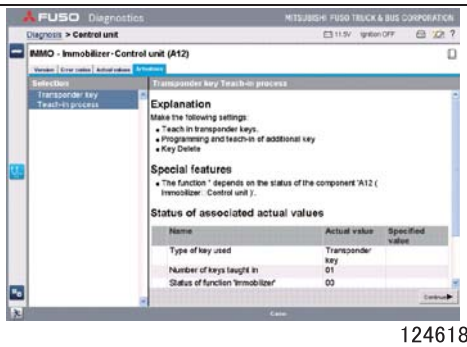
(1) Initial key registration

- After replacement of the immobilizer electronic control unit, this function should be executed to allow the electronic control unit to identify the starter key data in the memory or load new data to the memory.
  (The procedure of initial key registration is identical with the procedure of additional key registration after pressing the button “R” for “Register Initial Key” See “(2) Additional key registration”.)

(2) Additional key registration

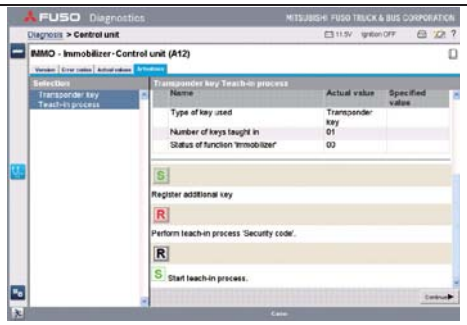
- At re-registration of starter key or addition of a new key, additional key registration function should be executed to allow the electronic control unit to identify the starter key data in the memory or load new data to the memory.
- Up to 6 sets of the key data can be registered in the immobilizer electronic control unit memory.

(2.1) Registration procedure



124618E

- Insert the starter key registered in the immobilizer electronic control unit memory.
- Check the actual value of “Type of key used” is “Transponder key”.



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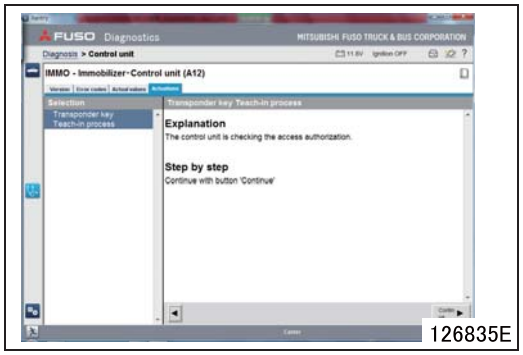
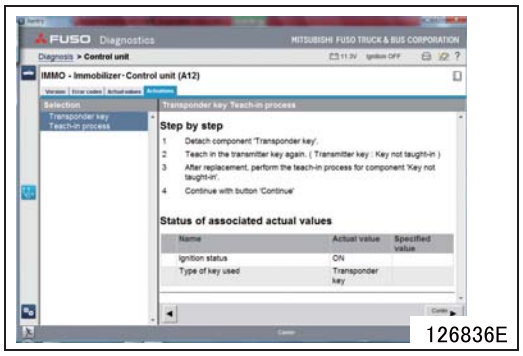
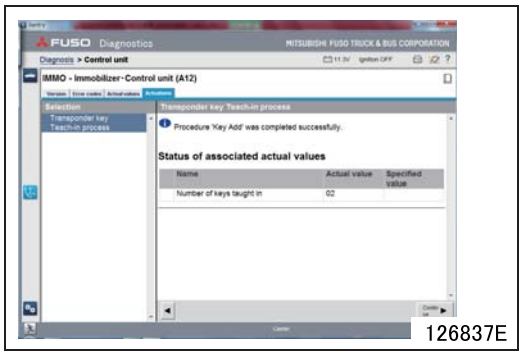
- Press the “R” (red) button of “Register additional key”.



- Press the “Continue” button.
  If an error occurs, or when work was interrupted in the middle, and then press the "Continue" button after the ON again to OFF once the starter switch.



- Insert a new starter key to be registered in the immobilizer electronic control unit memory into the starter key switch.
- Press the “Continue” button.



- A message appears to show registration of additional starter key data in the immobilizer electronic control unit has been successfully completed.
- Make sure that the number of the value of “Numbers of keys taught in” is increased.

(3) Secret key registration

- Secret key registration function should be executed whenever the following operations have been done. Without secret key registration, the engine cannot be started because engine cannot find the same key ID in the memory.
  - The immobilizer electronic control unit is replaced with new one.
  - The engine electronic control unit is replaced with new one.
  - The engine electronic control unit is replaced with one derived from other vehicles.

CAUTION ⚠

- **The immobilizer electronic control unit should never be replaced with one derived from other vehicles.**
- **The secret key registration function need not be executed after the starter key data is once deleted and registered again.**

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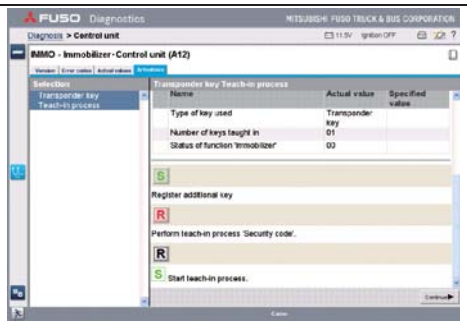
(3.1) Registration procedure



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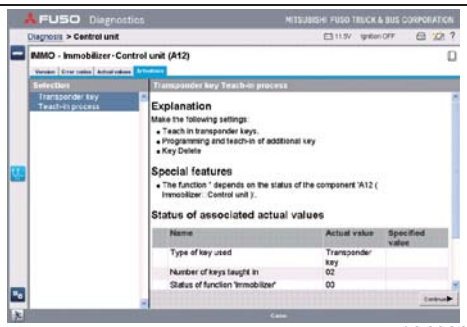
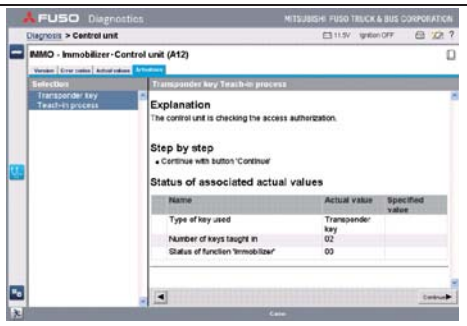
- Press the “R” (black) button of “Perform teach-in process ‘Security code’”.



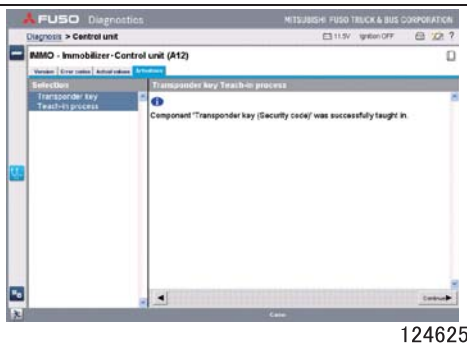
124623E

- Press the “Continue” button.



124624E

- Press the “Continue” button.



124625E

- A message appears to show that registration of the secret key in the engine electronic control unit memory has been successfully completed.