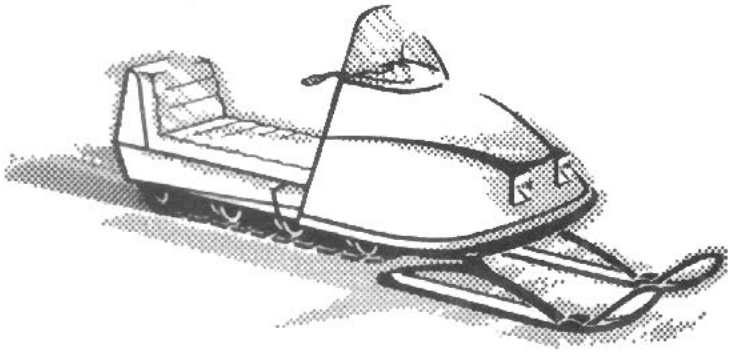
BOSCH
GERMANY

ELECTRICAL EQUIPMENT for Snowmobiles



BOSCH STARTERS

Design and Servicing

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BOSCH STARTERS
Type DD

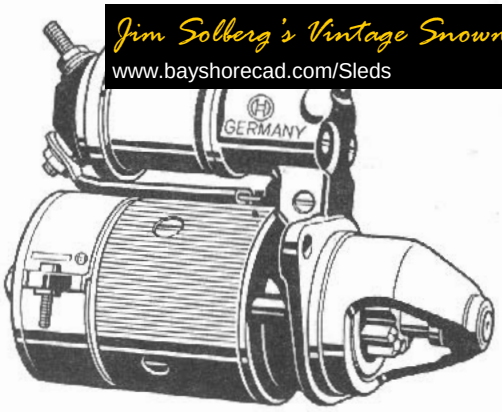


Fig. 1 BOSCH Starter Type DD

General

Internal combustion engines cannot start on their own power, but must be started with an external aid. An electric motor is generally used.

A series motor is best suited as the electric motor for starting operations as it provides the large torque required to accelerate from rest and to overcome the first compression stroke. It then cranks the engine up to the required crankshaft speed for starting.

The electric starter is basically an electric motor with pinion and engaging device.

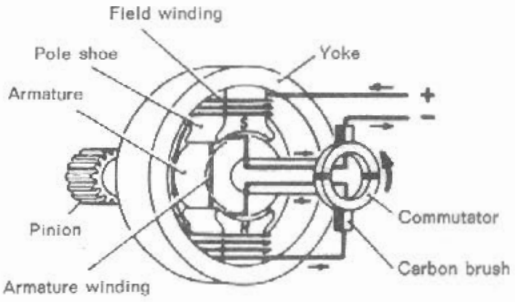


Fig. 2 Basic construction of the electric starter

Due to the high gear ratio between flywheel gear rim and pinion, the pinion should not remain in mesh with the flywheel. Pinion and starter armature would then be driven to high, non-permissible speeds. Therefore, power lock between the starter armature and the engine flywheel must be automatically broken as soon as the engine starts. In the BOSCH Starter, this is accomplished by a roller-over-running clutch between armature and pinion which releases the power lock immediately when the engine speed increases above the starter speed; this eliminates a direct armature-to-pinion connection.

Meshing

Starters without solenoid switches are actuated by a foot pedal or a manual lever. Those with solenoid switches are actuated by a starting switch. In both cases, the shift lever is initially moved against spring pressure without the field and armature windings being energized. The shift lever pushes the drive and the pinion toward the flywheel by means of the guide ring and a helical spring. At the same time, these parts are rotated by the coarse thread. If a tooth of the pinion meets a tooth gap on the flywheel ring gear, the pinion will mesh immediately. Shortly before the end of the meshing travel, the switch mounted on the starter (mechanical starting switch or solenoid switch) is closed. The starter armature begins to rotate. Due to the coarse thread, the pinion is pushed further onto the flywheel until it is stopped by a stop ring on the armature shaft. Since it cannot move any further, it is now positively coupled with the armature shaft through the overrunning clutch and the driver so that the starter can crank the engine.

The shift lever stops as soon as the switch on the starter closes. The drive, however, continues to advance and compresses the helical spring between the shift lever guide ring and the armature. The check ring moves away from the guide-ring half on the armature side.

Should the advancing pinion meet a tooth of the flywheel ring gear, the shift lever will compress the spring between guide ring and clutch until the switch closes. The pinion will then rotate against the face of the flywheel and mesh with the approaching tooth gap due to the pressure of the compressed spring and, above all, of the coarse thread. Since the thread is very coarse, the screwing action will not lead to jamming due to axial force.

The solenoid switch built on some starters has pull-in and holding coils. When the starting switch is pressed, both coils are energized and the solenoid plunger is drawn in. After the solenoid switch closes, the pull-in coil is shorted out and only the holding coil is energized.

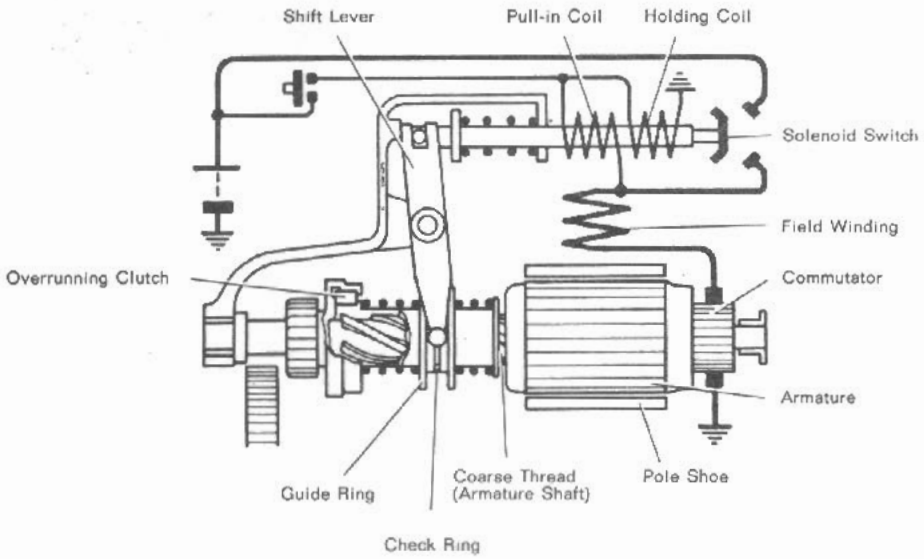


Fig. 3 Schematic Diagram of the BOSCH Starter Type DD

Releasing

When starting, the engine will run faster than the starter. As a result, the pinion must release so that the acceleration of the engine cannot be transmitted to the starter. The drive is relieved and pushed back by the compressed spring sitting between guide ring and armature. However, the pinion remains slightly in mesh as long as the shift lever is held in the "Start" position, either mechanically or electromagnetically. Only when the starter is switched off, i. e., the shift lever is released, will the drive and pinion return to their rest position by means of the spring acting upon the shift lever. This spring also holds the pinion in its rest position in spite of engine vibrations and until the engine is started again.

Roller-overrunning clutch

As a protective measure, starters are equipped with either an inner-wedge or an outer-wedge overrunning clutch (Fig. 4)

The overrunning clutch effects a power-lock connection between pinion and armature so that the pinion is driven when the armature shaft rotates. However, as soon as the pinion rotates faster than the armature, the connection is broken and the pinion runs freely. To accomplish this, the rollers move along a curved sliding track until it is wedged in the narrower end of the track between the driver or the freewheel ring and the pinion shaft. When the engine fires, the overrunning pinion shoves the rollers against a spring pressure into the larger end of the track where they will have only slight contact with the driver or the free-

wheel ring. When the rollers are at rest, springs with guide pins or guide sleeves push them into the narrower end of the track, ensuring a positive connection between pinion and driver or freewheel ring when the starter armature begins to rotate.

In the older, inner-wedge type overrunning clutch, the sliding tracks are in the internally positioned driver connected to the armature.

In the newer, outer-wedge type overrunning clutch, the sliding tracks are in the external, rotating freewheel ring which is connected to the armature shaft by means of the driver. This arrangement has the advantage that the mass of the pinion and, therefore, the overrunning torque when the engine overtakes the starter is small. Furthermore, the rollers are lifted off the pinion shaft by centrifugal force during overrunning. The friction between pinion and rollers and the noise level are therefore low, which leads to an increased service life of these parts as also of the starter bearings.

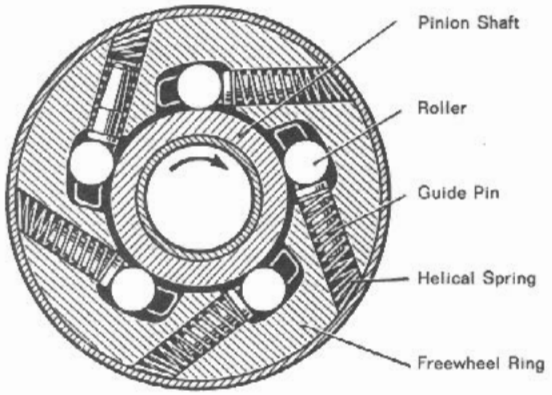


Fig. 4 Outer-wedge Overrunning Clutch

Installation

When installing the starter, particular attention must be paid to the voltage drop in the starter circuit. The cables must have adequate dimensions and no bad contact resistances must exist in the ground return line.

Operating

Open the fuel line cock before switching on the starter.

The starter must not be run longer than 10 seconds without a break. Wait at least 30 seconds before switching on again to allow the starter to cool and the battery to recover itself. **A blocked starter must be switched off immediately.** Release the starting switch as soon as the engine runs on its own power.

Never switch on the starter with the engine or pinion still rotating. This will damage the pinion or the flywheel teeth.

If the engine does not start after several attempts, do not continue trying. It would only result in running down the battery. Instead, look for the source of trouble and correct (check, above all, the fuel line and ignition). Do not start the engine with the vehicle in gear to prevent wearing out the starter and the battery.

Maintenance

General

There is the danger of short-circuiting when working on the electrical part of the installed starter. It is strongly recommended to disconnect the ground cable at the battery before carrying out work of this type. Do not place tools on the battery!

Carbon brushes

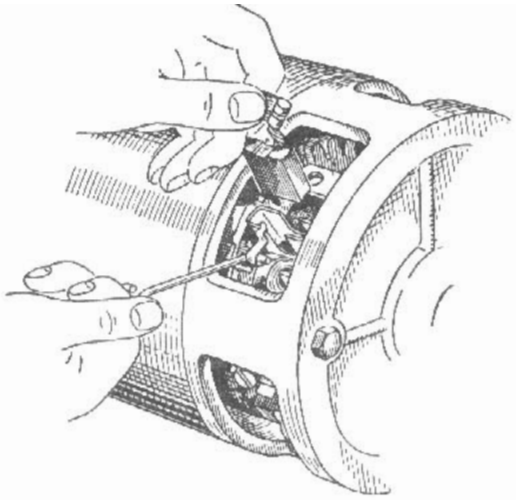
Check the carbon brushes for satisfactory condition from time to time.

After removing the end cover or band, use a hook and lift the spring pressing the carbon brush onto the commutator (do not bend the spring to the side nor lift up more than necessary). Then check the carbon brushes for easy movement in their guides in the brush holder.

The carbon brushes and brush holder must not be contaminated with dirt, oil or grease. If they are dirty or clamp, they must be cleaned with a clean rag (not with polishing wool since this frays easily) and gasoline and thoroughly dried.

Do not work the contact surface of the carbon brushes with emery paper, a file or knife. Blow out the brush holder thoroughly. If a carbon brush is broken, unsoldered or worn to the point where the spring or the wire soldered onto the brush touches the brush holder, replace the carbon brush. Only BOSCH carbon brushes may be used. When installing the carbon brushes, do not snap the spring onto the brushes.

At any rate, the carbon brushes should be replaced whenever the engine undergoes a general overhaul. The commutator should be machined with each change of the carbon brushes.



Checking the carbon brushes

Commutator

The commutator should have a smooth, even, grey-black surface and be free of dust, oil and grease. Dirty commutators are to be cleaned with a clean rag (not with polishing wool) and gasoline and thoroughly dried. Due to wear, scored and unround commutators must be machined in a workshop having the proper equipment. In no case may the commutator be worked with emery paper or a file.

Lubrication

Both bearings of the positive meshing starter are self-lubricating bearings (Compo bushings) which therefore do not need to be lubricated. These bearings must not be treated with grease-dissolving cleaning agents.

To increase life, clean flywheel teeth and pinion with a brush and gasoline from time to time and regrease. Where existing, remove burrs from flywheel teeth and pinion.

Trouble shooting

Causes of troubles are not necessarily in the starter itself nor in the battery, switches, cables, cable connections and defective electrical connections of vehicle grounding parts, but also in the ignition system and the fuel line.
The following directions on trouble-shooting are limited to the starting system.

I. Trouble: When starting, the starter shaft does not turn or turns too slowly.

Cause:	Correction:
1. Battery discharged.	1. Charge the battery.
2. Battery defective.	2. Have the battery checked in the workshop.
3. Loose or oxidized battery terminals; bad ground connection.	3. Tighten terminals; clean poles and terminals and grease with anti-acid grease.
4. Starter terminals or brushes shorted to ground.	4. Remove the ground shorts.
5. Starter carbon brushes are not sitting on the commutator; clamped in their guides; worn, broken, oiled or dirty.	5. Check carbon brushes, clean or replace. Clean guides in brush holder as required.
6. Starting switch damaged (loose parts so that the switch cannot make contact; burnt).	6. Replace starting switch.
7. Starter solenoid damaged.	7. Turn in for repair.
8. Voltage drop across cables too large; damaged cables, loose cable connections.	8. Check starter cables and their connections.

II. Trouble: Armature turns, but pinion does not engage.

Cause:	Correction:
1. Pinion dirty.	1. Clean pinion.
2. Pinion or flywheel teeth chipped; burr formation.	2. File off burrs.

III. Trouble: When switching on, the starter armature turns until the pinion engages; then it stops.

Cause:	Correction:
1. Battery is not sufficiently charged.	1. Charge the battery.
2. Carbon brush pressure too low.	2. Check the carbon brushes. Clean or replace.
3. Starter solenoid defective.	3. Have it repaired.
4. Voltage drop across the cables too large.	4. Check cables and connections.
5. Overrunning clutch slipping.	5. Repair or replace clutch.

IV. Trouble: Starter continues to run after the switch is released.

Cause:	Correction:
1. Starter switch does not switch off or the solenoid is stuck.	1. Immediately disconnect the starter cable at the battery or starter; have switch repaired or replace.

V. Trouble: Pinion does not disengage when the engine starts.

Cause:	Correction:
1. Pinion or flywheel teeth very dirty or damaged, return spring weak or broken.	1. Carefully clean or file off the burrs on flywheel teeth and pinion (push the vehicle back and forth while in gear); replace return spring.