SECTION EIGHT

MAGNETO SERVICE PRACTICES

MAGNETO SERVICE

Since a magneto is a precision type instrument, it should be serviced by expert technicians who are thoroughly familiar with this kind of work. Major overhauls should be undertaken only under suitable shop conditions, where the special tools and equipment specified by the various manufacturers are at hand.

A complete service routine applicable to each of the many makes and models of magnetos encountered in the field cannot, of course, be established, but an attempt is made to set up a general outline of service work. The procedures described should serve as a foundation for the specific service instructions issued by the individual magneto manufacturers.

As a whole, magneto adjustments and repairs can be classified in two groups: field service and shop service.

MAGNETO FIELD SERVICE

The prime requisite of field service work is that the make and model of the magneto be completely and accurately known before going out on the job. Service Stations who use a card file of magneto installations in their territory, together with a record of service work performed to date (Figure 119), find their field service work considerably simplified. If only the tractor or engine model is known, some idea of the application can be gained by referring to **Application 1-4**— Replacement Information—in the Fairbanks Morse Service Manual.

Field service work should be limited to spark tests, adjustments and minor repairs. Such work can be done by the operator of the engine, provided careful attention is given the directions accompanying the magneto.

TESTING THE IGNITION SPARK

The ignition spark can be tested in several ways, but it should be remembered that a spark produced within an engine cylinder with the fuel mixture compressed is not identical to a spark produced by the same equipment in open air.

Probably the best field test of ignition spark strength is provided when a short air gap is added to the standard gap of the spark plug and then making the ignition spark jump both gaps. This test must be made while the engine is operating, but it is quite easily accomplished by holding the end of each high tension cable in turn about 1/16″ away from its spark plug terminal. If the spark plug continues to fire in the cylinder, the strength of the ignition spark can be assumed sufficient. Unless the spark plugs are in good condition, an ignition spark test such as this is of little value.

(LDA120)

THE MAGNETO SUPER-SERVICE STATION

NAME *Henry Smith* PHONE *1437-R-8*

ADDRESS *RR #4 Rockton (3 mi. east on Highway #72)*

APPLICATION *Mpls. Moline Universal "V" tractor (1960)*

MAGNETO MFR. *Fairbanks Morse* MAGNETO MODEL *FMZ4B4*

PURCHASED FROM *Rock County Impl.* WHEN *11-1-60* SERIAL NO. *4130639*

MAGNETO SERVICE RECORD

DATE	BRKR. PTS.	COIL	CONDENSER	OVERHAUL	OTHER WORK	CONDITION	CHARGES
3-1-61	ok	ok	ok	✓	✓	Excellent	$2.00
2-1-62	new	ok	new	no	no	Good	7.00
6-10-63	ok	ok	new	no	Cleaning	Good	3.00
4-20-64	new	new	new	yes	✓	Good	15.00
7-12-65	ok	ok	ok	no	Oil Slinger	Good	2.00

Figure 119—Card Record of Magneto Service Work

TESTING THE MAGNETO SPARK

Remove the high tension cables from the magneto outlets and insert a short piece of stiff wire in one of the outlets. Bend this wire to within ⅛″ of the engine block. Crank the engine slowly and watch carefully for the spark discharge which should occur at the instant the impulse coupling releases. Several turns may be necessary before the impulse spark for the particular outlet under test is located. The test should then be repeated for each of the remaining terminals. If a strong spark is observed at each terminal, no dismantling of the magneto should be begun until cables, spark plugs and terminals have again been thoroughly inspected.

If no spark is observed, a careful examination of the ground switch and ground cable should be made as the first step towards locating the difficulty.

CARBON BRUSHES

In opening the magneto without removing it from the engine, the distributor end cap or cover is usually taken off first, permitting examination of the carbon brushes. These brushes should move freely in their holders and should exert a slight spring pressure when depressed. Remove the brushes and clean the brush holder sockets. Irregularly-worn or "stuck" brushes should be discarded and new brushes installed. It should be noted that nearly all multi-cylinder, jump-spark distribution magnetos have a single brush connection from the coil to the center of the distributor rotor. This brush should receive the same attention as that given distributor brushes.

FIELD SERVICE OF BREAKER POINTS

After the end cap has been removed from the magneto unit, the breaker point assembly is ordinarily easily accessible for cleaning and adjustment. The contact surfaces should be examined carefully and, if there are evidences of pitting or pyramiding, a small tungsten file or fine stone should be used to recondition the surfaces. It is considered highly advisable to remove the points from the magneto assembly and hold them in a vise during the resurfacing operation. Breaker points should be cleaned with a petroleum solvent, using a small brush such as a toothbrush. Oil and grease of any kind must be kept away from the points.

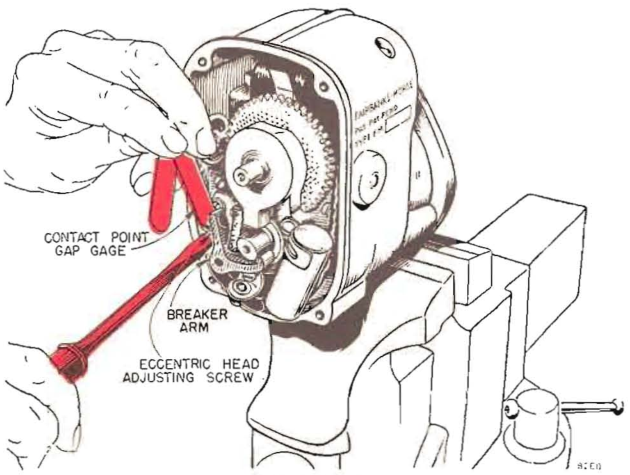


Figure 120—Adjusting Breaker Points

In cases where the contact surfaces cannot be renewed satisfactorily, or when there appears to be excessive wear of the breaker arm rubbing block, the breaker point assembly should be replaced by an entire new set. Improper functioning of the breaker arm actuating spring, a loose fit or any indication of binding at the pivot bearing are other reasons for complete replacement.

The recommended contact point gap must be ascertained from the magneto manufacturer's specification, and the points should be adjusted to within approximately ± .001″ of this figure. An accurate feeler gauge should be at hand and should be used carefully (Figure 120) in determining the point separation. The value given for the contact point opening is defined as the separation of the contact surfaces while the rubbing block of the breaker arm rides one of the high points of its actuating cam.

FIELD LUBRICATION

Magnetos are lubricated independently of the engine and as a result have often been neglected in the field. This condition has led to the development of permanently-lubricated designs in which sufficient lubricant for the life of the unit is placed in the bearings or bearing reservoirs during the original assembly at the factory. The lubricants used in such cases are usually special greases of a consistency suitable for operation through a wide temperature range. No field lubrication of magnetos of this type is necessary or advisable.

Other magneto models require the periodic addition of a light, highly-refined lubricating oil, but special care should be exercised not to over-lubricate the unit. The instructions found on the oiling plate should be followed closely insofar as quantity, grade and frequency of lubrication are concerned.

Whenever replacement of the breaker contact points is made, the small cam wick should be replaced. It is not considered good practice to oil or grease a wick such as this, since great difficulty is encountered in controlling the quantity of lubricant added as well as in matching the original impregnation.

SUBSTITUTION TESTS FOR COIL & CONDENSER

Urgent cases of magneto field service may necessitate the checking of the coil and condenser without dismounting the magneto from the engine. Since portable test equipment is rarely available, the substitution type of test must be used.

Assuming that a new, identical part is available, the questionable coil should be removed from the assembly and the new coil mounted in its place. If a test of the magneto spark then gives acceptable results, the original coil may be assumed to be at fault, although it should be retained and checked on standard test equipment at the next opportunity.

The condition of the condenser can be tested in a similar manner: dismount the questionable condenser from the magneto assembly and install in its place a new, identical condenser. Then test the magneto spark and, if satisfactory, return the original condenser to the Service Station for conclusive test.

IMPULSE COUPLING

Disconnect the ignition cables and crank the engine slowly. Listen carefully for the characteristic snap of the impulse coupling which occurs as each pawl releases. On most single cylinder four cycle engines the coupling impulses once each full revolution of the crankshaft, while on multi-cylinder four cycle engines there are two impulse actions per revolution of the crankshaft.

If no impulse snap can be distinguished, the magneto must be removed from the engine and the impulse coupling cleaned, repaired or replaced (See Section Seven).

Fairbanks-Morse recommendations concerning the lubrication of the impulse coupling consist in the addition of a small amount of FMCO11 grease to the drive spring.

SHOP SERVICE

The successful service station bases a large part of its business on a clean, well-equipped shop, conducted by expert technicians. A study of shop routine, working conditions and available equipment usually pays real dividends due to the improved methods adopted.

Probably the one factor which most affects shop work is the actual condition of the shop. Oil, grease, dirt and grime are the greatest contributing causes of magneto breakdowns; it is logical to assume that the place to begin eliminating such trouble is in the repair shop. Furthermore, a clean, orderly shop promotes systematic work and results in a fuller customer confidence in the work. Make sure that the service bench and its tools are clean, well-painted and in good order.

A work card (Figure 121) should be issued immediately for each magneto brought into the shop for service. The complete type designation, make, model and serial number of the magneto should be entered on the work card. The use of such a work card avoids confusion in identification, replacement parts used and labor charges.

ESSENTIAL SHOP EQUIPMENT

Specialized shop service for magnetos requires a combination of skilled personnel and suitable equipment. Because the amount of special equipment depends on the size of shop and on the territory it serves, no list of standard requirements can be arbitrarily established.

1(04/43)

MAGNETO WORK CARD

DATE 8-28-64 NO. 864

Mfr	Type	Serial No.	No. Cyl.	Application	Date Purchased	When Rec'd
Fairbanks Morse	FM2484	4130639	4	Mpls. Moline	3-62	8-64

Spark Test	Starting Speed	Idling Speed	Normal Speed
	OK	Misses	Misses

TEST & SERVICE RECORD

	Condition as Rec'd	Service Work Performed	Parts Used: Quantity	Part No.	Price	Labor Hours
Exterior	Coked	Removed dirt and grease	—	—	—	1/4
Interior	OK	—	—	—	—	—
Brushes	Worn	Replaced brushes	4	D2460B	0.85	1/4
Breaker Points	Worn	Replaced point set complete	1	P2437	3.00	1/4
Condenser	OK	—	—	—	—	—
Coil	OK	—	—	—	—	—
Impulse Coupling	OK	Cleaned and greased	-	-	—	1/4
Distributor Rotor	Tracks	Resurfaced distributor disc	—	-	—	1/4
Bearings	OK	—	-	-	-	—
					3.85	1 1/4

Customer John Smith

Address RR #4 Minot, N. Dakota

Labor Charge $7.50

Cost of Parts 3.85

Total 11.35

Figure 121—Shop Card for Magneto Repair Work

It seems reasonable, however, to expect every service station to be equipped with reliable coil and condenser testers, and to have some arrangement for driving the magneto so that the ignition spark produced can be tested on a standard spark gap. Provision should be made for slow speed tests, during which impulse coupling action may be observed as well as for tests at normal speeds. Possibly only service stations with a large volume of magneto repair business will find the synchroscope a worthwhile investment, but its convenience, accuracy and general usefulness should not be underestimated.

Tools for magneto repair work should be chosen very carefully, since it is highly important that they be suitable for such use. Bearing replacement tools in particular are important because the quality of the work performed is directly dependent upon the tools used. A substantial arbor press or screw type press is essential in bearing replacement procedures.

While the new Alnico magnets used in most modern magnetos rarely require recharging, the chromium, cobalt and tungsten magnets of older design magnetos often can be remagnetized with good results. The special equipment of most service stations includes a magnet charger of some kind.

PRELIMINARY CLEANING

When a magneto is brought into the shop, the first actual step in any service work should be a complete and thorough cleaning of its entire exterior. Use compressed air, a wire brush and a suitable petroleum solvent to remove completely the accumulated sludge.

PRELIMINARY TESTS

After exterior cleaning has been completed the magneto should be mounted on the test block and the rotor turned over slowly by hand. If there is a noticeable binding or rubbing action, no further rotative testing should be undertaken before dismantling, since such a condition indicates badly worn bearings, or a damaged distributor or breaker contact assembly. The pull due to the magnetic break which occurs during rotation should not be confused with binding.

If the rotor turns freely (except for the magnetic break), the testing should be continued, the rotative speed being stepped up to about 100 rpm. Observation of the impulse coupling action can usually be made at this speed, although it may be desirable to reduce the speed in cases where there are a number of engagements per revolution. Provision should also be made to increase the speed to the point where engagement no longer takes place in order to determine the cutout speed of the coupling.

The cable outlets of the magneto should be connected to individual spark gaps and observation made of the spark produced each time the impulse coupling releases. The rotative speed should be roughly comparable to the starting speed of the engine. If no sparks occur across the spark gaps or if there are misses or the spark quality is weak, notation should be made on the work card so that steps can be taken to correct this difficulty.

The rotative speed of the magneto should be increased just beyond the point where the impulse coupling cuts out completely and the spark produced again carefully inspected. The speed of this test should correspond approximately to the idling speed of the engine. A record of results should be kept on the work card.

A third spark test should be made at the normal operating speed of the engine and observations again tabulated. During this test the primary ground switch should also be closed to check its effect on the ignition spark.

CLEANING BREAKER POINTS

The use of a small, stiff brush such as a toothbrush, moistened with a petroleum solvent, provides the most suitable means of cleaning the breaker points. The assembly should be completely removed from the magneto before cleaning is begun. Special care should be taken to keep the breaker points entirely free from oil, lint or dust. In cleaning the breaker arm the fulcrum pin bearing hole should receive special attention and the fulcrum pin, mounted on the breaker plate, should also be polished.

BREAKER POINT ASSEMBLY WEAR

Long, continued use of a magneto produces signs of wear on the breaker arm rubbing block and possibly at the point of pivot. Wear of the rubbing block has an important effect on the operation of the magneto since the point at which the contact points open must come at the time the maximum magnetic flux lines are being cut. Examination of the rubbing block will usually establish an idea of the amount of wear which has occurred; excessive wear is often indicated when the contour of the rubbing block matches that of the cam. A worn breaker arm rubbing block is also indicated when it is impossible to make the specified edge gap adjustment. Excessive wear of the breaker arm pivot is indicated when the pin fits so loosely that point action is erratic. In either case, replacement of the assembly is necessary.

EDGE GAP ADJUSTMENT

In the analysis of the operation of rotary magnetos (Section Five) it has been explained that the maximum ignition spark discharge is obtained by interrupting the primary circuit at the instant the primary current reaches its maximum value. Since the current in the primary circuit is proportional to the rate of flux change in the magnetic circuit, maximum current occurs at the point the polarity of the magnetic circuit is reversed.

The location of the point at which maximum primary current is obtained can be determined electrically, at which time the actual distance between the edge of the

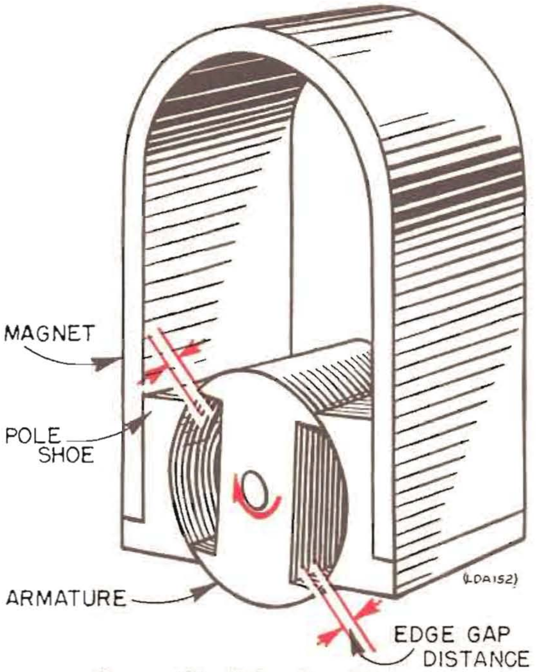


Figure 122—Edge Gap Distance

rotor laminations and the edge of the pole shoe laminations can be measured (Figure 122). For magnetos requiring such an adjustment this distance is usually specified as the "edge distance" in servicing instructions and special gauges are often available for convenience in its measurement.

With the edge distance measured and the rotor held in this position, the breaker points must be adjusted so that they are just beginning to open. The check which this gives on the proper functioning of the breaker points is important; if long periods of use have resulted in unbalanced wear of the contact surfaces and the rubbing block, a condition may have been reached where the points cannot be adjusted to open when the rotor is set at the correct edge distance. In such a case the breaker point set must be replaced.

Edge gap adjustment is of particular importance in many of the older design magnetos where the strength of the magnetic circuit is low in comparison with more recent models equipped with Alnico magnets.

MAGNETO BEARINGS

Field performance of magnetos and other similar units is highly dependent upon the design and construction of the bearings used. The three general types of bearings used are the ball bearing (Figure 123), sleeve bearing (Figure 133) and needle (or roller) bearing (Figure 135).

Since the magneto rotor must turn with a very small and uniform air gap between its laminations and those of the frame, the construction of its supporting members is of primary importance. Rotor bearings must be able to handle a certain amount of axial thrust caused by the engine drive as well as a certain amount of pounding which results from impulse coupling action.

The bearing support for the distributor shaft and gear assembly must provide uniform operation, since a definite spark gap must be maintained at all times between the distributor rotor and the end cap spark posts or, in the case of brush-distributor units, must provide a smooth operating surface for the brushes.

Other bearing surfaces in a magneto are located at the pivot point of the moving breaker point arm, at the pivot point of the impulse coupling pawls and along the center of the coupling hub where the shell moves in relation to the hub during impulse action.

BALL BEARINGS

Ball bearings are widely used in magnetos to support the armature or magnetic rotor, and are sometimes used to mount the distributor shaft. The chief advantages of the ball bearings are their long life, self-alignment, ability to withstand shock and thrust, and freedom from lubrication difficulties. Both oil and grease-lubricated ball bearings are available, the grease-lubricated type being almost universally used in magneto construction because further lubrication, except during complete overhauls, is unnecessary.

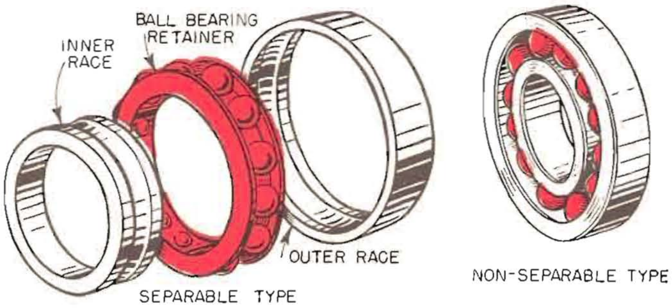


Figure 123—Ball Bearings

There are two general types of ball bearings which have been extensively used in the manufacture of magnetos. These are the open (separable) design and the non-separable design. The separable type ball bearing (Figure 123) consists of an inner race, a ball retainer with balls and an outer race. The fact that such a bearing can be pulled apart provides simplified dismantling of the magneto assembly, but difficulty is sometimes encountered in removing and replacing the races. Separable type ball bearings must always be used in pairs, faced opposite each other, in order to withstand axial thrust. The non-separable type ball bearing (Figure 123) is a one-piece assembly and must be so mounted and removed. Its advantage over the separable type lies in its ability to absorb a considerable thrust in either direction, making it possible to use such a bearing singly.

CLEANING BALL BEARINGS

It is much easier to prevent dirt from entering a ball bearing than it is to clean the dirt out. In cleaning ball bearings a perfectly clean surface should be provided on which to work.

Use a suitable petroleum solvent, such as Stoddard solvent, in a clean container. Swish the bearings in the cleaning fluid and finally revolve by hand while submerged. Compressed air, if absolutely free of dust or moisture, can be used to complete the cleaning.

RELUBRICATING BALL BEARINGS

After removing the ball bearing from the cleaning fluid, it should be immersed in a clean, light oil and spun until the solvent has been removed. Grease-lubricated bearings should then be repacked; the quantity of grease used should not exceed 1/3 to 1/2 of the total capacity of the bearing. Too much grease is a common cause of bearing failure due to overheating. *Fairbanks Morse recommendations specify 1C9 Ball Bearing Grease as particularly suitable for magneto bearings.*

REPLACEMENT OF BALL BEARINGS

Replacement of ball bearings is largely a matter of having the proper tools for the particular job. If ball bearing work is performed using makeshift tools, the possibility is very great that the bearings will be ruined insofar as further use is concerned. In general ball bearings are removed and replaced by either pulling or pressing; damage is likely to result from pounding or prying.

In replacing separable type ball bearings, the inner race must be pulled from the rotor shaft (Figure 124).

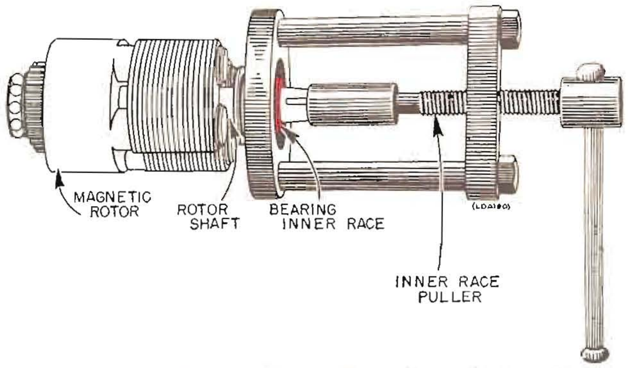


Figure 124—Pulling Inner Race from Rotor Shaft

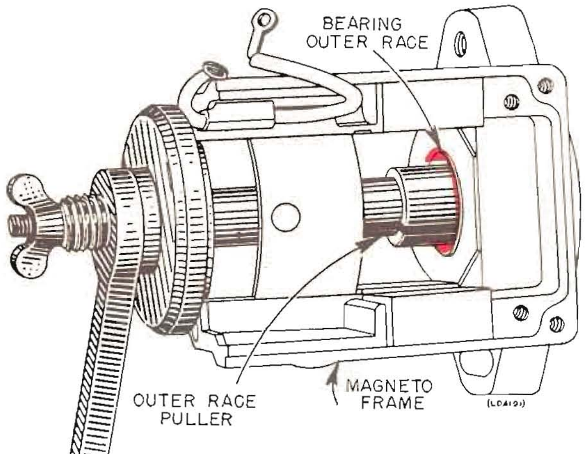


Figure 125—Pulling Outer Race from Frame

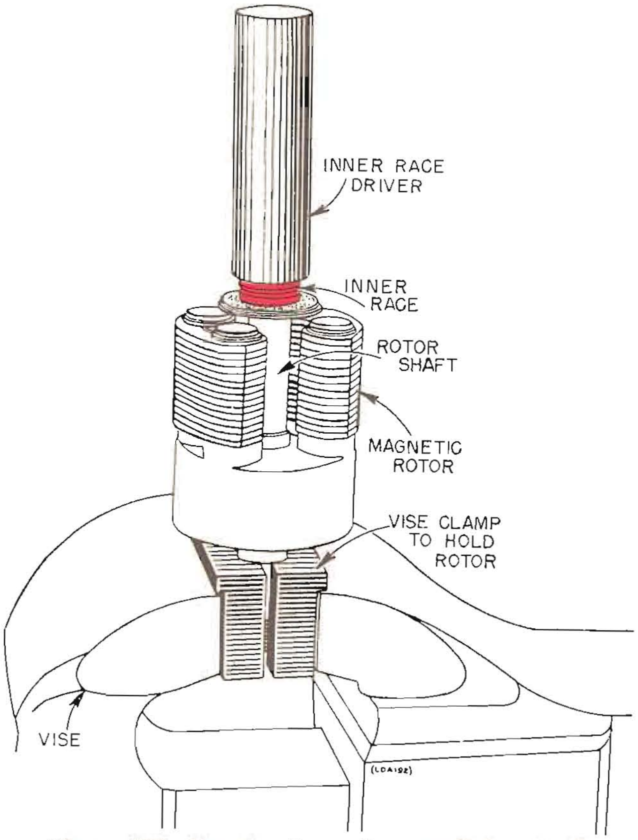


Figure 126—Pressing Inner Race on Rotor Shaft

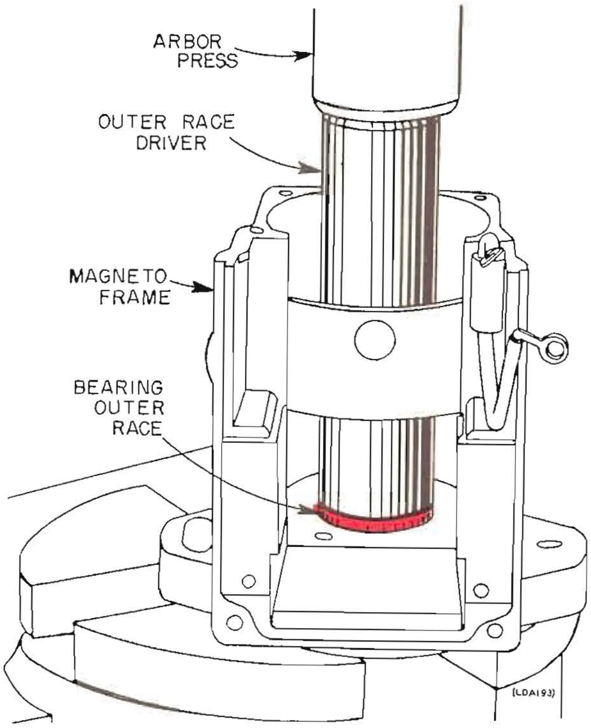


Figure 127—Pressing Outer Race into Frame

while the outer race must be pulled out of the frame recess (Figure 125). When reassembly is made, the inner race must be pressed on the rotor shaft (Figure 126), while the outer race is pressed into the frame recess (Figure 127). Wide variations in procedure are necessary according to the bearing support design.

In replacing non-separable type ball bearings, the rotor must first be unlocked by releasing the snap ring (Figure 128), then pressed out of the bearing (Figure 129). The snap ring holding the bearing in place must be released before the bearing can be pressed out of the frame recess

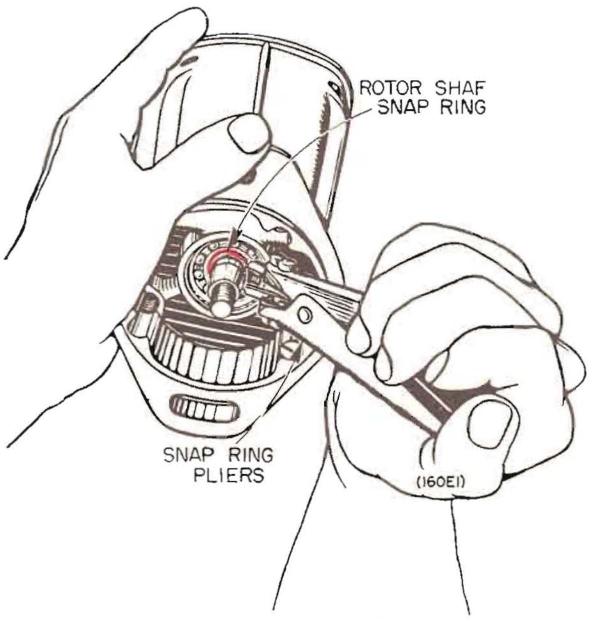


Figure 128—Removing Rotor Shaft Snap Ring

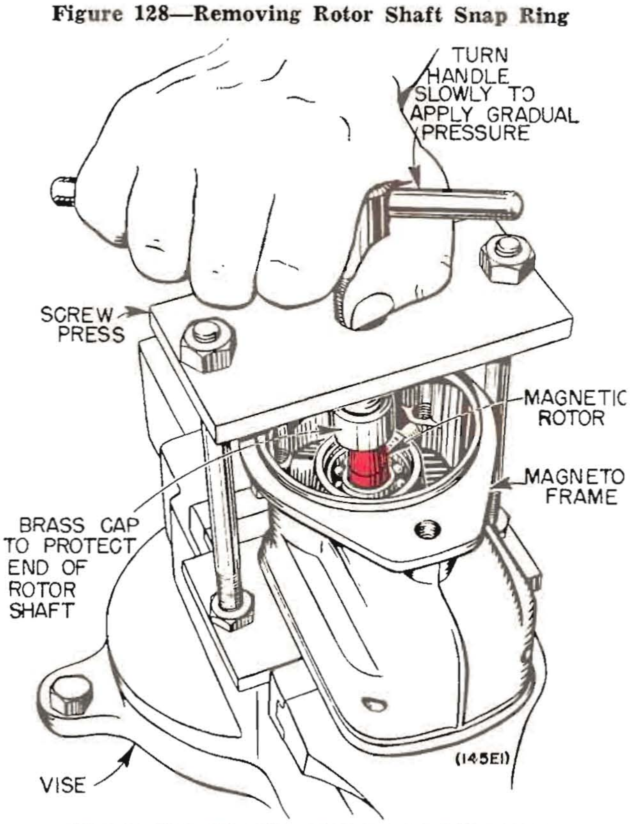


Figure 129—Pressing Rotor out of Bearing

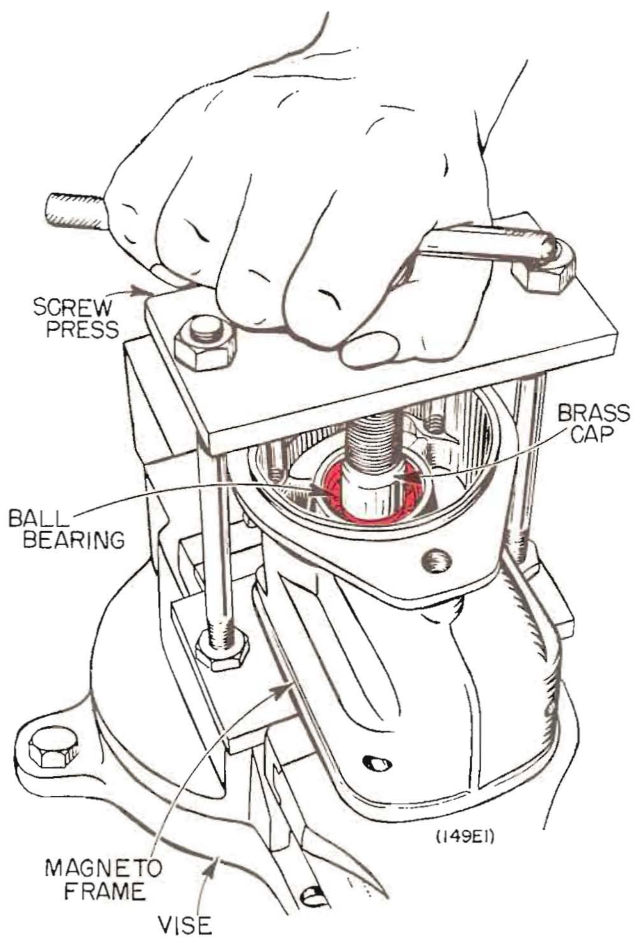


Figure 130—Pressing Ball Bearing out of Frame

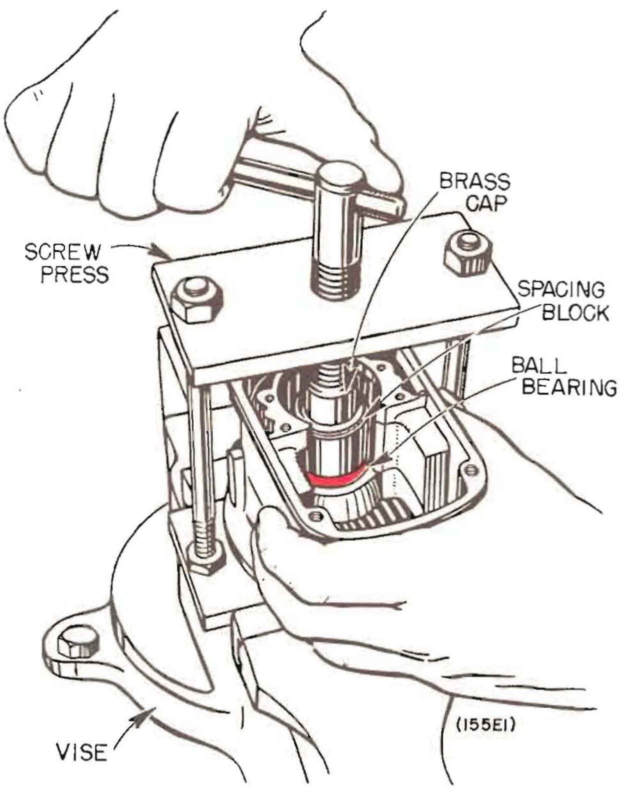


Figure 131—Pressing Ball Bearing into Frame

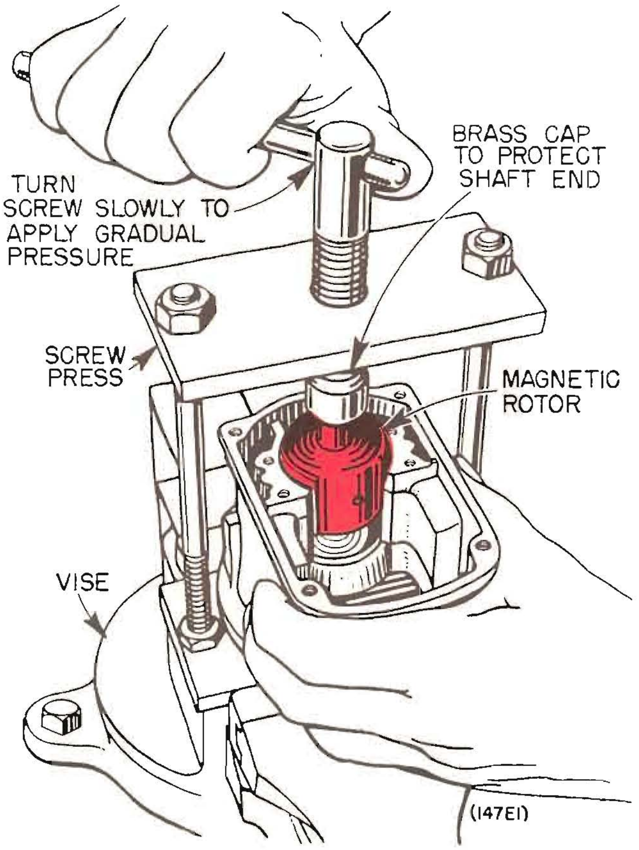


Figure 132—Replacing Rotor in Ball Bearing

(Figure 130). In reassembly the bearing is first pressed into the frame (Figure 131) and locked in place, then the rotor is pressed into the bearing (Figure 132) and locked in place.

Correct procedure for pressing or pulling one-piece ball bearings is to exert the pressure on the binding race in order that force does not have to be transferred from one race to the other across the balls.

SLEEVE BEARINGS

In a carefully designed magneto unit, sleeve type bearings (Figure 133) provide highly satisfactory service at comparatively low cost. Sleeve bearings are compact,

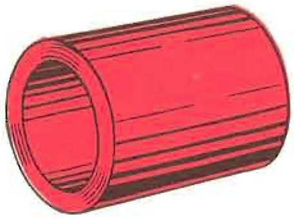


Figure 133—Sleeve Type Bearing

easy to replace and have an exceptionally long life under suitable operating conditions. The lubrication of sleeve type bearings has been greatly simplified through the recent development of the porous "metal sponge" type bearing materials. Bearings made of such a material, as for example Oilite, are factory-impregnated with lubricating oil, which greatly increases their length of service without the necessity of field lubrication. The porous nature of the bearing material also makes it possible to provide an additional lubricant reservoir in the bearing housing which functions to replenish any oil lost during operation.

REPLACEMENT OF SLEEVE BEARINGS

Removal of sleeve type bearings is usually accomplished by inserting a sizing tool of the proper diameter in the bearing and pressing both the tool and bearing through the bearing support (Figure 134). The diameter of the shoulder of the sizing tool must not be greater than the outside diameter of the bearing. If the sleeve bearing is located in a blind hole, removal can be made by using a properly-sized pipe tap to grip the inside surface of the bearing.

Before a new bearing is pressed into the support all traces of former lubricants should be removed, especially if there is a lubricant supply groove in the bearing housing. Clean, fresh lubricant of the grade specified for the particular application should be used to replenish the reservoir.

To insert the new sleeve bearing, it should first be placed on the sizing plug, after which the assembly of tool and bearing should be centered on the hole in the support and pressed into place. Observe carefully the instructions covering each specific bearing, since the position of the bearing in its housing is often of considerable importance.

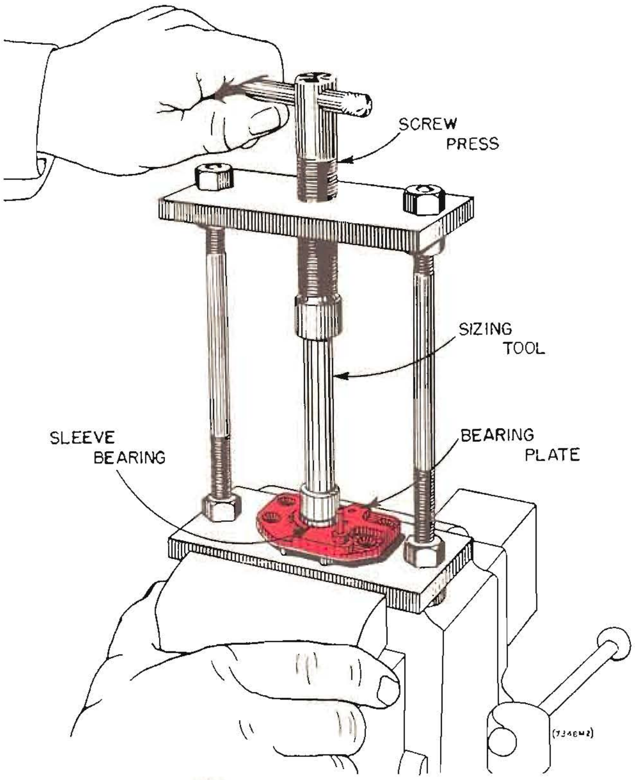


Figure 134—Replacing Sleeve Bearing

NEEDLE BEARINGS

Needle bearings (Figure 135) are actually small diameter roller bearings. The use of needle bearings is often advantageous because of their exceedingly small outside diameter in proportion to their load capacity. Relatively low in cost, needle bearings present certain additional problems in lubrication and service.

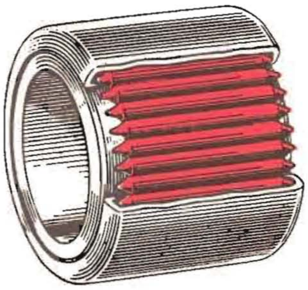


Figure 135—Needle Bearing

SERVICING DISTRIBUTOR ROTORS & DISCS

In many magneto models the distributor rotor or disc is tightly fitted to the end of the distributor shaft; after removing the pin which locks the rotor in position, two screwdrivers can be used to pry it off the shaft (Figure 136).

The working surface of distributor discs and rotors is originally given a very fine, smooth polish and refinishing in the field with sandpaper or emery cloth is extremely likely to mar this surface. As a result heavy carbon paths soon reappear, and the surfacing must be repeated.

Carbon deposits on the surface of the distributor can be loosened and removed, however, by wiping the sur-

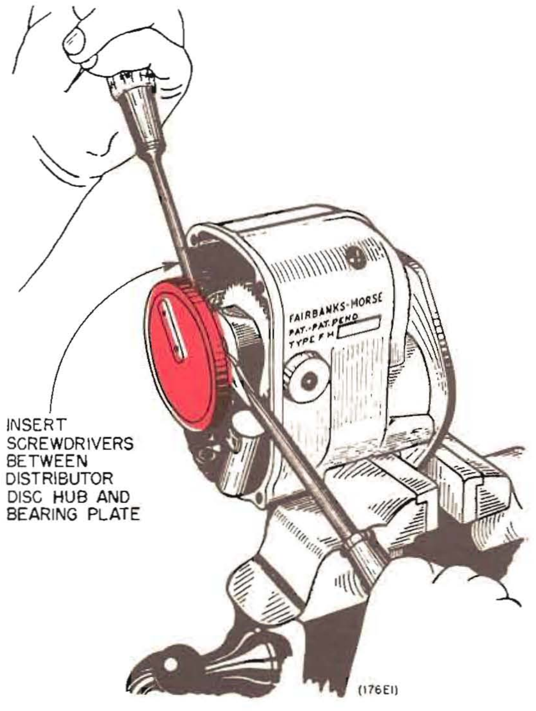


Figure 136—Removing Distributor Disc

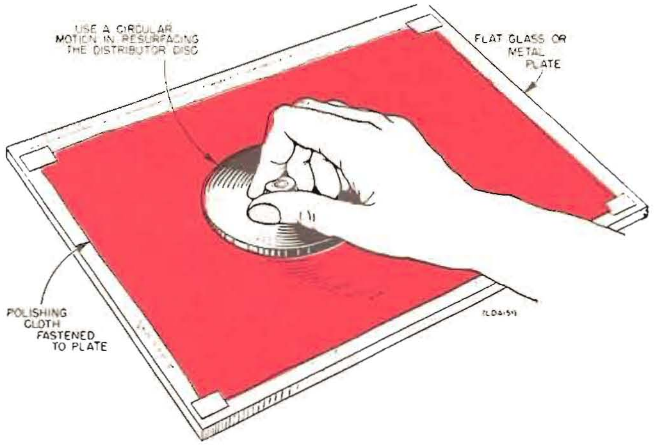


Figure 137—Resurfacing Distributor Disc

face with a clean, hard cloth, moistened in Stoddard solvent. It is also possible to smooth the surface by using a very fine polishing paper furnished by the factory, but such work should be undertaken with care and strictly according to instructions. In the case of drum rotors such as used in the Fairbanks-Morse Type RV, the part need not be removed from the magneto but should be rotated slowly with the polishing paper pressed to its surface. When resurfacing discs such as used in the Type FM (Figure 137), the polishing paper should be fastened to a flat surface, such as a piece of plate glass, and the disc moved with a circular motion on the polishing surface.

TIMING GEARS

Nearly all magnetos designed for multi-cylinder engines are built with a geared distributor assembly. On four cylinder engines where the magneto runs crankshaft speed, a 2 to 1 reduction gearing is used to cut the speed of the distributor to one complete revolution per two revolutions of the engine. On six cylinder engines where the magneto runs 1½ times crankshaft speed, a 3 to 1 reduction gearing is used to cut the speed of the distributor to one complete revolution per two revolutions of the engine.

The distributor electrode must move into the proper position to transfer the ignition spark to the correct spark post or brush each time the contact points begin to break. Any deviation from this position results in undesirable sparking or burning of the distributor contacts and of the breaker points.

To accomplish accurate timing the interlocking teeth of the distributor gear and the rotor pinion are marked, and care should always be taken in reassembling a dismantled magneto to be certain that the proper gear teeth are meshed. Common practice (Figure 138) is to mark a single tooth of the rotor pinion to be used for either rotation, while the distributor gear is marked in two places according to its use in a clockwise or counter-clockwise magneto.

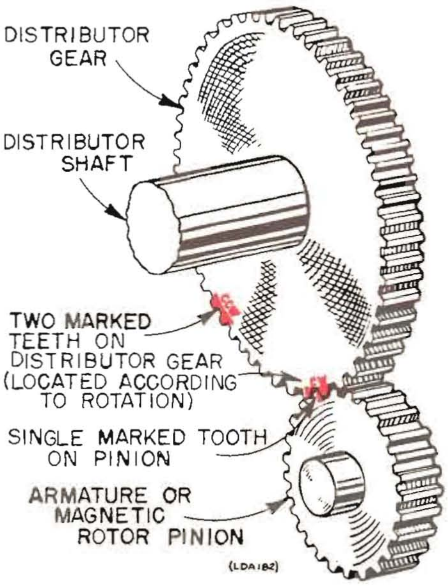


Figure 138—Meshing Distributor Gear Teeth

REMOVAL OF ROTOR PINION

The construction of certain magnetos makes it necessary that the rotor pinion be removed before service operations such as bearing or bearing plate replacement can be performed. The first step is to lift off the snap ring which locks the pinion to the rotor shaft; a special snap ring pliers (Figure 139) can be used to advantage. Careful prying with two large screwdrivers may separate the pinion from the rotor without damage, but it is recommended that a small puller (Figure 140) be used. Damage to the pinion is especially serious since it is almost certain to affect the distributor gear and thereby cause a complete magneto failure.

LEAKAGE PATHS

The high voltage surge of the secondary circuit occasionally establishes a path to ground by a different route than across the spark plug gap. Once such a path is established, the ignition spark is likely to continue to spark across to ground. Among the various causes of leakage paths are the following:

1. Broken cables or poor cable connections.
2. Too high engine compression.
3. Too wide a spark plug point gap.
4. Moisture, dirt, carbon or corrosion within the magneto.
5. Breakdown of air insulation within sealed units.

A surface leakage path can usually be located because of the burning effect the high voltage spark has on plastic or other insulating materials.

The first step in servicing units having one or more leakage paths is to remedy the condition which causes the high voltage spark to stray from its established circuit. The actual repair of the unit should be made very carefully, usually discarding any insulating parts which give evidence of high voltage flashover. Leakage paths may be cleaned from the surface of end caps and other similar pieces, but their subsequent use should be limited to temporary, emergency service. Smoothing off sharp edges or corners will also help prevent sparking across air gaps to ground.

CORROSION CAUSED BY OXIDATION

Continued high voltage arcing within a sealed magneto housing results in oxidation, a likely cause of complete failure. Interior corrosion is readily apparent once the unit is opened, since it causes a green discoloration of copper and brass parts (the ozone formed by the high voltage arc reacts with copper to form an oxide). A brown deposit is usually also found throughout the unit and there is sometimes some evidence of moisture condensation.

To eliminate oxidation, if the condition of the unit is noticed in time, the cause must first be located. There are several common causes:

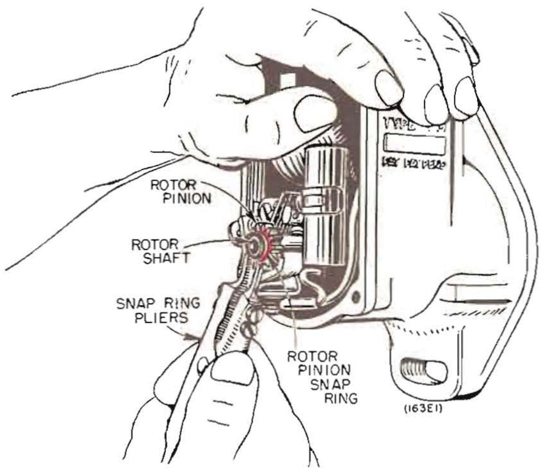


Figure 139—Removing Rotor Pinion Snap Ring

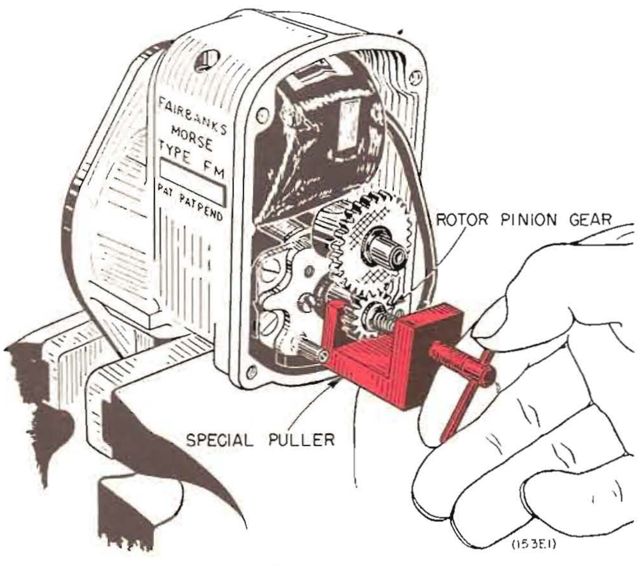


Figure 140—Pulling Rotor Pinion

1. A spark gap across a loose connection in the secondary (high voltage) circuit within the magneto.
2. High voltage arcing between coil and coil lead rod.
3. Carbon paths within the magneto.
4. Broken or sticking distributor brushes.
5. Inadequate ventilation of jump-spark magnetos.

OVERHAUL OF OXIDIZED UNITS

In most cases magnetos subjected to interior oxidation can be cleaned and put into satisfactory shape for re-use. The situation must first be very carefully analyzed so that the cause of the difficulty will not act to continue the trouble.

The magneto must be completely dismantled and each part cleaned individually. Bearings present an especially difficult problem since the lubricant is usually oxidized; in most cases it is advisable to discard the original bearing. In cleaning metal parts fine emery cloth may be used to advantage while rotors may be buffed, but parts so cleaned should be blown entirely free of dust particles with compressed air. All original brushes should be discarded and the brush holder sockets carefully cleaned. Where sticking brushes have been a result of the interior oxidation, attention should be given the surface of the distributor disc or rotor since it is possible that the face has been marred (See Par. Servicing Distributor Rotors & Discs). All gaskets, seals and washers should be replaced by new parts.

A close watch should be kept for indications of carbon paths on the bakelite parts. It is recommended that where there is evidence of flashover the part be discarded, since re-use is likely to result in further oxidation.

TESTING MAGNETO COILS

Conclusive coil tests can be made only through the use of reliable commercial coil tester (Figure 141). Simple circuit tests are of little value. It should also be noted that commercial battery ignition coil testers should not be used to test magneto coils unless provision is made for inserting a series resistor in the primary circuit in order to reduce the current to a suitable value.

The coil tester must check the primary and secondary windings for open circuits, shorts or high resistance. In addition the coil lead wire, its terminal and insulation should also be checked during this portion of the test.

One of the standard methods of determining coil efficiency (input to output) is to measure the amount of primary current which must be supplied in order to establish a standard spark discharge across the secondary terminals. The necessary primary current for individual coils varies, but if a tabulation of maximum values is at hand, coils requiring more than these established values can be assumed defective and discarded.

Coil testers usually provide for a heat test, which con-

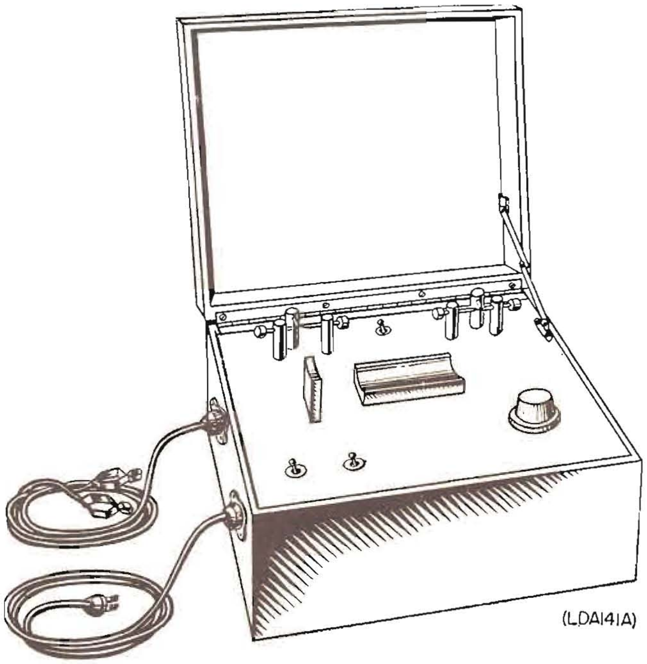


Figure 141—Commercial Coil Tester

sists of passing sufficient current through the primary winding to cause the coil to approach actual operating temperature, at which time tests are made to determine possible insulation breakdown.

A test of considerable importance, although infrequently performed, consists of connecting the coil for standard tests, then holding a grounded metal plate near the outside wrappings of the coil and watching closely for a leakage spark.

CONDENSER TESTING

A reliable condenser tester (Figure 142) is an essential part of a magneto service station's equipment. Makeshift devices seldom provide facilities for thorough testing.

Condensers should be tested for breakdown, leakage, capacitance and series resistance. Some testing instruments also provide for a test of the damping characteristic of the condenser.

While a direct-reading meter would show leakage and series resistance in ohms, most test instruments are furnished with a scale divided into a "GOOD" and a

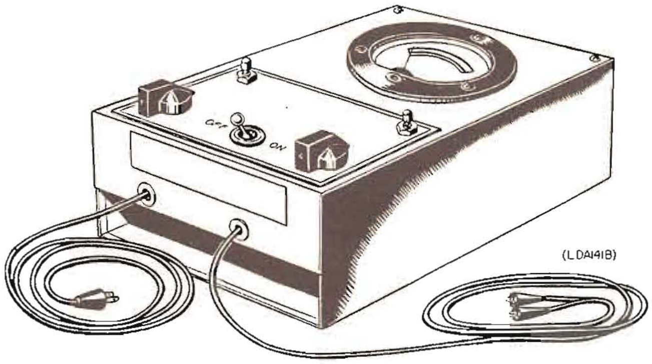


Figure 142—Commercial Condenser Tester

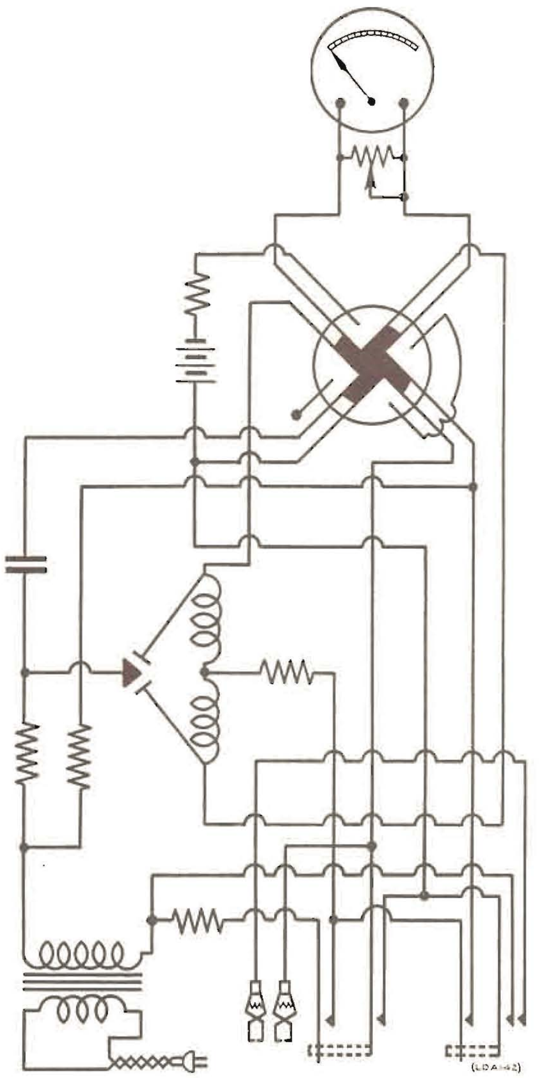


Figure 143—Condenser Tester Circuit Diagram

"DEFECTIVE" range. A calibrated scale, however, is necessary for capacitance tests, readings being made directly in microfarads.

Since it is both difficult and uneconomical to attempt to repair condensers, defective units should be destroyed. Limits for the capacitance test cannot be set for strict observance; it would seem that a 5% variation above or below the rated capacitance could serve as an approximate standard.

Condenser testers are basically an adaptation of an alternating current bridge circuit in which the capacitance of the condenser under test is balanced against that of a standard condenser. The circuit diagram of a representative tester (Figure 143) illustrates the intricate wiring necessary. Condenser testers are made to operate from 110 to 220 volt A.C. lines. This voltage is usually stepped up to provide 350 volts A.C. for capacitance tests, and stepped up and rectified to give 500 volts D.C. for breakdown tests.

MAGNET CHARGING

A magneto does not use up magnetism in producing ignition sparks. Other factors such as vibration, stray fields, temperature changes and ageing do, however, tend toward diminishing the strength of the permanent magnets, but the actual loss of magnetism varies widely with the magnetic steel used. The recently developed Alnico magnets retain their original magnetism to a remarkable degree and rarely require re-magnetization.

The technique and equipment necessary for efficient magnet recharging has been subject to extensive changes as the result of the introduction of Alnico magnets. The

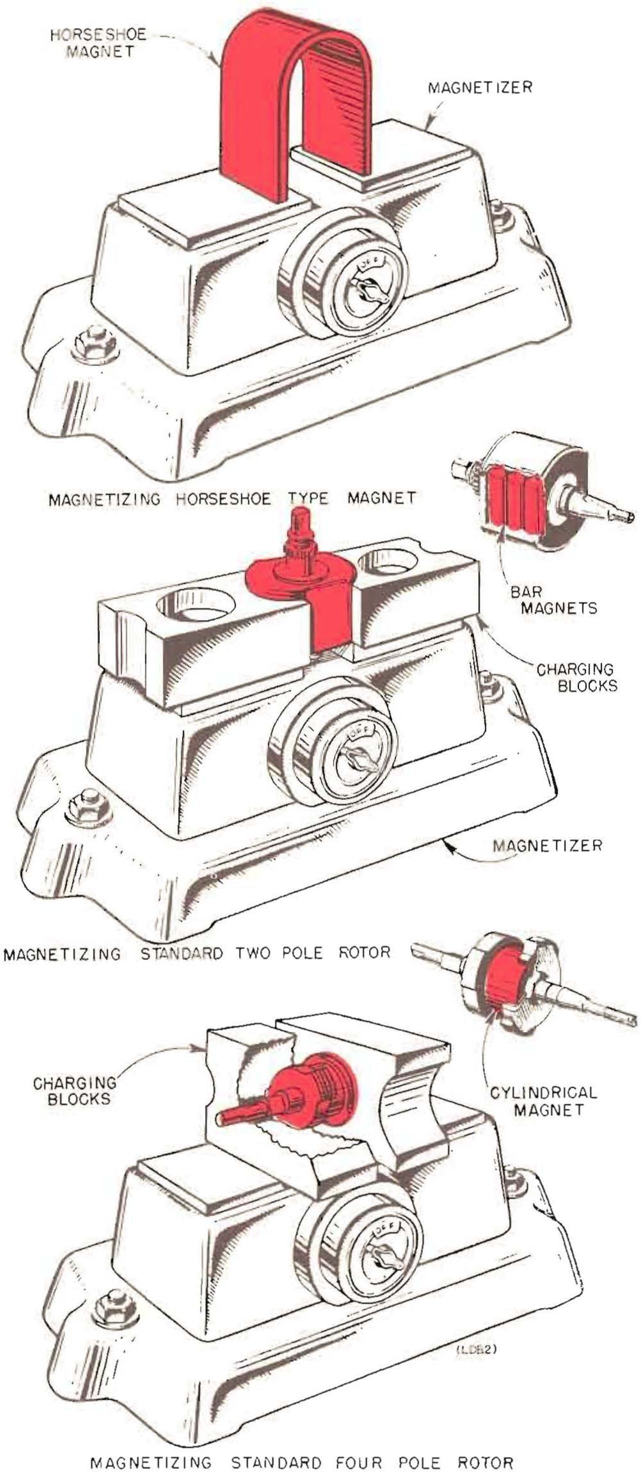


Figure 144—Magnetizing Procedures

old style horseshoe magnet made of tungsten, chromium or cobalt steel was easily and quickly re-magnetized by simply placing it in the proper position (Figure 144) on a magnet charger; in many cases it was not necessary to remove the magnet from the magneto frame. A different treatment is required in recharging magnetic rotors, especially those having Alnico magnets. Since it is of primary importance that all possible magnetizing force reach the rotor magnets, a short, efficient magnetic circuit must be established. This is possible only by removing the rotor from the magneto and placing it on the charger together with charging blocks of dead-soft iron. Note that the arrangements (Figure 144) are entirely different for two-pole and four-pole rotors.

In re-magnetizing rotors the polarities of the charger and rotor magnets should be carefully checked and unlike magnetic poles placed adjacent to each other. There is nothing to be gained through the tedious procedure involved in reversing the original polarity of the magnets.

THE SYNCHROSCOPE

The magneto testing instrument used at the factory and in many well-equipped service shops is the synchroscope. This device enables the serviceman to make a comprehensive check of the operation of both the magneto and the impulse coupling, as well as permitting accurate adjustment of the breaker point opening.

Synchroscope construction depends a good deal upon the power available. Since both clockwise and counterclockwise magnetos must be run at various speeds in order to secure complete test data, a variable speed, reversible source of power is necessary. If direct current electricity is available, these requirements are easily fulfilled by using a rheostat-controlled motor with a reversing switch (Figure 145). Synchroscopes for operation on alternating current power are often built with double-end drive motors in order to provide testing at either rotation, while a gear-reducer unit permits a selection of rotative speeds. A tachometer is usually mounted on the test board to indicate the test speed.

The synchroscope proper is a relatively simple arrangement of a metal pointer turning radially within a calibrated metal ring. The pointer is grounded to the synchroscope frame, thereby establishing an electrical connection to the magneto housing, while the calibrated ring is mounted on an insulating bracket, its electrical connection to the high tension outlets of the magneto being made through the spark test board.

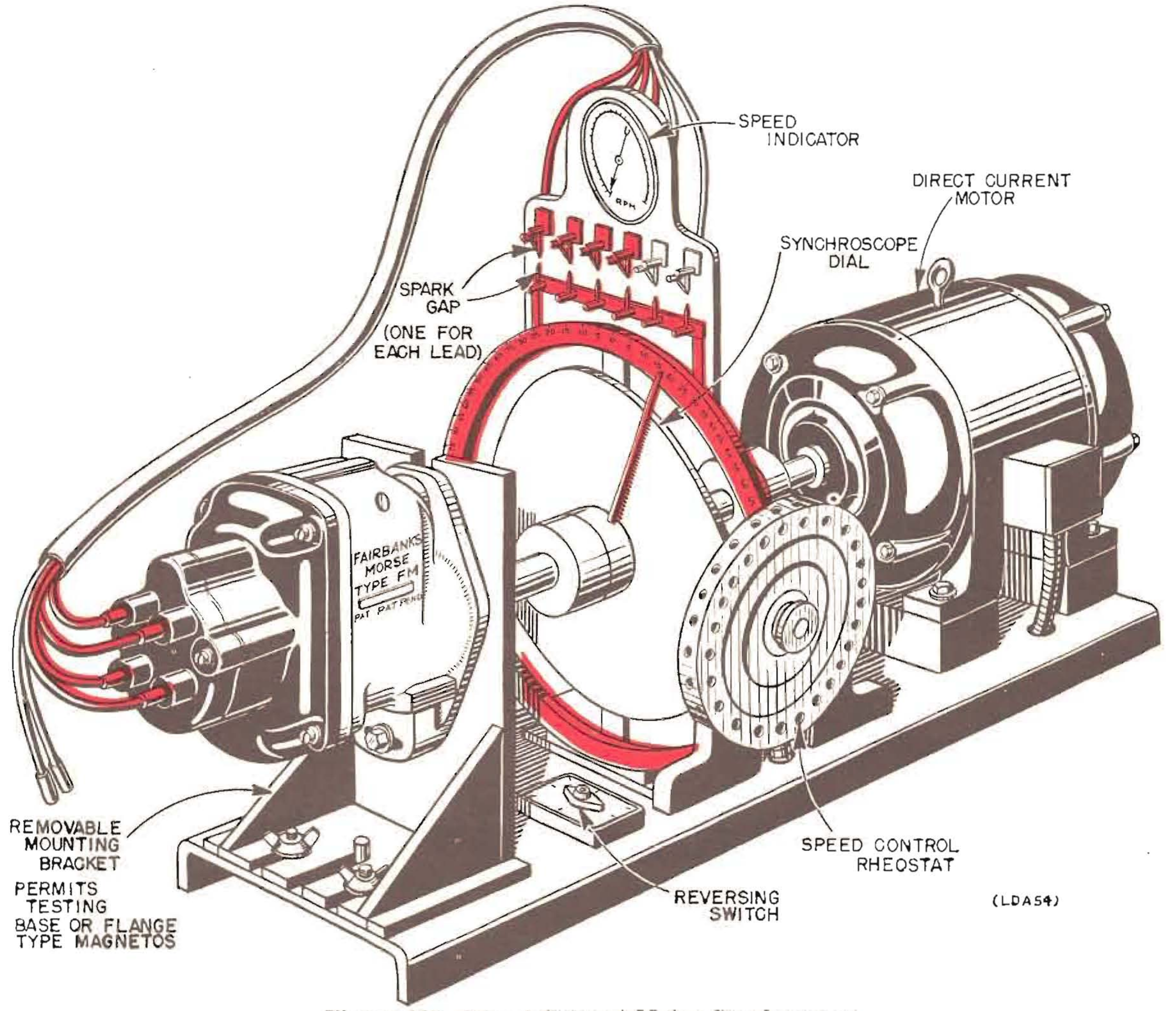


Figure 145—Direct Current Motor Synchroscope

The principle of operation of the synchroscope consists essentially in the fact that the ignition sparks produced by the magneto under test occur across the air gap which exists between the end of the pointer and the calibrated ring. Since the position of the pointer is definitely fixed in relation to the magneto rotor keyway, the angular sequence of the ignition sparks produced during rotation is indicated by the points along the ring at which they occur (solid pointer in Figure 146).

There are a number of important tests and adjustments which can be made quickly and accurately on the synchroscope. One of the most frequent operations consists of placing the magneto, without its impulse coupling, on the synchroscope stand and adjusting the breaker point gap until the ignition sparks occur at the exact points on the calibrated ring specified by the magneto manufacturer. Actually this adjustment is a more convenient and accurate method of setting the magneto for edge gap distance (See Page 52). The impulse coupling can then be assembled to the magneto and, if tested above the cut-in speed of the coupling, the location of the sparks on the ring will indicate the angular relation of the impulse coupling drive lugs to the magneto rotor keyway. Knowing the location of the running spark points on the calibrated ring, the synchroscope should be stopped and the drive shaft to the magneto turned slowly by hand permitting full impulse action. The points at which the impulse sparks occur indicate the amount of retard provided by the impulse coupling (dotted pointer in Figure 146). The mechanical operation of the impulse coupling can be checked by running the synchroscope at slow speed (50-100 r.p.m.), while the cutout speed of the coupling can be determined by gradually increasing the synchroscope speed to the point at which all coupling action ceases.

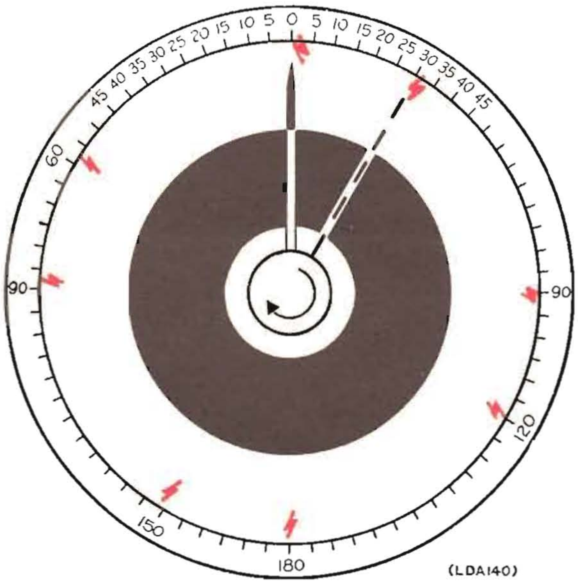


Figure 146—Synchroscope Dial

SPARK GAP ASSEMBLIES

Another essential item of magneto test equipment is an efficient, multiple spark gap assembly. There are many variations in the design of such apparatus, the simplest probably being the three-point unit construction (Figure 147) used by many service stations. Spark gap assemblies are usually built to provide for testing as many as four or six separate, consecutive ignition sparks.

In operation the single point spark post is connected to the magneto frame (ground), while the twin point terminal is connected to the high tension outlet of the magneto. The purpose of the static post and point is to dissipate the ionization which occurs in the vicinity of the spark points as a result of the electrical discharge. Ionization lowers the voltage required in bridging the spark gap and consequently causes an erratic spark.

Care should be taken to keep the spark gap assembly entirely free of oil, moisture and dust to avoid the possibility of damage due to high voltage leakage paths across the insulating base. The spark points, which are usually made of tungsten steel or monel metal, must be kept sharpened to needle fineness and adjusted precisely according to the requirements of the test. The width of the spark gap depends primarily upon the rotative speed of the test.

REPLACEMENT PARTS

Every service station should have an adequate stock of genuine replacement parts at hand. Replacement parts should never be removed from their containers until it is definitely determined that the part is necessary in the repair of the magneto. Reference should always be made to the repair parts list in the Service Manual to be certain that the part number is the one specified for the particular type magneto. Keeping parts in their original containers prevents the loss of their identity, as well as the damaged or shopworn appearance which often results when parts lie around on the service bench or shelf.

To build up an adequate replacement parts stock a service station must have some knowledge of the magneto applications existing in his territory. Such a survey can be made in a number of different ways as, for example, by direct post card inquiry to engine operators or by checking with local tractor and engine dealers.

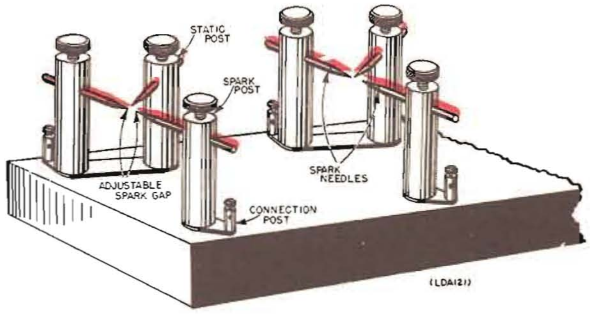


Figure 147—Three-Point Spark Gap Assembly

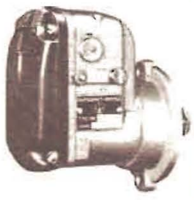
FAIRBANKS MORSE MAGNETOS

for Single Cylinder Engines

Type FM-X1A and FM-X1B

Type FM-X1A

The Type FM-X1 magnetos incorporate the latest in design and magnetic metal development. This type unit is ventilated to provide the necessary changes in air, yet is dust and moisture proof. The Type FM-X1 magnetos are available in SAE flange, SAE (45MM) base mounting, (35MM) base mounting for special applications and in standard or radio shielded versions. These magnetos are designed for the use of an impulse coupling and are permanently lubricated at the factory.



Type FM-X1B

for Medium Compression Engines

Type FM-X2B

TYPES FM-X2A & FM-X2B

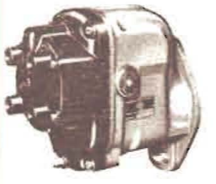
Of the gearless carbon-brush distributor design, Type FM-X2 magnetos have a spark interval of 180° and are suitable for use at crankshaft speed to two cycle engines, while at half crankshaft speed they are adaptable to four cycle engines with cranks at 360°. Type FM-X2 magnetos may also be used on engines firing 180 - 540° by allowing waste sparks to occur during the exhaust strokes.

TYPES. FM-X4A & FM-X4B

Type FM-X4 magnetos have established outstanding ignition standards for four cylinder tractor and industrial engines. The troublefree jump-spark distributor operates in a ventilated compartment separate from the sealed housing in which the magnetic rotor, coil and breaker points are contained. Construction is simple and sturdy in all details, assuring dependable service.

Type FM-X4B

for Tractor & Commercial Applications



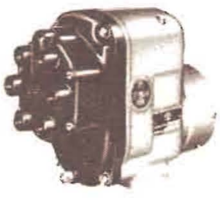
Type FM-XR4B

TYPES FM-XR4A & FM-XR4B

Larger and heavier than standard commercial units, Type FM-XR4 magnetos provide additional reliability. A separate, vented compartment is provided for the jump-spark distributor, while the breaker points, condenser, magnetic rotor, and bearings are housed in the main body of the unit, which may be vented or sealed according to operating conditions.

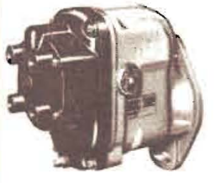
TYPES FM-XR6A & FM-XR6B

Similar to the Type FM-XR4 magnetos in design and construction, the Type FM-XR6 is recommended for six cylinder engines when additional reliability is required. Component parts are carefully made of the finest materials. Breaker points are long-lasting tungsten and are non-critical in adjustment. Dependable ignition is assured by painstaking design.



Type FM-XR6A

for Heavy Duty Service



Type FM-XOR4B

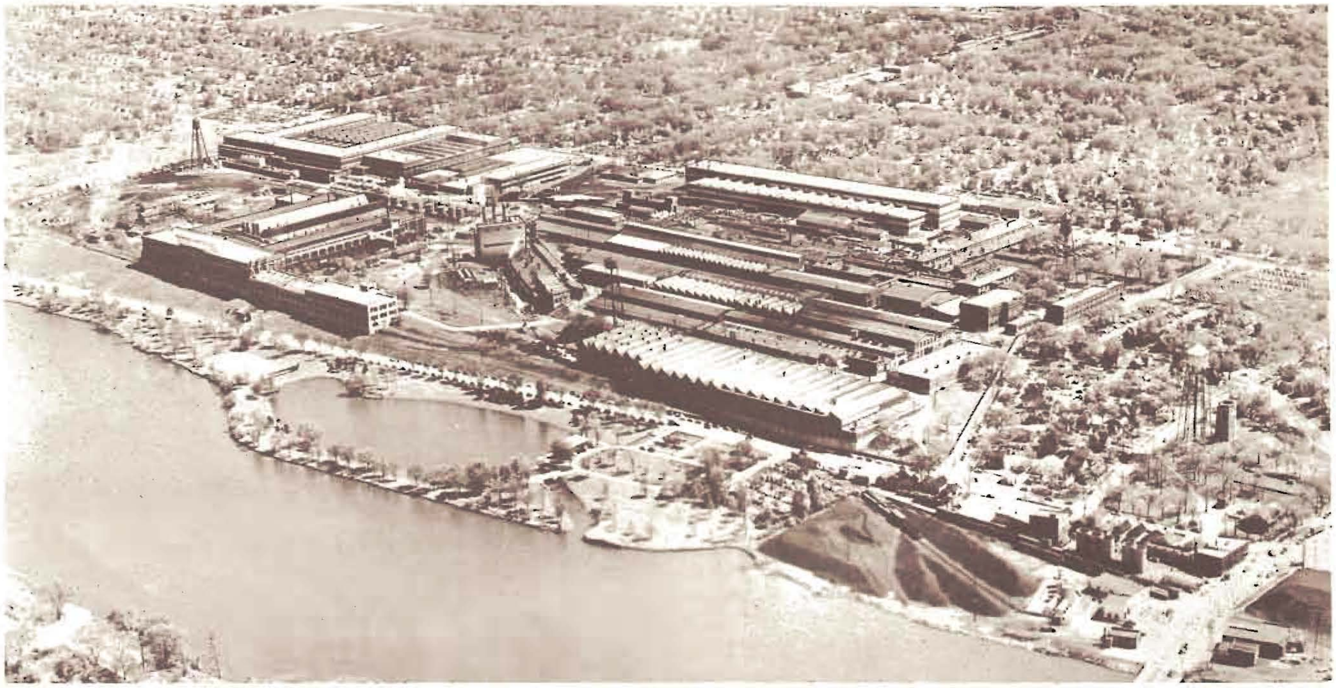
TYPES FM-XOR4A & FM-XOR4B

Type FM-XOR4 magnetos are rugged, powerful units with jump-spark distribution, intended primarily for heavy-duty service on power unit engines. Built with a separate, vented distributor compartment, the ball bearing rotor, coil and breaker mechanism operate in a frame which may be sealed or vented, as operating conditions dictate.

TYPES FM-XOR6A & FM-XOR6B

Built specifically for continuous, heavy-duty ignition service, Type FM-XOR6 magnetos have rotors with 50% more Alnico magnetic alloy than magnetos for standard applications. The jump-spark distributor operates in a separate, vented compartment and the ball bearing magnetic rotor, coil, and breaker mechanism are mounted within the magneto frame, which may be sealed or vented, depending on operating conditions. Ball bearings are used throughout.

Type FM-XOR6A



The Fairbanks Morse factory in Beloit, Wisconsin