EMD | MAINTENANCE INSTRUCTION

MAGNAFLUX INSPECTION OF ENGINE COMPONENTS

DESCRIPTION

Engine components are designed and manufactured to provide excellent service over an extended period of time. Upon removal of such components from the engine, they should be carefully inspected to qualify them for continued service. Such inspections generally include dimensional checking for wear and physical checking of the structural condition of the item.

The Engine Maintenance Manual provides detailed information on dimensional checking while this bulletin covers the physical aspects of component inspection. Both types of inspection are very important from the standpoint of safe, efficient and economical operation.

The Magnaflux method of inspecting the physical condition of parts is used on parts that are capable of being magnetized. This is a magnetic particle inspection which is a safe, non-injurious type of inspection that is capable of disclosing indications of apparent damage in the parts that might not otherwise be visible to the naked eye.

The principles of magnetism are used in Magnaflux inspections. A suitable magnetic field is set up within the part by current flow or by placing the part within a magnetic field. The part becomes a path for the magnetic flux or lines of force. Irregularities such as cracks and/or non-magnetic inclusions or bodies cause a distortion or interruption of the lines of force. Magnetic poles are set up by such interruptions or distortion. When specialized particles capable of being magnetized are applied to the piece being inspected, these particles will congregate at those places of opposite polarity, or north and south magnetic poles, and indicate possible defects. When the particles are coated with material having the property of fluorescence under "black light," the method of inspection is called "magnaglo." The magnaglo method aids in inspection since it allows the indication to be seen better.

This bulletin outlines the application of the magnaflux method of inspection on selected parts. Information is provided covering the preparation, procedure and inspection standard to be followed. It serves as a guide to determine if the inspection indicates the part may be reused or rejected.

It should be noted that the magnaflux method of inspection is very searching. Our recommendations in the use of magnaflux inspection are based on our knowledge of material standards in effect on our products during past years, in addition to investigation of parts performance in service. Indiscriminate scrapping of parts showing magnaflux indications without regard to their effect on part function may be very costly. If any doubt exists concerning the significance of a specific magnaflux indication, the Engineer of Tests or equivalent authority employed by your respective company should be consulted.

* THIS BULLETIN SUPERSEDES ALL ISSUES OF MAINTENANCE INSTRUCTIONS 2125, 2126, 2127, 2128, 2129, 2130 AND 2132.

ELECTRO-MOTIVE DIVISION
GENERAL MOTORS CORPORATION • LA GRANGE, ILLINOIS, U. S. A.
Oct. 1957
DE-LPR

EQUIPMENT

The equipment required for magnaflux inspection will vary from the XRR unit shown in Fig. 1, used for crankshaft inspection to portable KC units which may be used for the same purpose as the XRR but not as conveniently. Conditions such as number of parts in use, necessity of portability, and availability of the apparatus for general magnaflux inspection in the shop will determine the types of equipment required. The current capacity required may vary from 500 amperes or less to much higher values such as the 2000 amperes required for piston magnaflux inspection.

Magnetic particles used in the magnaflux inspections may be used in the "dry" or "wet" method. As implied, the fine metallic powder may be used dry or in a liquid with or without magnaglo particles. Magnaglo lends itself to rapid inspection and may be preferred for this reason. Also, the metallic powder may be of different colors. The color and powder selection will have to be chosen for the particular inspection to provide maximum contrast for easy visibility to facilitate the inspection. Some recommendations are made for the individual parts in the respective inspection procedure. It is recommended, however, that full details covering the types of equipment and supplies be obtained from the Magnaflux Corporation or their representative.

PREPARATION

Before magnaflux inspection of any part, it must be thoroughly cleaned to remove any oil deposits and loose carbon. Other carbon deposits should be removed by wire brushing or other non-destructive means. It is particularly important to dry the part after cleaning, especially so if the dry method of inspection is used, to permit free flow of the powder to prevent false indications.

INSPECTION PROCEDURE - CRANKSHAFTS

Magnaflux inspection of the crankshaft should conform to the following procedure and inspection standard.

A. Procedure

Indications of detrimental defects will be produced by flowing alternating current through a coil around the crankshaft. The axis of the coil must be parallel with the normal axis of the crankshaft. When the XRR type unit, Fig. 1, is used, place the coil over the center of a 24" section, magnetize with 600-800 amperes alternating current and proceed to the next 24" section until the remainder of the shaft is magnetized. The current must be shut off before proceeding to each new section. The inspection medium may be applied while the current is flowing or after the current is shut off.

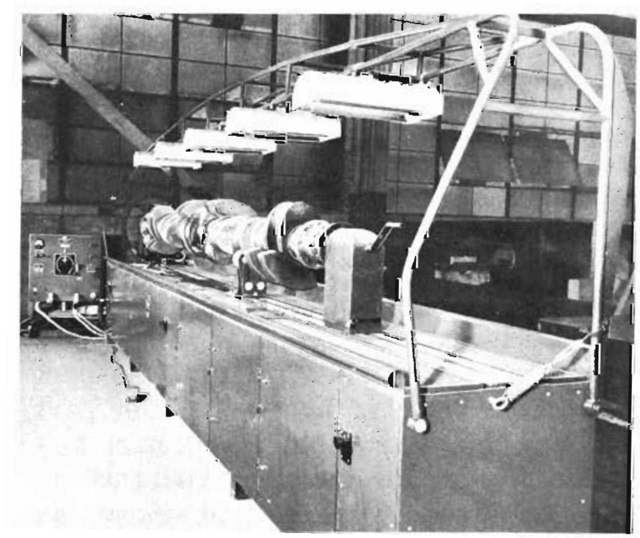


Fig. 1 - Type XRR Magnaflux Unit

Where an XRR type unit is not available, the leads from the power pack may be formed into a coil by making three loops and taping them together for ease of handling. The magnetizing procedure is the same as described above. Another satisfactory method is to take the leads and make continuous loops around the entire crankshaft. As nearly a complete loop as possible should be made around each journal. Magnetize with 600-800 amperes alternating current.

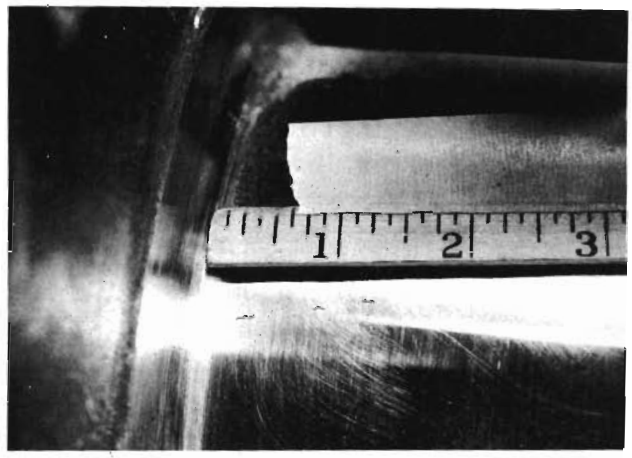
When dry powder is used, the powder should be applied sparingly so as not to hide possible indications. It is often helpful to tap the shaft with a lead or wood hammer to remove excess powder and to permit more pronounced build-up of indications.

B. Inspection Standard

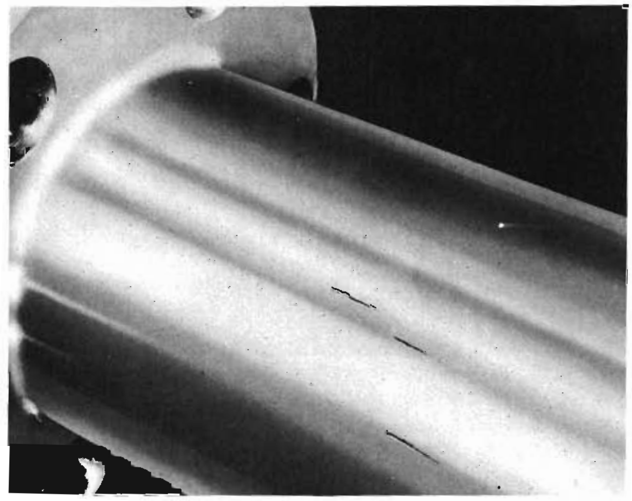
1. Types of Indications, Interpretations and Dispositions

The four types of indications disclosed by magnafluxing used crankshafts are: nonmetallic inclusions, hardening or "Tocco" checks, seizure cracks, and fatigue cracks. Particulars relative to each indication are as follows:

a. Nonmetallic Inclusions: These are shown in Figs. 2a, b and c. All steels contain varying quantities of nonmetallic materials which may appear as magnaflux indications. Those shown in Fig. 2c are confined to welded shafts. They are oxide deposits which resulted in incomplete fusion during the welding process. The practice in the past was to remove the inclusion in its entirety by "dimpling." Present practice is to flat the sharp edges to prevent bearing scraping but not necessarily remove all of the inclusion. Inclusions have in the past been highly overrated as causes for failures. In our experience we have never been able to definitely correlate a crankshaft failure with inclusions. Unless very definite evidence of fatigue progression from one of these nonmetallic inclusions is found, it may generally be considered that the crankshaft has been



2a



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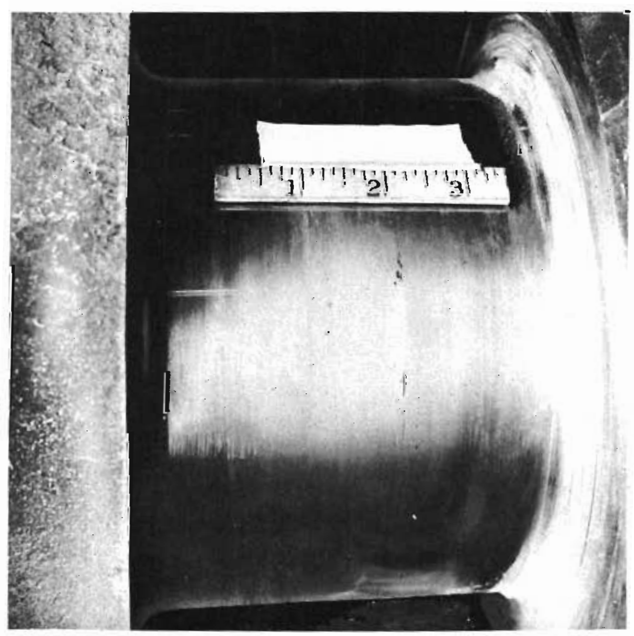


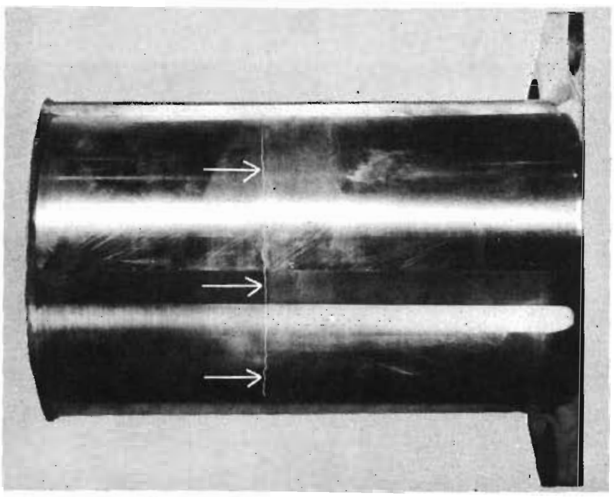
2c

Fig. 2 - Nonmetallic Inclusions

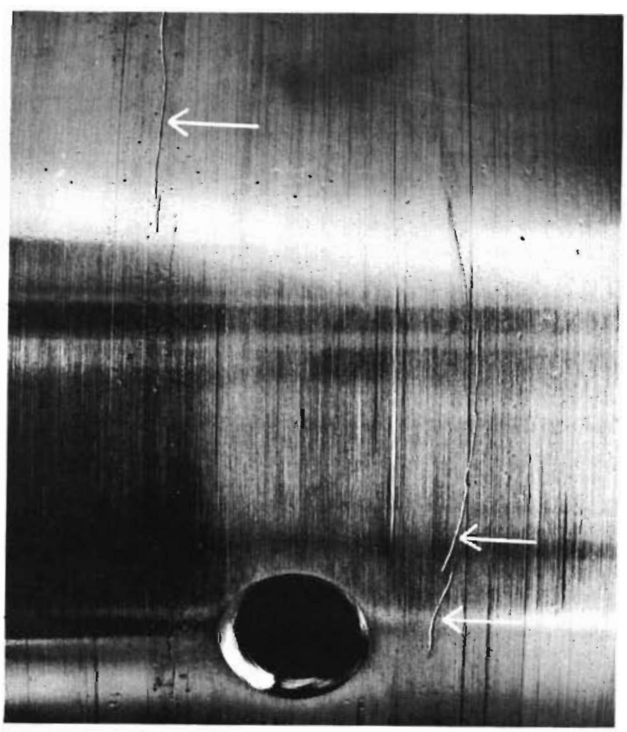
qualified by its service to date of inspection.

b. Hardening or "Tocco" Checks: Figs. 3a, b and c. Hardening or "Tocco" checks sometimes develop in the induction hardening process on the journals. They are very fine hairline cracks found at the edge of the hardened zone circumferentially to the axis of the shaft. Occasionally, they are found on the crankpin journals but more often on the mains, expecially at the edge of the hardened area near the center of the last or double main journal. They are never in the fillets but approximately 5/8" from the thrust wall. On welded shafts this condition exists also at the edges of the welds as shown in Fig. 3b. These "Tocco" checks have definitely been established as harmless insofar as the life of the crankshaft is concerned.

c. Seizure Cracks: Figs. 4a, b and c. When an oil failure results in bearing seizure, quite often there are longitudinal or circumferential cracks sometimes accompanied by a network pattern of cracks. This is usually associated with discoloration and other evidences of bearing seizure. The circumferential heat cracks are often deep, however, when using wet magnaflux medium, one must differentiate between actual heat checks and



3a



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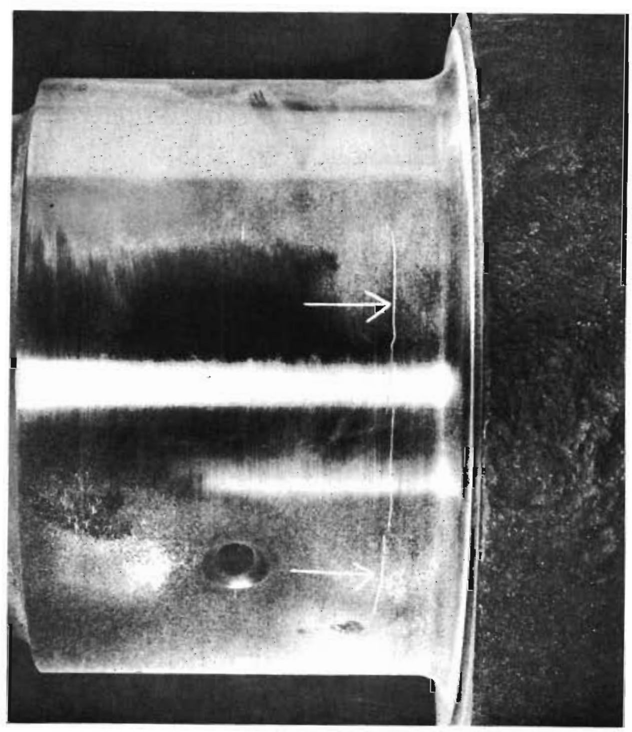
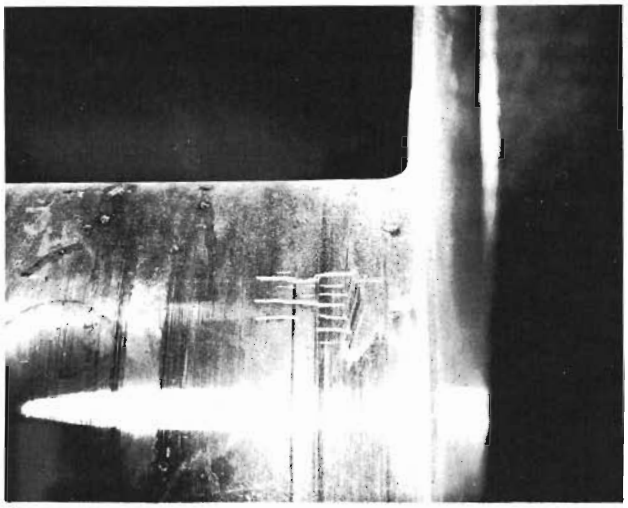
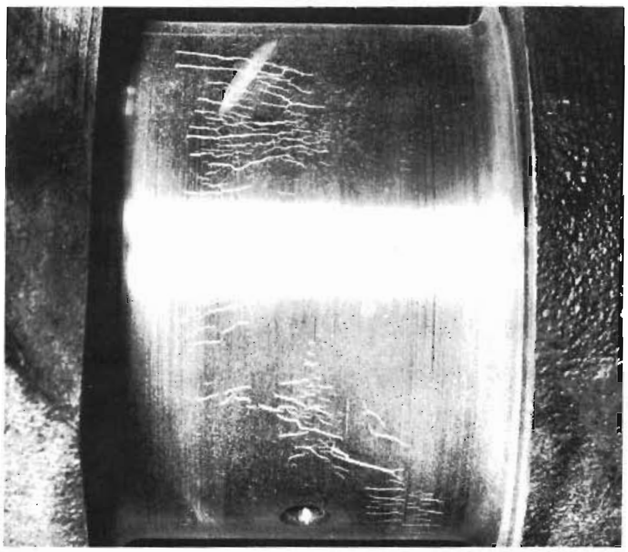


3c

Fig. 3 - Hardening Or "Tocco" Checks



4a



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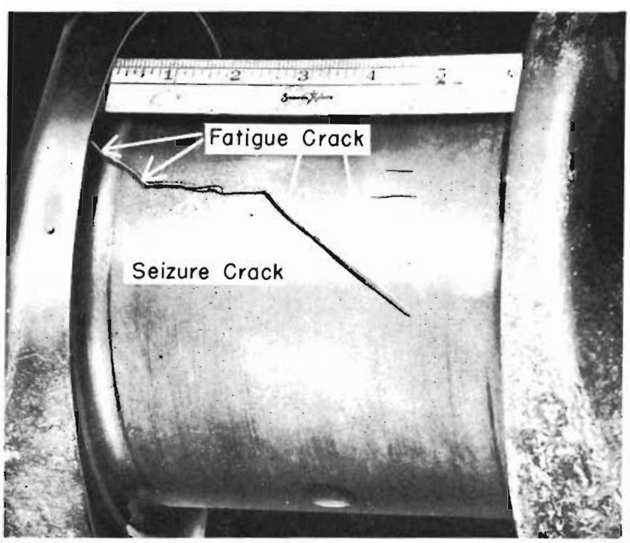
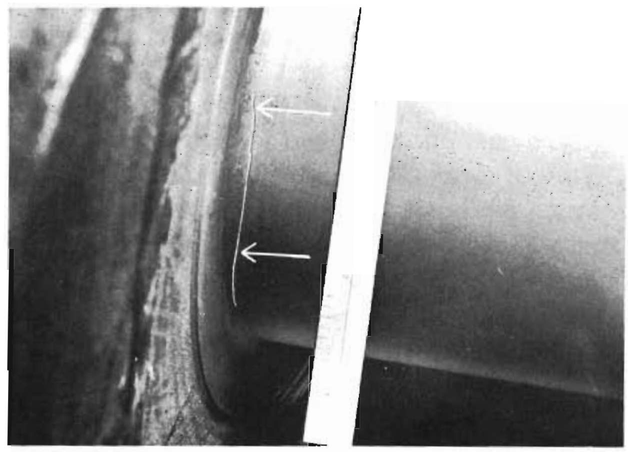


4c

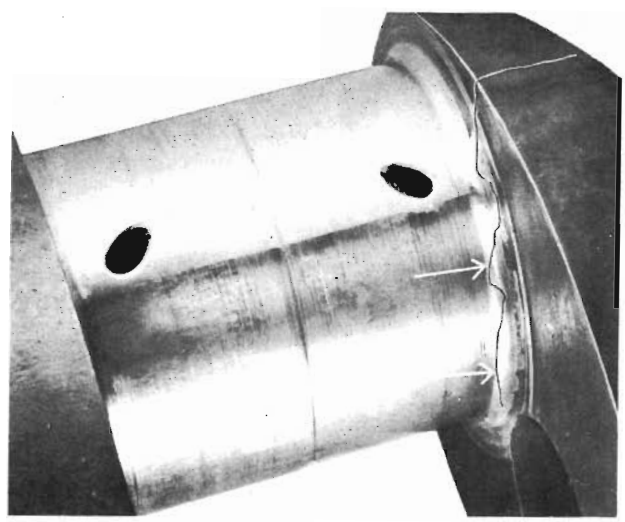
Fig. 4 - Seizure Cracks

indications developed due to scoring. Discoloration is usually the distinguishing evidence in this case. When still in doubt, observation with a magnifying glass is often helpful. Any crankshaft which shows indications of heat checks resulting from bearing seizure should not be placed back in service. Fig. 4c is a photograph of a journal which shows a fatigue crack starting from a heat check.

d. Fatigue Cracks: Figs. 5a and b. Occasionally, due to the lack of proper bearing support, the crankshaft is subjected to



5a



5b

Fig. 5 - Fatigue Cracks

excessive bending stresses. Fatigue failures originating due to this overstressing generally occur in the center of the fillets, run circumferentially for several inches in the fillet and then proceed through the cheek to ultimate failure. Circumferential indications in the center of the fillets should be viewed with extreme suspicion since it is probable that they represent the start of fatigue failure of the shaft.

C. Crankshaft Salvage

Regrinding of "Tocco" hardened crankshafts in the field is not recommended, since these crankshafts are hardened by special induction hardening equipment, and during the regrinding the "Tocco" hardening is checked for depth. Where necessary, the shaft must be "Tocco" annealed and rehardened by the same process. All 567 series engine crankshafts and some 8-cylinder 201A shafts are "Tocco" hardened. If in doubt of a 8-201A shaft being "Tocco" hardened or not, Electro-Motive will endeavor to identify it upon receipt of the serial number of the shaft.

While it is possible in some cases to regrind 12 and 16-201A crankshafts in the engine with a portable grinder, attempts to grind "Tocco" hardened shafts in the field have proved unsuccessful.

A crankshaft cannot be salvaged if there is a crack over 1" long and more than 1/16" deep in the surface of either a main bearing or crankpin journal or any journal fillet. The depth of the crack may be determined by trial grinding with a high speed machine fitted with a fine conical stone. If, after this examination, it appears that a shaft may be salvaged, it should be returned for machine grinding and rebalancing.

If one section of a 16-cylinder crankshaft has been damaged beyond repair, the damaged section can be replaced. In such instances, the good half must be returned for assembly with a new section and the complete crankshaft rebalanced.

For details on crankshaft rework, consult your Factory Rebuild Service Bulletin.

INSPECTION PROCEDURE - CONNECTING RODS AND BASKETS

There are two designs of connecting rods and baskets in use: the trunnion design, and eye type connecting rods; the current bolted design basket and the prior used hinged type fork rod basket. The trunnion design blade connecting rod is shown in the magnaflux unit, Fig. 6. Although the connecting rods and baskets differ in design, the method of inspection and the inspection standard for the respective parts are the same.

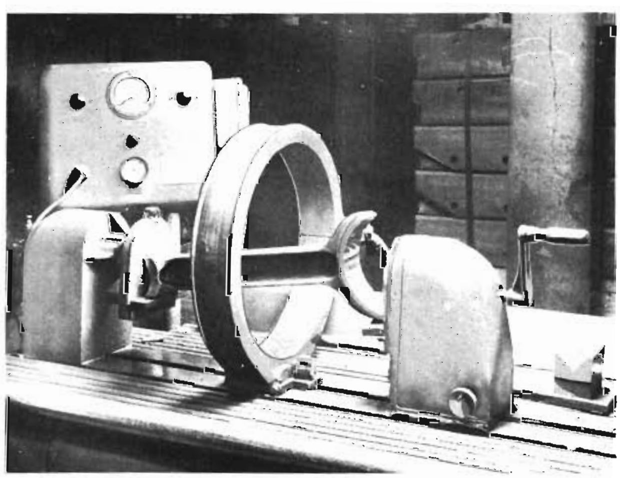


Fig. 6 - Blade Rod In Magnaflux Machine

A. Procedure

1. Connecting Rods

When an XRTL type of unit is employed, place the connecting rod inside the coil as indicated in Fig. 6, showing the blade rod in place. Another satisfactory method of magnetizing the rods is to make

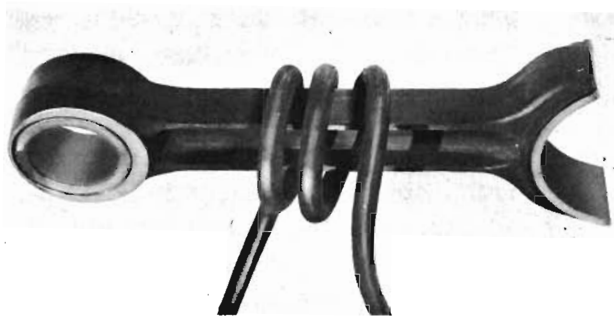


Fig. 7 - Cable Magnetizing Application

three loops of cable as shown in Fig. 7 around the rod.

The fork portion of the fork rod should be magnetized by placing it within the field of the coil or loops to check for possible defects at the bottom of the serrations. The coil or loop should also be placed over the slipper end of the blade rod.

Magnetize with 500-600 amperes alternating current. Apply the inspection material, magnaflux or magnaglo, either while the current is flowing or after the current is shut off. The parts will usually retain enough magnetism to permit residual inspection. Apply the powder sparingly so that minute indications are not hidden.

2. Fork Rod Baskets

Although the fork rod basket is inspected separately from its mating connecting rod, care must be taken

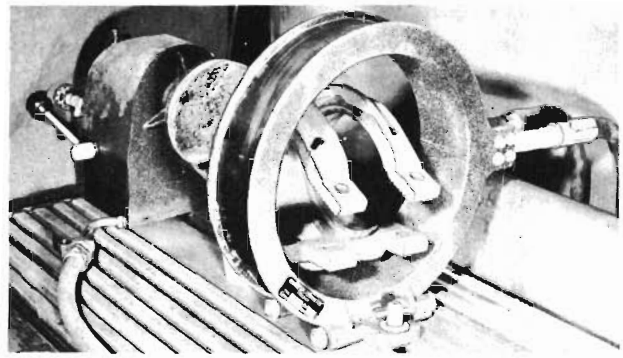


Fig. 8 - Position Of Rod Basket For Magnafluxing

to be sure an acceptable basket is again matched to the mating rod. To aid in this identification, both the rod and its matching basket have the same serial number.

Place the basket within the coil as shown in Fig. 8. When such a coil is not available, a suitable coil may be made with three turns of #0000 flexible cable and connecting the ends to a portable magnetizing unit.

Magnetize with 500-600 amperes alternating current and apply the inspection material, magnaflux or magnaglo, either while the current is flowing or after it has been turned off.

B. Inspection Standard

1. Connecting Rods

Fig. 9 shows magnaflux indications of transverse defects in the rod

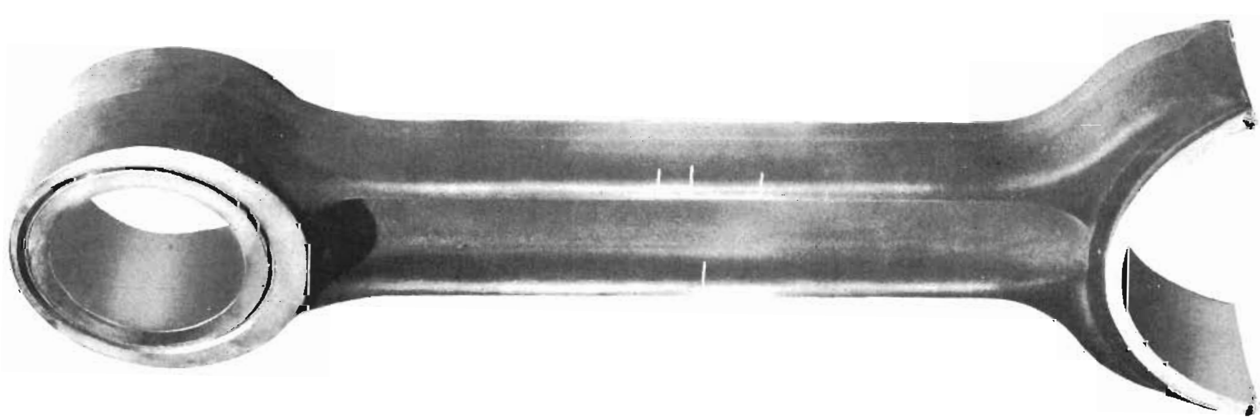


Fig. 9 - Connecting Rod Defect Indications

flanges, using gray magnaflux powder. Any defects in this direction and location reject the blade or fork rod, since they usually result in failure.

Sometimes due to bearing seizure, heat checks develop in the blade rod slipper face. Special attention should be paid to this area, since defects of this nature will probably result in failure. Therefore these indications are cause to reject the blade rod.

Detrimental defects in the fork rod are usually confined to the serration area. The indications will appear at the end of the serrations with their origin at the root or in the cap screw hole. Further progression of such defects will probably result in failure. Accordingly, these defects are cause to reject the rod.

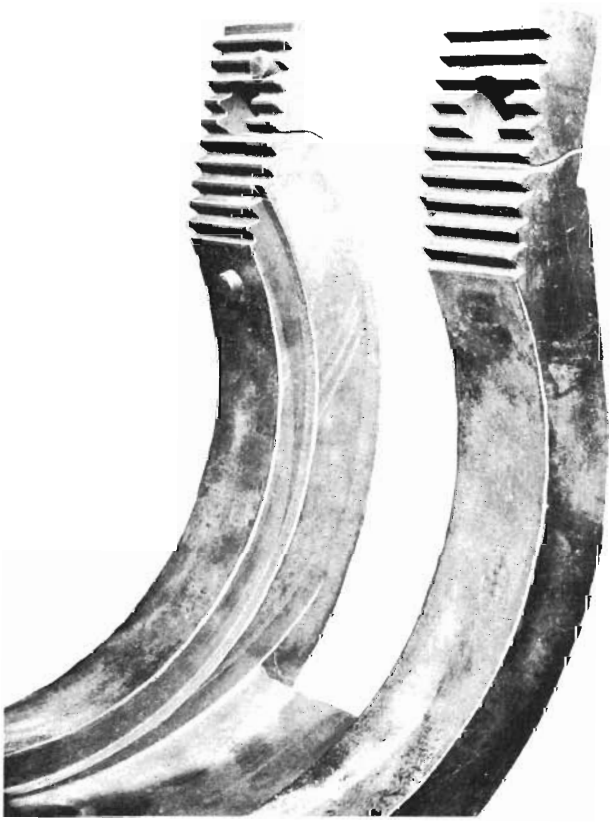


Fig. 10 - Example Of Fatigue Cracks

Indications of longitudinal laps, seams, or inclusions in the "I" beam section or similar indications on other areas of the connecting rod are usually considered harmless.

NOTE: Lap is defined as a surface discontinuity in forgings due to the hammering in of folds in the metal. Seams are defined as a discontinuity caused by a void or crack found in rolled material parallel to the axis of the material. Inclusions are defined as particles of impurities, usually oxides, sulphides or silicates that are generally dispersed at random through all steel products.

2. Fork Rod Baskets

Failures of the fork connecting rod baskets are mostly due to loose cap screws and are confined to the serrated ends. The "Procedure" for the baskets has therefore been aimed at disclosing cracks in these areas which may lead to ultimate engine failure. Fig. 10 shows an example of typical defect indications of fatigue cracks. Any baskets which show indications of cracks emanating from serrations or bolt holes should be rejected.

NOTE: Refer to your Factory Rebuild Service Bulletin for return of connecting rod assemblies for rework. See the Engine Maintenance Manual for dimensional inspection and limits on connecting rod assemblies.

INSPECTION PROCEDURE - PISTONS

The following magnaflux inspection procedure is intended as a basis to determine if a used piston should be accepted for reuse (provided it is otherwise conditionally and dimensionally satisfactory) or rejected according to the inspection standard.

A. Procedure

Satisfactory magnetization can be accomplished by connecting one conductor from a portable KC unit to a flat head plate, and the other conductor to a bar conductor inserted in the piston. The bar conductor should be a 1/2" copper or brass tube about 18" long to hold the piston in the unit securely, as shown in Fig. 11. Magnetize with 2000 amperes direct current.

Use a 12" diameter coil similar to that shown in Fig. 11 and energize with 1500 amperes direct current with the coil around the piston at its approximate center, as an alternate method.

Then remove the piston and apply magnaflux gray powder or magnaglo to the inside and outside of the piston. Shake out excess powder or let drain and inspect. If heat checks are suspected in the crown contour, clamp the piston diametrically on the outside diameter, above the upper ring band and repeat the preceding current application.

B. Inspection Standard

Piston nomenclature referred to in the following is given in Fig. 12, for the two designs of pistons currently found in 567 series engines.

1. Crown Rim

Fatigue failures of the crown have their origin in the recess under the crown rim. See Fig. 12 for location. This area is difficult to inspect. Extreme care must be exercised in interpreting accumulations of powder or magnaglo because of the natural tendency for the inspection material to settle in this area. When using magnaglo, the piston should be tilted to permit excess to drain away from the area being inspected. If a crack has progressed at any extent, it should be visible on the outside of the piston at the crown rim. Heat checks in the crown or "bowl" as well as fatigue cracks under the crown rim reject the piston.

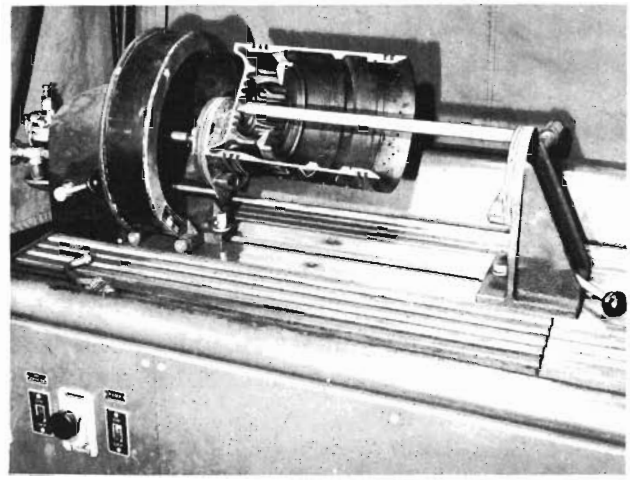


Fig. 11 - Piston (Section) Showing Application

2. Platform Supports

Indication of cracks in the platform supports are cause for rejection of the piston. Frequently the inspection material accumulates at the casting parting line of the support, which should not be confused with an actual crack.

3. Platform Tie Ribs

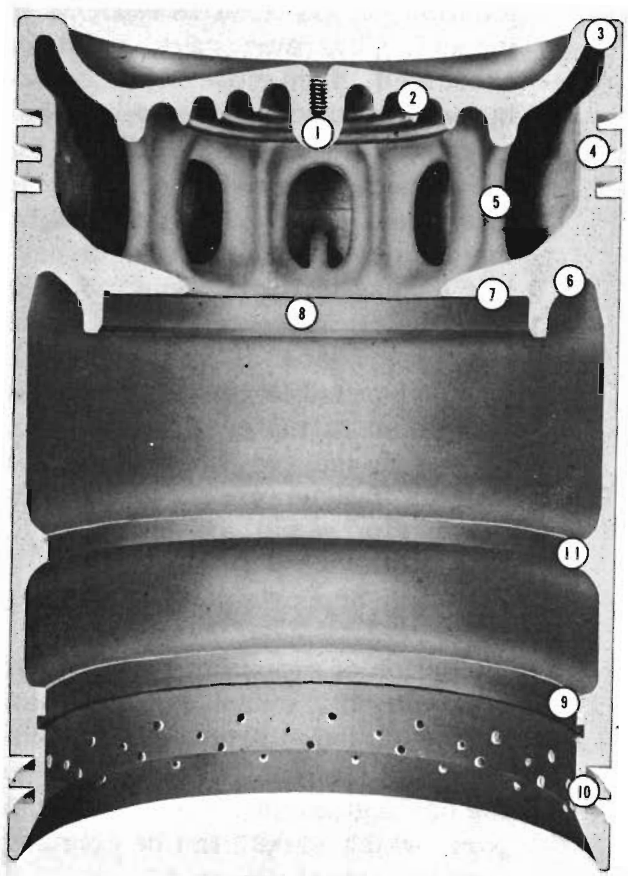
Cracked platform tie ribs reject the piston. Generally, indications on the tie ribs are due to casting characteristics, and are not true indications of cracks. Fig. 13 shows the tie rib core parting line with normal lighting. The same area taken with "black light" is also shown. Fracturing the casting through this parting line reveals no defect and shows that false indications are prevalent in this area. If doubt remains as to the interpretation of the indications, typical samples should be sectioned through the questionable area.

4. Platform

Pistons having platform rims, Fig. 13, should be rejected when the platform rim is cracked. A false indication may appear in the machined recess. Unless the indication emanates from the corner, the piston should be accepted.

5. Cooling Fins

Fig. 14 shows indications on the piston cooling fins. A certain percentage of pistons in the field are known to have cracked cooling fins. They may be found on all the fins, in-line or staggered. Pistons showing cooling fin cracks are acceptable for further service, except those pistons which have been damaged due to some related part failure, as for example a valve, since the cracks induced by the

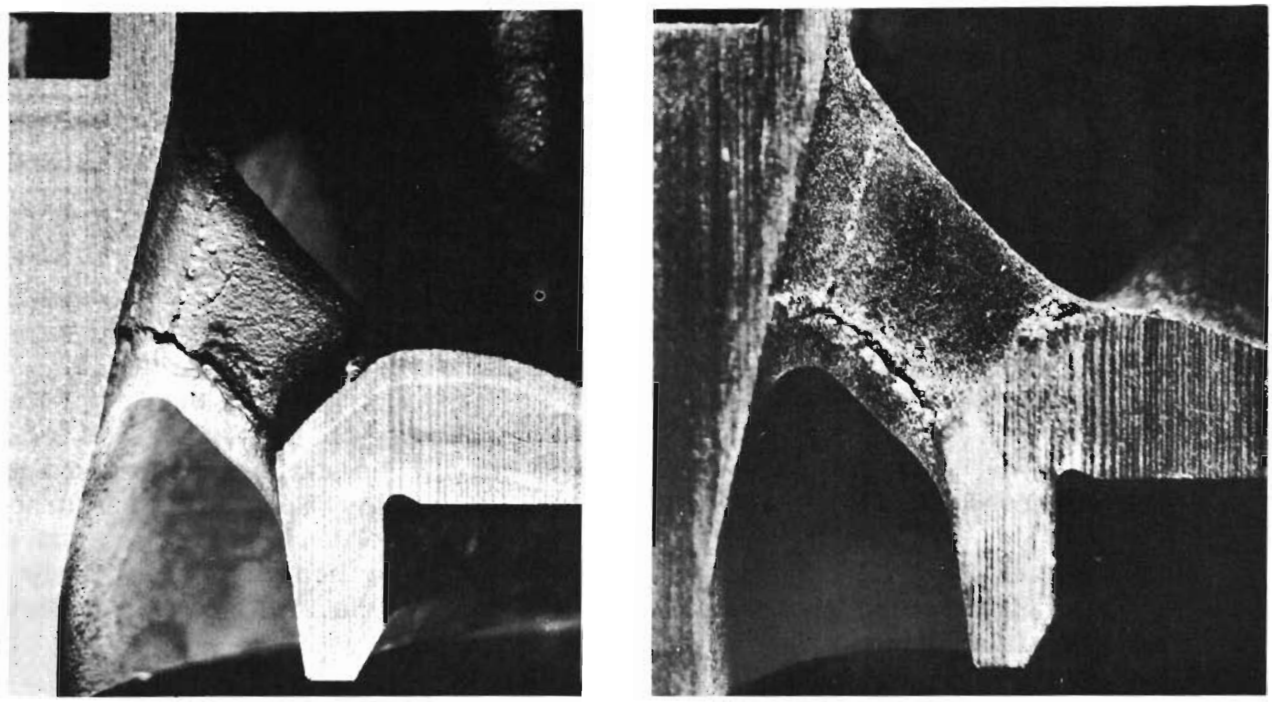


This Piston Uses
Floating Pin Design Carrier

This Piston Uses
Trunnion Design Carrier

1. Puller Hole Boss
2. Cooling Fins
3. Crown Rim
4. Compression Ring Lands
5. Platform Supports
6. Tie Ribs
7. Platform
8. Upper Pilot
9. Lower Pilot
10. Oil Ring Lands
11. Pin Ring

Fig. 12 - Piston Nomenclature



Normal Lighting — Under Black Light

Fig. 13 - Tie Rib Core Parting Line

failure have not been subjected to the thermal stress relieving operations which our production pistons undergo.

6. Inside Crown Area

Fig. 15 shows indications in this area. Cracks encircling the puller

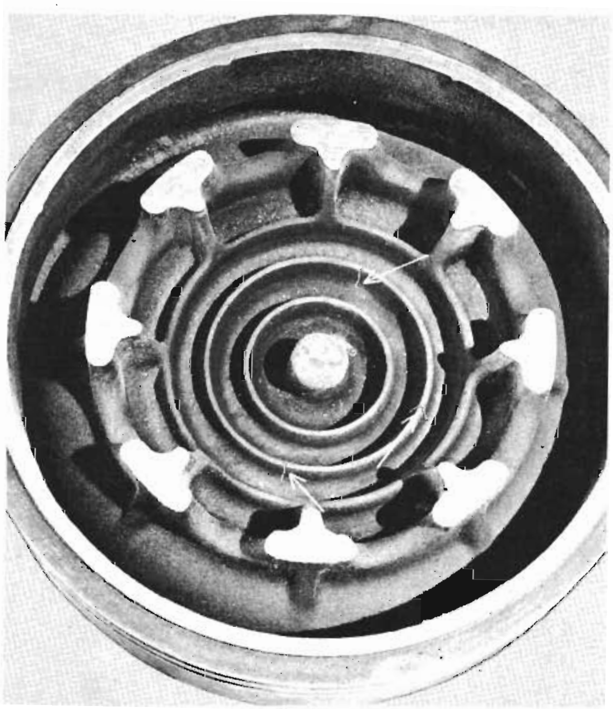


Fig. 14 - Cooling Fin Magnaflux Indication

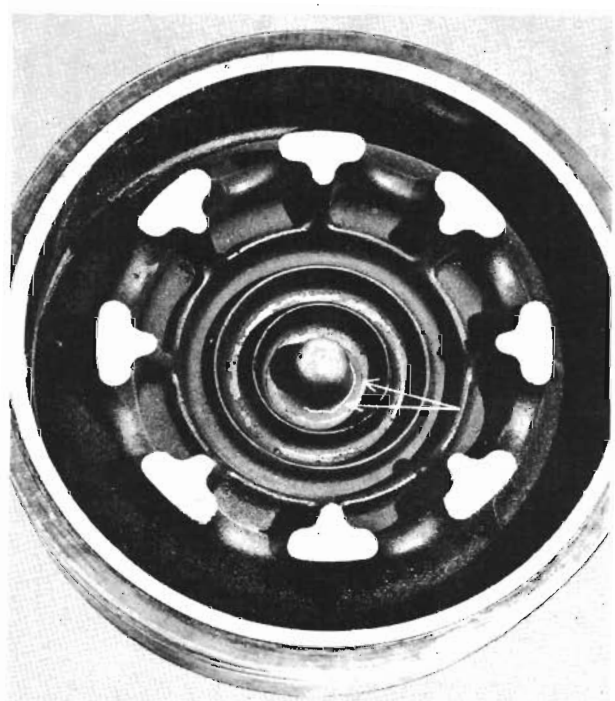


Fig. 15 - Defect Around Puller Hole Boss

hole boss or similarly concentric cracks between the cooling fins, reject the piston.

7. Pin Ring

Fig. 16 shows an indication in the pin ring. Pin ring cracks are acceptable, provided they do not extend into the piston wall. Pin ring cracks extending into the piston wall are cause for rejection of the piston.

8. Ring Grooves

Magnetizing the ring land area with a coil or high current densities may produce false indications in the sharp corners of the ring grooves. Magnaflux indications may also be produced if scale is not completely removed, or because of sub-surface porosity. This is especially true when magnaglo is used. Currently produced pistons are free from porosity in the ring grooves. There are, however, numerous pistons in the field that have provided satisfactory service which contain porosity in varying degrees. Any indication in the ring land area should be carefully appraised to determine whether it is a real crack or due to conditions stated above. Any indication proved definitely a crack in the ring land area rejects the piston.

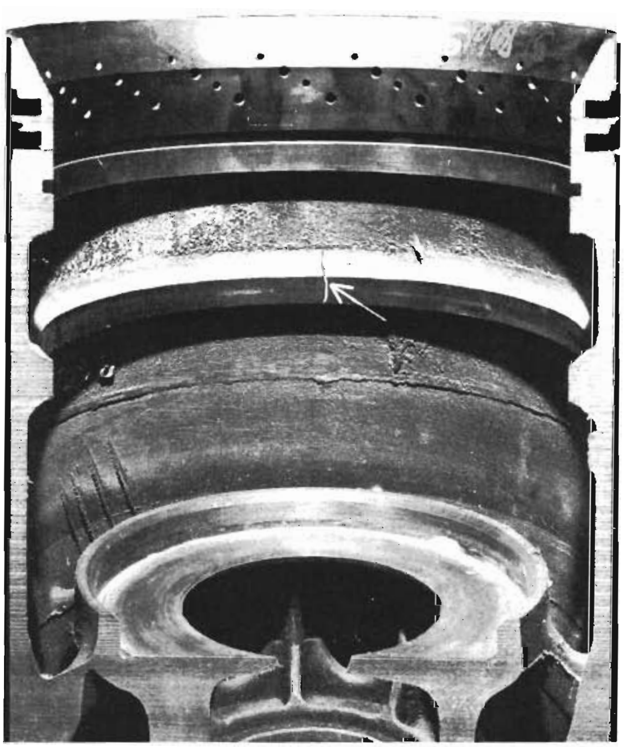


Fig. 16 - Pin Ring Magnaflux Indication

9. Other Areas

Indications of cracks may be found on the inside or outside of the skirt or wall. These are usually due to mishandling and are found more at the bottom taper than in the upper part of the wall, and are cause to reject the piston.

C. Preparing Part For Use

All pistons magnetized with the coil method must be demagnetized after inspection. Demagnetization may be accomplished by withdrawing the piston from the influence of a coil energized with 600-1000 amperes alternating current.

The piston should then be washed and flushed to remove any magnetic particles used in the inspection.

INSPECTION PROCEDURE - PISTON CARRIER

Two designs of piston carriers are in use in the field. The "trunnion" forged design carrier, Fig. 17a, which is used with the trunnion or "saddle" design connecting rod and piston assembly; and the cast iron carrier, Fig. 17b, having pin bushings and is used with the "eye" type connecting rod and piston assemblies. The magnaflux procedure is the same for both carriers, however, the inspection standard for the carriers is different.

A. Procedure

The following methods may be used to magnetize the piston carriers.

1. Insert an approximately 2" diameter copper or brass bar through the piston pin bore of the carrier. Use care not to damage the pin bearing surface of the trunnion type carrier or the piston pin bushings used in the other design of carrier. Clamp the bar (or tube) between the heads of a magnaflux unit, as shown in Fig. 18.
2. Thread a single cable through the pin bores as shown in Fig. 19, and magnetize with 500-600 amperes AC current.
3. Make three loops of the cable through the carrier as shown in

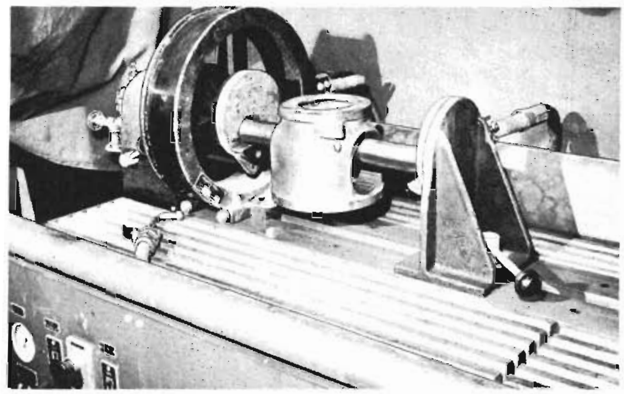


Fig. 18 - Carrier On Magnaflux Unit

17a

17b

Fig. 17 - Piston Carriers

Fig. 19 - Magnetizing With Single Cable

Fig. 20 - Magnetizing With Multiple Cable

Fig. 20, and magnetize with 300-400 amperes AC current.

The inspection medium may be applied while the current is flowing or after the part is magnetized. If powder is used, it should be applied sparingly so as not to hide possible indications of cracks. The excess powder may be shaken off or blown off using low pressure compressed air.

B. Inspection Standard

1. Trunnion Carrier

   In the inspection of the trunnion design carrier, cracks found anywhere on the carrier are cause for rejecting the carrier. Particular attention should be given to the polished pin bore where fine heat checks may develop.

2. Carriers Using Piston Pin Bushings

   Magnaflux indications found on these carriers are generally three types: fatigue cracks, foundry defects, and mishandling defects.

   a. Fatigue Cracks

      Usually fatigue cracks have their origin in oil holes of the carrier. Figs. 21 and 22 are

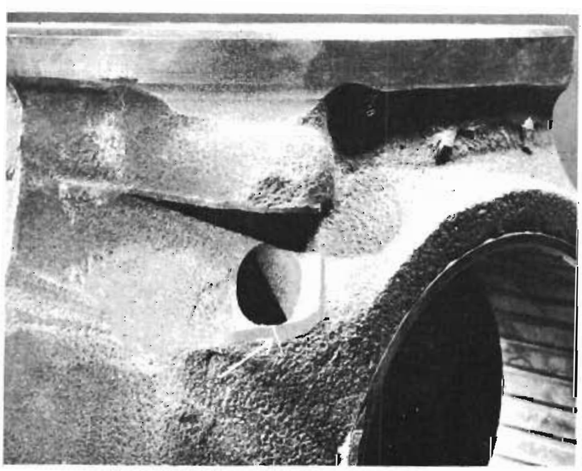


Fig. 21 - Oil Hole Defect Indication

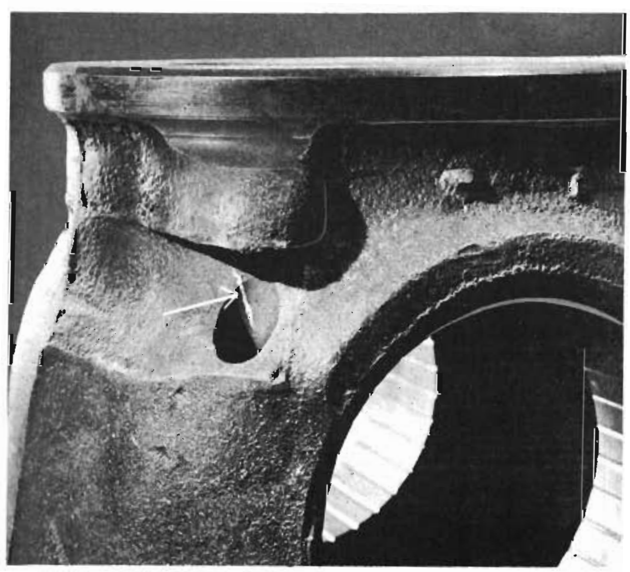


Fig. 22 - Oil Hole Defect Indication (Inside)

photographs of the beginning of failures. Fig. 23 shows an advanced stage of failure where the fatigue crack has progressed to piston pin bore. Carriers which reveal magnaflux indications in these locations should be rejected.

b. Foundry Defects

Certain defects may be revealed at overhaul inspections which are due to abnormal conditions in the foundry at the time the parts are cast. The most common of these are shrink cracks surrounding the piston bore boss as shown in Fig. 24. Similar indications may also appear in the crown recess. Unless definite progression of these can be found, they should be accepted. In general, indications found on the lower half of the carrier are harmless.

c. Mishandling Defects

Occasionally, due to dropping the carrier or other mishandling, cracks will be found in the bottom wall. These are usually through the wall, and the part should be rejected. The indication shown on Fig. 25 is one type which may be attributed to mishandling and is cause for rejection of the part. Often, cracks will be vertical in direction.

Fig. 23 - Defect Progression From Oil Hole

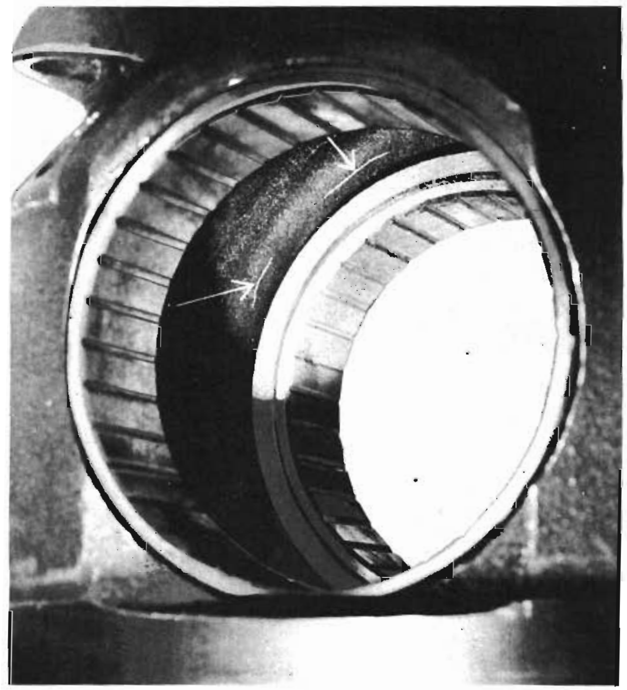


Fig. 24 - Magnaflux Indication Inside Of Pin Boss

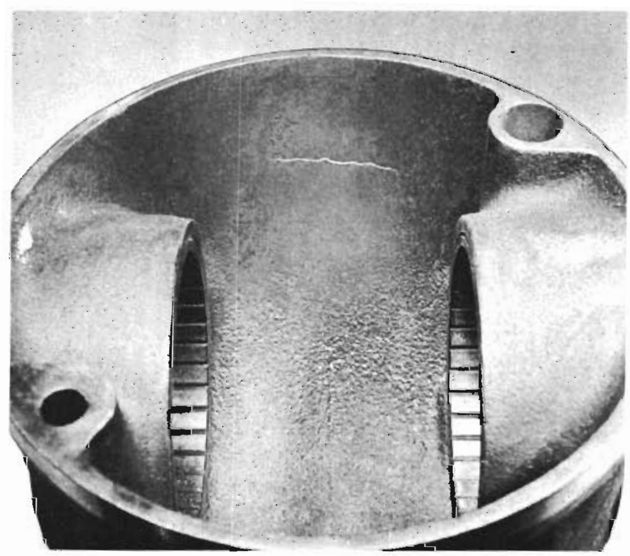


Fig. 25 - Defect Indication Bottom Wall

INSPECTION PROCEDURE - PISTON PINS

There are two designs of piston pins in use; the trunnion type, Fig. 26a, which bolts to the saddle of its respective connecting rod, and the floating type, Fig. 26b, used with eye type connecting rods. The magnaflux procedure is similar for both types of piston pins, however, the inspection standard is different.

A. Procedure

Before magnetizing the piston pin and after they are initially cleaned, examine the pins for obvious pitting, etching and surface cracks. Also examine the pins for discoloration caused by localized heat. Any discoloration caused by localized heat will disqualify the pin. Dimensionally the piston pin must qualify for use according to the recommendations in the Engine Maintenance Manual.

Insert a central conductor, either a copper or brass bar about 1-1/2" in diameter through the bore of the piston pin. Then mount the pin (or pins) in the magnaflux unit as shown in Fig. 27. Magnetize with 500-600 amperes AC current.

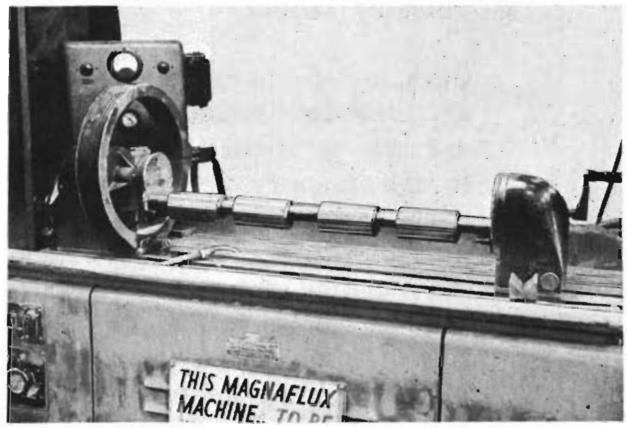
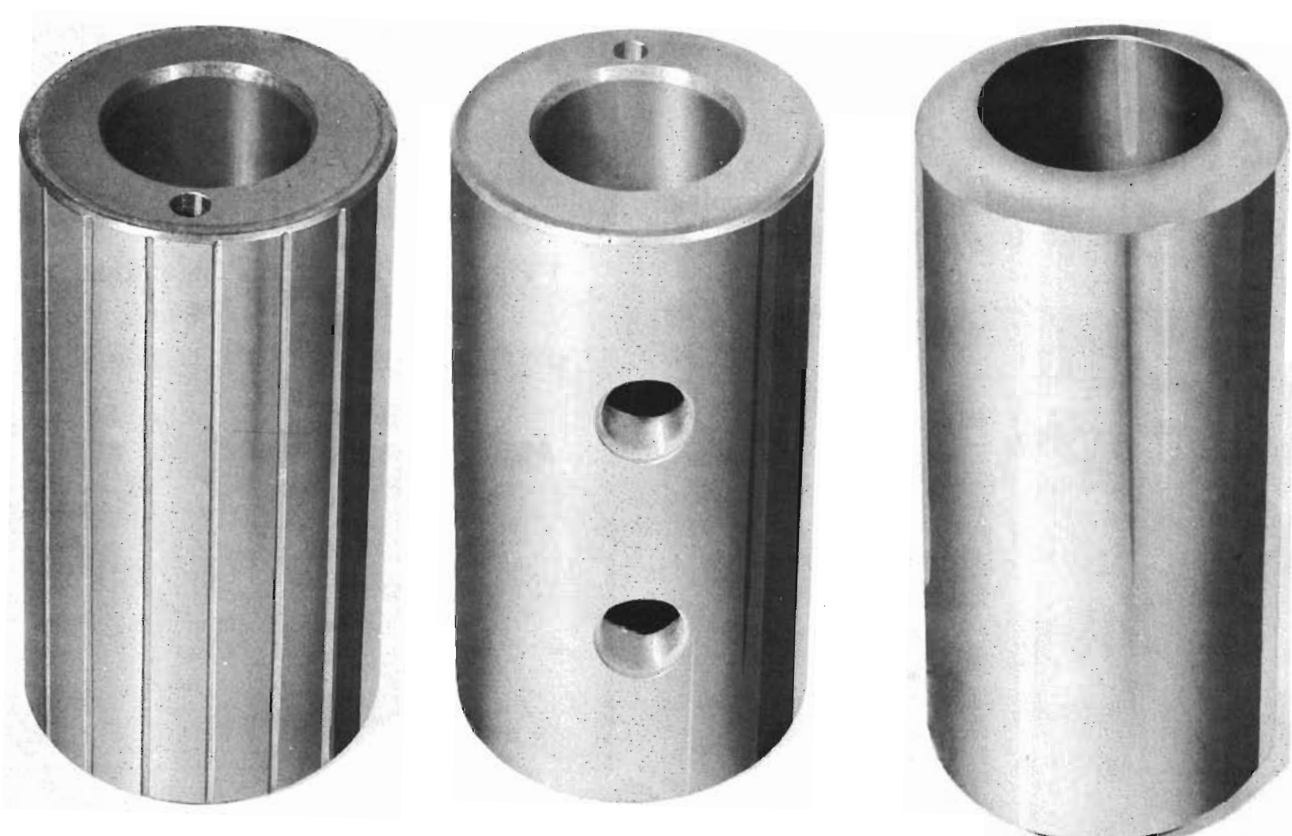


Fig. 27 - Piston Pins In Magnaflux Machine



Top Bottom
Trunnion Piston Pin
26a

Floating Piston Pin
26b

Fig. 26 - Piston Pin Designs

Apply the inspecting medium, magnaglo or magnaflux powder while the current is flowing or if desired after the current is discontinued.

B. Inspection Standard

1. Trunnion Piston Pins

Inspection of the trunnion pin should be confined to the bore and the two 7/8" diameter bolt holes. Fatigue cracks in the bore and/or bolt holes are cause for rejection of the pin.

2. Floating Piston Pins

Failure of this type of piston pin is nearly always a result of overheating. Fatigue cracks originate from heat checks on the surface. These checks are longitudinal in direction in the center section of the pin, Fig. 28. As the fatigue cracks progress, they tend to become circumferential at the witness band (the area between the rod bushing and the carrier bushing), Fig. 29. The surface of overheated pins is sometimes straw to blueblack in color. At other times, however, no discoloration is present due to subsequent polishing action in the engine.

Nonmetallic inclusions, the impurities contained in various amounts in all steels, are also in a general longitudinal direction. It is therefore often difficult to differentiate between nonmetallic inclusions and fatigue cracks when high current densities are employed. This is especially true in the absence of discoloration. The indications of inclusions shown in Fig. 30 were produced with high amperages on new pins.

Fig. 28 - Piston Pin Magnaflux Defect Indication

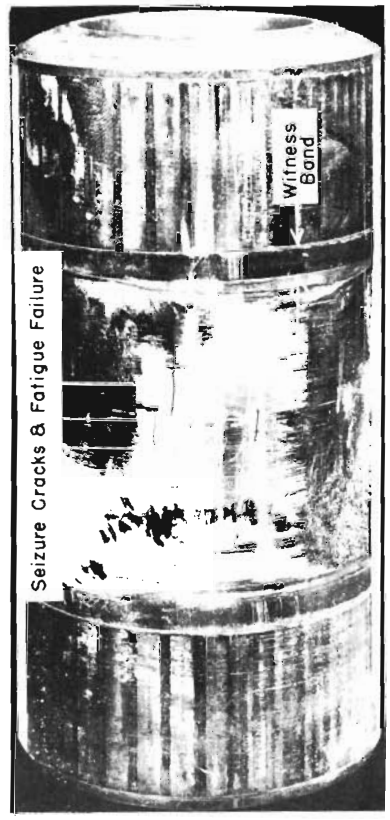


Fig. 29 - Progression Of Magnaflux Defect Indications

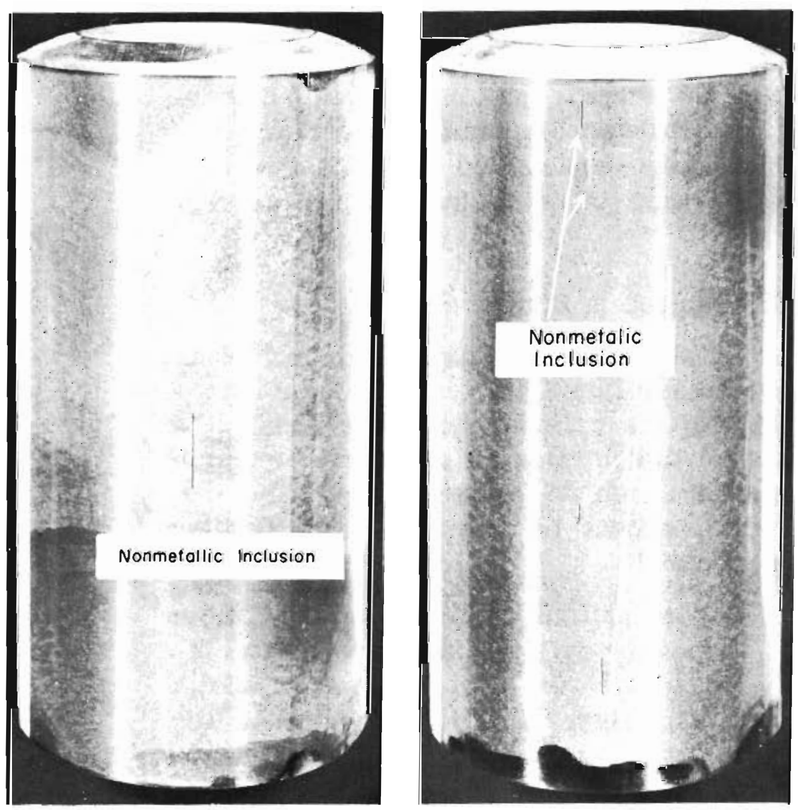


Fig. 30 - Nonmetallic Inclusion Indications

Although fatigue cracks are nearly always confined to the portion of the pin under the rod bushing, inclusions may be anywhere on the part.

Where question arises as to the type of indication in the center portion of the pin, hardness tests may be made to determine if the pin has been overheated. A Shore scleroscope is the preferred instrument for making these tests since it does not damage the surface finish of the pin appreciably. It is recommended that a hardness check be made in the witness band compared to the suspected overheated areas. A hardness of scleroscope 71 or less in the center of the pin as compared to a scleroscope 78 or higher in the witness band will indicate overheating and such a pin should be scrapped. Evidence of frictional distress on the silver connecting rod bushing will often serve as a tip-off to a piston pin which has overheated. Magnafluxing of the pin, observation of the mating silver bushing, and scleroscope test should be used if a question exists on a particular piston pin.

Magnaflux indications of fatigue cracks or heat checks are cause for rejection of the pins. Indications of nonmetallic inclusions are acceptable.

INSPECTION PROCEDURE - CYLINDER HEADS

A. Procedure

Place a copper tube or a bar of proper diameter through the valve seat and valve guide. Clamp leads from the magnaflux unit to this central conductor. Magnetize with 600-800 amperes alternating current. Repeat these operations for the three remaining valve openings. The inspection medium (powder or solution) may be supplied while the current is flowing or residually (while current is off).

B. Inspection Standard

Magnaflux indications in the areas which are cause for acceptance or rejection of the cylinder head are illustrated as an aid in making a definite decision as to a usable cylinder head and one which should be removed from further service.

1. Indications of cracks on the bottom of the cylinder head around the injector well or valve seat as shown in Figs. 31 and 32 are cause for rejection of the cylinder head.
2. Indications of cracks on inside of the head, such as in the exhaust ports are cause for rejection of the cylinder head.
3. Heads disclosing stud hole cracks in the outer wall as shown in Fig. 33 are usable, unless the crack exceeds 4" in length.

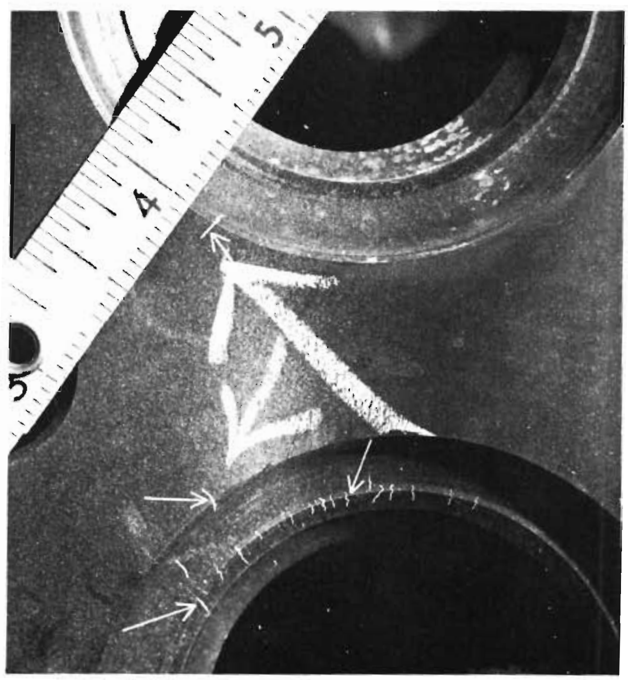


Fig. 31 - Magnaflux Indication Of Cracks On Valve Face

Although the cylinder head may pass this inspection, other considerations should be given in determining its reuse, such as valve seat wear and so forth. For information on these factors refer to the Engine Maintenance Manual.

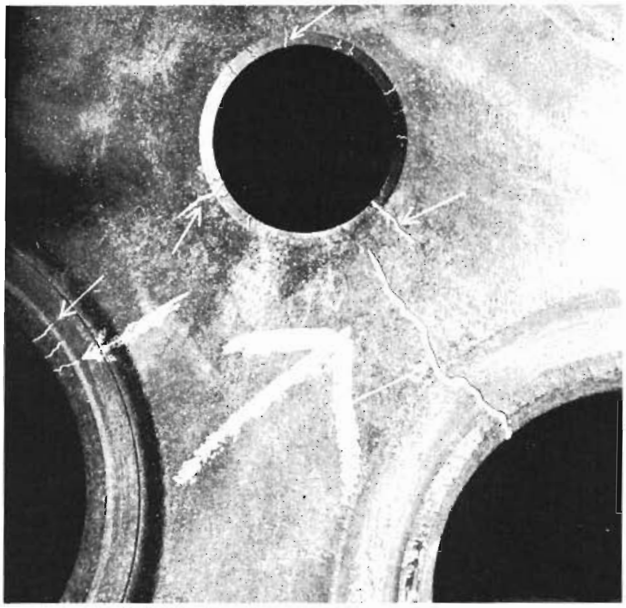


Fig. 32 - Magnaflux Indications At Injector Well And Valve Faces

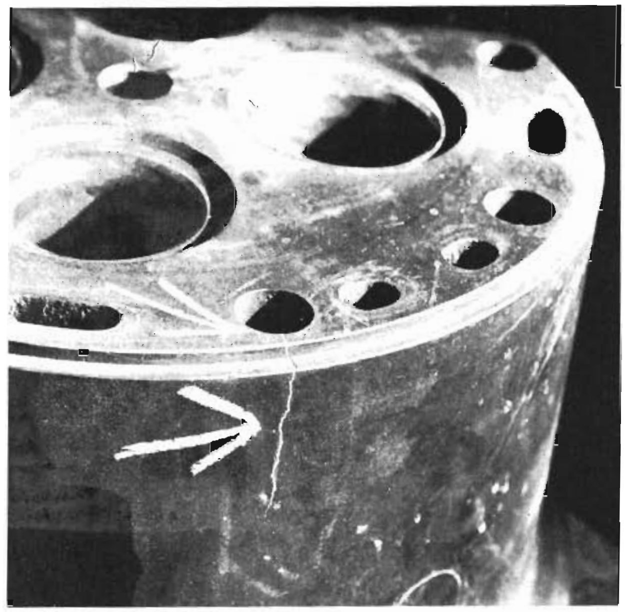


Fig. 33 - Magnaflux Indication At Stud Hole Of Cylinder Head

INSPECTION PROCEDURE - CAMSHAFT

Only camshaft segments and stub shafts that show heat discoloration or signs of distress on the journals require magnaflux inspection and hardness tests. Discoloration on the unfinished portion of the camshaft should be disregarded as it is the result of the manufacturing process as may be seen on a new camshaft.

A. Procedure

The same type of unit used to magnaflux the crankshaft may be used to inspect the camshaft as shown in Fig. 34. However, a 9" diameter coil should be used on the camshaft. Place the coil over the center of a 24" length of camshaft and magnetize with 600-800 amperes of AC current. Proceed along the length of the camshaft in 24" sections until the entire segment or camshaft is magnetized. The current must be shut off before proceeding to each new section. (Moving the coil with the AC current flowing is equivalent to withdrawing the part from the AC magnetizing influence which causes demagnetization.) The inspection material, magnaflux powder or magnaglo, may be applied while the current is on or off.

If the crankshaft magnafluxing unit is not available, the camshaft can be magnetized by making three loops of

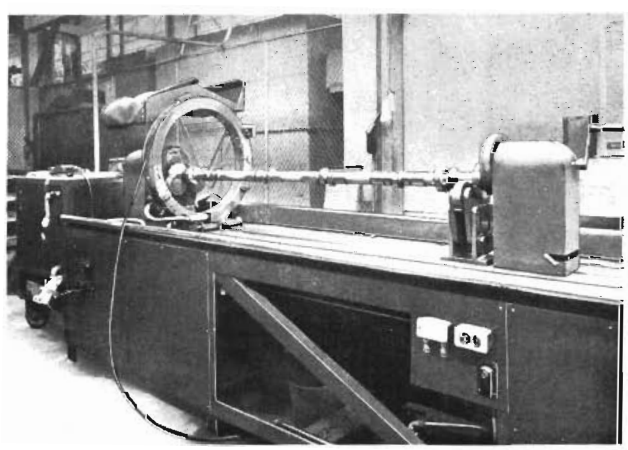


Fig. 34 - Camshaft Magnaflux Inspection

#0000 cable, taped together, using 600-800 amperes of AC current. The magnetizing procedure is the same as is used with the unit, working along the camshaft in 24" sections.

B. Inspection Standard

Thermal cracks or heat checks on any journal are cause for rejection of the camshaft.

Hardness values on the journals and cams should be checked using a Shore scleroscope. Hardness values below 73 Shore scleroscope (Rockwell "C" 55) on any journal or cam are cause for rejection of the camshaft.

NOTE: The outer edges of the journal may drop off slightly due to the tempering effect of hardening the adjacent cam.

INSPECTION PROCEDURE - ENGINE GEARS

A. Procedure

Clamp the gear between the contacts of the magnaflux unit as shown in Fig. 35, so the current will pass through at right angles to the bore. Magnetize with two "shots" of 800-1000 amperes AC current. Revolve gear 90° and repeat magnetization applying the magnaflux material during the time current is flowing.

If a magnaflux unit is not available, the inspection may be made by placing a three turn coil of #0000 flexible cable around the gear and magnetize with 200-300 amperes. The powder should be applied while the current is flowing.

B. Inspection Standard

The purpose of the magnaflux inspection of the gears is to detect fatigue cracks which may develop in service. Fatigue cracks reject the gear, and they usually occur in the root area of the teeth.

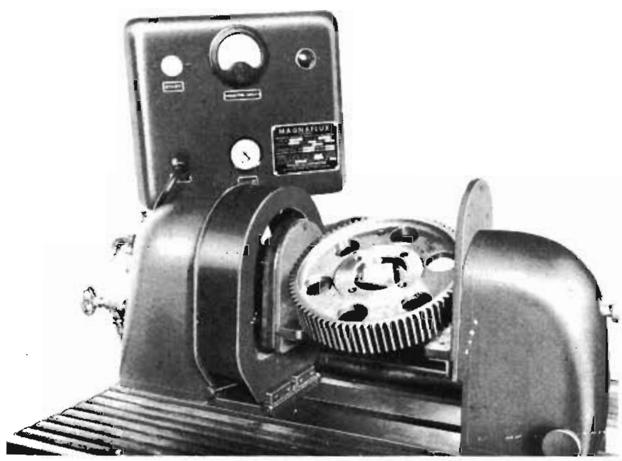


Fig. 35 - Gear Magnaflux Inspection