The electric starting system uses a direct current motor to transform the battery's electrical energy into the mechanical energy needed to crank the engine. Amperage requirements are relatively high, so an electromagnetic switch and heavy gauge electrical leads are used to make the connection between battery and starter motor. When the starter motor is actuated, it drives an overrunning starter clutch that directly or indirectly (depending on Honda model) engages the engine crankshaft. Reduction gears are used between the starter motor and starter clutch to multiply the starter motor's torque.

D.C. Motor Operating Principle:

When an electric current flows through a wire, magnetic lines of force encircle the wire (see Fig. 12, page 7). If the current carrying wire is placed between the north and south poles of magnets (Fig. 73), a reaction occurs between the magnetic field encircling the wire and the magnetic field between the magnets.

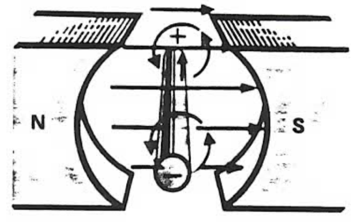

Fig. 73 Magnetic Fields Acting on Current Carrying Wire Between Magnet Poles

If the directions of the magnetic fields are as indicated in Fig. 73, then these fields will reinforce each other below the wire where they run in the same direction, and will cancel each other above the wire where they run in opposite directions. Consequently, the wire will be pushed upward (Fig. 74). The current carrying wire is always pushed away from the side where the resultant magnetic field is strongest.

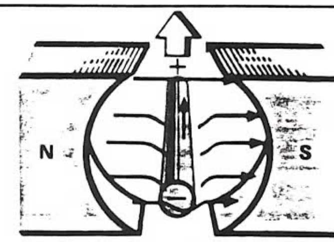

Fig. 74 Resultant Magnetic Field and Direction of Force on Wire

If the electrical current through the wire were reversed, then the magnetic field would encircle the wire in the opposite direction and would react with the field between the two magnetic poles to push the wire downward.

When a loop of current carrying wire is placed between the north and south poles of magnets (Fig. 75), the direction of current flow (and consequently the direction of the magnetic field encircling the wire) in one side of the loop (A) is opposite to the direction of current flow in the other side of the loop (B). Side (A) is forced downward, side (B) is forced upward, and the loop will rotate until it stands perpendicular to the lines of magnetic force between the magnet poles, as indicated in Fig. 75 by the white loop shown at right angles to the black loop.

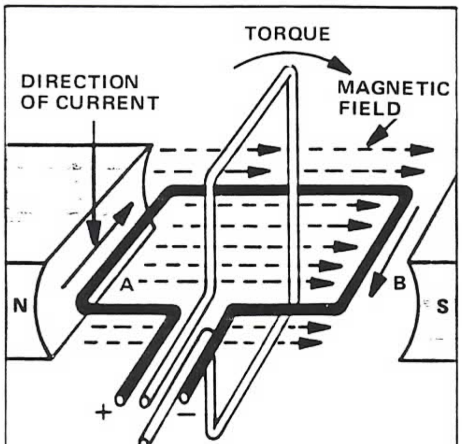

Fig. 75 Motion of Wire Loop Between Magnet Poles

Rotation would stop at the point where (A) is forced downward as far as it can go, and (B) is forced to its upward limit (white loop in Fig. 75), but if the direction of current flow is quickly reversed (before the loop loses its momentum and comes

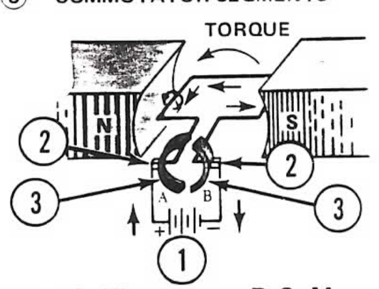

Fig. 76 Elementary D.C. Motor Position 1

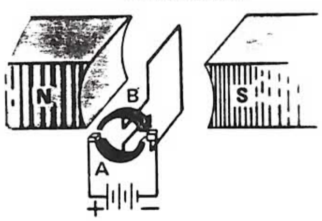

Fig. 77 Elementary D.C. Motor Position 2

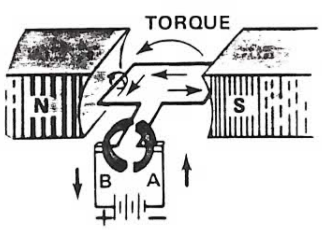

Fig. 78 Elementary D.C. Motor Position 3

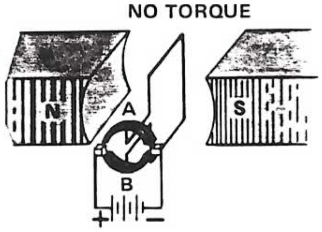

Fig. 79 Elementary D.C. Motor Position 4

to a complete stop), the loop will rotate another 180°. To achieve continuous rotation, it is necessary to provide a means for reversing current flow whenever the wire loop reaches the position where it is about to stop.

Reversal of current flow is accomplished by a commutator and brush arrangement (Fig. 76 - 79). The battery ① (Fig. 76) is connected to carbon "brushes" ② which slide against commutator segments ③ connected to the ends of the wire loop. The commutator segments rotate with the wire loop, and as they turn, each brush slides from one commutator segment to the next. The direction of current flowing through the wire loop is automatically reversed when the brushes contact opposite commutator segments, and the loop will continue to rotate as long as the battery supplies current to the brushes.

In Fig. 76, the wire loop is connected to the battery in the same polarity as in Fig. 75 (page 47). Side Ⓐ is forced down, side Ⓑ is forced up, and the wire loop rotates to the position shown in Fig. 77.

Electrical contact between the wire loop and the battery is broken as the loop coasts through the position shown in Fig. 77. No magnetic force drives the loop until the brushes establish contact with the opposite commutator segments. Torque increases as the loop fully enters the field between magnet poles (Fig. 78).

In Fig. 78, sides Ⓐ and Ⓑ have rotated 180°. Now side Ⓑ is forced down, side Ⓐ is forced up, and the wire loop rotates to the position shown in Fig. 79.

The D.C. motor shown in Fig. 76 - 79 has been greatly simplified to illustrate the basic principles. In an actual D.C. motor, additional loops of wire *(armature windings)* are used to make the motor run more smoothly and develop more power. Also, a Honda starter motor uses four electromagnets (see page 7) rather than the permanent magnets shown here.

Starter Motor Construction:

A cutaway view of a Honda starter motor is shown in Fig. 80. A diagrammatic view of the same motor is shown in Fig. 81.

(1) BRUSH
(2) BRUSH SPRING
(3) FIELD COIL WINDINGS
(4) FIELD COIL CORE
(5) POSITIVE TERMINAL
(6) COMMUTATOR
(7) ARMATURE
(8) REDUCTION GEARS

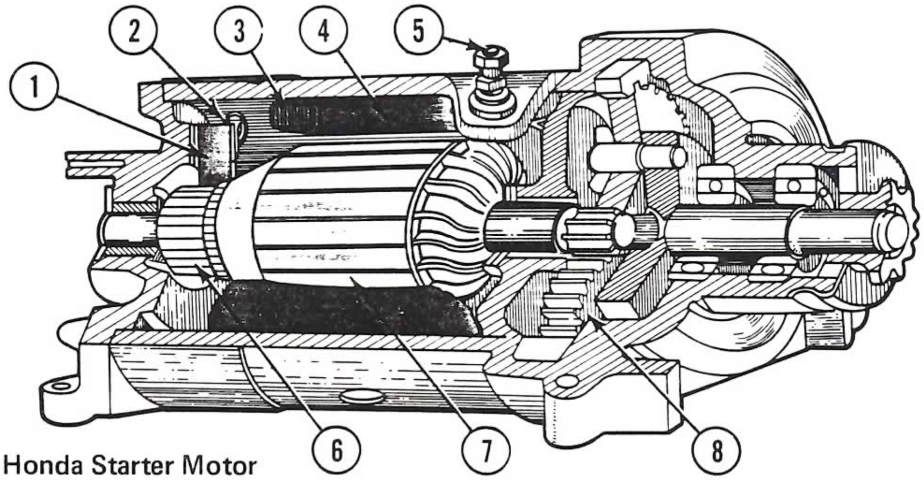

Fig. 80 Cutaway View of Honda Starter Motor

The torque of a motor containing only a single armature winding (Fig. 76 - 79) is neither continuous nor very effective. A practical starter motor (Fig. 80) contains a large number of wire coils wound around a laminated iron armature core. At one end of the armature (7), there are a number of copper commutator segments (6), corresponding to the number of armature coils. The commutator segments are insulated from each other by pieces of mica. The armature coils are so spaced that, for any position of the armature, there will be coils near the poles of the field magnets (4). This makes the torque both continuous and strong. Electromagnets (3) (4) are used in the starter motor because they can be made to furnish a stronger field than the permanent magnets shown in Fig. 76 - 79.

The brushes (1) are blocks of graphitic carbon, which have long service life and cause minimum commutator wear. Springs (2) are used to hold the brushes firmly against the commutator (6).

The brushes (1) and commutator (6) connect the field coil windings (3) with the armature (7) windings in series (Fig. 81). Any increase in current therefore strengthens the magnetism of both the field and armature. A series D.C. motor produces high starting torque, which is necessary in a starter motor. Relatively thick wire is used to keep resistance low, enabling the motor to draw large amperage.

The armature shaft is connected to reduction gears (8) which multiply the motor's torque, enabling it to crank the engine. Reduction gears may be contained in the engine crankcase or built into the starter motor housing, depending on Honda model. Fig. 80 shows a planetary gear set (8) within the starter motor housing.

(1) BRUSH
(3) FIELD COIL WINDINGS
(4) FIELD COIL CORE
(5) POSITIVE TERMINAL
(6) COMMUTATOR
(7) ARMATURE

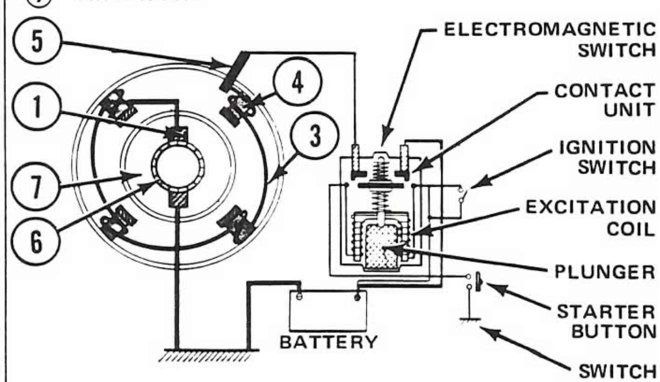

Fig. 81 Diagrammatic View of Honda Starter Motor

Starter Motor Service:

Brushes and commutator segments are the only parts which wear significantly in normal use and are the only parts which the mechanic can service. Replacement armatures and field coils are not available for Honda starter motors, so if malfunctions occur in those areas, the entire starter motor must be replaced.

① BRUSHES
② BRUSH SPRINGS
③ COMMUTATOR

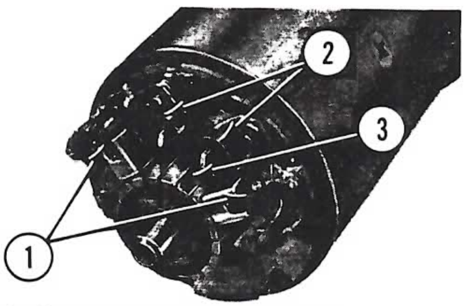

Fig. 82 Commutator and Brushes

④ COPPER SEGMENT
⑤ MICA INSULATION

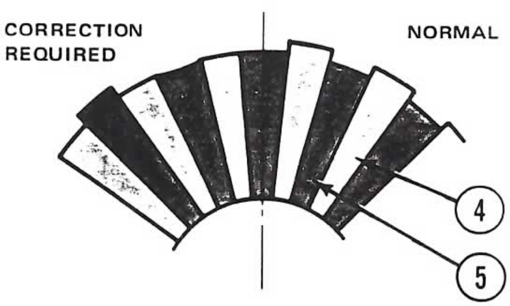

Fig. 83 Commutator Undercutting

Inspect carbon brushes ① (Fig. 82), and replace if worn to the limit of their travel within the brush holders, or refer to the shop manual for service limits in terms of brush length. Check brush springs ② , and replace if weak or broken. Refer to the shop manual for spring tension service limits.

Inspect the commutator ③ . The commutator surface should be clean and copper segments ④ smooth. Mica insulation ⑤ must be slightly undercut, as shown in Fig. 83. When copper segments become worn, they will no longer stand above the mica insulation, and the brushes may not obtain good contact. Mica undercutting can be performed with a thin saw blade or small file. Rough or irregular surfaces on copper segments can be filed smooth. The use of sandpaper or emery cloth is not recommended, as abrasive particles may become imbedded in the commutator segments. Wipe the commutator clean before reassembly.

Continuity tests can be performed to determine whether a malfunction in the starter motor is due to short circuits or open circuits in the armature or field coils, and test procedures are shown in some shop manuals. However, faulty armatures or field coils in Honda starter motors can be corrected only by replacing the entire starter motor.

Continuity testing can be done with a VOM, ohmmeter, or a battery powered continuity tester of the same sort used to check static ignition timing (see page 37). Test results, indicating continuity or no continuity, should correspond logically with the circuit shown in Fig. 81 (page 49). Other results indicate faulty connections, or a faulty armature or field coils.

Electromagnetic Starter Switch:

The starter motor draws about 120 amperes of current when cranking the engine. Heavy electrical cable and a heavy-duty switch are required to properly handle the current. It would not be practical to run heavy cables up to the handlebar and install a large, heavy-duty switch there. Instead, a small push button switch on the handlebar activates an electromagnetic starter switch (Fig. 84) that connects the battery to the starter motor. The electromagnetic starter switch is mounted on the motorcycle frame, near the battery.

When the main switch ① (Fig. 84) is turned on, and the starter button ② is depressed, current flows from the battery ⑥ through an electromagnet ③ within the starter switch. The electromagnet draws the plunger ④ into contact with the terminals ⑤ of the starter switch, completing a circuit between the battery ⑥ and starter motor ⑦

① MAIN SWITCH
② PUSH BUTTON STARTER SWITCH (ON HANDLEBAR)
③ ELECTROMAGNET
④ PLUNGER
⑤ STARTER SWITCH TERMINALS
⑥ BATTERY
⑦ STARTER MOTOR

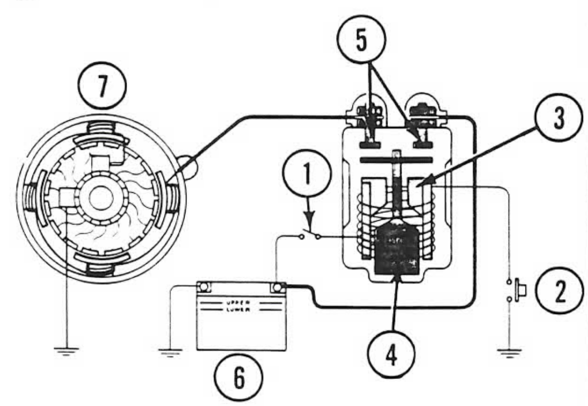

Fig. 84 Electromagnetic Starter Switch Circuit

The electromagnetic starter switch is not ordinarily repairable and should be replaced if it malfunctions.

If the starter motor does not actuate when the push button on the handlebar is depressed, the most frequent cause is simply a discharged battery. If the battery is somewhat less than completely discharged, the switch will at least produce an audible click as the plunger moves within the electromagnet.

If the battery is well charged, and the starter motor will still not actuate when the push button on the handlebar is depressed, the electromagnetic switch can be bypassed by short circuiting the switch terminals with a screwdriver blade or other implement. If bypassing the switch actuates the starter motor, the problem is in the switch iteself, or in the circuit which leads to the switch's electromagnet. If the starter motor does *not* actuate when the switch is bypassed, this indicates that the malfunction may be in the starter motor.

If the starter motor continues to run after the push button on the handlebar is released, the problem is usually due to a stuck plunger in the electromagnetic switch. If this malfunction should occur, immediately turn the main switch off, then disconnect the starter motor or battery cable. The starter motor may become seriously damaged, if the engine starts, and the starter motor runs continuously at high rpm.

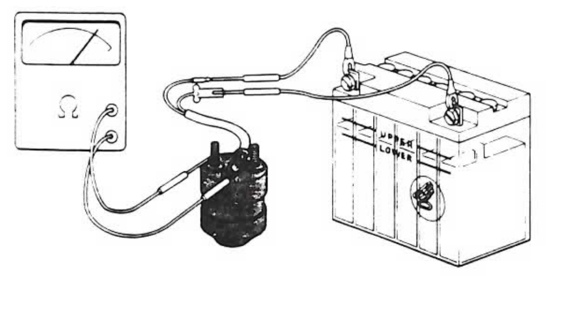

Fig. 85 Electromagnetic Starter Switch Testing

(1)	STARTER CHAIN	(4)	CLUTCH HOUSING
(2)	CLUTCH SPROCKET	(5)	ROLLER
(3)	SPROCKET HUB	(6)	CRANKSHAFT

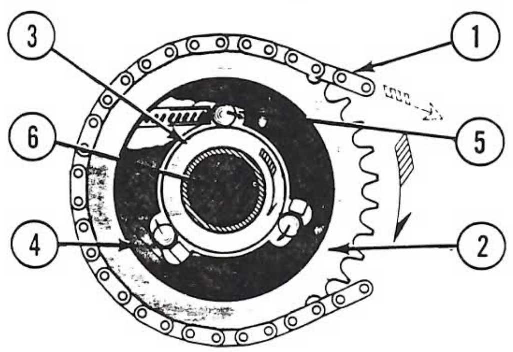

Fig. 86 Overrunning Clutch (viewed from side of engine)

(2)	CLUTCH SPROCKET	(5)	ROLLER
(4)	CLUTCH HOUSING	(6)	CRANKSHAFT

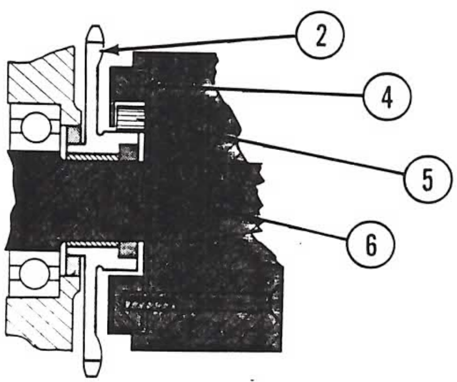

Fig. 87 Overrunning Clutch (viewed from front of engine)

Electromagnetic switch function and continuity can be checked by connecting it as shown in Fig. 85. When the electromagnet leads are connected to the battery, the internal plunger should contact the switch terminals, creating continuity. Continuity should cease when the electromagnet leads are disconnected. An ohmmeter is shown in Fig. 85, though any self-powered continuity tester can be used for this purpose.

Overrunning Clutch:

Reduction gears and sprockets enable the starter motor to turn at much higher rpm than the engine in order to develop the necessary cranking force. When the engine starts to run, however, the starter motor must be quickly disengaged; otherwise the starter motor would be driven to excessive rpm by the engine, and the motor would become seriously damaged.

The overrunning clutch is a coupling mechanism that enables the starter motor to engage the engine's crankshaft or transmission shaft only while the starter motor is operating under a load (cranking the engine). When the engine starts, the engine's increased speed automatically disengages the starter motor.

Fig. 86 and 87 show cross sectional views of an overrunning clutch. The particular type illustrated is installed on the engine crankshaft and is chain driven, like the starter clutch used in Honda CB-360 and CB-500T motorcycles.

The starter motor drives the chain (1) and its sprocket (2) in the direction shown in Fig. 86 (some Honda models use a gear rather than a chain and sprocket). The clutch housing (4) is attached to the engine crankshaft (6) (some Honda models mount the clutch housing on a transmission shaft). Starter engagement is achieved by locking the sprocket to the clutch housing, and disengagement is achieved by unlocking these parts. Spring loaded rollers (5) in the clutch housing perform this locking/unlocking function.

The rollers (5) ride on ramps in the clutch housing (4) . When extended, the rollers wedge the sprocket hub (3) tightly against the clutch housing. When the rollers are retracted, the sprocket hub and clutch housing are no longer locked together.

When the sprocket drives the clutch housing (i.e. starter motor cranks engine), the motion of the sprocket hub causes the rollers to extend and lock it to the clutch housing. When the clutch housing rotates at higher rpm than the sprocket (i.e. engine starts and its rpm increases), the relative motion of these parts retracts the rollers and disengages the starter motor.