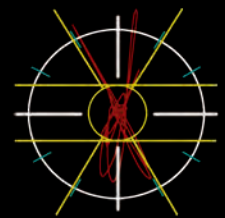




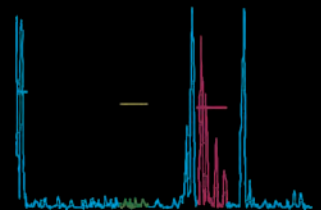
NDT of Tube ■ Bar ■ Wire ■ Parts



Flux Leakage



Eddy Current



Ultrasonic

OVERVIEW

Magnetic Analysis Corporation



*Joseph Vitulli
President*

Magnetic Analysis Corporation has been a leader in nondestructive testing since 1928. We developed the first American-made system using electromagnetic principles for the detection of flaws in steel products. Since 1980, I have seen MAC endure market shifts and economic turmoil, while continuing to implement the state of the art innovations demanded by the metals industry. MAC has grown to be one of the foremost world-wide suppliers of eddy current, ultrasonic, and flux leakage test instruments as well as multi-mode inspection systems for testing metal tube, bar, wire and parts.

We are production-oriented in our approach - from individual test instruments to completely automated inspection systems. Over eighty years of in-plant experience have made us aware of our clients' concerns for reliability and simplicity of design, with minimal operator supervision. The results are seen in plants throughout the world.

Our design engineers are based in our home office in Westchester County, New York, and at MAC's Nordic plant in Östersund, Sweden. Our manufacturing operations in New York and Boardman, Ohio are ISO 9001:2008 certified and our facility in Östersund produces CE compliant systems, all to ensure the highest quality for your installation.

MAC maintains an international staff of support technicians and engineers to provide superior customer service. We are here to provide you with a free quote on systems from simple to complex, and countless custom solutions to fully satisfy your needs. You may also contact MAC for local contact information worldwide, training of personnel, lease options, and other NDT needs. We look forward to helping your company reach its maximum potential.

Sincerely,
Joseph Vitulli, President

MAC Worldwide

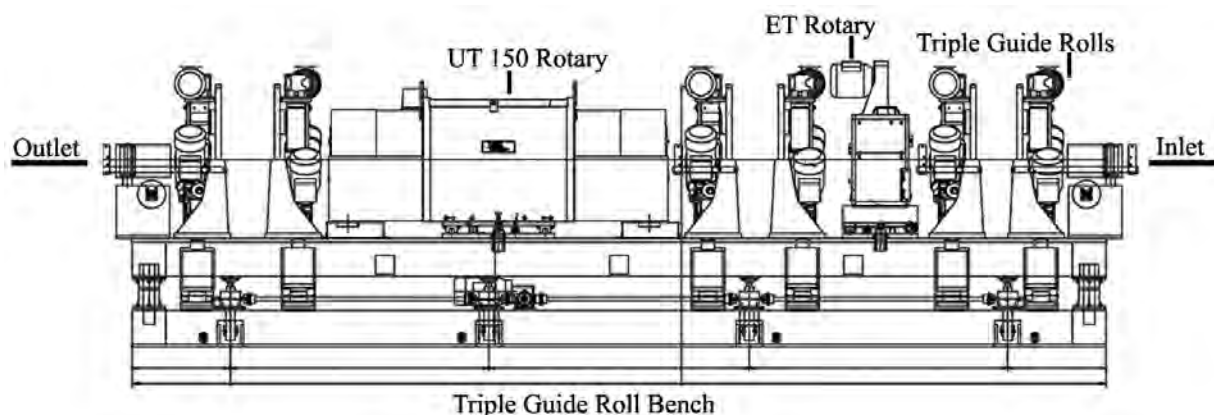
MAC's experienced Field Engineers are based in the United States, Europe, Australia, and China. Knowledgeable and trained representatives are located in Argentina, Brazil, Chile, India, Korea, Mexico, Russia, Romania, South Africa, Spain, Thailand, Turkey, and the Ukraine. They can:

- Consult on test system selection
- Train operators and QC personnel
- Install equipment
- Maintain, repair and calibrate equipment

Visit us at www.mac-ndt.com

E-Mail: info@mac-ndt.com

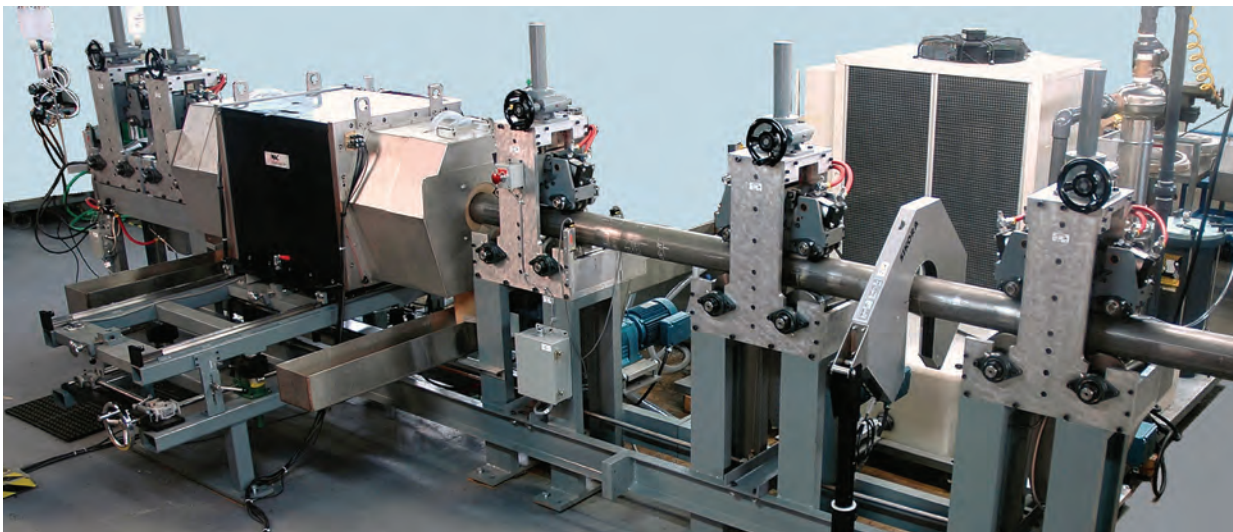
Phone: 800-4NDT MAC (800-463-8622)



MAC Eddy Current, Ultrasonic and Flux Leakage Instruments and Systems

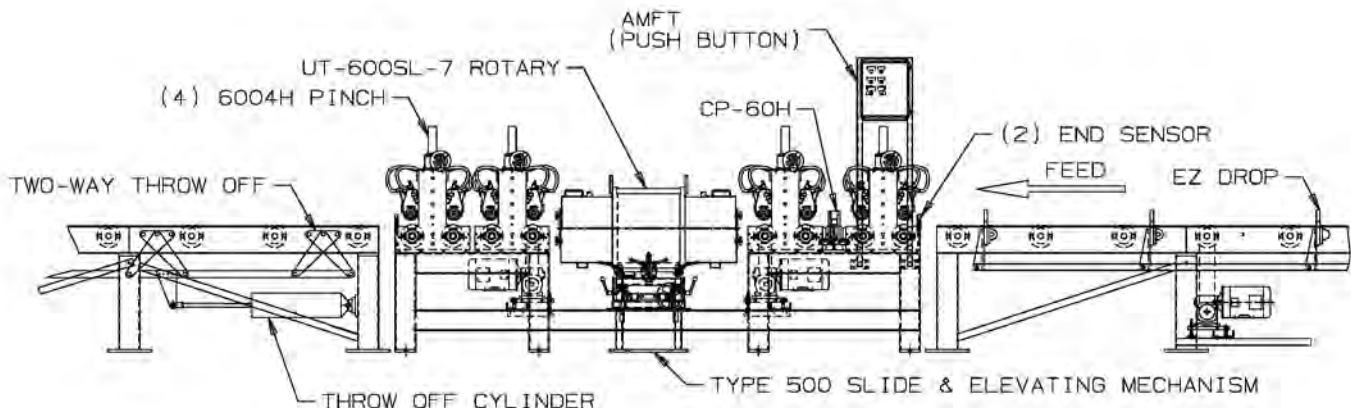
Magnetic Analysis Corporation produces a complete line of non-destructive testing instruments and systems.

- Eddy current, ultrasonic and flux leakage test instruments and inspection systems
- Inspect bar, rod, tubing, wire, strip and metal parts on- or off-line
- Detect surface, subsurface, internal, ID and OD defects
- Measure wall thickness, OD, ID, ovality and eccentricity in tube and pipe
- Detect variations in alloy, heat treatment, hardness, grade
- Designed for production-line use
- Custom fixtures, controls, or complete systems can be designed to meet special needs



Unique MAC Lease Option

MAC offers short and long term operating leases on most standard test systems. Installation assistance, training and service by MAC's own Field Staff is provided as part of the lease agreement. Service contracts or pay per visit arrangements are also generally available for systems that have been purchased.



TESTING SYSTEMS

Typical Applications

Designing a Test System for Your Needs

Testing isn't about rejecting product. It's about shipping the maximum amount of product that meets your customer's specifications — each and every time. Your test system should be designed for your particular application, whether you must meet the most exacting customer requirements or are testing to your own internal standards to maintain your quality reputation.

Simple Test Systems

Eddy Current Testers

For many applications, a simple eddy current test instrument can meet your specifications. Copper water tubing, for example, is often tested for surface cracks, pinholes and other defects, in conjunction with a coiler or recoiler using a one- or two-channel instrument such as the **MultiMac**[®]. A Coil Platform to hold and position the test coil may be all that is needed to complete the system.

Eddy current testers can be installed in line with many production operations, such as welding, drawing, straightening and cold forming. Insulated wire and cable can be tested for breaks or welds with a simple tester such as the **Minimac**[®].

Ultrasonic Testers

For some simple ultrasonic test applications, a two or four channel **Echomac**[®] **FD-4** with fixed transducers may be sufficient for mounting on your weld line with irrigated test shoes, a bubbler or similar couplant device, or with an existing "spin the tube" immersion system for full body coverage.

Meeting More Demanding Test Specifications

By combining one or more eddy current, ultrasonic or flux leakage testers with sophisticated electronic controls and precise mechanical components for handling and positioning your material and test sensors, you can achieve optimum performance on even the most difficult test applications at production speeds.

WELDED OR SEAMLESS STEEL TUBE OFF LINE

A typical test station for inspecting welded steel tube might include an **Echomac FD-4** and **Echomac Rotary** ultrasonic test system to measure wall thickness and detect longitudinal defects, such as incomplete welds; a **MultiMac** eddy current test to detect small, short incomplete welds, inclusions, voids or cavities; a **Varimac**[®] electromagnetic comparator for checking alloy; **Coil Platforms** and **Elevating Tables**, **Automatic Markers**, a **Learn Drive** with **Auto-Diameter** for automated adjustments of timing and positioning; and a **Feed System**, with feed table, accept and reject pockets.



Combined encircling coil eddy current and ultrasonic test on welded steel tube. Eddy Current coil is at right with the tall handle, UT transducers are in the black enclosure near center. Monitors for the Echomac FD-4 and Eddy Current instrument are at center, above.

WELDED STAINLESS ALLOY TUBE ON LINE

An eddy current test for stainless steel tube could incorporate a dual channel tester providing two separate coils testing at different points on the line to detect weld zone defects and to inspect the full circumference for base metal defects. Test components would include the **MultiMac** with two channels, an encircling test coil and a sector test coil and Coil Platforms.

CARBON STEEL BAR TEST STATION

A system for inspecting barstock might include a **MultiMac** eddy current encircling coil test for short surface defects and a rotary probe test for long, continuous defects; a **Production Comparator** for checking grade changes; **Automatic Markers**; **Learn Drive**; and **Auto Diameter** for fast changeovers between sizes; a **Coil Platform**; a **Demagnetizer** to eliminate residual magnetism; and a **Feed System**. For shaped material such as hex or rectangular, a special **Drive Mechanism** would be included.

TESTING ABOVE THE CURIE POINT IN ROLLING MILLS

The **Rotomac® BQ** can operate in extreme conditions, such as above the Curie point. This eddy current system combines stationary and rotating probes that can be mounted directly in a hot rolling bar mill to detect seam type defects.

TESTING PLATE, STRIP AND SHEET

MAC has both eddy current and ultrasonic custom test systems for inspecting ferrous and nonferrous plate and strip. Eddy current systems can test for surface defects while ultrasonic systems have been designed to do 100% inspection for lamination type defects on plate and strip up to 5 meters in width. Ferrous inclusions in nonferrous sheet can be detected with MAC's flux leakage test technology.

MEETING INDUSTRY STANDARDS FOR OIL COUNTRY TUBE AND PIPE

An increasing demand for heavy wall tube for OCTG applications has resulted in developments in flux leakage technology that allow detection of transverse as well as longitudinal defects. Systems incorporating both flux leakage and ultrasonic tests provide the most comprehensive inspection.

A recent MAC-designed system utilized a rotary **Rotoflux®** unit for the longitudinal defect detection, and a second rotary **Rotoflux** unit for the transverse defect detection. A fixed **Echomac FD-4 UT** tester measures wall thickness, while a second **FD-4** tester detects laminations. Additional components in the system are a **Demagnetizer** and articulating roll feed system for upset pipe ends. All components are installed on a **Triple Roll Guide Bench**.

INSPECTING INSULATED CABLE FOR DISCONTINUITY AND WELDS

For detecting discontinuities and butt welds in single and multi-conductor insulated cable and wire, a one-channel eddy current tester such as the **Minimac® MAC 40** is frequently used.

A high frequency option is available to detect welds or brazes in small diameter stranded wire. A **Coil Platform** such as the **CP 10** or **15** would be appropriate for a typical diameter cable and wire.



A combination Ultrasonic and Eddy Current inspection system for detecting defects in bar. The system is complete with a demagnetizer and a "V" Roll Dual Pinch test bench.

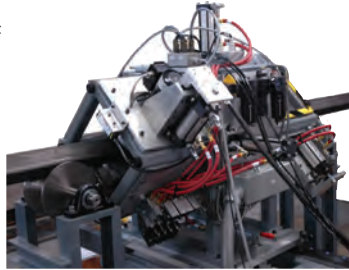
TESTING SYSTEMS

Typical Applications

ROUND & SQUARE BILLET TESTING

MAC recently developed an ultrasonic billet test to inspect for internal defects in hot rolled 9" (228.6mm) square billets and round bars up to 9" (228.6mm) diameter, and an eddy current test to detect flat surface and corner defects of square billets.

The UT system uses 36 channels of **Echomac FD-4 UT** electronics with custom built mechanics. The eddy current system includes custom designed mechanics, 8 channels of **MultiMac** electronics with rotary probes for the flat surfaces, and 4 sector coils for the corners.



Eddy Current Square Billet Tester

DETECTING FERROUS AND NON-FERROUS INCLUSIONS IN ROD, TUBE, OR SHEET

When production processing results in unwanted ferrous inclusions that may cause corrosion and failure in the end use product, a flux leakage test, incorporated with an eddy current test may be the answer. Use of flux leakage allows penetration of relatively thick portions to detect the presence of ferrous inclusions. An eddy current test, particularly on small diameter material, allows inspection of the cross section for non-ferrous inclusions or other defects. Both flux leakage and eddy current detectors can be incorporated in a single coil structure operating through the **MultiMac** tester. A common application is the inspection of aluminum or copper rod on a rolling mill.

PARTS TESTING

Standard parts test systems usually utilize the **Varimac**® eddy current comparator with one of MAC's parts sorting gates, shown at right, to separate the parts into three categories — above spec., below spec., or acceptable.



Fasteners, bearings and similar parts can be inspected for conditions such as hardness and alloy with this basic system.

CUSTOM INSPECTION SYSTEMS

For many critical parts, custom designed test systems are necessary. MAC has designed custom systems to test bearing races, automotive parts, non-ferrous strip, plate and military ordnance products, among others.

Custom system can incorporate multiple tests and different technologies along with suitable mechanical handling components and system controls.



A combination Ultrasonic and Flux Leakage (MFL) system for inspecting large diameter, heavy wall oil country tubular goods (OCTG). The system includes a UT rotary, a transverse MFL and longitudinal MFL.

MAC ISO Accredited NDT Test Facility

- Encircling coil or rotary probe eddy current tests
- High speed rotary ultrasonic tests
- Detect surface, subsurface & internal defects
- Measure or check alloy, grade or hardness
- Measure wall thickness in tubing to .0001"
- Meet industry specifications, including ASTM E-213,
- Test and return ship your product as fast as 48 hours

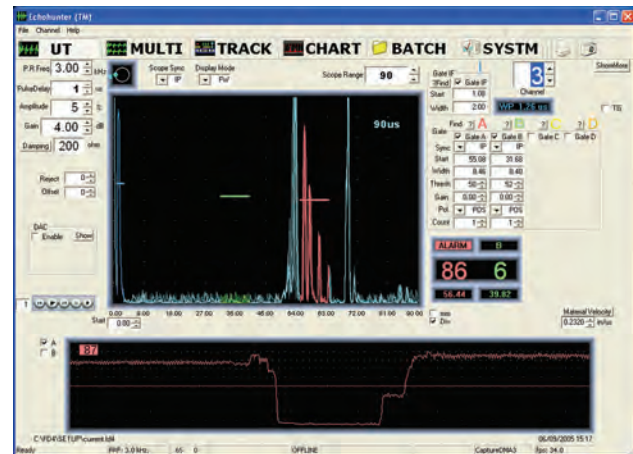
Contact MAC at (330) 758-1367
Boardman, Ohio Test Facility



Steel bar being eddy current tested in MAC's Ohio Lab

Ultrasonic Testers for Surface and Internal Flaw Detection and ID, OD and Wall Thickness Measurement

In ultrasonic testing, high-frequency sound vibrations are transmitted into material by a transducer. The tester analyzes the signals which are received using a pulse-echo or through-transmission method. In pulse-echo, the transducer is also the receiver and analyzes the reflected signal with respect to amplitude and time. In through-transmission, the signal is received by a separate transducer which analyzes the amplitude loss of signal.



Echomac® FD-4 UT A-scan display of OD surface notch 0.3mm deep

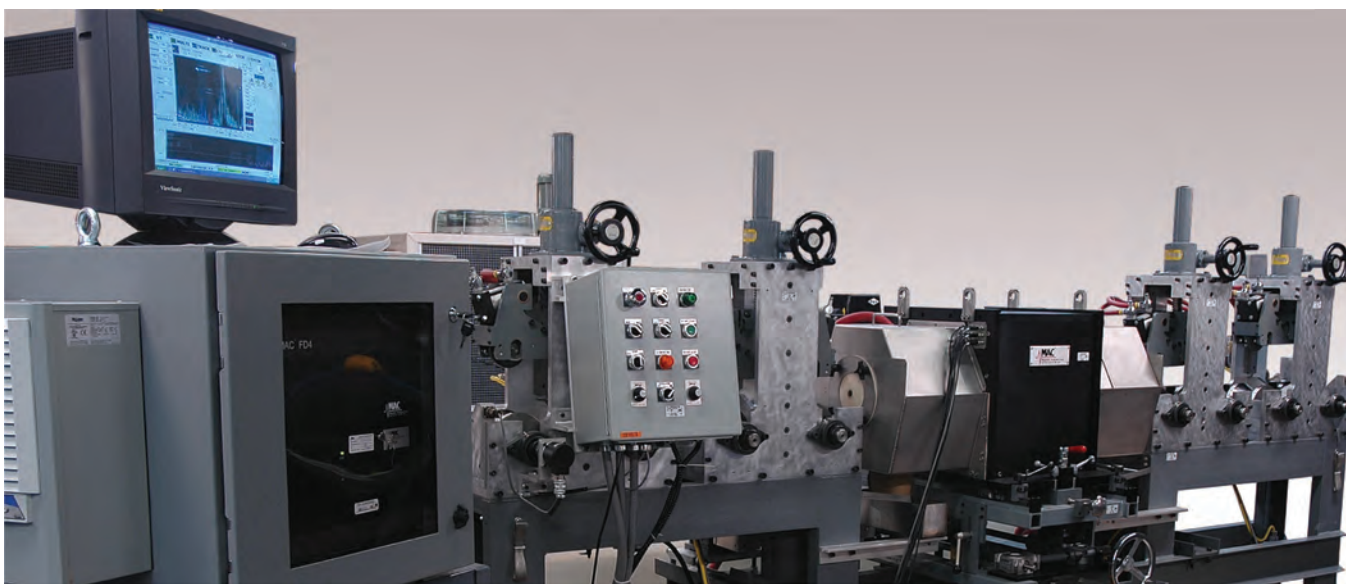
ECHOMAC® FD-4 INSTRUMENTATION

FD-4 instruments can be configured with up to 32 simultaneously synchronized channels. Provides outstanding performance for in-line user configured flaw detection, ID, OD and thickness measurement for each channel. Operates with longitudinal or shear waves. Full network support for remote viewing and control.

MAC's proprietary software controls the instrumentation, displays setup parameters and simultaneous A-scan and strip chart for all channels. Features two independent flaw gates in each channel. The FD Series can be used with rotary, immersion, squirter, bubbler or other type ultrasonic systems. Older UT instruments can be upgraded without replacing transducers.

MAC ULTRASONIC ROTARY

The ECHOMAC UT rotary provides ultrasonic inspection at high throughput speeds. Rotating transducers are available for shear wave configuration (surface and subsurface defects) and compression-wave configuration (internal defects and dimensional measurements such as wall thickness). Standard models are available for inspecting material from 1/4" to 14" (6.35mm to 360mm) in diameter at test speeds up to 400 fpm, depending on the size and condition of the material.



A 4" capacity ultrasonic inspection system. FD-4 electronics are at left. Rotary transducers are mounted in the black housing with enclosures for water couplant on either side. Pinch stands position and drive the material through the test.

EDDY CURRENT

Eddy Current Inspection Systems

Eddy Current Inspection Systems to detect transverse, non-continuous, and longitudinal, seam-type flaws

MAC eddy current inspection systems integrate computer based test instruments; test sensor coils or probes; coil platforms or rotaries; and other mechanical handling and controls to ensure the best test for your product.

MULTIMAC®

Multi Channel Tester for use with Encircling/Sector Coils or Rotary Test Probes

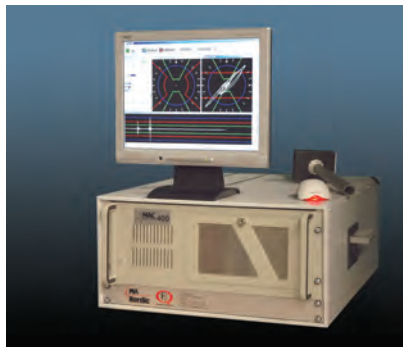
The versatile MultiMac® is the solution for applications requiring detection of transverse, non-continuous and/or longitudinal, seam-type surface defects.

Features include up to 8 test channels in any combination, a broad test frequency selection from 1KHz to 5MHz, and a superior graphical interface. The instrument is a high speed, industrial quality computer with Windows® Operating System and MAC's proprietary software. The MultiMac SM is also available as a smaller, 4 channel instrument with built in touch screen.

MultiMac can operate on a wide range of non-magnetic products, or use magnet coils or direct current saturation to inspect magnetic material. End suppression circuitry, when combined with an optional sensor, can be used to prevent false signals from leading and trailing ends in cut length material.



MultiMac with built in monitor and air conditioning. Also available in a smaller cabinet with built in touch screen monitor.



MAC 400 with optional monitor

MAC 400

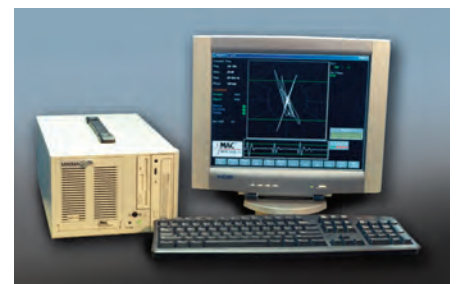
Multi Channel Tester for use with Encircling/Sector Coils

The multi frequency MAC 400 provides up to 4 independent test channels for detecting transverse, non-continuous defects. Windows®-based test results and settings are displayed in large on-screen windows on an optional monitor. Easy to use "drag and drop" setting capability on a touch screen with pen, mouse, or keyboard entry; fully networkable.

MINIMAC® MAC 40

Economic Single Channel Dedicated Application Tester

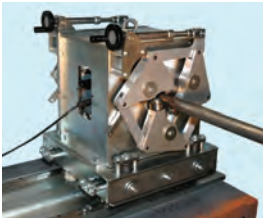
Designed for continuous production testing where simple setup, without critical operator adjustment, is desired. Selective circuits include phasing, filtering, sensitivity and frequency. Test data can be saved, transferred and printed using an optional monitor and choice of keyboard or keypad. Networkable, the Minimac inspects magnetic and non-magnetic tube, wire and bar stock at speeds up to 4000 fpm.



Minimac MAC 40 with optional monitor

Selecting the Appropriate Test Sensors

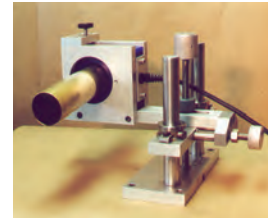
Eddy current test sensors interact with material under test to provide data which is processed by the instrument. Two primary types of eddy current sensors are encircling/sector coils, and rotary test probes.



65mm Coil Platform, to be used with encircling or segmented eddy current applications, uses an electromagnetic coil to saturate the material.

Encircling or Sector Test Coil Technology

In encircling/sector coil technology, the product under test passes through or adjacent to an electrical test coil which has been excited by an alternating current. This induces a flow of eddy currents around the test material, or, in the case of a sector coil, in the area under the coil. Short, intermittent anomalies or flaws cause a variation in the eddy current pattern which the instrument detects. Absolute, differential, or combinations of both coils are available.



Encircling Coil mounted in a CP 30 Coil Platform

Typical Applications

Encircling/Sector Test Technology

- Detect short surface and some subsurface defects, on or off-line, in magnetic and non-magnetic wire, bar and tube
- Inspect welded tube for short ID or OD defects in the weld zone or on the full circumference
- Test uniform cross sectional material, including squares, rectangles, hex and round
- Inspect small diameter wire or tube for short defects
- Check continuity and locate welds in single and multi-conductor insulated wire and cable



354 Tangent Coil Platform for testing welded tube

Rotary Probe Technology



E-Rotary

In rotary probe technology, the product under test moves longitudinally through the rotating test probes resulting in a helical search pattern. As the probe passes over a defect, variations in the induced eddy current pattern are detected. The minimum flaw length, which can be consistently detected, is a function of the rotary speed of the probe and the throughput speed of the material.

Current MAC rotaries feature continuously variable high-speed rotaries (1800 - 6000 RPM) and multi-probe headplates to detect shorter defects without sacrificing throughput speed. Similar results can be obtained by holding the test probe stationary and rotating the material past the probe. Rotary testing is the method of choice for detecting seam type surface defects in non-magnetic and magnetic grades of wire and bar. MAC has rotary mechanics for up to 7-1/2" (191mm) diameter material.



750 Rotary

Typical Applications

Rotary Test Technology

- Detect seam type surface defects in cold drawn wire or cut length bar stock
- Inspect in line with continuous wire operations such as wire drawing, parts forming, re-spooling, or straight and cut
- Inspect cut lengths, usually off-line
- Test parts, such as small shafts and bearings, for longitudinal surface defects

FLUX LEAKAGE

Rotoflux® Test Systems

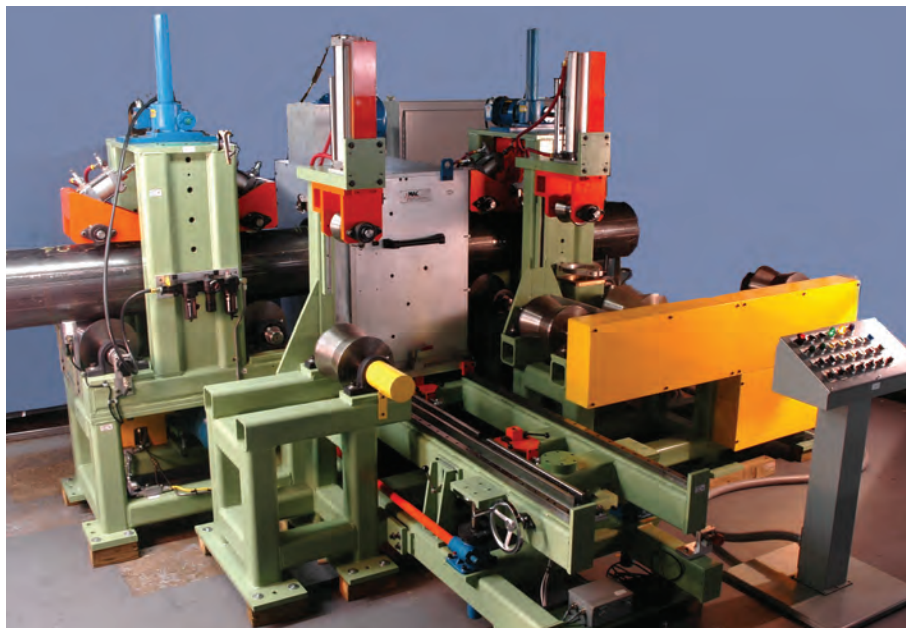
Flux Leakage Testers to Detect Transverse & Longitudinal Flaws in Heavy Wall Magnetic Tube

Flux leakage instruments detect distortions in normal flux patterns caused by defects when the material is saturated by a magnetic field. Because ID defects tend to produce lower frequency signals than OD defects, separate channels and filters permit identification of both types of flaws. This technology is particularly effective on heavy-wall tubes used in OCTG applications.

ROTOFLUX®

MAC's Rotoflux systems now include the world's first rotary flux leakage transverse defect detection capability. With 48 channels, the system meets demanding industry standards for heavy wall tube. 24 test channels provide longitudinal testing with 24 channels of OD and 24 of ID simultaneously displayed on the test screen. A strip chart display shows the maximum ID and OD signals.

Present systems detect longitudinal and transverse defects in tube from 2" (50mm) to 16" (406mm) diameter and 3/4" (19mm) wall. Electronics can also detect ID, mid-wall and OD defects in magnetic parts.



16" Rotoflux Electronics

16" Rotoflux System with 24 channel multiplex electronics and 24 test probes for inspecting heavy wall pipe.

The heavy duty welded steel system includes a built in calibration station, and a jib crane for handling the standard calibration piece.

Typical Applications

Ultrasonic Testers

- Demanding tests for surface, subsurface and internal defects in bar, billets, wire and plate
- Sophisticated test for ID and OD defects, ID and OD diameter, and wall thickness in tube and pipe
- Replace and upgrade existing electronics in rotary, immersion or other couplant type systems
- Inspect hex, square or round barstock for internal flaws that are not detectable with eddy current

Flux Leakage Testers

- Heavy wall ferrous oil & gas tube and pipe
- Ferrous parts such as piston rings

COMPARATORS & ANCILLARY EQUIPMENT

Magnetic Analysis Corporation

COMPARATORS

Detect Variations in Physical Characteristics

Electromagnetic comparators detect and sort materials by variations in the amplitude or phase of an induced signal created by changes in the test piece's physical characteristics.

VARIMAC® COMPARATOR

Eddy Current Comparator
Used to detect variations such as alloy, heat treatment, hardness, some dimensions and certain types of cracks in metal, particularly parts. Used with MAC Part's Gates, parts can be sorted and counted at speeds up to six parts per second into three separate groups. Selective circuits allow precise adjustment to provide optimum separation.



Varimac V

PRODUCTION COMPARATOR

Electromagnetic Comparator

A sensitive low-frequency instrument with highly selective circuits which permit it to distinguish between changes in test signal phase, amplitude or harmonic distortion. Highly selective acceptance within a narrow range can be achieved. New optional multi-frequency software allows simultaneous analysis of 8 frequencies to meet complex test requirements. Used to detect variations in case depth, core hardness, grade and structure in carbon steel products.



*Production Comparator
PC-VI with
multi-frequency display*

HANDLING & FEED COMPONENTS

Modular & Custom Feed Systems

For testing barstock, tubing or pipe, MAC offers standard modular feed and runout tables to handle sizes ranging from 1/8" to 7-1/2" (3mm to 191mm).

MAC also offers custom design feed and handling systems for many specific applications, including for material up to 14" diameter. These systems can include conductor controls to allow complete command of the test bench, multiple test instruments and pinches. Extensive input/output configurations can be handled by programmable logic controllers (PLC).



Easy Down Receiving Pocket

COIL PLATFORMS, DRIVES & BENCHES

Mechanisms to precisely hold and position test instruments, test coils or probes, and drive the product through the test, are essential for accurate, consistent test results. MAC offers a wide range of coil platforms, drives, elevating platforms, constant center benches and other accessories.



Constant Center Triple Guide Roll Bench

DEMAGNETIZERS

Used to eliminate unwanted magnetism that develops during production, or residual magnetism from test operations. Operate at relatively high speeds. Available for any material which can pass through a 9" (228 mm) diameter coil.



EDDY CURRENT ■ ULTRASONIC ■ FLUX LEAKAGE

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