SECTION SEVEN

IMPULSE COUPLINGS

GENERAL PURPOSE

A mechanical device, known as the impulse coupling or starter, is installed between the engine drive and the magneto proper on a majority of rotary magneto installations. Its primary function is to intensify the ignition spark at low rotative speeds in order to facilitate engine starting. The construction of the coupling in addition provides the means for automatically retarding the ignition spark during the starting period, thus reducing the possibility of damage to the engine or injury to the operator due to engine back-firing.

TYPES OF IMPULSE COUPLINGS

There are many variations of impulse couplings in general use, each magneto manufacturer having done considerable development work in this field. The principles of operation are much the same for the various designs and once understood should be readily applicable to similar units.

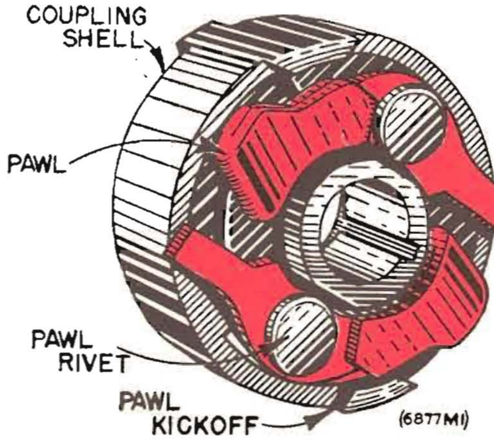

Figure 98—Pivoted Pawl Impulse Coupling

An arbitrary grouping of current impulse coupling designs can be made by classifying the couplings by their pawl action. In the pivoted pawl design (Figure 98) each pawl is securely fastened to a hub plate, its movement being confined to a turning action in an arc about its pivot point. In the sliding pawl design (Figure 99) the pawls are free, but move in a guide which restricts their motion to a straight line action.

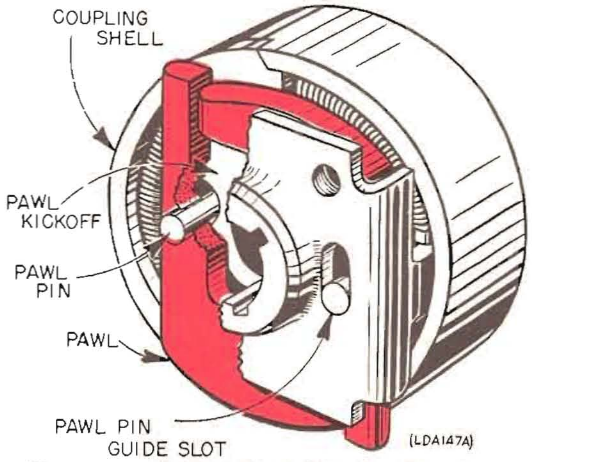

Figure 99—Sliding Pawl Impulse Coupling

DESCRIPTION OF OPERATION

The impulse coupling functions as a mechanical reservoir to store the energy which is available at a low rate during the engine starting period. Then, when the point is reached in the engine cycle where ignition of the fuel mixture should occur, all of this accumulated energy is instantly released to the magneto with the result that a strong ignition spark is produced. Since the point at which the energy release occurs can be controlled in the construction of the coupling, it is possible to provide an automatic retard of the ignition spark during the starting period.

Basically the impulse coupling consists of a shell and a hub, connected together by a strong spring. One half of the coupling (the shell) is fitted to a drive member on the engine drive shaft, while the other half (the hub) is keyed to the magneto rotor shaft. In operation at slow speeds (Figure 100) a pawl on the magneto half of the coupling engages a stop pin mounted on the magneto

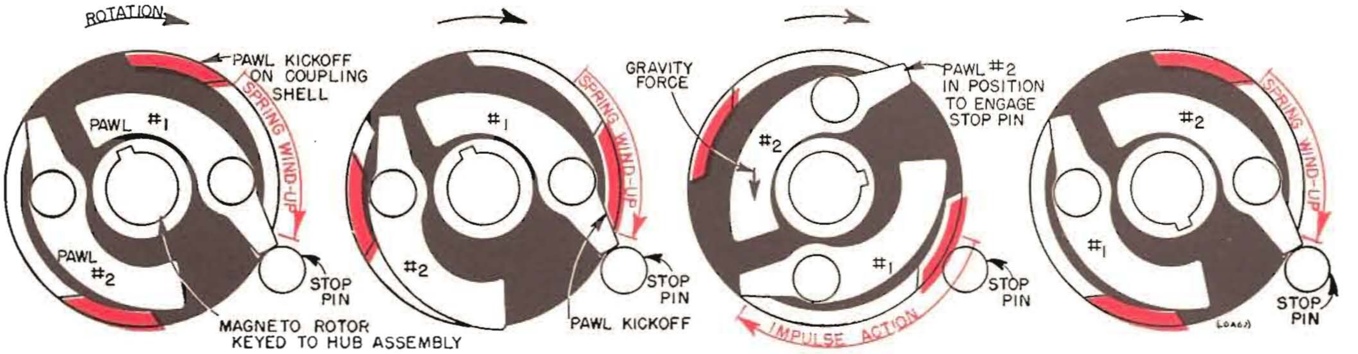

Figure 100—Sequence of Operations of Impulse Coupling for 180° Spark Magneto

frame, which acts to prevent further movement of the rotor, while the engine half of the coupling continues to rotate; the relative change in position winds up the connecting spring. When the point is reached where an ignition spark is desired, the pawl is released and the drive spring permitted to snap the magneto rotor forward at high speed through its firing position. As the speed of the engine picks up, centrifugal force acting on the pawls withdraws them to a position where they no longer engage the coupling stop pin, the impulse coupling then acting as a solid drive member.

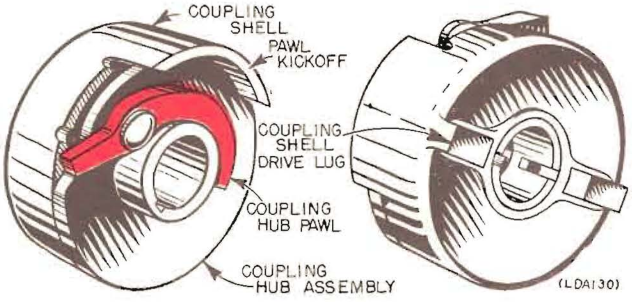

Figure 101—Single Pawl Coupling

SINGLE PAWL COUPLINGS

Where only one impulse spark per revolution of the magneto rotor is desired, a single pawl coupling (Figure 101) is used. This requirement is usually found in connection with single cylinder engines and with two cylinder engines firing each 360° of crankshaft rotation.

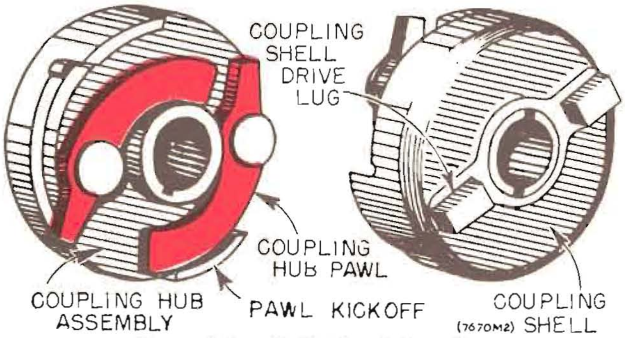

Figure 102—Twin Pawl Coupling

TWIN PAWL COUPLING

To produce two impulse sparks per revolution of the magneto rotor a twin pawl coupling (Figure 102) is used. Since these pawls are placed symmetrically on the coupling hub plate, each 180° of rotation brings a pawl into position to engage the stop pin.

With only slight changes the twin pawl coupling can be arranged to produce four impulse sparks per revolution (Figure 103). In such a case two stop pins are used instead of the usual one, and are located 180° apart. The pawls are spring-loaded to make them independent of gravity-operation and to speed up their action. A stronger drive spring is provided to compensate for the shorter wind-up period.

COUPLING PAWL OPERATION

In nearly all cases, both sliding and pivoted pawls operate automatically as the result of the two natural forces gravity and centrifugal. At slow speeds the gravity force dominates the pawl action, holding the pawl in such a position as to force it to engage the stop pin. With an increase in rotative speed, there is a corresponding increase in the centrifugal force acting upon the pawl, this force gradually overcoming the original gravity force and thus becoming dominant in the pawl action. Centrifugal force acts to prevent the pawl from engaging the stop pin.

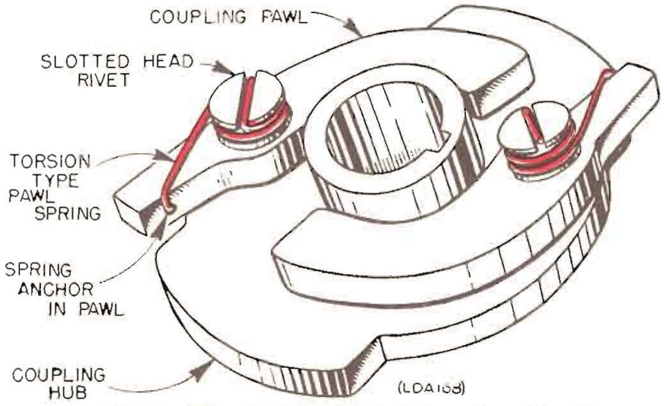

Figure 104—Spring-Loaded Coupling Pawls

SPRING-LOADED COUPLING PAWLS

While centrifugal force always acts at right angles to the axis of operation and therefore depends only upon rotative speed, gravity force always acts downward and is therefore dependent upon the coupling position. In the application of most magnetos the rotor shaft is horizontal and the downward gravity force accordingly is at right angles to the axis of operation. In other applications, however, the magneto is mounted at such an angle that the gravity force cannot operate the pawls during

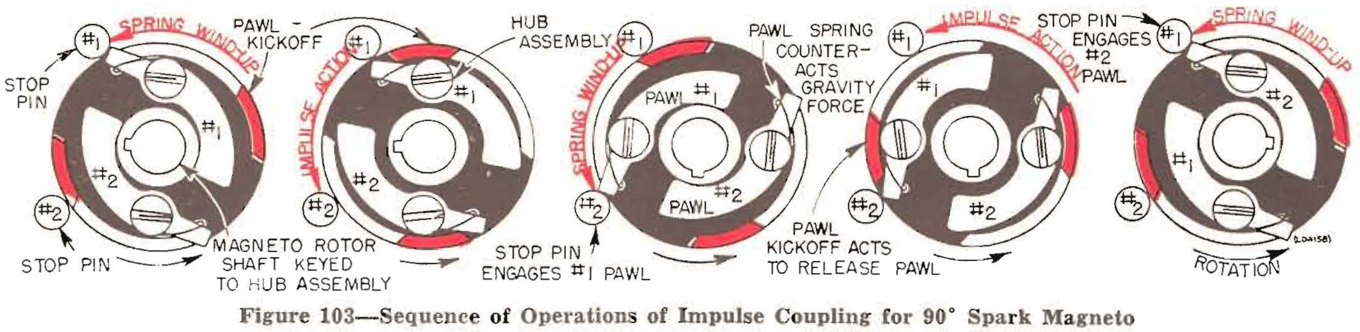

Figure 103—Sequence of Operations of Impulse Coupling for 90° Spark Magneto

the starting period. To cause the necessary engagement action, small wire springs (Figure 104) are attached to pawls to act opposite the centrifugal force and are of such strength as to replace the gravity force entirely.

The same arrangement (that is, pawl springs) is used to strengthen the gravity force in some applications in order to cause engagement of the pawl through higher than normal rotative speeds, or to speed up the action of pawls in order to engage stop pins located relatively close together.

COMBINED DRIVE GEAR & COUPLING

In certain special engine applications, the magneto drive gear has been made an integral part of the impulse coupling, serving as the outer shell. In a typical design (Figure 105) a single pawl hub is mounted in the conventional way on the magneto rotor shaft, while the drive gear is machined to fit the outer edge of the hub. In assembly the inner end of the coupling drive spring is anchored in the coupling hub, after which the spring is wound to the proper tension and its outer end fastened to the gear. The assembly is closed off with a large flat washer which fits under the coupling nut.

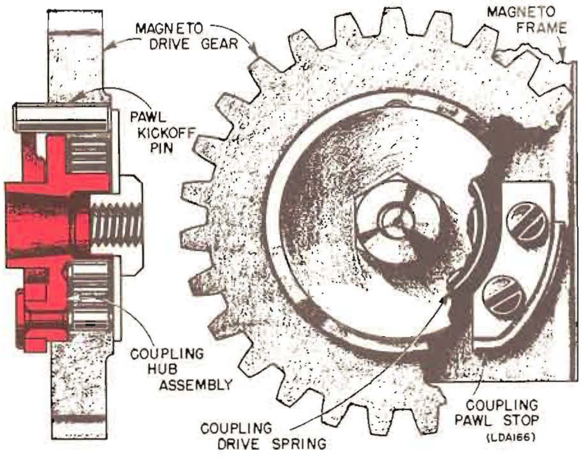

Figure 105—Combined Drive Gear and Coupling

In operation at slow speeds the coupling hub pawl engages the stop plate mounted on the magneto and winds up the drive spring. When the spring wind-up is complete, the pawl kickoff pin which is inserted in the gear strikes the pawl and forces it off the stop, releasing the hub and providing an impulse spark.

A more common type of combined drive gear and coupling is the two-piece design (Figure 114, Page 47) in which the drive lugs of a standard impulse coupling are fitted into a slot on the face of a drive gear, the assembly being mounted on an extended magneto rotor shaft. The drive gear and coupling shell turn together and must move in relation to the rotor shaft during the impulse period. Provision for this movement is usually made by inserting a bushing between the drive gear and rotor shaft.

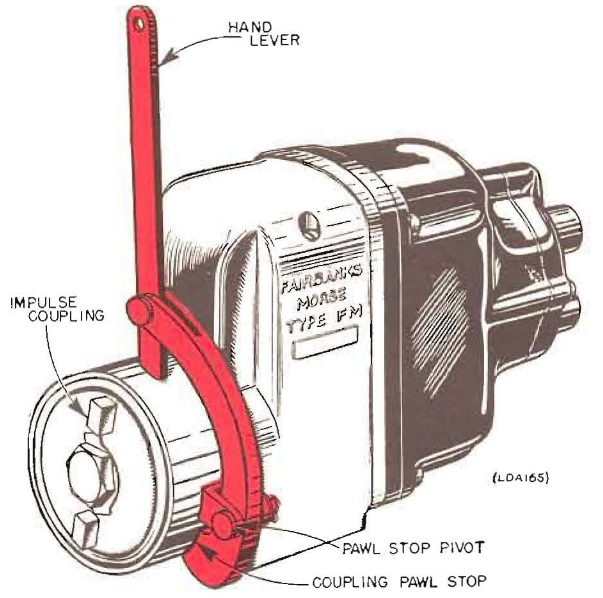

Figure 106—Manually-Engaged Impulse Coupling

MANUALLY-ENGAGED IMPULSE COUPLINGS

In certain types of magneto applications, usually in connection with slow speed oil or gas engines, there appears to be considerable advantage in manually-controlled impulse couplings. In such installations the operator moves the impulse coupling stop pin into position to engage the coupling pawl before engine starting is attempted. This procedure provides an intensified impulse spark, automatically retarded for starting. After the engine is running the coupling continues to impulse until the operator moves the pawl stop into the inactive position.

The manually-engaged impulse coupling is a simple assembly (Figure 106), usually consisting of a lever and pivot arrangement by which the impulse coupling pawl stop can be moved and locked into position. Remote control of the engagement lever can be provided by a system of wires and pulleys.

IMPULSE COUPLING DRIVE SPRINGS

During the starting period of the engine the impulse coupling stores up mechanical energy in the drive spring which connects the engine half of the coupling with magneto half. When the pawl releases, the drive spring snaps the magneto rotor through the arc necessary to produce an ignition spark.

Two types of impulse coupling drive springs are used in current designs. Most widely used is the torsion type spring (Figure 107), which resembles closely the mainspring of a clock. When the coupling is assembled, this spring is given an initial tension of approximately one or two turns, the impulse action providing additional tension. In the compression type spring (Figure 108), the coil spring must be compressed in order to assemble it into the shell, and additional compression takes place

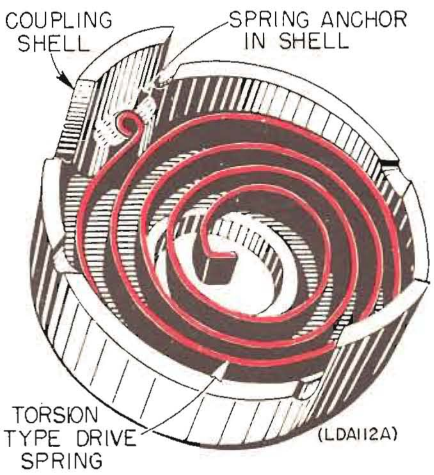

Figure 107—Torsion Type Drive Spring

during the impulse action.

The strength of the impulse coupling drive spring varies with the amount of wind-up (Figure 109) permitted by the coupling design and application. Obviously a long wind-up can be secured with a single pawl coupling where engagement occurs only once per revolution, while a very short windup is obtained in the case of an impulse coupling which is subject to four impulse actions per revolution.

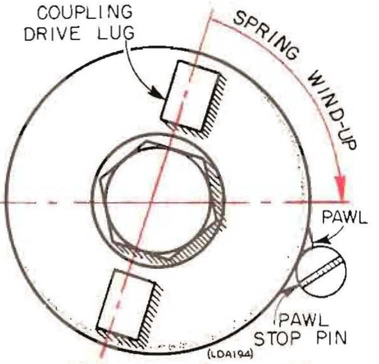

Figure 109—Drive Spring Wind-Up

IMPULSE COUPLING SPARK RETARD

The impulse coupling acts to intensify the starting spark, and at the same time to automatically retard this spark to the extent that it occurs at approximately top dead center of the compression stroke of the engine piston.

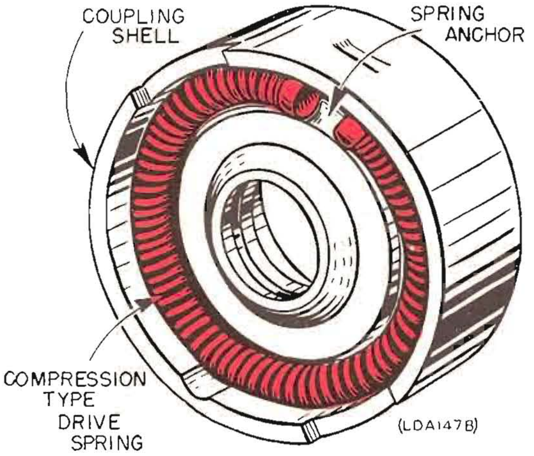

Figure 108—Compression Type Drive Spring

In distinguishing the ignition spark positions the retarded starting spark is usually termed the impulse spark, while the normal running spark is often called the advance spark.

To analyze the method by which the normal spark of the magneto is automatically retarded while the impulse coupling functions, the angular relation between the coupling and the magneto rotor must be closely observed.

In Figure 110 the action of the impulse coupling is illustrated in terms of the angles involved in its operation. The first step (a) occurs when the coupling pawl engages the stop pin, at which point the magneto rotor is prevented from further rotation, while the coupling shell continues to turn through angle A. During this period the mechanical energy supplied to the magneto is stored in the coupling through the wind-up of the drive spring.

The second step (b) of the impulse action occurs just as the wind-up period of the drive spring is completed and the pawl kickoff projection on the shell functions to release the pawl from the stop pin. The angle D shown on the coupling end of the assembly indicates the mechanical lag from the instant the pawl kickoff strikes the pawl to the instant the drive lugs of the shell reach the horizontal centerline. Note that in both steps (a) and (b) the magneto rotor is held stationary in a position preceding its spark point by an angle C which includes the edge gap distance.

In the third step (c) the drive spring of the coupling

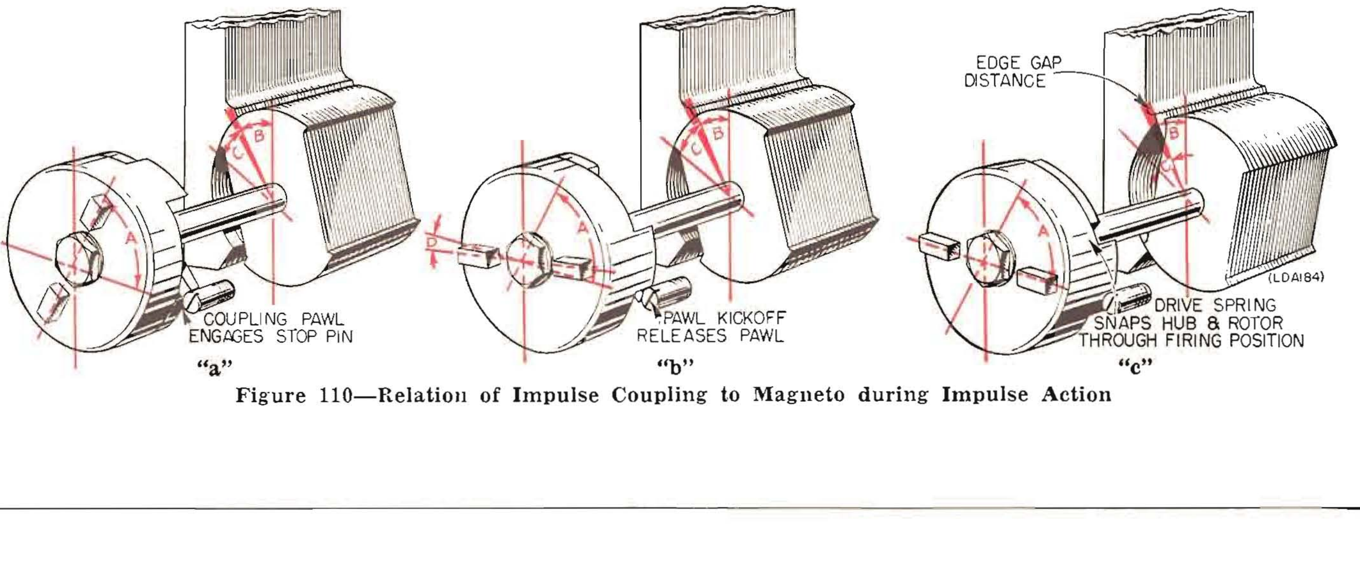

Figure 110—Relation of Impulse Coupling to Magneto during Impulse Action

functions to snap the hub of the coupling together with the magneto rotor through its wind-up angle A, the magneto rotor passing through the entire spark angle C, including the edge gap distance. Since the speed of this action is determined by the strength of the drive spring, a very strong ignition spark can be produced during the starting period of the engine.

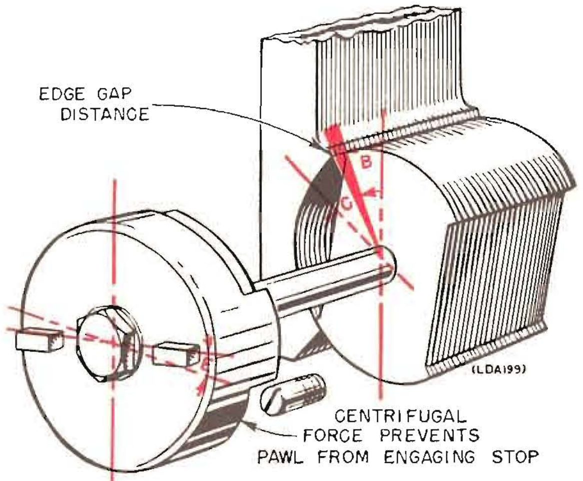

Figure 111—Angular Relation at Normal Running Speed

As the engine speeds up after starting, the impulse action of the coupling ceases, since the pawls no longer engage the stop pin. In Figure 111, the coupling is shown as it operates at speeds greater than those permitting impulse action. Since the pawls do not engage the stop pin, no drive spring wind-up occurs and the coupling acts as a solid drive member, the magneto rotor turning at exactly the same rate as the coupling shell. Consequently the magneto rotor passes through its spark position, as indicated by the edge gap distance, when the coupling drive lugs are at an angle E before the horizontal centerline is reached. This angle E is the amount the ignition spark has been advanced in the change from impulse spark to running spark. Conversely, it is the angular degrees the running spark is retarded during impulse action, and is commonly referred to as the lag angle of the coupling.

The angle E of an impulse coupling is determined by the location of the keyway in the hub; the lag angle can be increased or decreased within limits by moving the keyway when making the hub.

LOCATION OF COUPLING SHELL DRIVE LUGS

The location of the coupling shell drive lugs in relation to the advance and impulse spark positions varies according to the specifications of different engine manufacturers. Two practices, opposites in method, are commonly used in determining these spark positions:

(a) SAE standards have attempted to establish the method by which the impulse spark always occurs when the coupling drive lugs reach the horizontal centerline (Figure 112), the position of the advance spark then being at a point preceding the horizontal by the specified lag angle degrees.

(b) In the second method the advance spark position is fixed at an arbitrary point (for example, 30° before the horizontal as in Figure 113), the impulse spark positions then following this point by the specified lag angle degrees.

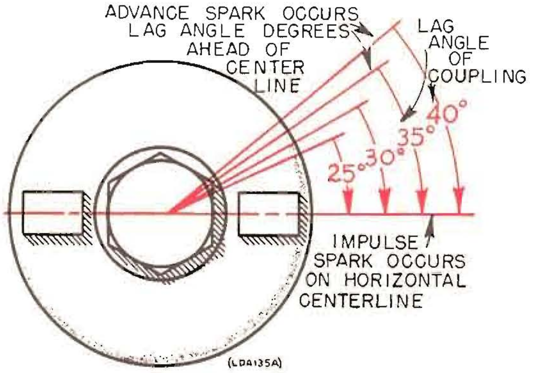

Figure 112—Impulse Spark on Horizontal Centerline

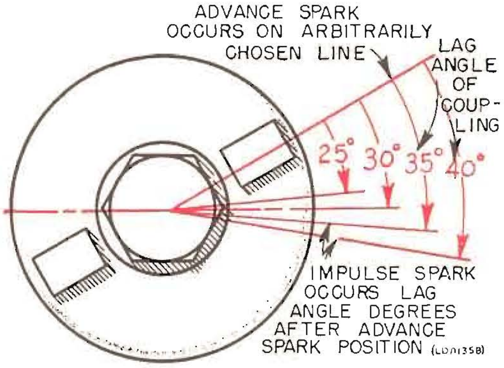

Figure 113—Location of Advance Spark Constant

REMOVAL OF IMPULSE COUPLING

In dismantling the impulse coupling assembly the first

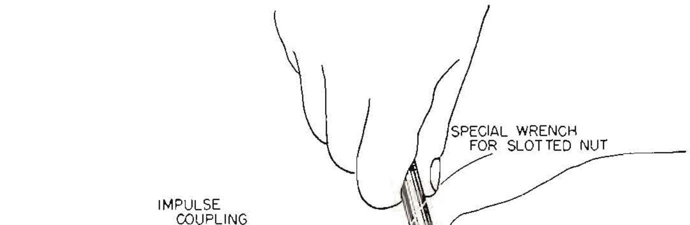

Figure 114—Removing Drive Gear Nut

operation is to remove the coupling nut. This nut is usually locked in place by means of a special washer or wire, which must be broken. The coupling must then be held stationary in order to turn the coupling nut off the shaft end. In some cases where a drive gear is assembled to the coupling shell, it is convenient to catch the gear in a vise (Figure 114), being careful not to injure the teeth of the gear, and then remove the coupling nut with a wrench. A special slotted wrench can be obtained to hold the drive lugs of completely enclosed couplings (Figure 115) while turning off the coupling nut.

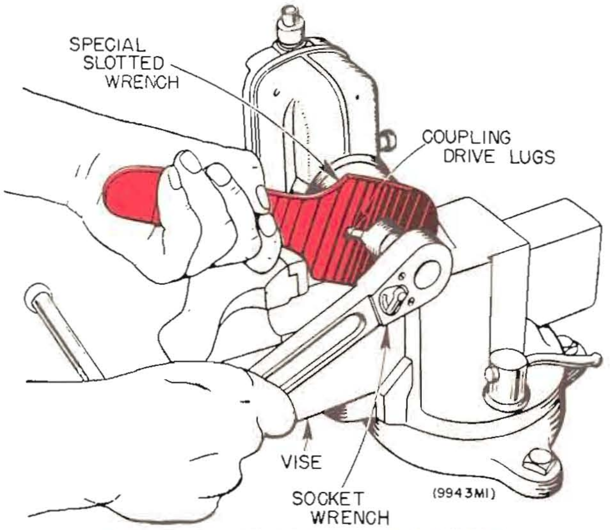

Figure 115—Removing Coupling Nut

To disengage the coupling shell, one of the drive lugs of the shell should be grasped firmly with a pair of pliers, and the shell turned and pulled at the same time (Figure 116) until the drive spring releases. Do not try to force the shell to separate itself entirely from the assembly; the drive spring should first be pried out of its anchor slot by means of a screwdriver.

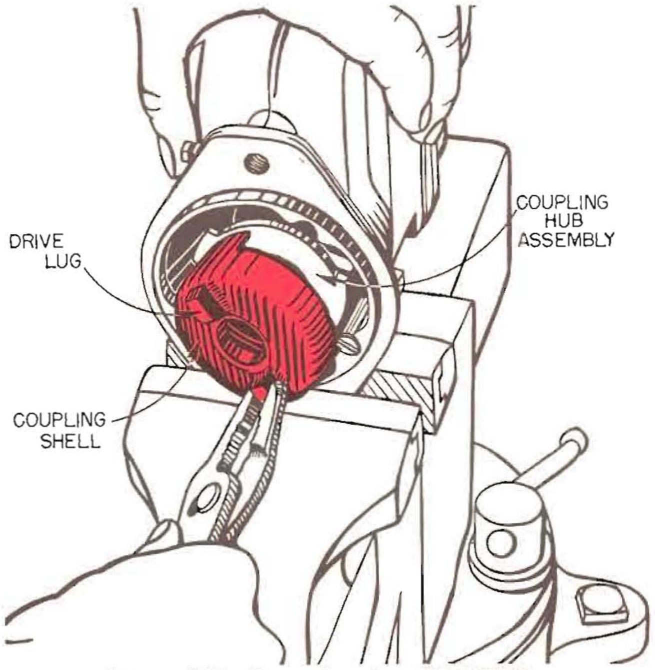

Figure 116—Removing Coupling Shell

A puller should be used to remove the impulse hub from the rotor shaft, since it is keyed and pulled down tightly on the taper shaft. In using the puller (Figure 117) care should be taken not to damage the end of the rotor shaft by excessive tightening of the puller screw.

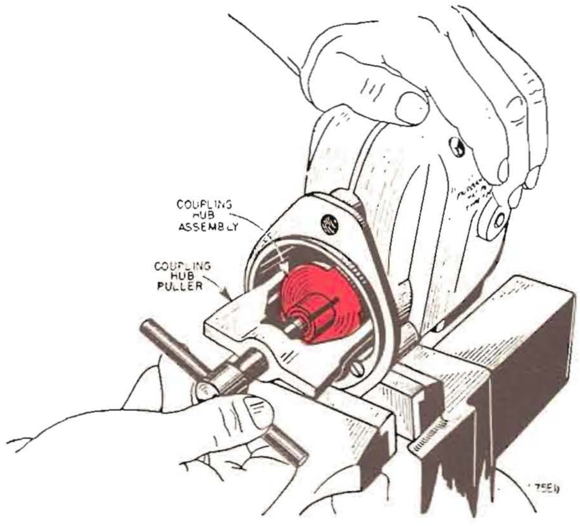

Figure 117—Pulling Coupling Hub

REASSEMBLY OF IMPULSE COUPLING

The first step in the reassembly of the impulse coupling is to insert the drive spring in the coupling shell. Before this can be done the rotation of the coupling unit must be definitely ascertained, since the drive spring must be wound in accordance (Figure 118).

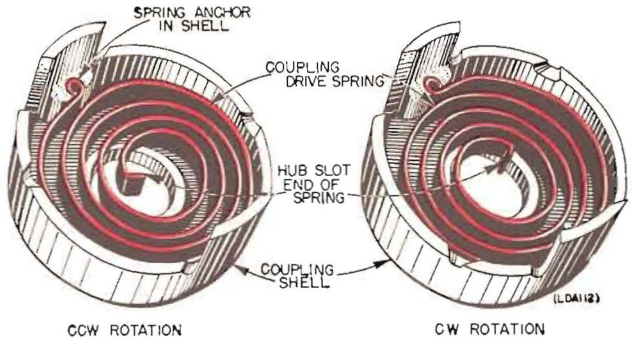

Figure 118—Location of Coupling Spring in Shell

With one end of the drive spring anchored in the shell, the coupling hub assembly should be fitted to its opposite end and the hub turned until the spring is wound sufficiently, then pushed into its final position. The turns necessary to wind the coupling drive spring vary with different types and the manufacturer's specifications must be followed closely.

To replace the coupling on the magneto, the key must first be inserted in the shaft, after which the coupling can be placed in position and tightened down on the shaft by turning the coupling nut.