

Cranking Motors...Or "Starters" To The Rest Of Us

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It should come as no surprise that the theory of how a starter works is much the same as how the generator works. This means all the time and effort you spent learning how a generator works will not be wasted. We, of course, know that a starter has only one job, to crank over the engine so the engine can start. Let's look at what is the same.

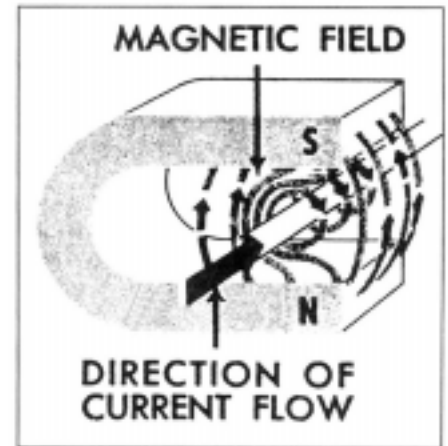
A starter, internally, is built much like a generator. Inside you will find an armature, pole shoes (magnets) and field coils. You will also find a commutator end of an armature, and brushes just like a generator.

BEFORE WE CAN TALK ABOUT THE DIFFERENCES, WE NEED TO TALK ABOUT MOTOR PRINCIPLES, OR THE THEORY OF HOW A STARTER MOTOR WORKS.

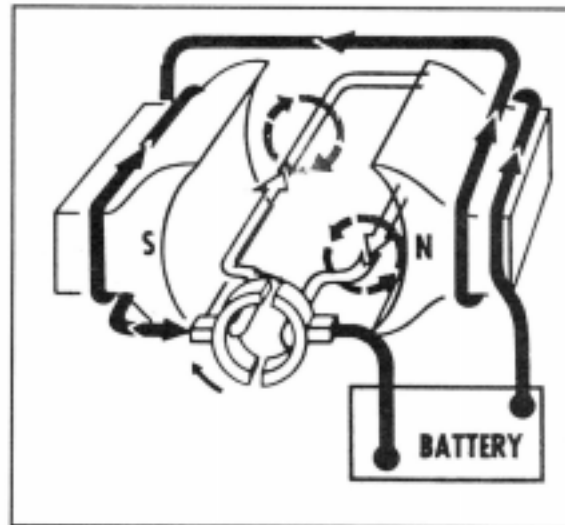
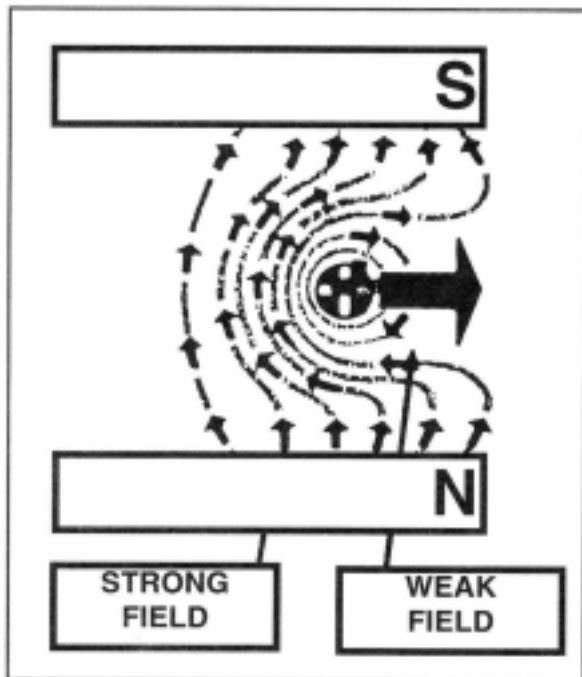
If you will remember the armature and pole shoe arrangement we had for our generator, to that we are going to add a "horseshoe" shaped magnet. With this arrangement there will be two magnetic fields, one created by the "conductor" current and one created by the horseshoe magnet.

Since magnetic lines leave the north pole and enter at the south pole (trust me on this) the direction of the current of the horseshoe magnet would be upwards. The conductor current we create with a rotating magnetic field is in the clockwise direction, just as it did in the generator.

The result is a heavy concentration of magnetic current on the left-hand side of the wires, where the two magnetic currents come together and become stronger.



Direction of current flow in a magnetic field.



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A basic motor is illustrated. A loop of wire is located between two iron pole pieces and is connected to two separate commutator segments, or bars. Riding on the commutator bars are two brushes, which are connected to the battery and to the windings located over the pole pieces. With this arrangement, current flow can be traced from the battery through the pole piece windings to a brush and commutator bar, through the loop of wire to the other commutator bar and brush, and then back to the battery. The resulting magnetic field imparts a turning or rotational force on the loop of wire as illustrated.

The magnetic current left over on the right-hand side is just the opposite of the conductor current, so they will cancel each other out.

The strong current of the horseshoe magnet and the strong current from the conductor will combine. Because the weaker currents on the right-hand side have canceled each other out, the left-hand current is where the cranking motor will actually get its cranking power.

NOW THAT WE KNOW HOW THINGS WORK, LET’S ADD A COMPLETE ARMATURE AND FIELD COILS TO OUR STARTER MOTOR. WE CAN THEN DEVELOP THE CURRENT FOR A COMPLETE STARTER MOTOR.

One of the main differences of a starter is that it requires a lot of current for a short time, as opposed to a generator, which works with a small amount of current over a longer period of time.

Because of this, there are two types of field coils used in starters. They are series and shunt. The current that flows through a series coil also flows through the armature windings. The current that flows through a shunt coil bypasses the armature and flows directly back to the battery.

FRAME AND FIELD ASSEMBLY

The frame and field assembly consists of field coil windings assembled over iron pole pieces which are attached to the inside of a heavy iron frame. The iron frame and pole shoes not only provide a place onto which the field coils can be assembled, but also provide a low reluctance, or low resistance path for the magnetic flux produced by the field windings.

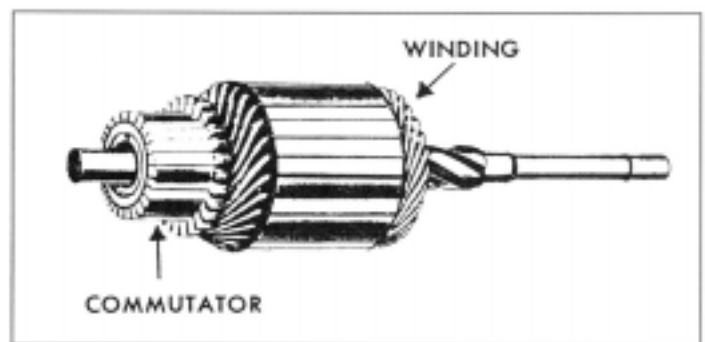
A number of wiring diagrams showing the various types of field coil connections are illustrated. By tracing the current flow through the windings, and by using the “Right Hand Rule,” it is seen that the polarity of the face of each pole shoe over which the coil is wound alternates around the field frame. That is, the polarities alternate north, south, north and south.

The **shunt coil** can be easily identified because of its direct connection to ground. Shunt coils will also be made up of a number of turns of smaller wire, just like in a generator.

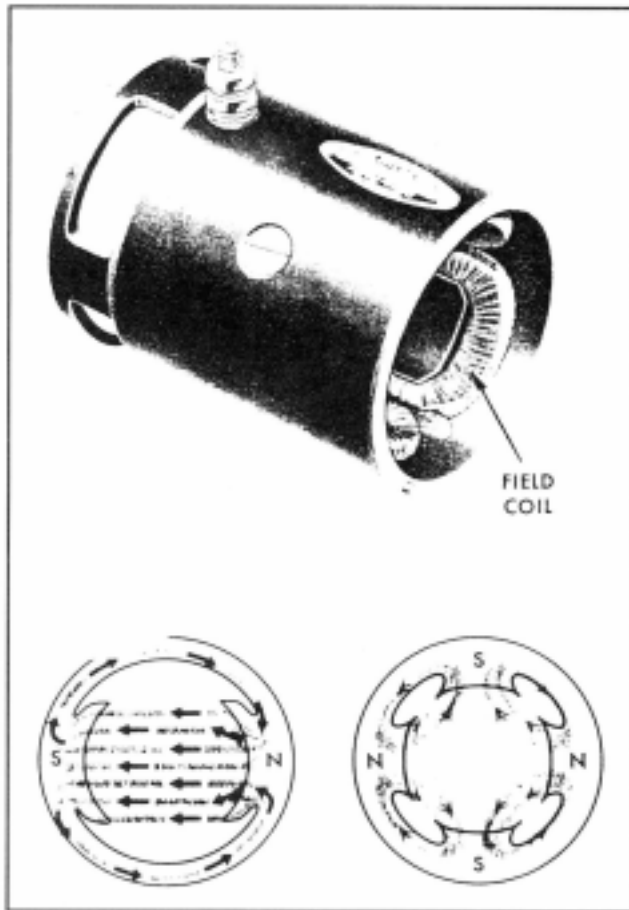
Because of the extra current necessary for the starter to do its job, a starter will need at least two sets of brushes. Sometimes three sets are required for heavy-duty applications.

A shunt coil does for a starter, just like it does for a generator (controls the output). As we learned about generators, if there is not some control of the output, overcharging will occur and damage to the electrical system will result.

For a starter, if the electrical current output is not regulated, the starter motor will spin out of control, causing damage to itself, just like a generator. So the job of the shunt coil is to control the output of the starter.

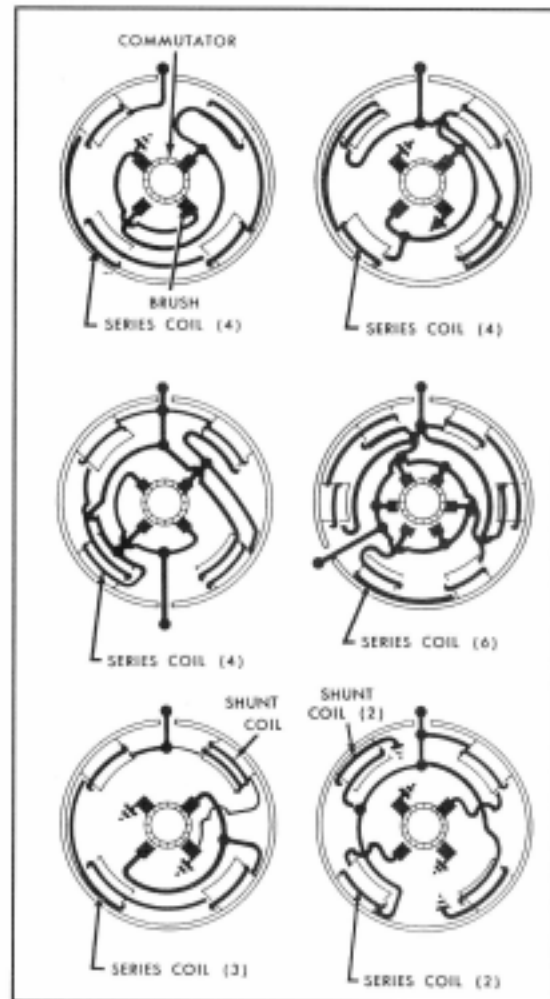


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The series coils have the job of increasing the current output of the pole shoes, much like the field coils in a generator. The turning force or “torque” of a starter is determined for the most part by the current available to the series coils, and their position inside of the starter, along with battery cable size, battery capacity, and current carrying capacity of the motor brushes.

In some applications it is necessary to add an **equalizer bar** across two or more brushes to equalize the voltage at the brushes.

OK, WE KNOW THE STARTER IS LIKE A “MOTOR.” NOW HOW DO WE GET THE MOTOR TO CRANK OVER THE ENGINE?

This is done through the motor drive, or starter bendix as it is commonly called. The motor drive is assembled on the armature shaft and is the part that actually comes into contact with the flywheel (the big gear on the back of the motor), and cranks over the engine. There are a number of different types of drive mechanisms used on cranking motors, and these are covered in the sections that follow.

All drives, regardless of type, will contain a pinion that slides along the armature shaft, and engages to the flywheel. Every starter will also have a gear reduction between the starter and flywheel of about 15:1. This gear reduction will give the starter the strength to crank over the engine.

After the engine is started, the starter drive is designed to disengage from the flywheel. This protects the starter from having to spin as fast as the engine after it is started. (This would be darn fast at a 15:1 ratio!)

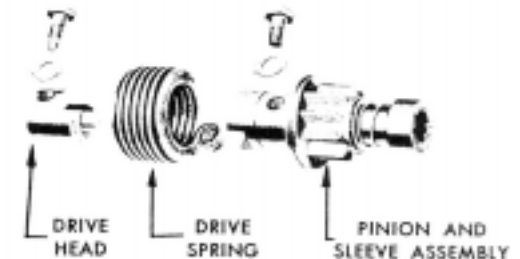
The **Bendix drive** shown at right is one of the most common types of starter drives in use. So common, in fact, that when a starter drive goes out or fails, we tend to say the bendix is out of the starter. The Bendix drive is actually a type of starter drive called an “inertia” drive.

Although there are a variety of different types of Bendix drives which may differ considerably in appearance, each drive operates on the principles of inertia to cause the pinion to engage the engine ring gear when the motor is energized.

The drive pinion is normally unbalanced by a counterweight on one side, and has screw threads or splines cut on its inner bore. These screw threads match the screw threads cut on the outer surface of the Bendix Sleeve. The pinion and sleeve assembly fits loosely over the armature shaft, and is connected through the drive spring to the drive head, which is keyed to the shaft. Thus, the pinion and sleeve assembly is free to turn on the armature shaft to the extent permitted by the flexing of the drive springs.

When the starting switch is closed and the battery energizes the motor windings, the armature starts to revolve. This rotation is transmitted through the drive head and drive spring to the sleeve, and these parts increase in speed with the armature. The pinion, however, being unbalanced and having a loose fit on the sleeve, does not increase in speed with the armature due to its inertia. The net result is that the spiral splined sleeve rotates within the pinion, and the pinion moves endwise along the shaft to engage the ring gear. When the pinion reaches its stop on the sleeve, cranking takes place, with the initial shock being taken up by the spring.

When the engine begins to operate, the pinion is driven by the ring gear at a higher speed than the armature. This causes the pinion to rotate in the same direction as the sleeve but at a higher speed, and the pinion is driven back out of mesh with the ring gear teeth. For as long as the operator keeps the motor energized with the engine running, the motor free wheels. The motor start switch, therefore, should be released immediately after the engine has started.



A partially exploded view of a typical inertia drive consisting primarily of a pinion and sleeve assembly, a drive spring, and a drive head.

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A **Folo-Thru Bendix** drive is illustrated, top, with the pinion and barrel assembly in the cranking position and partially cut away to show the internal construction. This drive operates in the same manner as the type previously discussed, and has two additional features.

A spring-loaded detent pin that moves into a notch cut in the spiral spline serves to lock the pinion in the crank position. This feature prevents unwanted disengagement during false starts. When the engine starts and reaches sufficient speed, centrifugal force causes the detent pin to move out of the notch, and the pinion then is driven out of mesh with the ring gear. A second pin rides on the spiral spline and acts as an anti-drift device during engine operation.

The second feature of the Folo-Thru drive is a sleeve or screw shaft having two pieces that are connected by a **Dentil Clutch**, or mating ratchet teeth. This feature prevents the armature from being driven to excessive speeds by allowing the pinion and mating sleeve to overrun the ratchet teeth until the detent pin has disengaged the notch.

A drive (see illustration at right, bottom) that is used on some of the smaller motors is the **rubber compression type**. This drive has the mating ratchet teeth feature, but uses a rubber cushion located inside the cup to take shock of initial cranking. A small spring located over the screw shaft inside the pinion and barrel assembly prevents the pinion from drifting into the ring gear during engine operation.

Another Bendix drive is the friction-clutch type that is used on some of the larger cranking motors. This type of drive uses, instead of a drive spring or rubber cushion, a series of flat spring-loaded clutch plates inside the housing that slip momentarily during engagement to relieve shock. A meshing spring is located inside the drive to allow the pinion to clear a tooth abutment condition. An anti-drift spring is located over the spiral spline.

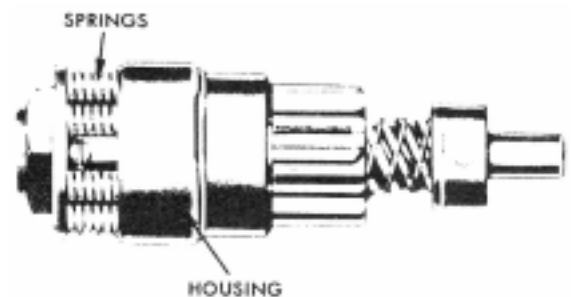
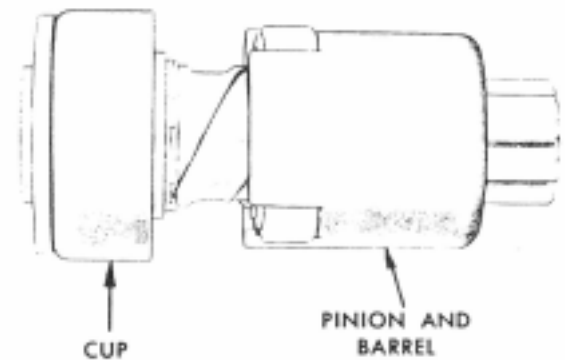
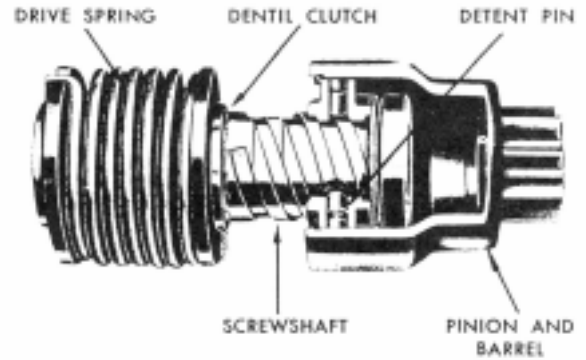
Lost yet? Kind of? Okay. This arrangement makes the pinion and sleeve assembly free to turn on the armature shaft.

When the solenoid is closed or the foot pedal is pushed (in the case of the older cars), this sends current to the motor windings making the armature spin. This rotation of energy is sent to the drive head and spring, then on to the sleeve. All of these parts begin to spin faster along with the armature.

The pinion, because it is unbalanced by the counterweight, does not speed up. So the sleeve inside of the pinion has to speed up by itself. This will cause the pinion to move away to the end of the armature shaft.

When the pinion reaches the end of the line, it will be engaged to the flywheel and engine cranking will take place. The pinion spring is there to absorb some of the shock of coming to the end of the line.

When the engine starts, the pinion is driven by the flywheel at a higher speed than the armature. This will cause the pinion to rotate the same direction as the sleeve, but at a much faster



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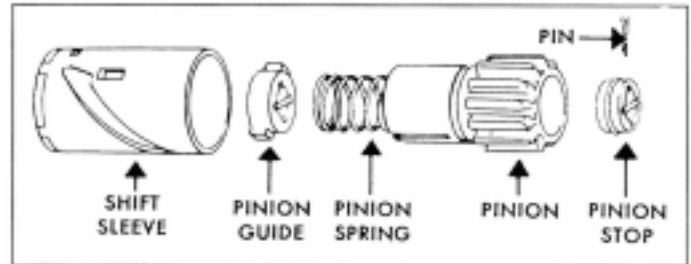
speed. This will cause the pinion to be pulled back and the pinion will become disengaged.

The spinning process that engages and disengages the starter is called inertia. This is why these starters are called **inertia drive starters**.

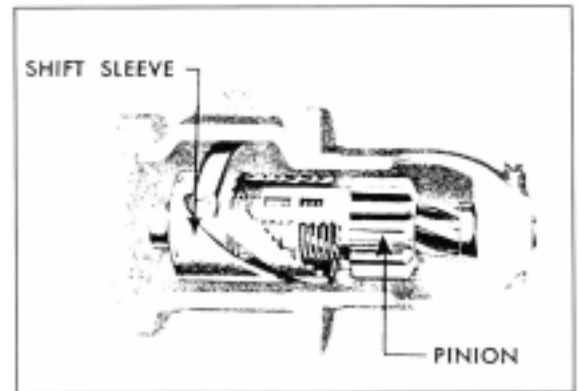
This type of starter drive was one of the most common types in use up through the mid-1950's, and is still in use today with a few improvements. Also shown on the next few pages are a few different variation of the inertia drive.

DYER DRIVES – These are the next most common type of starter drive you will encounter. The Dyer drive pinion is moved into mesh with the ring gear by a shift lever that is either manually operated or operated by a solenoid. This type of drive is used on large motors and features positive engagement of the pinion with the ring gear before the switch can be closed between the battery and motor. This feature avoids spinning meshes, which are damaging on high horsepower motors with rapid armature acceleration.

The Dyer drive mechanism consists essentially of a shift sleeve, pinion guide, pinion spring, pinion, pinion stop, and cotter pin. The pinion guide is a close fit on the spiral splines of the armature shaft, while the pinion (which has internal splines matching the armature splines) fits loosely on the armature shaft splines. An exploded view showing the major components is illustrated at the bottom of the previous page.



A cutaway view of a Dyer drive in a partial view of the motor assembly is illustrated at right. The drive mechanism is shown in the “at-rest” position. The spring located between the guide and pinion holds the internal teeth of the pinion and guide against the spiral splines on the shaft. In this position, the pinion guide teeth are located in milled notches in the spiral splines, which holds the pinion and guide assembly at the at-rest position. The only way the assembly can be released from this position is by movement of the shift lever.



Movement of the shift lever causes the shift sleeve, pinion guide, pinion spring and pinion to be moved endwise along the shaft so that the pinion meshes with the ring gear teeth. Since the guide and pinion have internal splines matching the shaft splines, these parts rotate as the pinion spring allows further movement of the pinion guide, which continues to rotate the pinion until the abutment is cleared. The spring then causes the pinion to mesh with the ring gear. Continued movement of the shift lever closes the switch and cranking takes place, with the pinion held in place by the pinion stop.

When the armature begins to rotate, friction between the pinion guide and shift sleeve causes the sleeve to move back to its original position on the shaft, with the shift lever button following the groove in the shift sleeve. As the engine starts, the ring gear drives the pinion faster than the speed of the armature, and the pinion, spring, and guide are moved back to the at-rest position with the guide held in place by the notches in the shaft spines. Another cranking cycle cannot be started without first moving the shift lever back to the at-rest position.

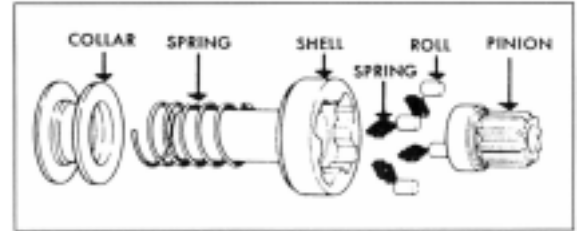
An important adjustment on Dyer drive motors involves the amount of pinion travel against the pinion spring with the shift lever in the cranking position. This measurement is made by energizing the solenoid or moving the shift lever by hand to the crank position with the motor windings de-energized, and then pushing the pinion back by hand against the spring and noting the full extent of its travel.

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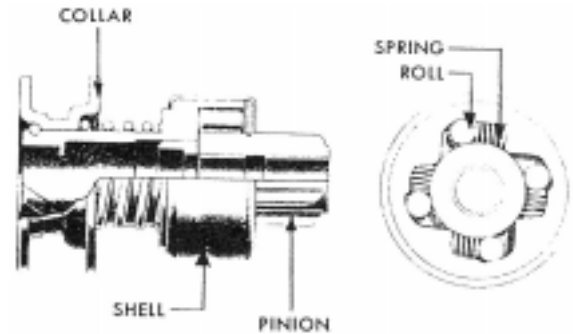
Other styles of starter drives you might encounter are shown below. They include roll clutch drive and sprag clutch drive. No matter the style, the basic theory is the same

ROLL CLUTCH DRIVE

The Roll Clutch drive pinion is moved into and out of mesh with the ring gear by a shift lever that is either manually operated or operated by a solenoid switch. The Roll Clutch drive has a shell and sleeve assembly that is splined internally to match either straight or spiral splines on the armature shaft. The pinion is located inside the shell along with spring-loaded rollers that are wedged against the pinion and a taper cut inside the shell. The springs may be either the helical or accordion type, and four rolls are used. A collar and spring located over the sleeve are the other major clutch components. An exploded view and a cutaway view are shown.



When the shift lever is operated, the shift lever buttons located inside the collar move the collar endwise along the shaft, and the spring pushes the pinion into mesh with the ring gear. If a tooth abutment should occur, the spring compresses with lever movement until the switch is closed, at which time the armature starts to rotate and the tooth abutment is cleared. The compressed spring then pushes the pinion into mesh, and cranking begins with torque being transmitted from the shell to the pinion by the rolls, which are wedged tightly between the pinion and taper cut into the shell.



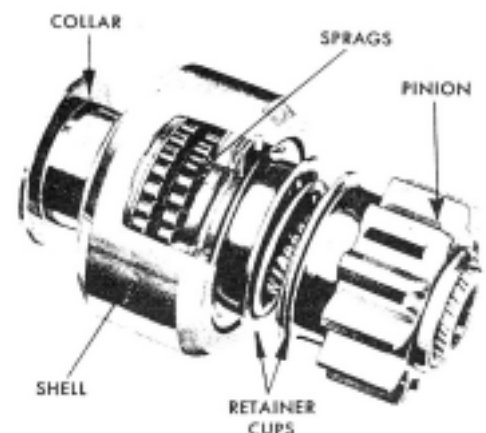
When the engine starts, the ring gear drives the pinion faster than the armature rotation, and the rolls are moved away from the taper, allowing the pinion to overrun the shell. The start switch should be opened immediately when the engine starts to avoid prolonged overrun. When the shift lever moves back by return spring or manual action, the pinion is moved out of mesh and the cranking cycle is completed.

An important service check on roll clutches involves the clearance in the crank position between the pinion and housing or retainer with the pinion pushed back toward the shift lever. Proper clearance is needed to prevent rubbing of the collar against the shift lever during motor operation and to insure proper engagement before cranking begins.

SPRAG CLUTCH DRIVE

The Sprag Clutch drive is constructed and operates in a manner somewhat similar to the Roll Clutch drive, except that a series of sprags, usually 30 in number, replace the rolls between the shell and sleeve. The sprags are held against the shell and sleeve surfaces by a garter spring. The shell and collar assembly is splined to the armature shaft, and the pinion is spiral splined to the sleeve with a stop collar on the end of the sleeve. A cutaway view is shown.

Movement of the shift lever against the collar either manually or by a solenoid causes the entire clutch assembly to move endwise along the splined shaft, and the pinion teeth to engage the ring gear. If a tooth abutment should occur, continued movement of the shell and spiral splined sleeve causes the



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pinion to rotate and clear the tooth abutment. The compressed meshing spring then forces the pinion into mesh with the ring gear. If sufficient rotational movement is not imparted to the pinion to clear the abutment before the two retainer cups meet, the shift lever movement is stopped by the retainer cups and the operator must start the engagement cycle over again. This feature prevents closure of the switch contacts to the motor with the pinion not engaged and resulting damage caused by spinning messes. On the second attempt the pinion will engage in a normal manner.

With the pinion engaged and the switch closed to energize the motor windings, the cranking cycle begins. Torque is transmitted from the shell to the sleeve and pinion through the sprags, which tilt slightly and are wedged between the shell and sleeve. When the engine starts, the ring gear drives the pinion and sleeve faster than the armature, and the sprags tilt in the opposite direction to allow the pinion and sleeve to overrun the shell and armature. To avoid prolonged overrun, the operator should immediately open the start switch as soon as the engine starts.

The Sprag clutch drive is used primarily on larger cranking motors, and is designed to carry the high torque transmitted by the armature. Like the Roll clutch drive, **an important service procedure is the proper adjustment of pinion clearance in the crank position, and this adjustment is accomplished as covered in the appropriate service bulletin.**

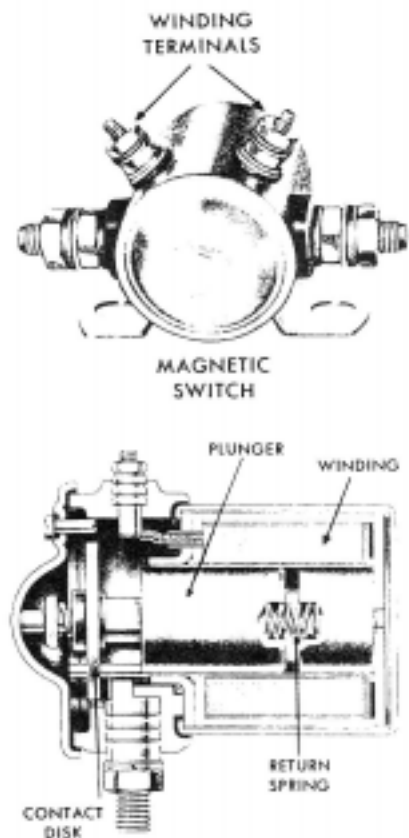
MAGNETIC SWITCHES AND SOLENOIDS – These are the final link in building our working starter. Keep in mind that some of the older applications used a foot pedal that stuck through the floor and mechanically engaged the starter. But by the mid-1950’s, most all of the starters used some kind of electrical switch or solenoid. Let’s look at some of these.

A magnetic switch (like used on many Fords) is made up of windings mounted on a hollow cylinder. Inside of the hollow cylinder is a plunger with a contact disk attached to it, just like those found on a set of contact points, only heavier.

When the windings of the hollow core are energized, the magnetic current travels to the plunger causing it to move, and the contacts to close. This will cause the contact disk to be held tight against the two main switch terminals, and completes the circuit. As you have figured out by now, when the windings are no longer energized, a return spring causes the plunger to return to its original position.

A magnetic switch is often chosen for those applications that need a circuit of short length and low resistance between the battery and the starting motor. Since the starter will draw 100 plus amps, heavy cables of a short length are used to make the starting system more efficient. There is less voltage drop because of less resistance. This also allows the wire that travels from the starter switch on the dash to the starter to be the same size as the rest of the wiring harness because it only has to carry minimal amps to engage the solenoid.

SOLENOID SWITCHES – A solenoid switch is built nearly the same as a magnetic switch except that a sole-



A typical switch is shown, along with a cross-sectional view of one of the larger models. Some models have one switch terminal with the other winding end grounded internally to the switch case, and others have two switch terminals to which the winding ends are connected.

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noid usually is mounted in a horizontal position on top of the starter. In addition, a shift lever or rod may be connected to the plunger.

When the windings are energized and the plunger contacts are drawn together, the shift lever or rod will be moved and the starter will become engaged. At the same time, current is being sent to the starter windings. When this happens together, cranking over of the engine takes place.

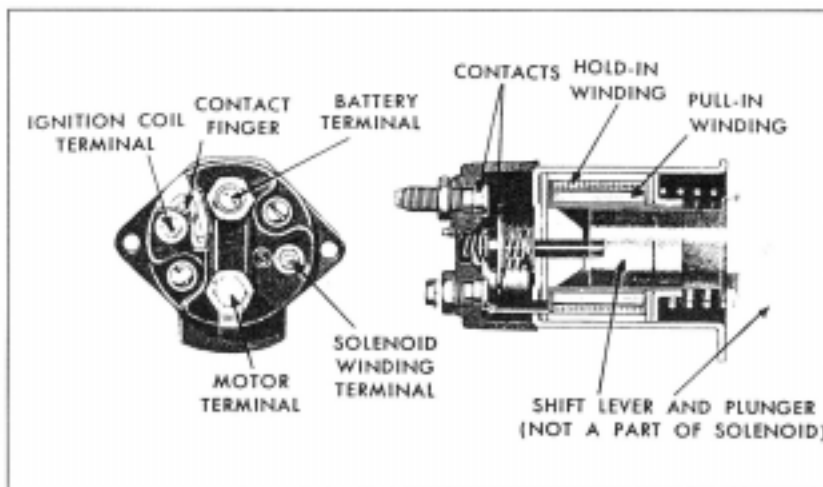
The round hollow part inside of a solenoid is called a **plunger**. If you look at the terminal end of a plunger, you will see the top big post is the battery terminal. The other big post directly below that is the motor post and is connected to the starter itself. The other terminals you will find are the “I” terminal, which stands for ignition, and “S” terminal, which is the starter terminal that is energized by the start switch on the dash.

The “I” terminal has a special job. In the early days it was learned that when starting the car, the majority of current from the battery was used by the starter. As a result, the current left for the ignition coil was minimal.

(As we will learn in the next chapter, the **ballast resistor** used on the ignition coil is there to reduce the voltage at the coil approximately two volts to extend the life of the contact points in the distributor.)

When the starter was cranking over the motor, the voltage dropped even further, causing a weak ignition and hard starting. The cure became the “I”, or sometimes labeled “R” terminal. It

allows the ignition current to bypass the ballast resistor during starting only (while the solenoid is engaged). After the car was started, the voltage was again routed through the ballast resistor.



A cross-sectional view of a typical solenoid.

Some of the old foot pedal “button” style of starter switches, like those found on GM cars and many early farm tractors of the early 1950’s, used this same type of starter switch with this side terminal. An 18-gauge wire was connected from the battery side of the ignition coil to this stud and served the same purpose as the “I” terminal on the solenoid.

This style of **starter button** can be used as a replacement for the plain style without the stud, and can help, if you are experiencing hard starting. The starter button with the side terminal is Standard ignition brand part number SS-521. This style of switch should be available at your local full-line auto parts store.

Some of you know or have experienced GM products that do not start well when the engine is warm. This is common to large cubic inch V-8’s as well as cars with headers or exhaust that fit close to the starter. The excess heat from the headers will be absorbed by the starter and solenoid. This is called “heat soak.” In some applications, a heat shield was placed around the starter to help this out. Another cure would be to move the solenoid up and away from the heat and mount it up on the firewall or fender, just like a Ford car or truck does.

But is that possible? Yes. Use Standard replacement solenoid 12V (SS-581), which will be a Ford style solenoid. It will have an “I” terminal and “S” just like the GM Style, so all of the connections will be the same. The only thing you have to do to the solenoid on the starter is connect the “I” and “S” terminals together using a short jumper wire made from 18-gauge wire, and two solderless terminals that will provide the permanent connections.

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The rest of the connections to the new terminal will be just the same as they were for the old one. Now your starter solenoid will be out of the heat, which should make your car start better.

IMPORTANT: Another note of “havoc” for your reference file. Some of the Ford cars of the late 1940’s and early 1950’s had a positive ground electrical system (which we will get into in the next chapter). This means that the negative wire is the “hot” wire.

This also means that the starter solenoid trips from the groundside, and not the positive side, as do nearly all of the rest of the magnetic switches you will encounter. The replacement magnetic switch you buy for this application will need to have an insulated base. Your shop manual should remind you of this. When you go to the local auto parts store you want to be prepared; you may have to “educate” the counterperson when you get there.

Most of the auto parts counter people today are young, and they have no idea there were two types of magnetic switches used in “the old days.” It’s true, insulated switches were not used for all that many years. (Nonetheless, they will not interchange!) So knowing this will save you some social embarrassment and aggravation that you don’t deserve.

AND NOW FOR THE CREATIVE STUFF –

We have covered the most common magnetic switches and solenoids used. But a few of the engineers had a different idea about how to start a car. A few of those ideas got into production. They include the following:

POLARITY SWITCHES – These were quite common on many makes of cars and trucks prior to the late 1940’s. The idea was simple. By reversing the polarity to the ignition contact points, each time the vehicle was started (only on the primary side), it would extend the life of the contact points by keeping the surface of the contact points clean of carbon residue or “tracking.” This kept the carbon burned off the contact points. This was not necessary in later years when condensers improved and the “after sparks” that caused the carbon tracking were eliminated. Chevrolet cars during the 40’s used this setup.

VACUUM STARTING SWITCHES – About 1940, the Delco-Remy Company invented a vacuum switch to control the starter. It hooked into the line of the regular starting solenoid control circuit. The purpose of this vacuum switch was to protect the starting motor from damage by preventing it from accidentally becoming engaged while the engine was already running.

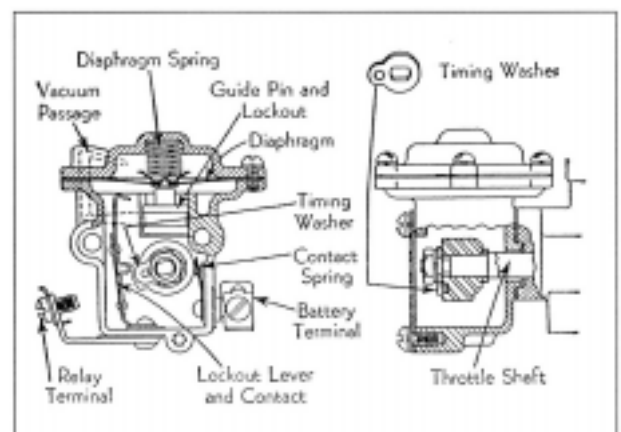
The vacuum switch was operated off of the manifold vacuum and the opening of the throttle. When the throttle opened, it allowed the contacts of the switch to close, completing the starting circuit. As soon as the engine started, the vacuum from the engine manifold “latched” open the contact points, and prevented the starter from being engaged as long as the engine was running.

Buick cars built between 1940-1947 used this type of starter switch, along with a special Stromberg carburetor.

Buick 1940-47 with Stromberg Carburetors

This type switch requires not attention in normal service other than to compensate for manufacturing tolerances in the switch, rotor, and throttle shaft. This is taken care of by special timing washers, supplied by the Stromberg Carburetor Co., which vary the position of the rotor on the throttle shaft, thus establishing the relationship between the throttle shaft and lock-out lever. The washers are numbered and each number represents a difference of three angular degrees in throttle shaft rotation.

A felt gasket, located beneath the cover plate, is a protection against dust entering the unit. The gasket is porous enough to allow breathing, which is caused by



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the movement of the diaphragm. Gaskets of any other material should never be substituted.

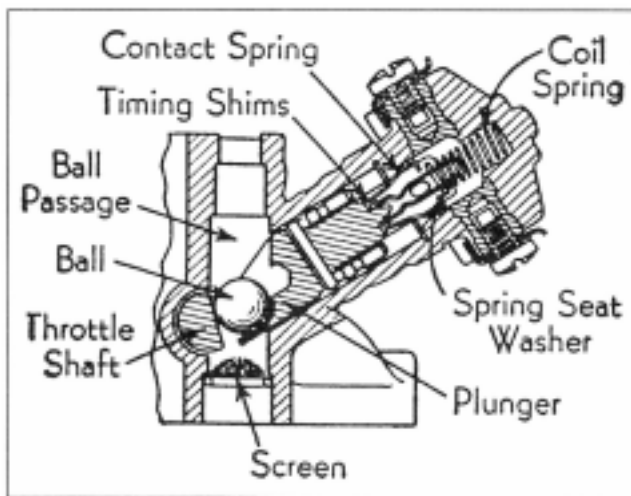
To check for minimum clearance between cold idle cam and idle screw, proceed as follows:

1. Set idle screw for 8 mph, hot idle.
2. Turn on ignition and start engine. Release throttle, then open throttle until distance between idle screw and cold idle cam in fast idle position is approximately $\frac{1}{4}$ inch. Turn off ignition, then release throttle slowly until this distance is $\frac{3}{64}$ inch. Do not allow idle screw to drop closer than $\frac{3}{64}$ inch to the cam, as this would void the test.
3. Now turn on ignition switch and open throttle from $\frac{3}{64}$ -inch position to start. Car should start.
4. Repeat this cycle several times. If engine starts each time, the vacuum switch is timed for starting in all positions of the cold idle cam.
5. If engine fails to start more than once on the above test, it will be necessary to use a higher number timing washer to allow engine to start.

To check for maximum clearance between cold idle cam and idle screw, proceed as follow:

1. Set idle screw for 8 mph, hot idle.
2. Turn on ignition and start engine. Release throttle, then open throttle until distance between idle screw and cold idle cam in fast idle position is approximately $\frac{1}{4}$ inch. Turn off ignition, then release throttle slowly until this distance is not less than $\frac{1}{8}$ inch. Do not allow idle screw to drop closer to the cam than $\frac{1}{8}$ inch, as this would void the test.
3. Turn on ignition, and open the throttle from $\frac{1}{8}$ -inch position to attempt starting. Car should not start. If the car does start, it indicates that the maximum clearance is above the specified high limit and it will be necessary to use a lower numbered timing washer. After changing to a lower numbered washer, repeat the check for minimum clearance as described above.

Buick cars built between 1939-1954, along with Packard cars built between 1942-1954 using a **Carter carburetor**, also used a special starting switch called a **Carter carstarter**.



Buick 1939-54 and Packard 1942-54 With Carter Carburetors.

The starting switch, on the following page, is incorporated in the carburetor. When the accelerator is depressed with the engine stopped, a steel ball which rests on the milled portion of the throttle shaft is forced against a plunger, which raises a W-shaped copper contact spring until it makes an electrical connection between two brass blocks in the bakelite top of the switch. This closes the solenoid relay circuit.

As soon as the engine start the manifold vacuum raises the steel ball up away from the shaft and plunger to a seat in the casting, where it remains

as long as the engine runs.

As soon as the ball is raised, the coil spring pushes down on the W-shaped contact, forcing the contact and plunger down, which breaks the connection, opening the starting solenoid relay circuit. The ball cannot return to the starting position until the engine stops, and the throttle is returned to the idle position.

SERVICE NOTES: The W-shaped contact spring rests on two or more brass shims with square holes. These shims determine the point at which the switch contact is made. Contact should be made when the throttle valve is opened between 30 and 45 degrees. If not enough of these shims are in place, contact will not be made soon enough. Too many will cause the switch to function too soon (before 30 degrees) in which case, there is danger that the switch may be in contact all the time.

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In disassembling the switch, carefully remove these shims and put them aside in a safe place so they all will be returned to their proper position.

Between the W-shaped spring and the coil spring is a round washer with a square hold. This washer must not be confused with the timing shims. Neither the W-shaped spring nor the coil spring should be stretched or otherwise altered or the operation of the switch will be affected.

When reassembling the switch to the carburetor, be sure the plunger is placed in the position shown, above. If the piston is installed wrong side up, the switch will not function.

Never apply oil or grease to any of the switch parts as dust will collect and eventually cause the switch to stick.

In making the electrical connection, the red or hot wire should be attached to the terminal screw nearest to the center of the carburetor.

It is good practice to use Carstarter Gauge T-109-155S after the switch has been reassembled.

When any new switch parts are installed, it is essential to do so to make certain that the contact is not made before 30 degree throttle opening and is made before 45 degree opening.

In using Gauge T-109-155S, shown right, for determining the degree of throttle opening at which switch contact is made, proceed as follows for WDO series carburetors.

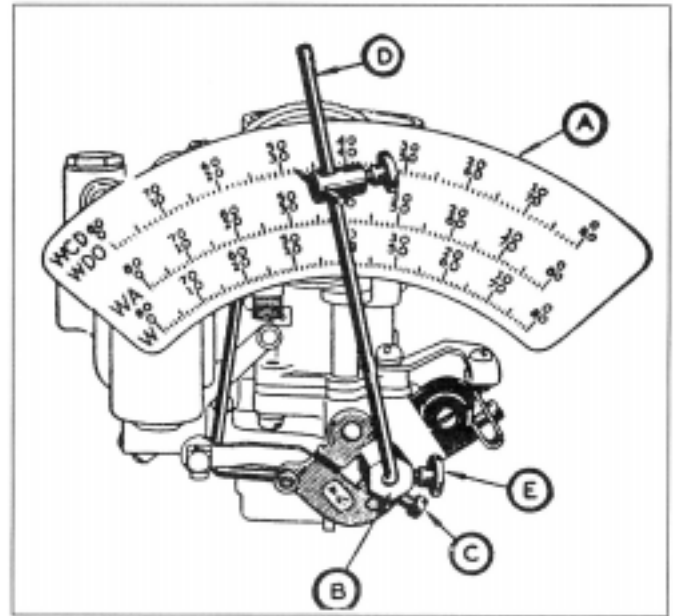
Attach plate “A” to the climatic control housing and tighten in position. Connect block “B” to the throttle shaft lever by means of the screw, as shown, being sure the block is tight. Back out throttle lever adjusting screw “C”. Hold choke valve open to release fast idle block, close throttle valve tight, and set shaft “D” so that the pointer rests on the line marked zero next to WDO at the left of the plate. Tighten adjusting screw “E”. With the carburetor on the car and the switch connected, the switch should make contact when the throttle is opened so that the indicator has passed 30 degrees, but engine must start before pointer has reached 45 degrees. If it does not, the shims mentioned above must be increased or decreased in number until the desired result is obtained. (On 1947 and 1948 Buick carburetors that use the late style throttle connector rod with the bend at the top of the rod, disconnect upper end of rod before installing the protractor gauge T109-155S.)

When the carburetor is on the bench, it is necessary to attach a battery and a bulb in series by wires to the two switch terminals. The point of contact of the switch can then be determined by the lighting of the bulb.

Keep in mind that while both Stromberg and Carter Systems work on the same principle, they are of two separate designs and not much will interchange. It’s best to refer to your owner’s manual for the fine details of making adjustments.

EARLY FORD STYLE – These starting switches are similar to magnetic switches we talked about earlier. The only difference is that they have a metal “cap” covering the plunger inside of the switch. The engineer that designed this style of solenoid must have been a believer in the KISS (Keep It Simple, Stupid) principle.

When the push button dash switch completes the circuit to the solenoid magnetic switch, heavy battery current energizes the magnetic coil, which draws in the solenoid plunger. The contact disc, which is mounted on the plunger, is pulled toward the terminals until the circuit is completed to the starting motor.



Carstarter Gauge

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When the circuit is completed, the major portion of the magnetic coil is short-circuited and only a small portion is required to maintain contact with the terminals, thereby releasing practically all the battery current to drive the starting motor. The starting motor will continue to run until the dash switch is released.

As a safety feature, should the switch fail to operate electrically; it can be operated manually by removing the metal cap on one end of the switch and pushing the plunger in by hand.

Chapter 6 Review

1. Starter drives are often referred to as bendix drives, which is actually a common type of inertia starter drive.
2. Starter solenoids, while firewall mounted (like Ford) or starter mounted (like GM), will all have the same basic wiring connections.
“I” or sometimes-called “R” terminal comes from the battery and provides a hotter spark during engine cranking.
“S” terminal is the wire that comes from the ignition switch itself. This is the terminal that engages the starter when we turn the key to the start position.
“B” terminal is where the battery cable from the battery connects to the starter.
3. Keep in mind that Ford used a positive ground electrical system during the late 1940's and early 1950's. Along with this they also used a **positive ground starter solenoid. The ground wire is the “hot” wire on this solenoid, and is what engages the starter. This will be opposite of 90 percent of all other solenoids you encounter.** If you have one of these on your Ford, you must replace it with one just like this one. You will want to be prepared to educate the counterperson at the auto parts store who has never seen such a solenoid and will ask you if you are “nuts” because they didn't make them like that. Your Ford solenoid will be insulated from its mounting bracket.
4. Another type of Ford starter solenoid had a little metal cap on top of the solenoid. If it fails to work for some reason, you can remove the metal cap and manually force the plunger down to engage the starter.
5. **Time-Saving Bonus Tip:** If a solenoid of either type fails to work, you can manually bypass the solenoid and start your car, but you must be careful. Using a pair of pliers or a big screwdriver, touch both the **battery terminal** and the **“S” terminal** at the same time. Be prepared, because **sparks will fly** and your **engine will turn over**. But, if you're in the way, it is curtains. So plan ahead—car in neutral, etc., etc.

**We would like to thank Randy Rundle
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“Wired For Success” book.**