SECTION 10-E

CRANKING (STARTER) SYSTEM

CONTENTS OF SECTION 10-E

NOTES

10-29 THE CRANKING (STARTER) SYSTEM

a. General Description

The Buick cranking system permits the engine to be cranked by turning the ignition switch on and depressing the accelerator pedal. While accelerator pedal is depressed the cranking motor continues operation until the engine starts running on its own power, then the cranking motor circuit is automatically opened and the motor is disengaged from the flywheel ring gear.

The cranking system, shown schematically in figure 10-25, is composed of the following units:

1. *Battery* and battery *cables* (par. 10-14).

2. *Cranking motor,* including the drive assembly which engages the flywheel ring gear during cranking operation (par. 10-32).

3. *Cranking motor solenoid switch,* mounted on cranking motor, for shifting drive assembly and closing the motor circuit. During cranking the switch also connects the ignition coil directly to the battery, thereby bypassing the ignition coil resistance unit (par. 10-32).

4. *Solenoid switch relay,* mounted on left fender skirt, for operating the solenoid switch. (par. 10-32).

5. *Accelerator vacuum switch,* mounted on the carburetor and operated by the throttle shaft. This switch permits control of cranking system by the accelerator pedal (par. 10-30).

6. *Generator windings,* which are used for completing the vacuum switch and solenoid relay magnet coil circuit to ground.

7. *Charge indicator, ignition switch,* and necessary *wiring* to connect the various units.

8. *Neutral safety switch,* only on cars equipped with Dynaflow Drive. This switch is connected in series with the solenoid switch relay to prevent cranking of engine except when the transmission control lever is in either the neutral (N) or parking (P) position.

b. Operation of Cranking System

CAUTION: *The radio should be turned off while starting the engine because certain radio parts may be damaged if cranking motor is operated with radio turned on.*

When the ignition switch is turned on and the accelerator pedal is depressed to open the throttle valve in carburetor, the throttle shaft actuates the accelerator vacuum switch to close the switch contacts. *On Dynaflow Drive cars, the* *transmission control lever must be in neutral (N) or parking (P) position so that neutral safety switch is also closed.*

Closing of the ignition, vacuum, and neutral safety switches permits battery current to flow through the magnet windings of the solenoid switch relay and through the field windings of the generator to ground. See figure 10-25. Flow of current through the relay windings magnetizes the core which pulls the relay armature down to close the relay contacts. Battery current then flows through the "pull in" and "hold in" coils of the solenoid, magnetizing the solenoid. The plunger is pulled into the solenoid so that it operates the shift lever to move the drive pinion into engagement with flywheel ring gear and then closes the solenoid switch contacts.

The closing of the solenoid switch contacts causes the motor to crank the engine and also cuts out the "pull-in" coil of the solenoid, the

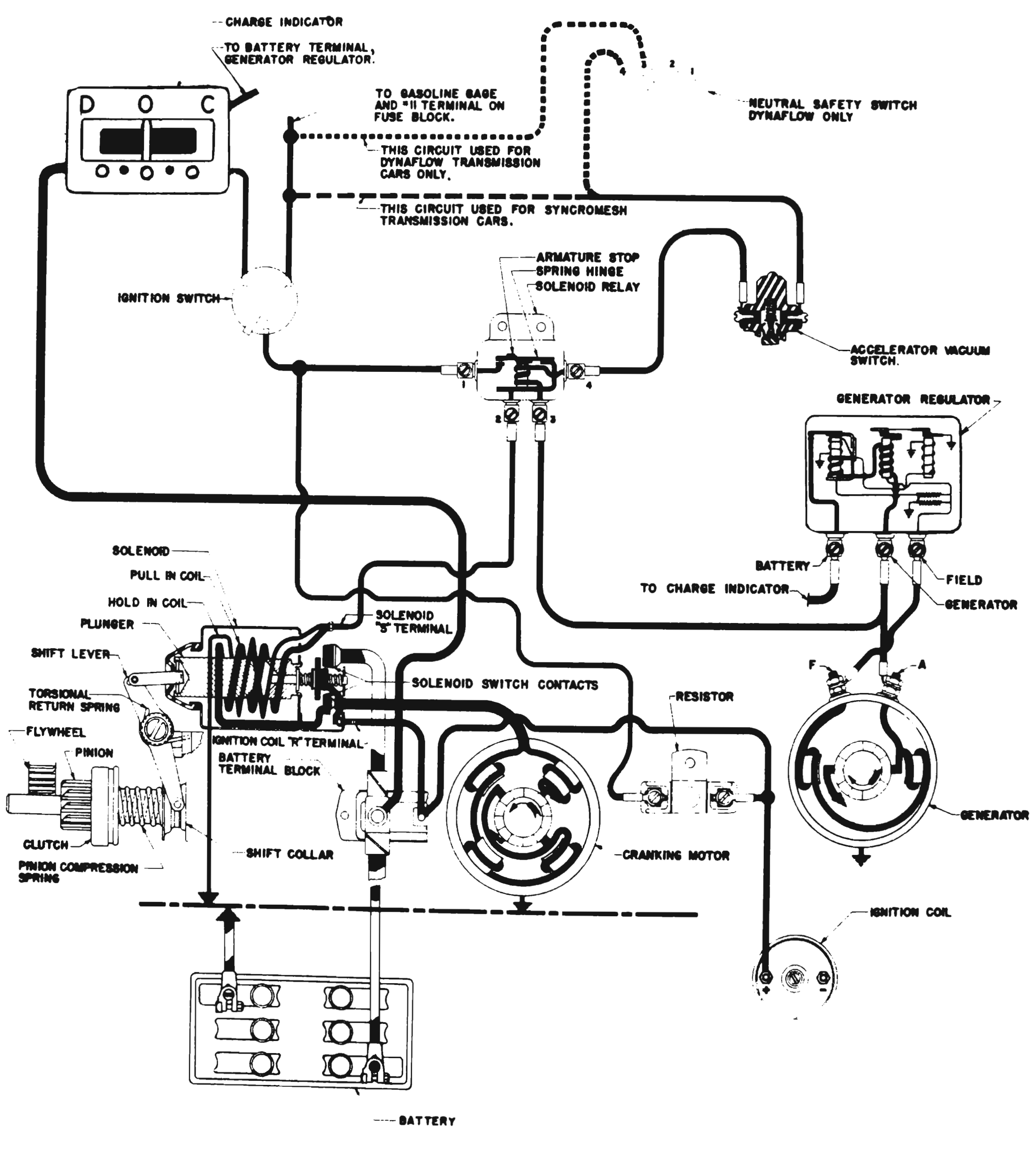

Figure 10-25—Cranking System Circuits

magnetic pull of the "hold-in" being sufficient to hold the pinion in mesh after the shifting has been performed. This reduces the current consumed by the solenoid while the cranking motor is operating.

As soon as the engine starts running, the generator output voltage opposes the flow of current through the solenoid switch relay and generator windings, consequently the relay circuit ground connection is blocked and the circuit is opened. This demagnetizes the relay core and permits the relay contacts to open and break the solenoid circuit so that the solenoid is also demagnetized. A torsional return spring then actuates the shift lever to retract the solenoid plunger, which permits another spring to open the solenoid switch contacts. At the same time, the shift lever disengages the drive pinion from the flywheel ring gear.

Whenever the throttle is returned to idle position after the engine starts running, the accelerator vacuum switch contacts are separated and the solenoid switch relay circuit is opened at this point. Manifold vacuum controls a lock out device in the switch which prevents the contacts from closing when the throttle is again opened to accelerate the engine. These lockout devices are described in paragraph 10-30.

In cold weather, if the first explosions are too feeble to keep the engine running under its own power the generator output voltage will not be sufficient to block the solenoid switch relay circuit and permit the relay contacts to open. If the throttle is held open the cranking motor will continue in operation until the explosions are strong enough to keep the engine running at a speed where generator output voltage is high enough to block the relay circuit and cut out the cranking system.

While the engine is running, operation of the accelerator pedal will not bring the cranking motor into operation because of two separate and independent safety features: (1) Blocking effect of generator voltage on soleniod switch relay circuit. (2) Mechanical lockout of switch contacts in the accelerator vacuum switch.

10-30 ACCELERATOR VACUUM SWITCH

a. Description and Operation

The accelerator vacuum switch or starter switch is built into the throttle body of the carburetor in position to be operated by the throttle shaft.

The switch consists of a special stainless steel ball, plunger, guide block, W-shaped contact spring, and return spring housed in a passage in body flange which is closed by a terminal cap containing two contacts. When the engine is not running and throttle is closed, the ball rests on a lip on the lower end of switch plunger and bears against a flat spot on the throttle shaft. The plunger, guide block, and contact spring are held in a down position by the return spring so that the contact spring does not touch the contacts in terminal cap. See figure 10-26, view A.

When the accelerator is depressed with engine stopped and ignition switch turned on, the flat spot on throttle shaft acts as a cam to push the switch ball, plunger, guide block, and contact

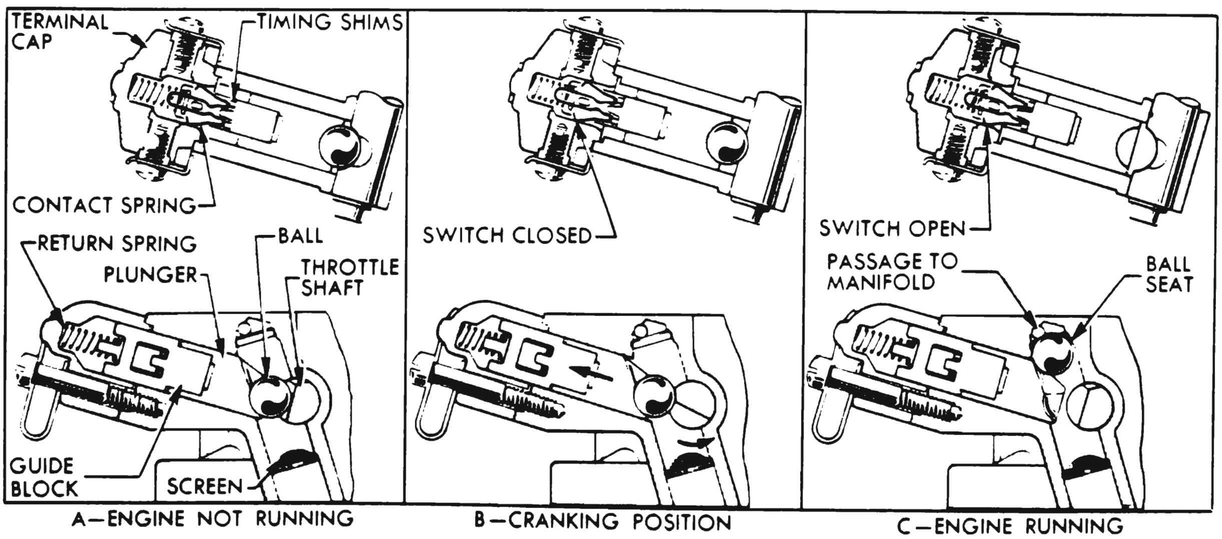

Figure 10-26—Accelerator Vacuum Switch Operation

spring upward until the contact spring touches both contacts in terminal cap. This closes the solenoid relay switch circuit and puts the cranking system into operation. See figure 10-26, view B.

After the engine starts running and the throttle is returned to idle position, manifold vacuum causes the ball to move upward against a seat in the throttle body and the switch return spring pushes the contact spring and plunger down to separate the switch contacts, thereby opening the solenoid switch relay circuit at this point. See figure 10-26, view C. As long as the engine continues running the switch ball is held against its seat due to manifold vacuum; therefore movement of the throttle shaft cannot be transmitted to the plunger to close the switch contacts. When the engine stops so that manifold vacuum ceases, the ball drops down to the starting position between throttle shaft and plunger.

It is very important that the switch contact is made at a specific throttle opening, to assure proper starting conditions. If the switch makes contact too early the throttle will not be opened sufficient to give a good cold start. If the switch makes contact too late the throttle will be opened too far, which may cause gear clash as well as hard starting due to unloading of carburetor choke by the throttle mechanism. The correct throttle opening for switch contact is 30° to 45° on 2-barrel carburetors, and 25° to 40° on 4-barrel carburetors. Check switch timing as described below (subpar. *c* or *d*).

b. Cleaning and Lubricating Switch

Switch timing may be changed without removing carburetor from engine; however, if switch is dirty the carburetor should be removed so that switch passages can be properly cleaned.

1. Disconnect wires from terminals. Hold down on switch terminal cap while removing hold down clip. Remove terminal cap and return spring, then lift out switch guide block with contact spring and shims. Do not lose timing shims and the spring washer on contact spring. See figure 10-27.

2. Remove plunger and steel ball from carburetor throttle body.

3. Wash all metal parts in Bendix Metalclene, or its equivalent, and wipe dry. Clean out passages in throttle body. Do not soak terminal cap and guide block in cleaning solution, but wipe with a clean cloth.

4. Inspect ball, plunger, and cylinder in throttle body to make sure that all are clean and smooth. Check terminal cap for cracks. Switch contact surfaces must be smooth and free of corrosion. If screen is damaged or clogged so that it cannot be cleaned it should be replaced.

5. Check condition of contact spring and replace it if burned or otherwise damaged. The free width of spring across the points, with return spring washer in place is 7/16" + 1/32" – 0.

6. The free length of switch return spring is 11/16" to 3/4". Replace a weak or distorted spring; do not stretch or alter spring as switch operation will be affected.

7. The contact spring rests on a number of square brass shims which control the switch timing. If switch timing was found to be too early (subpar. *b*, *d*, or *e*), reduce the total thickness of these shims. If timing was too late, increase total thickness of shims. These shims are furnished in thicknesses of .006" and .018".

8. Before installing parts, the contact surfaces in terminal cap should be given a light coating of Standard Oil Artic Cup Grease No. 3. If these lubricants are not available petroleum jelly may be used. Work lubricant into a piece of clean cloth and lightly swab the inside of terminal cap. CAUTION: *Do not use ordinary lubricants as poor switch contact will be obtained in cold weather. Do not apply lubricant to the ball or plunger.*

9. Place plunger in position with the groove up so that the ball rests on lip at inner end of plunger. See figure 10-27. If the plunger is installed with groove down, the ball will be prevented from rising into the ball passage when the engine starts. As a result, the switch will

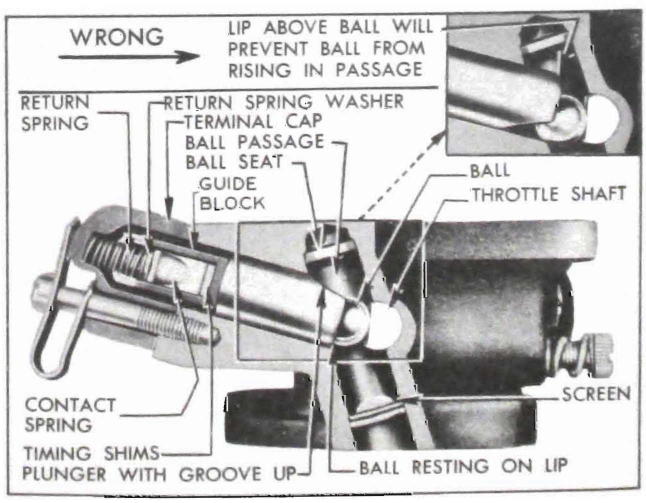

Figure 10-27—Assembly of Accelerator Vacuum Switch

close each time the throttle is opened, causing gear clash at low speeds when the generator is not producing sufficient voltage to open the solenoid relay. If generator should be inoperative, gear clashing would occur at all speeds.

10. Make sure that all timing washers, contact spring, and the return spring washer are in proper position before installing the return spring and terminal cap. Make sure that terminal cap is properly seated. See figure 10-27.

11. After switch is assembled, check the timing as described below (subpar. *c* or *d*), *and* change shims as required until proper timing is obtained.

c. Checking Switch Timing on Bench

1. Connect a 12-volt battery and test lamp across switch terminals so that lamp will light when switch makes contact.

2. Block choke valve open so that fast idle cam is at slow idle position, and back off throttle stop screw to permit full closing of throttle valve.

3. *While holding carburetor in normal upright position,* insert a 1/4" drill between wall of throttle body and lower edge of one primary throttle valve, at the center. With valve closed against the drill, the switch should make contact and light the test lamp. See figure 10-28.

4. Remove the 1/4" drill and insert a 7/64" drill in same position. With valve closed against drill, the switch should be open so that test lamp does not light.

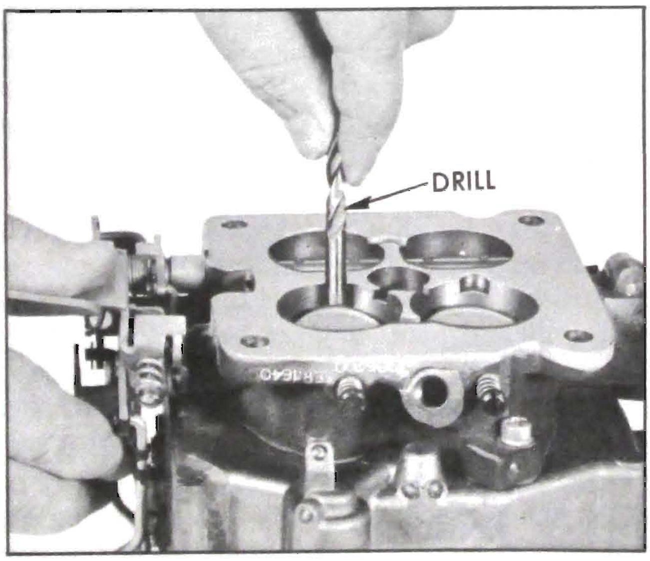

Figure 10-28—Checking Switch Timing on Bench

5. If switch does not operate within the limits specified, retime it by changing shims as required (subpar. *b*, above).

d. Checking Switch Timing On Car

When the carburetor is installed on engine the following procedure may be used to determine whether the vacuum switch timing is within proper limits.

1. *Make certain that transmission is in neutral and that parking brake is applied.*

2. Back off throttle stop screw, rotate fast idle cam to slow idle position if necessary, and fully close the throttle valve. On *Dynaflow* car, make certain that dash pot will not prevent full closing of throttle valve in the next step.

3. Remove left oil filler cap. Hold a stiff 6" scale, or similar straight edge, against the rear face of the lower arm of the throttle lever which contacts the dash pot, so that scale rests on rocker arm cover. *With throttle valve fully closed,* make a pencil mark on cover at front edge of scale. See figure 10-29, step 1.

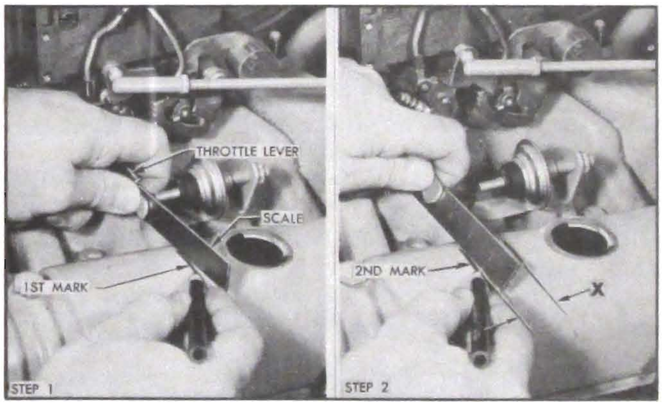

Figure 10-29—Checking Switch Timing on Car

4. With ignition switch turned on, slowly open throttle while holding scale in position against throttle lever. At point where the cranking motor is energized hold the throttle lever and make a second mark on rocker arm cover at front edge of scale. See figure 10-29, step 2.

5. If vacuum switch is correctly timed, the distance (X) between pencil marks on rocker arm cover will be 3/4" to 1 1/8" with all 2-barrel

carburetors, ½" to 13/16" with a Carter 4-barrel carburetor, or ¾" to 1¼" with a Rochester 4-barrel carburetor.

6. If necessary, retime switch by changing the number of timing shims as described above (subpar. *b*). When switch is correctly timed, set engine idle speed at 450 RPM when hot, and make sure that throttle linkage and dash pot are correctly adjusted (par. 3-9).

10-31 NEUTRAL SAFETY SWITCH—DYNAFLOW CARS

A combination neutral safety and back-up lamp switch is mounted on the steering column jacket under the cowl and is actuated by the transmission control shaft. The neutral safety switch is connected in series with the cranking motor control circuit through the two terminals on left side of the switch assembly. The back-up lamp switch section is connected to the lamp circuit through the two right hand terminals.

Slotted mounting screw holes permit sidewise movement of the switch assembly for proper neutral safety switch timing, which also sets the switch for proper back-up lamp timing. Neutral safety switch timing may be checked and adjusted as follows.

1. Check manual control linkage and adjust if necessary (par. 5-12).

2. Ground primary terminal of distributor with jumper wire so that engine can be cranked without firing.

3. Firmly engage "step-on" parking brake and place transmission control lever in neutral (N) position.

4. Place a narrow strip of masking tape on

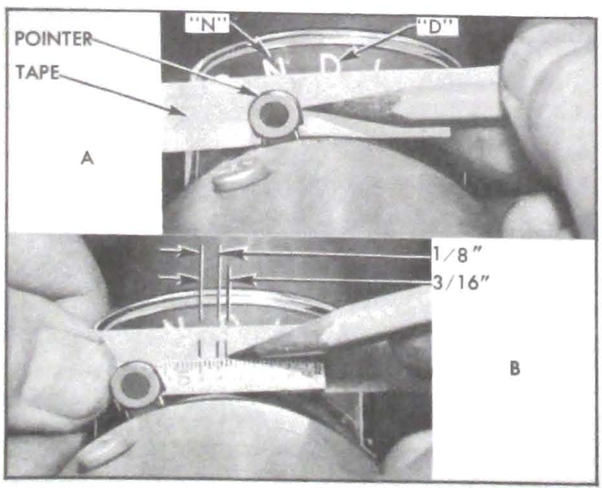

Figure 10-30—Marking Tape for Checking Switch Timing

speed ratio dial so that upper ends of letters "N" and "D" are visible.

5. With transmission control firmly engaged in Neutral detent, make a pencil mark on masking tape at *right edge* of speed ratio dial pointer, then make two marks on tape at ⅛" and 3/16" to right of the first mark. See figure 10-30.

6. Move control lever to driving (D) position, turn ignition on and depress accelerator pedal to close accelerator vacuum switch.

7. Slowly move dial pointer from "D" toward "N" and note position of *right edge* of pointer at instant the cranking motor just starts to operate. Release accelerator pedal.

8. The *right edge* of dial pointer should be between the two marks made on masking tape at ⅛" and 3/16" out of neutral.

9. If the neutral safety switch does not cut in within the specified limits, move it sideways on column jacket as required to obtain proper timing.

10-32 CRANKING MOTOR, SOLENOID SWITCH, AND RELAY

The cranking motor assembly consists of a motor, drive assembly, shift lever, and solenoid switch. See figure 10-31. It is mounted on the flywheel upper housing on the left side of engine.

a. Cranking Motor, Drive and Shift Lever

The cranking motor is an extruded frame type, having four poles and a compound field. Three field coils are connected in series from the field terminal to the insulated brushes, and one shunt coil is connected from the field terminal to ground. The armature shaft is supported at both ends in graphite bronze bushings pressed into the commutator end frame and the drive housing. Neither of these bearings require added lubrication.

The four brushes are supported by brush holders mounted on the field frame. Two opposing brushes are connected to the field coils. The field coils are held in place by the pole shoes which are attached to the field by large screws. The field coils are connected to an insulated connecting link in the field frame, through which current is supplied to the motor.

The drive assembly is mounted on the motor armature shaft and keyed to it by helical splines so that it can be moved endwise on the shaft by the solenoid operated shift lever. It transmits

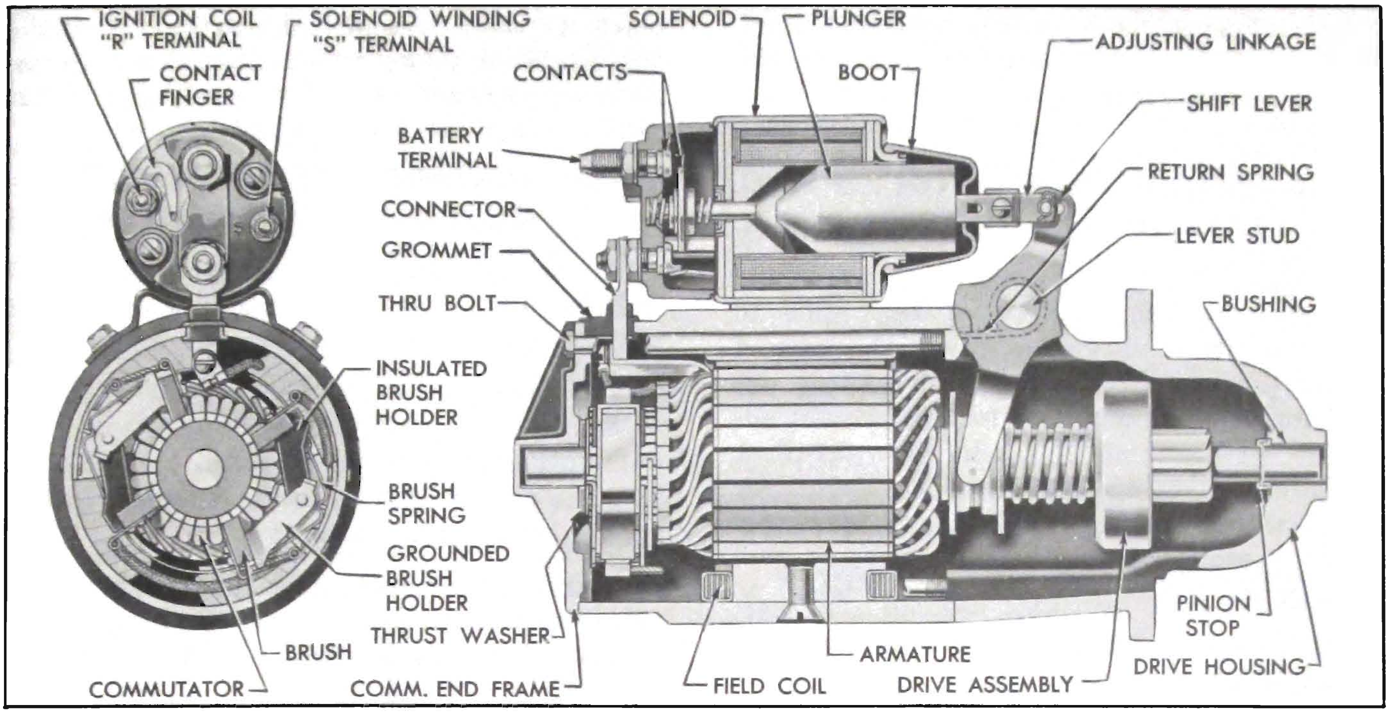

Figure 10-31—Cranking Motor—Sectional View

cranking torque to the flywheel ring gear, but its overrunning clutch allows the drive pinion to rotate freely with reference to the armature shaft when the engine begins to operate, thus preventing the armature from being driven at excessive speed by the engine.

The drive assembly pinion is moved into engagement with flywheel ring gear by action of the solenoid upon the shift lever, which engages the shift collar of drive assembly. The shift collar moves the drive assembly by pushing on the clutch spring, which serves as a cushion in case the pinion and gear teeth butt instead of meshing. The helical splines assist in obtaining proper pinion engagement. The drive pinion is pulled out of engagement, after engine starts, by action of the shift lever return spring. The shift lever is connected to the solenoid switch plunger by a link and adjusting screw. See figure 10-31.

b. Solenoid Switch and Relay

The solenoid switch not only closes the circuit between the battery and the cranking motor to produce cranking action, but it also operates the shift lever to move the drive pinion into engagement with the flywheel ring gear.

The solenoid section of the switch has a plunger and two windings, the "pull-in" winding and the "hold-in" winding. Together, they provide sufficient magnetic attraction to pull the solenoid plunger into the solenoid. The plunger actuates the shift lever and drive assembly and it also closes the solenoid switch contacts by pressing against a push rod upon which a contact disk is mounted between two coil springs. One spring serves as a cushion to insure firm contact of the disk with two stationary contacts. The other spring pushes the disk away from the stationary contacts to break the circuit when the solenoid is demagnetized after the engine starts. One stationary contact is connected to the battery positive cable and the other is connected to the motor windings through a connector or bus bar. See figure 10-31.

The solenoid switch has an additional small terminal which touches the switch contact disk only when the solenoid is energized. A lead connects this terminal to the battery side of the ignition coil, thereby by-passing the ignition coil resistance unit during cranking operation and making full battery voltage available at the coil.

The separately mounted solenoid switch relay is an electrical switch which closes the circuit between the battery and the solenoid windings when cranking action is desired, and opens the circuit when the engine starts running. The relay has one winding surrounding a core which, when magnetized by current flowing through the winding, attracts a flat steel armature. The armature has a contact point which makes contact with a stationary point to close the circuit.

Operation of the solenoid switch and relay, as well as the entire cranking system, is described in paragraph 10-29.

10-33 PERIODIC INSPECTION OF CRANKING MOTOR

As a general rule, the cranking motor should be tested and inspected every 5000 miles to determine its condition; however, the type of service in which some cranking motors are used may make more frequent inspection advisable. Frequent starts, as in city operation, excessively long cranking periods caused by hard-starting engine conditions, excessively dirty or moist operating conditions, all will make more frequent inspection advisable.

Cranking motor action is indicative, to some extent, of the cranking motor condition. A cranking motor that responds readily and cranks the engine at normal speed when the control circuit is closed is usually in good condition.

Check motor and solenoid switch attaching bolts to make sure these units are solidly mounted. Inspect and manually check all wiring connections at solenoid switch, solenoid relay, generator regulator, generator, accelerator vacuum switch, ignition switch, charge indicator, and neutral safety switch (Dynaflow Drive cars only). Make sure that all these connections in the cranking motor and control circuits are clean and tight. It is advisable to test the cranking circuit to make certain that excessive resistance does not exist. See paragraph 10-34.

10-34 VOLTAGE TEST OF CRANKING MOTOR AND SOLENOID SWITCH

The voltage across the cranking motor and switch while cranking the engine gives a good indication of any excessive resistance. NOTE: *Engine must be at normal operating temperature when test is made.*

1. Inspect battery and cables (par. 10-15) to make certain that battery has ample capacity for cranking and ignition.

2. Connect jumper wire to primary terminal of distributor and to ground on engine, so that engine can be cranked without firing.

3. Remove cranking motor splash pan and connect voltmeter positive (+) lead to the motor terminal on solenoid switch; connect voltmeter negative (—) lead to ground on engine. See figure 10-32.

4. Turn ignition switch on, crank engine and take voltmeter reading as quickly as possible. If cranking motor turns engine at normal cranking speed with voltmeter reading 9 or more volts, the motor and switch are satisfactory. If cranking speed is below normal and voltmeter reading is 9 or greater, the cranking motor is defective.

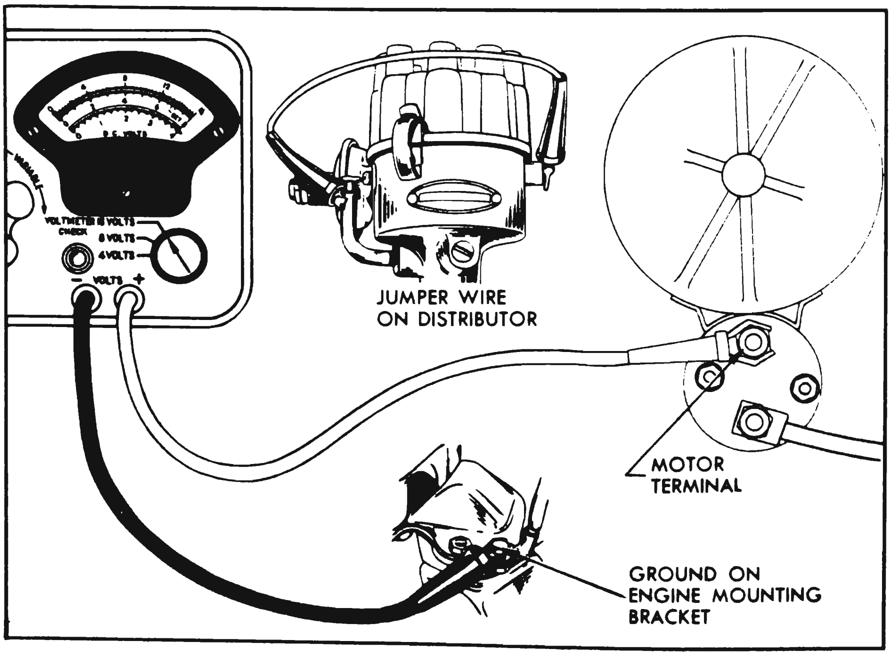

Figure 10-32—Cranking Voltage Test Connections

CAUTION: *Do not operate cranking motor more than 30 seconds at a time without pausing to allow motor to cool for at least two minutes; otherwise, overheating and damage to motor may result.*

5. If cranking motor turns engine at low rate of speed with voltmeter reading less than 9 volts, test solenoid switch contacts as follows.

6. With voltmeter switch turned to any scale above 12 volts, connect voltmeter negative (−) lead to the motor terminal of solenoid switch, and connect positive (+) lead to battery terminal of switch. See figure 10-33.

7. Turn ignition switch on and crank engine. Immediately turn voltmeter switch to low scale and take reading as quickly as possible, then turn switch back to higher scale and stop engine.

The voltmeter will read not more than 1/10 volt if switch contacts are satisfactory. If voltmeter reads more than 1/10 volt, switch should be repaired or replaced.

10-35 TEST AND ADJUSTMENT OF SOLENOID SWITCH RELAY

The solenoid switch relay must close at very low voltage in order to assure positive operation in cold weather when the battery may be low. Because it is calibrated at low voltage no attempt should be made to test or adjust it without accurate test equipment.

The switch relay may be tested on the car with the following equipment: (1) 12-volt test lamp (2) Accurate low reading voltmeter (3) Variable rheostat of at least 10 ohms and a capacity of 2 amperes. The Ohmite Model J rheostat, 50 watt stock No. 0314, 12 ohms 2.05 max. amp., is satisfactory. It is made by Ohmite Manufacturing Co., and is available at most electrical supply stores.

a. Testing Solenoid Switch Relay Closing, Sealing, and Opening Voltages

NOTE: *Relay must be tested cold (at room temperature).*

1. *With ignition switch turned off,* remove black wire from relay terminal marked (2) in figure 10-34.

2. Connect 12-volt test lamp between relay terminal marked (2) and ground on relay mounting bolt.

3. Connect lead attached to rotating arm of rheostat to relay terminal marked (4). Connect one resistance lead to relay terminal marked (1) and connect the opposite lead to relay mounting bolt. See figure 10-34.

4. Connect leads of low reading voltmeter to relay terminals marked (3) and (4).

5. Turn rheostat arm until voltmeter reads zero then slowly turn arm and note voltmeter reading at instant that test lamp lights, indicating that relay contacts have closed. This *closing voltage* should be between 3.8 and 5.0 volts.

6. Continue to slowly turn rheostat arm in same direction and note voltmeter reading at instant that a slight click occurs in relay, indicating that relay armature has sealed to the

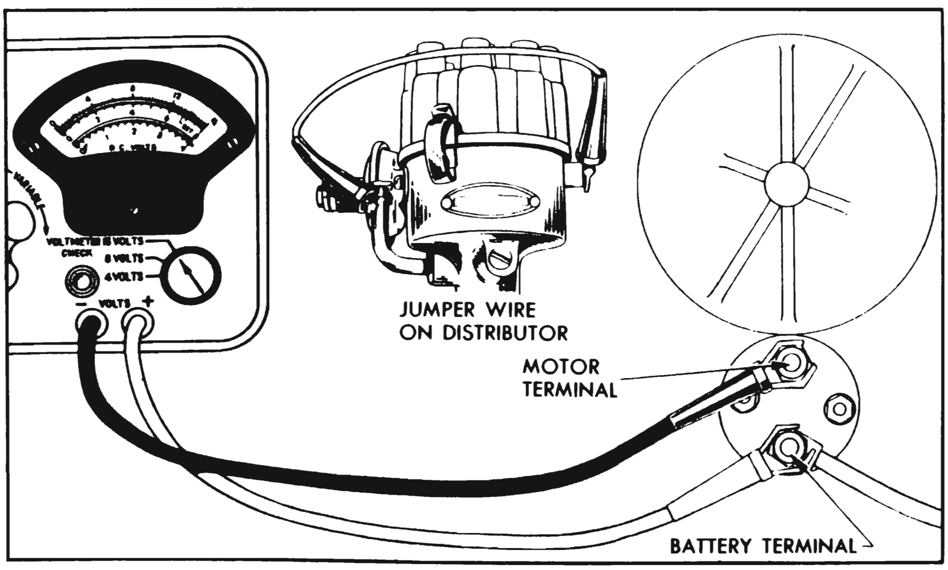

Figure 10-33—Solenoid Switch Contact Test Connections

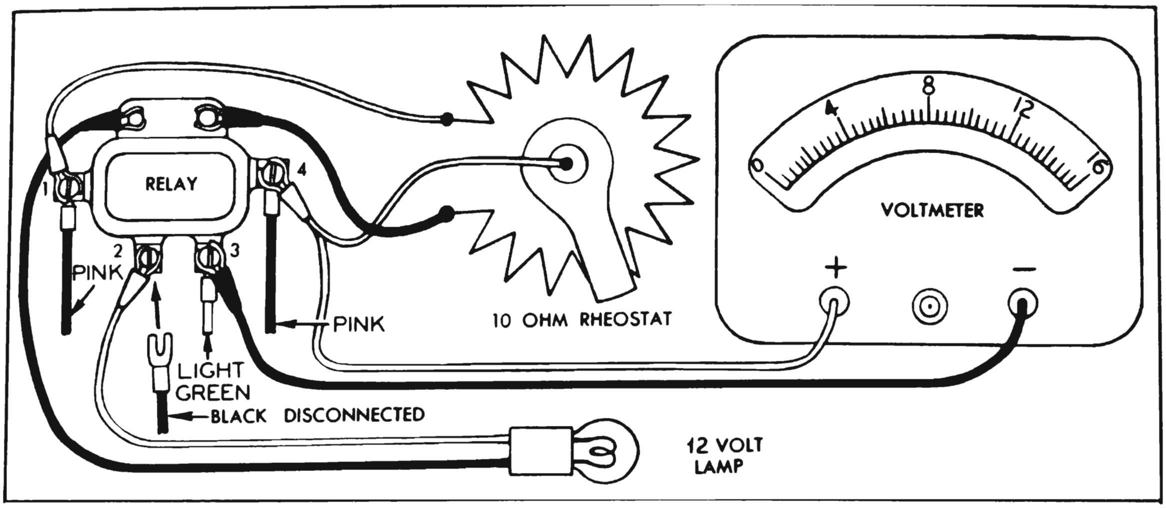

Figure 10-34—Solenoid Switch Relay Test Connections

magnet core. This *sealing voltage* should be not more than 0.2 volt above the closing voltage obtained in step 5.

7. Quickly turn rheostat arm until voltmeter reads 12 volts, for the purpose of fully saturating the relay magnet core.

8. As quickly as possible turn rheostat arm to decrease indicated voltage, noting voltmeter reading at instant that test light goes out as relay contacts open. This *opening voltage* should be not less than 0.6 volts.

9. If the solenoid switch relay does not operate within the specified voltage limits it may be adjusted as described below (subpar. b).

b. Solenoid Switch Relay Adjustments

1. Remove relay from car and remove the cover, which is crimped in place.

2. Push relay armature down until contact points just touch, then check air gap between

Figure 10-35—Relay Air Gap Adjustment

armature and core with feeler gauges. Air gap should be .011″ minimum and may be adjusted, if necessary, by bending the lower point support. See figure 10-35.

3. With armature free, check contact point opening with feeler gauges. Point opening should be between .020″ and .030″ and may be adjusted, if necessary, by bending the upper armature stop. See figure 10-36.

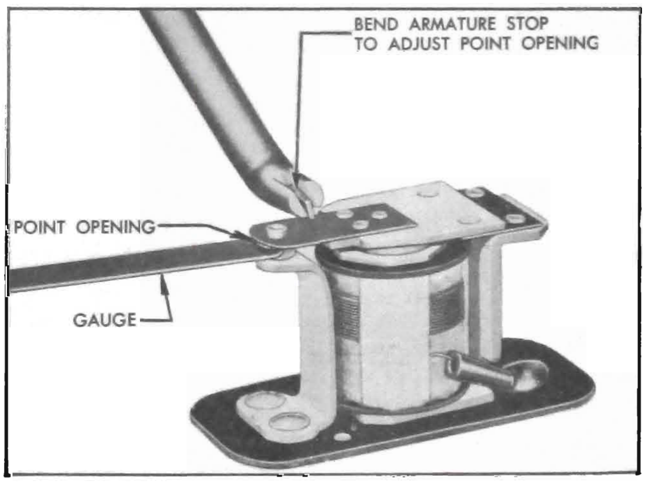

Figure 10-36—Relay Contact Point Adjustment

4. Connect the positive terminal of a 12-volt battery to relay terminal marked (1); connect the negative terminal of battery to relay terminal marked (3) and also to ground on relay mounting bracket.

5. Connect a 12-volt test lamp, low reading voltmeter and 10 ohm rheostat to relay terminals as shown in figure 10-34.

6. Test relay closing voltage as previously described in subparagraph *a*, step 5. If voltage

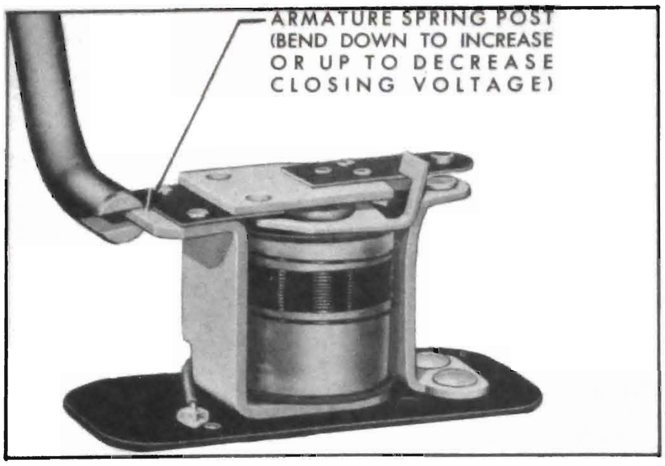

Figure 10-37—Relay Closing Voltage Adjustment

is not within specified limits, bend armature spring post down to increase spring tension and closing voltage, or bend up to decrease voltage. See figure 10-37. Recheck closing voltage after each adjustment.

7. After the specified closing voltage is obtained, test the sealing and opening voltages as previously described in subparagraph *a*, steps 6, 7, 8.

8. Sealing and opening voltages can be adjusted by varying the adjustments of air gap or closing voltage within specification limits. Closing voltage should be rechecked after adjustments of sealing or opening voltage.

9. After all adjustments are completed, install relay cover and reinstall relay on car.

10-36 SOLENOID SWITCH TEST AND REPLACEMENT

a. Testing Solenoid Switch Windings

When the cranking motor is removed from engine, the solenoid switch windings may be tested with switch removed from the cranking motor. Two tests should be made to determine: (1) Current draw of both windings in parallel; (2) Current draw of hold-in winding alone.

1. Ground the switch motor terminal to solenoid base with a jumper wire.

2. Connect a 12-volt battery, a variable resistance, and an ammeter of 100 amperes capacity in series with the base of the solenoid "S" terminal on switch. See figure 10-31 for location of the "S" terminal.

3. Connect a voltmeter between base of solenoid and the small solenoid "S" terminal.

4. Slowly adjust resistance until voltmeter reads 10 volts then note ammeter reading. This shows current draw of both windings in parallel, and should be 72 to 76 amperes at 10 volts, *with solenoid cold (room temperature).*

5. Remove jumper wire from switch motor terminal and readjust resistance until voltmeter reads 10 volts, then note ammeter reading. This shows current draw of hold-in winding alone, and should be 18 to 20 amperes at 10 volts, *with solenoid cold (room temperature).*

6. If the solenoid windings do not test within the specifications given, the solenoid switch assembly should be replaced.

b. Installing Solenoid Switch and Adjusting Drive Pinion Travel

Whenever the solenoid switch is removed and reinstalled on cranking motor it is necessary to adjust the drive pinion travel so that proper clearance will exist between the pinion and the pinion stop retainer when pinion is in cranking position.

1. Install solenoid switch and connect plunger link to shift lever.

2. Connect a source of approximately 4 volts (2 battery cells in series) between the solenoid "S" terminal and ground. CAUTION: *Do not use 12-volt current because this will cause the motor to operate. Do not connect to the opposite "R" ignition coil terminal of solenoid.*

3. Push the solenoid plunger into solenoid by hand; once in, battery current will hold plunger in place.

4. Push the pinion away from pinion stop retainer as far as possible and use feeler gauge to check clearance between pinion and retainer. See figure 10-38.

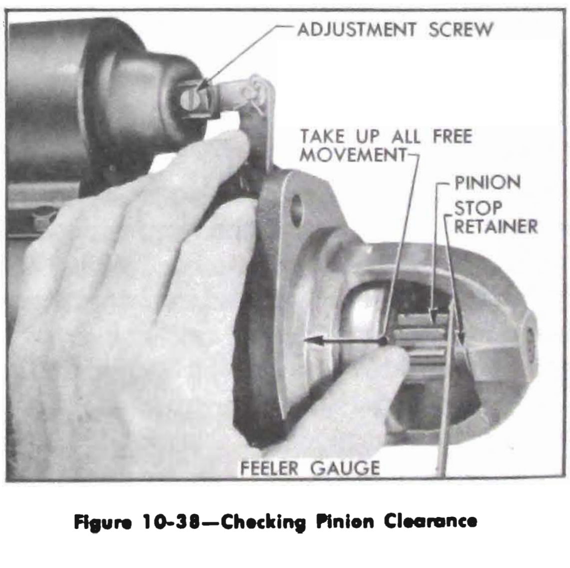

Figure 10-38—Checking Pinion Clearance

5. If clearance is not between .010″ and .050″, lossen plunger link screw and shorten or lengthen the link as required to obtain specified clearance, then firmly tighten screw.

10-37 BENCH TEST OF CRANKING MOTOR

To obtain full performance data on a cranking motor, or to determine the cause of abnormal operation, the motor should be removed from the engine and be submitted to a no-load and a torque test with equipment designed for such tests. Test specifications are given under Electrical Specifications in paragraph 10-3.

(a) *No-load Test.* Connect the cranking motor in series with a 12-volt battery and an ammeter capable of indicating several hundred amperes. If an RPM indicator is available, set it up to read armature RPM.

(b) *Torque Test.* Torque testing equipment should be used to determine if the motor will develop rated torque. A high current-carrying variable resistance should be connected into the circuit so that the specified voltage at the cranking motor may be obtained, since a small variation in the voltage will produce a marked difference in the torque development.

Rated torque, current draw and no-load speed indicates normal condition of cranking motor. Abnormal conditions may be indicated by one of the following:

1. *Low free speed and high current draw with low developed torque* may result from:

(a) Tight, dirty, or worn bearings, bent armature shaft or loose field pole screws which would allow the armature to drag.

(b) Shorted armature. Check armature further on growler (par. 10-25).

(c) A grounded armature or field. NOTE: *Remove commutator end frame and disconnect shunt field (small wire) from insulated motor terminal before checking for grounds.*

Check for grounds by raising the grounded brushes and insulating them from the commutator with cardboard, and then checking with a test lamp between the insulated terminal and the frame. If lamp lights, raise other brushes from commutator and check fields and commutator separately to determine whether it is the fields or armature that is grounded.

2. *Failure to operate with high current draw may* result from:

(a) A direct ground in the terminal or fields.

(b) Frozen shaft bearings which prevent the armature from turning.

3. *Failure to operate with no current draw* may result from:

(a) Open field circuit. Disconnect shunt field, item 1 (C) above, then inspect internal connections and trace circuit with test lamp.

(b) Open armature coils. Inspect the commutator for badly burned bars.

(c) Broken or weakened brush springs, worn brushes, high mica on the commutator, or other causes which would prevent good contact between the brushes and commutator. Any of these conditions will cause burned commutator bars.

4. *Low no-load speed with low torque and low current draw* indicates:

(a) An open field winding. Disconnect shunt field, item 1 (C) above, raise and insulate ungrounded brushes from commutator and check field with test lamp.

(b) High internal resistance due to poor connections, defective leads, dirty commutator and causes listed under item 3 (c).

5. *High free speed with low developed torque and high current draw* indicates shorted fields. There is no easy way to detect shorted fields, since the field resistance is already low. If shorted fields are suspected, replace the fields and check for improvement in performance.

10-38 CRANKING MOTOR REPAIRS—ON BENCH

a. Disassembly, Cleaning and Inspection

When it is necessary to disassemble cranking motor for any reason, make a complete clean up and inspection to make sure all parts are in satisfactory condition. See figure 10-31 for identification of parts.

1. Disconnect plunger from shift lever by removing link pin, remove nut and lockwasher from terminal of solenoid switch, then remove solenoid from cranking motor.

2. Remove nut and lockwasher from shift lever stud, unhook return spring from shift lever, and remove stud.

3. Take out the thru bolts and remove commutator end frame and the field frame assembly.

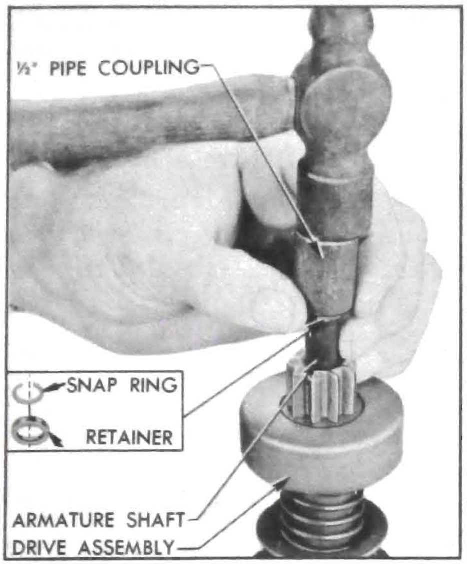

Figure 10-39—Removing Pinion Stop Retainer and Snap Ring

4. Remove armature with drive assembly and shift lever from drive housing. Remove thrust collar from pinion end of armature shaft, and remove leather thrust washer from opposite end of shaft.

5. Place a metal cylinder of proper size (½" pipe coupling will do) over end of armature to bear against the pinion stop retainer. Tap retainer toward armature to uncover the snap ring, remove snap ring from groove in shaft then remove retainer and drive assembly. See figure 10-39.

6. Remove screws attaching leads and brushes to holders then press center of each brush spring out of its retaining recess and remove the two brush holders and spring as a group. Remove thrust washer from brush holder pivot pin.

7. Remove nuts and insulating washers from the small "S" terminal and the large motor terminal adjacent to mounting bracket of solenoid then remove two screws that attach switch cover to solenoid and remove cover for inspection of switch contacts.

8. Clean all parts by wiping with clean cloths. The armature, field coils, and drive assembly must not be cleaned by any degreasing or high temperature method. This might damage insulation so that a short or ground would subsequently develop, and will remove lubricant originally packed in the overrunning clutch so that clutch would soon be ruined.

9. Carefully inspect all parts for wear or damage and make necessary repairs or replace unserviceable parts. Any soldering must be done with rosin flux; *never use acid flux on electrical connections.*

10. Test armature and make necessary repairs or turn commutator if required, following the same procedure as specified for generator armature in paragraph 10-25.

b. Assembly of Cranking Motor

1. Lubricate drive end of armature shaft with SAE 20 engine oil and install drive assembly with pinion outward.

2. Slide pinion stop retainer down over shaft with recessed side outward.

3. Stand armature on commutator and place a *new* snap ring on drive end of shaft and hold it in place with a hard wood block. Strike block with hammer to force snap ring over end of shaft, then slide the ring down into groove in shaft. See figure 10-40, view A.

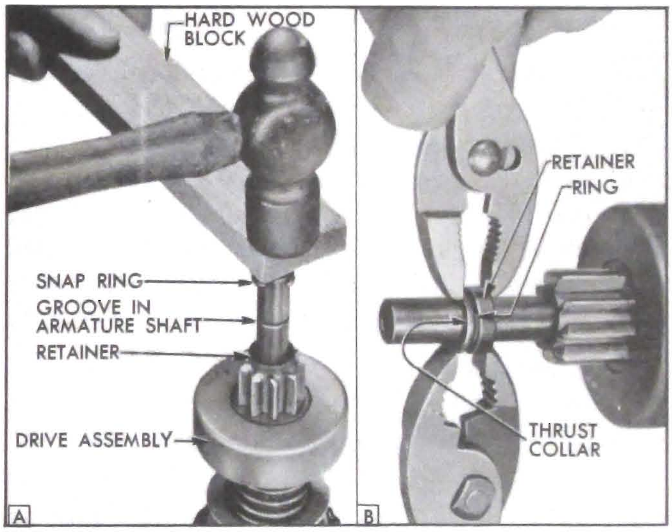

Figure 10-40—Pinion Stop Retainer and Snap Ring Installation

4. Place thrust collar on shaft with shoulder next to snap ring, and move the retainer into contact with ring also. Using pliers on opposite sides of shaft squeeze retainer and thrust collar together until snap ring is forced into the retainer. See figure 10-40, view b.

5. Continue with assembly of cranking motor by reversing disassembly procedure. If field coils were removed from field frame, use care in tightening pole shoe screws to avoid distortion of parts and make sure that screws are securely tightened.

6. Before installation of commutator end frame, attach spring scale at each brush and check the pull required to just lift brush off commutator. Brush spring tension should be

40 to 70 ounces. If spring tension is excessive, pull brush holders out to limit of travel several times to give a slight bend to spring. If spring tension is too light, replace brush spring. Make sure that brush holders do not bind on the support pins.

7. Before installation of solenoid switch check the shift lever spring for proper tension. A weak spring may cause sluggish disengagement of drive clutch pinion in cold weather, particularly if the shaft is gummed up. With spring scale connected to hole in upper end of shift lever, the pull at start of travel should be 20 pounds and at end of travel should be 40 pounds.

8. When solenoid switch plunger is connected to shift lever, adjust drive pinion travel to provide specified clearance in cranking position as described in paragraph 10-36.