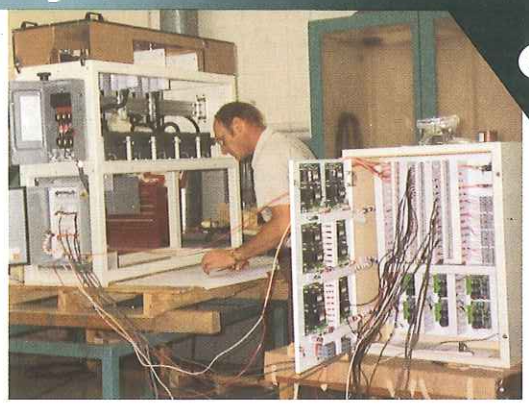
Enercon Corona Treating Systems

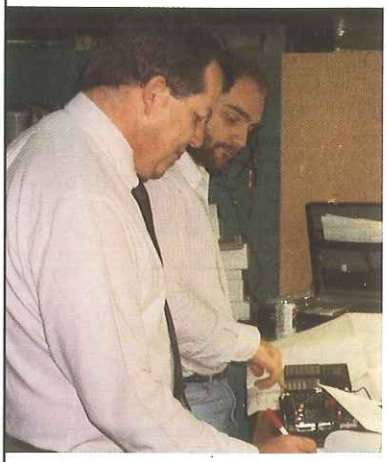
the enercon edge

A Philosophy..... borne of excellence..... rooted in our people.... & driven by technology.

Station pneumatics are setup on the test floor.



Complex controls for special system receive final test.

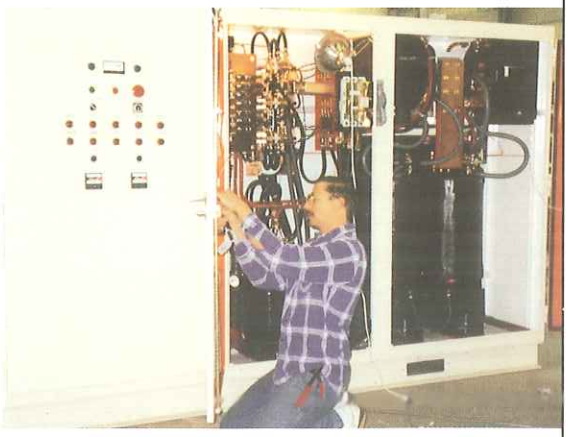


Engineers resolve a problem.

New 9000 power supply being assembled.

Sales engineer explains system features & benefits to customer.

R&D never ends at Enercon.



Large power supplies provide an engineering & manufacturing challenge.

Our modern plant provides 35,000 square feet of engineering, test and manufacturing capability.

enercon®
INDUSTRIES CORPORATION

P.O. Box 773
Menomonee Falls, WI 53052
Phone: 414/255-6070
FAX: 414/255-7784

Enercon Corona Treating Systems

ENERCON INDUSTRIES: A COMPANY PROFILE

the enercon edge

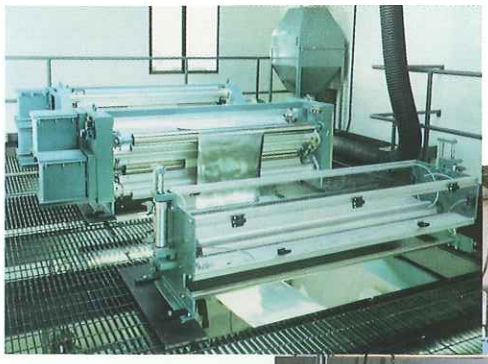
A Philosophy..... borne of excellence..... rooted in our people.... & driven by technology.

Enercon Industries, the leading manufacturer of corona treating equipment for the converting, plastics and packaging industries, also supplies 3-D plasma surface treaters and induction cap sealing systems.

The company, founded in 1974, designs, manufactures and markets all its products from a 35,000 square-foot headquarters in Menomonee Falls, Wisconsin.

Enercon manufactures standard and custom built bare-roll and covered-roll corona treating systems for both conductive and non-conductive materials, from narrow web to ultra-wide web. Marketed to plastics, converting and textile industries, Enercon systems are powered by our new line of Compak power suppies. This universal design provides automatic control that is capable of total load matching, a feature that enables the unit to adjust to any size load automatically.

To help customers determine sizing data and power requirements for particular applications, Enercon Industries has established separate cap sealing and corona treating labs at its headquarters. Both labs are fully equipped with experienced Enercon personnel on-site to aid in testing.



Corona Treating Technical Test Center.

Engineering product manager inspects every unit before shipment.

Large ceramic covered-roll being installed in station frame.

Every system is electronically tuned prior to shipment.

Enercon Corona Treating Systems

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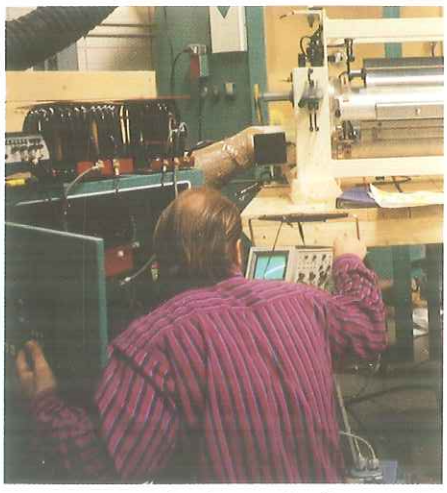


Every system is electronically tuned prior to shipment.

Enercon Corona Treating Systems

The Bare-Roll "H" Station:

Ceramic Electrode/Coated-Roll Treaters for High Level Treatment

Station Sizes and Configurations

a) Wide web width capability.
b) Line speeds up to 2000 fpm single or double side treatment.
c) Purged stations are available for use in hazardous atmospheres.

Station Construction

a) Rugged mechanical construction. Aluminum shield protects the electrode and provides operator safety.
b) Components constructed of steel and aluminum for maximum operational life in industrial environments.
c) Ozone removal and electrode cooling are an integral part of the electrode assembly design.

Station Features

a) Save cost of a spare dielectric roll since it is no longer necessary.
b) No loss of film or production time due to small roll covering pinholes. Keep operating and repair roll when convenient.
c) Treater roll size (diameter) is reduced.
d) Universal system—treater any web—plastic, foil, metalized film or paper.
e) Exhaust system provides for both ozone removal and electrode temperature stability.
f) Ceramic Electrodes have a substantially increased life and provide a high degree of operator safety.

Station Options

Through the use of the "H" System, multiple electrode assemblies, nip roll, idler rolls or a combination of these features, stations are available for:

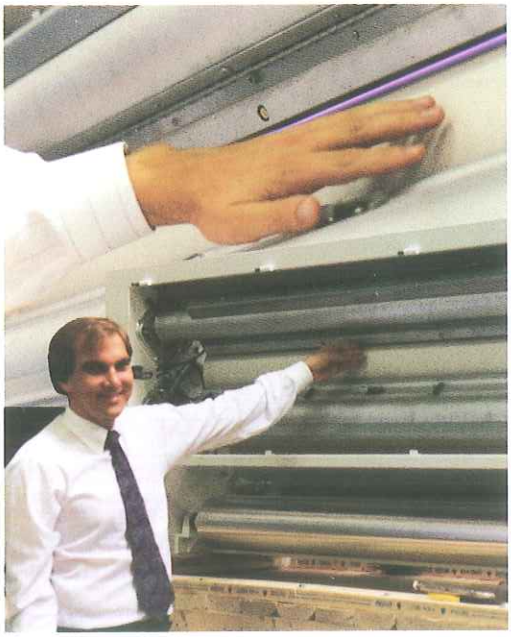
a) Enhanced treatment for hard-to-treat material.
b) Applications where backside treatment is a potential problem.
c) Applications where wrinkling is a potential problem.
d) Electrode assembly mounted over existing idler roll where space is almost non-existent.

System Options

a) Proportional speed and watt density control.
b) Remote control panel.
c) Computer interface.
d) Power Supplies: 16 models cover a range from 1 kW to 100 kW.
e) Ozone-Ex™ Ozone Eliminator.

Standard Features	Benefit
Electrode Safety Interlocks	Protect Operators
Zero Speed Switch	Protects Web
Ozone Resistent Construction	Long Operational Life
Separate Low Voltage Circuitry	Long Term Reliability
Duct Connection for Ozone Exhaust	Eases User Installation
Air Flow Switch	Safety Interlock
Integral HV Transformer Mount	No High Voltage Ducting

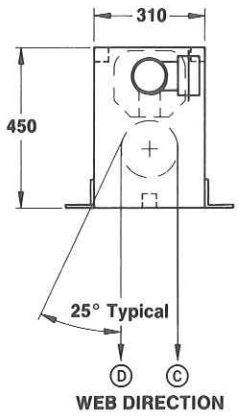
Optional Features	Benefit
Exhaust Blowers	Insures Adequate and Safe Ozone Removal
Extended Shafts	Allows Driven Station
Drives	Engineered to Meet Your Application Requirement
Ozone Elimination Unit	Allows Ozone Free Exhaust to Atmosphere
Skip Treat Control	Solves Heat Seal Problems
Nip Rolls	Help Prevent Backside Treatment
Idler Rolls	Allow Wide Range of Web Entry and Exit Angles



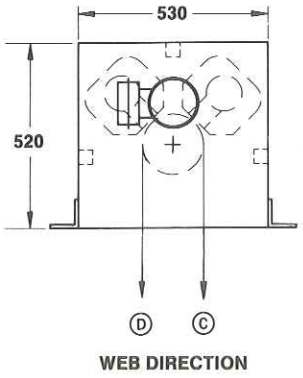
"H" System retains the safety of the Bare-Roll Open Design.

CAUTION: Although there is no danger of high voltage shock, as with any moving web, there is a danger of static shock. Further, it is best not to place your hand in close proximity to any rotating machinery.

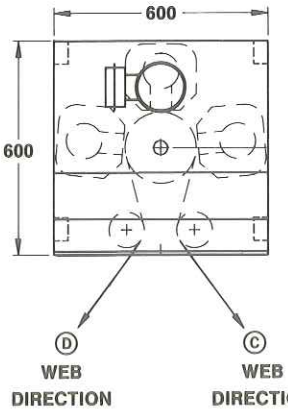
Standard Configurations



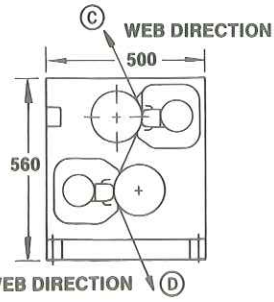
One Electrode Assembly



Two Electrode Assembly



Three Electrode Assembly



One Electrode Assembly Two-Sided Treater

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Enercon Industries Corporation
P.O. Box 773
Menomonee Falls, WI 53052-0773
Phone: 414/255-6070
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A Philosophy..... borne of excellence..... rooted in our people.... & driven by technology.

The New Bare-Roll "H" Station*:

The Bare-Roll "Cover-Up" for "High" Level Treating

Bare-Roll treating, corona treating without a dielectric covered roll, is a significant advancement which Enercon pioneered in 1980. Now, well-known as the experienced leader in Bare-Roll treating, Enercon has continued its research and development of electrode materials and station design to achieve higher levels of effectiveness and efficiency.

The "H" Station is a true "Hybrid" in that it provides all the benefits of Bare-Roll stations while delivering significantly higher surface energy (Dyne) levels.

Enercon Bare-Roll "H" stations feature: an air flow and exhaust system that results in an ozone-safe work area, high-efficiency rectangular ceramic electrodes that provide increased dwell time, and a proprietary roll coating that reduces wrinkling of webs and inhibits oxidation of the treater roll. But, best of all, the "H" Station delivers all the safety of the Bare-Roll system with an open design while providing higher levels of treatment. *And*, Enercon will provide a written guarantee of treatment level based upon your definition of application specifications. You can be sure that your Enercon system is at the forefront of corona treating technology.

Custom Bare-Roll "H" Treater Station: Designed to Treat at 1,500 Feet-Per-Minute.

Standard Bare-Roll "H" Treater

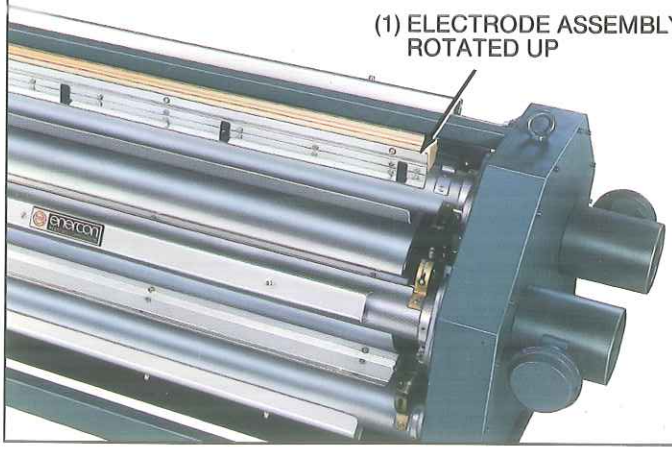
- Superior Treatment Levels.
- Eliminates:
  - Backside Treatment
  - Pinholing
  - Wrinkling on light gauge films.
- Provides Ozone-Safe Work Area.
- Treats Any Web: paper, film or conductive foil/metalized film.
- High Degree of Operator Safety With Open Station Design.
- Lower System Cost.

Hinged Electrode Assembly Option

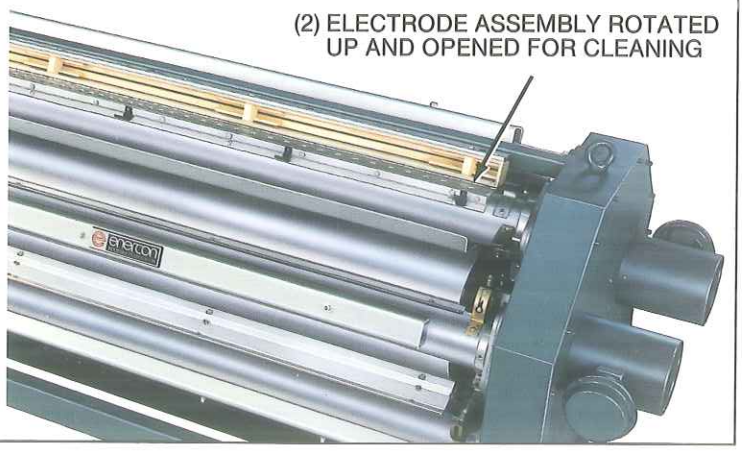
- **EASIER MAINTENANCE**
- **REDUCE DOWNTIME**
- **INCREASE RELIABILITY**

The shroud containing the electrodes is hinge-mounted to the electrode assembly exhaust tube. To clean the exhaust path, merely rotate the assembly up (1), lock into place and unsnap the heavy-duty clips on one side of the shroud. The electrode shroud can then be rotated out of the way (2). This permits easy cleaning of the exhaust air ports and areas behind and between the electrodes without complete assembly removal. This procedure eliminates the need to reset the air gap after each cleaning.

(1) ELECTRODE ASSEMBLY ROTATED UP



(2) ELECTRODE ASSEMBLY ROTATED UP AND OPENED FOR CLEANING



*Protected under foreign patents and US Patent No's. 4,446,110.

Enercon Corona Treating Systems

The Bare-Roll Open* Station:

Ceramic Electrode/Bare-Roll Treaters

Station Sizes and Configurations

a) Web width up to 140 inches.
b) Line speeds up to 2000 fpm single or double side treatment.
c) Purged stations are available for use in hazardous atmospheres.

Station Construction

a) Rugged mechanical construction. Aluminum shield protects the electrode and provides operator safety.
b) Components constructed of steel and aluminum for maximum operational life in industrial environments.
c) Ozone removal and electrode cooling are an integral part of the electrode assembly design.

Station Features

a) Eliminates dielectric covering on treater rolls.
b) Save cost of a spare dielectric roll since it is no longer necessary.
c) No loss of film or production time due to roll covering burn out.
d) Treater roll size (diameter) is reduced.
e) Universal system--treater any web--plastic, foil, metallized film or paper.
f) Exhaust system provides for both ozone removal and electrode temperature stability.
g) Ceramic Electrodes have a life measured in years and provide higher treatment levels.

Station Options

Through the use of multiple electrode assemblies, nip roll, idler rolls or a combination of these features, stations are available for:

a) Enhanced treatment for hard to treat material.
b) Applications where backside treatment is a potential problem.
c) Applications where wrinkling is a potential problem.
d) Electrode assembly mounted over existing idler roll where space is almost non-existent.

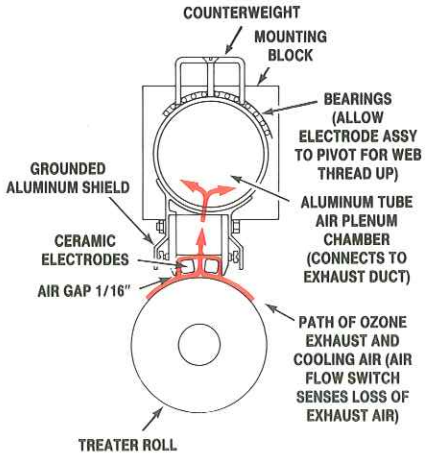
System Options

a) Proportional Speed and Watt Density Control.
b) Remote control panel.
c) Computer interface.
d) Power Supplies: 16 models cover a range from 1kW to 100kW.
e) Ozone-Ex™ Ozone Eliminator.

Standard Features	Benefit
Electrode Safety Interlocks	Protect Operators
Zero Speed Switch	Protects Web
Ozone Resistent Construction	Long Operational Life
Separate Low Voltage Circuitry	Long Term Reliability
Duct Connection for Ozone Exhaust	Eases User Installation
Air Flow Switch	Safety Interlock
Integral HV Transformer mount	No High Voltage Ducting

Optional Features	Benefit
Exhaust Blowers	Insures Adequate and Safe Ozone Removal
Extended Shafts	Allows Driven Station
Drives	Engineered to Meet Your Application Requirement
Ozone Elimination Unit	Allows Ozone Free Exhaust to Atmosphere
Skip Treat Control	Solves Heat Seal Problems
Nip Rolls	Prevents Backside Treatment
Idler Rolls	Allow Wide Range of Web Entry and Exit Angles

Patented Air-Flow Design*



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INDUSTRIES CORPORATION

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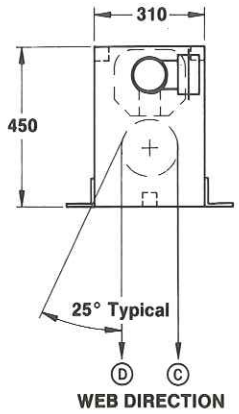
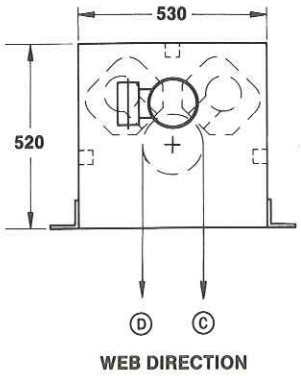
Menomonee Falls, Wisconsin 53052-0773
Phone: 414/255-6070 FAX: 414/255-7784

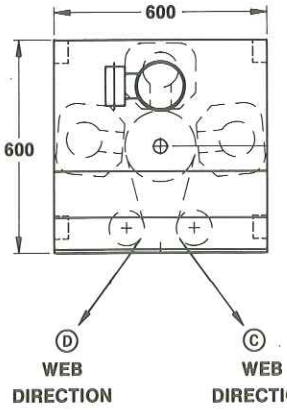
Standard Configurations



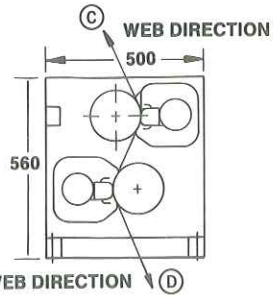
One Electrode Assembly



Two Electrode Assembly



Three Electrode Assembly



One Electrode Assembly
Two-Sided Treater

Enercon Corona Treating Systems

The Bare-Roll Open* Station

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Ceramic Electrode/Bare-Roll Treaters

Bare-Roll treating, corona treating without a dielectric covered roll, is a significant advancement which Enercon pioneered in 1980. Now, well-known as the experienced leader in Bare-Roll treating, Enercon has continued its research and development of electrode materials and station design to achieve higher levels of effectiveness and efficiency while retaining all the benefits of Bare-Roll treating.

For example, Enercon stations feature an air flow and exhaust system that results in an ozone-safe work area, our high efficiency rectangular ceramic electrodes increase treatment levels, and we developed station designs that reduce wrinkling of webs and inhibit oxidation of the treater roll. You can be sure that the product you purchase from Enercon is at the forefront of corona treating technology.

Custom Bare-Roll Treater Station: Designed to Treat Sides at 2,000 Feet-Per-Minute.

Standard Bare-Roll Treater

Bare- Roll Features

- Reliable, Even Treatment at High Line Speeds.
- Eliminates High-Cost, High Maintenance Covered-Rolls.
- Air-Flow System Allows An Open Station For Easy Web Threading.
- High Degree of Operator Safety With Electrically Grounded Roll.
- High-Efficiency Treatment of Non-Conductive & Conductive Webs.

Hinged Electrode Assembly Option

- **EASIER MAINTENANCE**
- **REDUCE DOWNTIME**
- **INCREASE RELIABILITY**

The shroud containing the electrodes is hinge-mounted to the electrode assembly exhaust tube. To clean the exhaust path, merely rotate the assembly up (1), lock in to place and unsnap the heavy-duty clips on one side of the shroud. The electrode shroud can then be rotated out of the way (2). This permits easy cleaning of the exhaust air ports and areas behind and between the electrodes without complete assembly removal. This procedure eliminates the need to reset the air gap after each cleaning.

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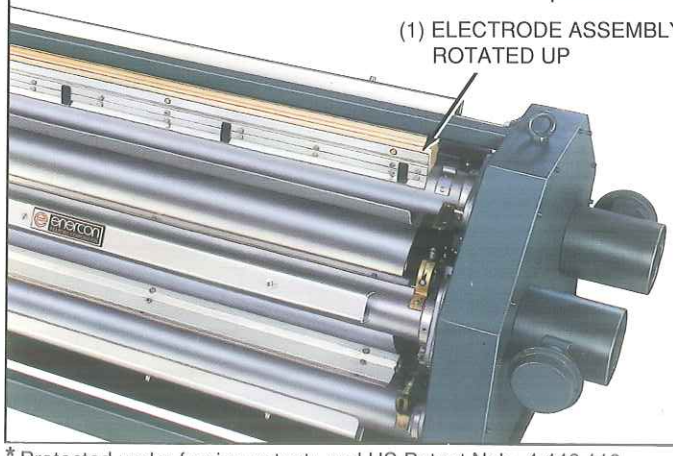

(2) ELECTRODE ASSEMBLY ROTATED UP AND OPENED FOR CLEANING

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Enercon Corona Treating Systems

Universal Compak™ Power Supply

Series 9000: Full Function Control

Specifications

Rating	Dimensions		
	H	W	D
3 kW 5 kW 7.5 kW 10 kW 15 kW	36″	36½″	12″
20 kW 25 kW 30 kW	42″	36½″	12″
40 kW 50 kW 60 kW	60″	42″	16″
75 kW 100 kW	84″	40″	25″

- ***Input Power:***
  460 Volts, 3 Phase, 50/60 Hertz
- ***Output Frequency:***
  Automatically adjusts over wide 5 to 1 load range.
- ***Ambient Environment:***
  Temperature 122°F (50°C)
  Humidity 90% Noncondensing
- ***Controls***
  Membrane Pushbuttons:
  POWER
  AUTO/MANUAL
  LOCAL/REMOTE
  RESET
  START
  STOP
  12 Function Key Pad

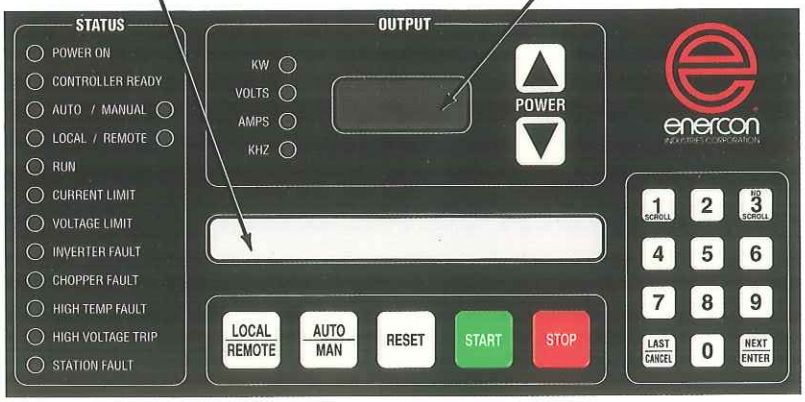
- ***Advanced Protective Circuits Guard Against:***
  Over-Temperature, Over-Current, and High-Voltage.

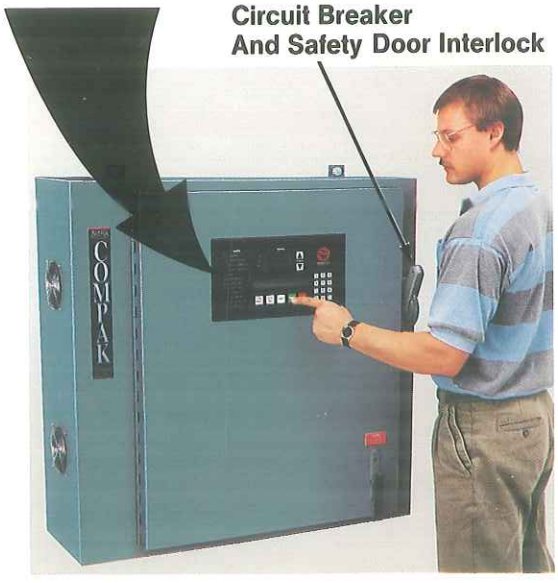
Applications

1. Bare-Roll and Covered-Roll Stations/Systems
2. Wire/Blade/Shoe/Fin/Segmented Metal Electrodes
3. Rectangular, Round or Segmented Ceramic Electrodes
4. Cast, Blown or Tentered Film Extrusion
5. Solvent or Water-Based, UV or EB Converting
6. Extrusion Coating/Laminating or Coating/Laminating Lines

- ***Liquid Crystal Display:***
  80 characters provide prompts and entered data for setup and operation.

- ***Indicators***
  Digital Meter:
  3 digit numeric readout displays Output KW, Volts, Amps and KHZ.





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INDUSTRIES CORPORATION

W140 N9572 Fountain Boulevard • P.O. Box 773 • Menomonee Falls, Wisconsin 53052-0773
(Milwaukee Metro Area) • Telephone (414) 255-6070 • FAX (414) 255-7784

Universal Compak™ Power Supply Series 9000: COS 3.0 Full Function Control

The New Industry Standard

Strong Enough To Carry Any Load: The Enercon 9000 power supply meets the seemingly insurmountable challenge... matching the load requirements of a great variety of electrode types... automatically. Some suppliers solve this problem with transformer taps and other operator initiated adjustments, Enercon achieves true automatic adjustment of output to match a wide range of load conditions. Enercon 9000 offers automatic 5 to 1 load matching range and COS™ 3.0 intelligent software control.

Enercon's 9000 will handle any type of roll or electrode combination; bare-roll to covered-roll and electrodes from blade to shoe type, or tube to segmented.

Small Enough To Fit: Another advantage of these new advances in power supply technology is the ability to pack more effective power into less space. *And,* higher efficiency results in more useful power to the load.

The New Industry Standard: Putting it all together:

- Advanced Technology
- Programmable Operation
- Software Intelligence
- Full Function Control
- User-Friendly, Easy-to-Operate
- 3 - 100 kW in 13 Ratings
- Great Prices... Compak Size

3 to 100 kW Power Available in Compact, Option Packed Packages

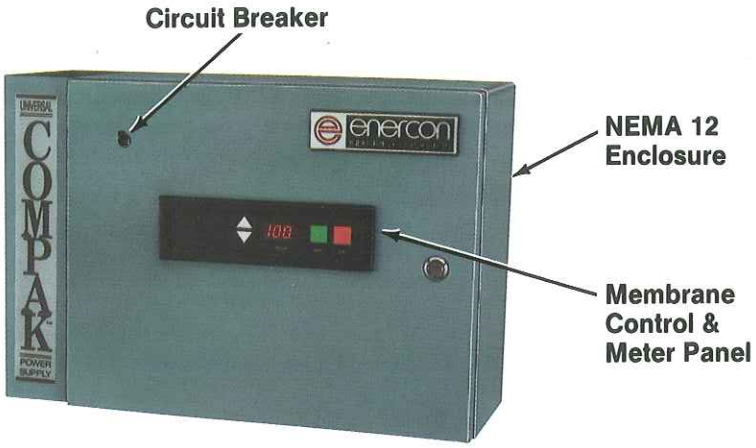
COS 3.0: Corona Operating System Advantages

Standard Features	Benefits
• Broad Load Matching	• Use with any station. • Reduces operator error. • Wide 5 to 1 load matching range versus 2 to 1 max. for typical power supply.
• Membrane Panel Control and Indication	• Digital readout of output **KW, VOLTS, AMPS and KHZ.** • 80 character display provides system status and line speed data. • Enter your input data to set system running conditions.
• Microcomputer Control • Zero Speed Plus	• Easy setup and operation. • Self-checks all interlocks for safe start-up. • Retains setpoints in non-volatile memory. • Allows pre-set stop and start speed.
• System Diagnostics • LTI Plus	• LED's display operating status and fault isolation. • Loss-of-treatment indication and over-treatment indicated.
• Easy Installation	• No Input Isolation Transformer required.

Additional Features	Benefits
• Auto/Manual Mode	• Operational flexibility.
• Programmable a) **Watt Density** b) **Proportional Speed** c) **Treat Width (Covered Roll)** d) **Zero Speed**	• User friendly set-up and control. • Maintains consistent treatment despite line speed or other variables. • All setpoints are retained.
• Local/Remote Mode	• Can be initiated at either control.
• Computer Interface	• Allows integrated central control. • Dual serial port access.

Enercon Corona Treating Systems

Universal Compak™ Power Supply



- ***Output Frequency:***
  Automatically adjusts over wide 5 to 1 load range.
- ***Ambient Environment:***
  Temperature 50°C
  Humidity 90% Noncondensing
- ***Controls***
  Membrane:
  POWER - Pushbuttons (Up/Down)
  START Pushbutton
  STOP Pushbutton
  Circuit Breaker:
  Input Power
- ***Indicators***
  Digital Meter:
  Digital readout displays Output kW.
  LED'S:
  POWER — Green
  TEMP — RED
  RUN — Green
  REMOTE — Green
  FAULT — Red
- ***Advanced Protective Circuits Guard Against:***
  Over-Temperature, Over-Current, and High-Voltage.

Specifications

	Input Power		Dimensions (Metric)		
Rating	**Volts**	**Phase**	**W**	**H**	**D**
1 kW 2 kW 3 kW	115 230 230	1 1 3	24″ (610 mm)	16″ (407 mm)	8″ (203 mm)
4 kW 5 kW	230 230	3 3	25″ (635 mm)	20″ (508 mm)	13″ (330 mm)
All input 50/60 Hertz. (380 V input available as option)					

Full Function Remote Control in a 5″ x 5″ x 12″ enclosure.

This small 10″ x 10″ x 6″ unit provides either Watt Density Control or Computer Interface to the Series 2000 Power Supply.

Applications

1. Bare-Roll and Covered-Roll Stations/Systems
2. Wire/Blade/Shoe/Fin/Segmented Metal Electrodes
3. Rectangular, Round or Segmented Ceramic Electrodes
4. Cast, Blown or Tentered Film Extrusion
5. Solvent or Water-Based, UV or EB Converting
6. Extrusion Coating/Laminating or Coating/Laminating Lines

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The New Industry Standard

Strong Enough To Carry Any Load: The Enercon 2000 power supply meets the seemingly insurmountable challenge... matching the load requirements of a great variety of electrode types... automatically. Some suppliers solve this problem with transformer taps and other operator initiated adjustments, Enercon achieves true automatic adjustment of output to match a wide range of load conditions. Enercon 2000 offers automatic 5 to 1 load matching range and easy membrane front-panel control.

Enercon's 2000 will handle any type of roll or electrode combination; bare-roll to covered-roll and electrodes from blade to shoe type, or tube to segmented.

Small Enough To Fit: Another advantage of these new advances in power supply technology is the ability to pack more effective power into less space. *And,* higher efficiency results in more useful power to the load.

The New Industry Standard: Putting it all together:

- Advanced Technology
- User-Friendly, Easy-to-Operate
- 1, 2, 3, 4, & 5 kW
- Great Prices... Compak Size

1 to 5 kW Power Available in a
NEMA 12, Compact, Cost-Effective Package

Series 2000: Operating System Advantages

Standard Features	Benefits
• Broad Load Matching	• Use with any station. • Reduces operator error. • Wide 5 to 1 load matching range versus 2 to 1 max. for typical power supply.
• Membrane Panel Control and Indication	• Digital readout of output **kW.** • Easy setup and operation. • Self-checks all interlocks for safe start-up. • Retains setpoint in non-volatile memory.
• System Diagnostics • LTI Plus	• LED's display operating status and fault isolation. • Loss-of-treatment indication.
• Easy Installation	• No Input Transformer required.

Optional Features	Benefits
• Remote Control	• Allows full function remote control.
• Auto/Manual Mode	• Operational flexibility with Watt Density Control or Computer Interface.
• Programmable Control a) **Watt Density & Proportional Speed** b) **Treat Width (Covered Roll)**	• User-friendly setup and control. • Maintains consistent treatment despite line speed or other variables. • All setpoints are retained.
• Computer Interface	• Allows integrated central control of Watt Density or kW Output.

More Power, Still Compak™ is Available:

If your application requires more power, you can still take advantage of Compak technology. Compak Power Supplies with even greater control capability are also available from 3 thru 100 kW in 13 ratings and application options.

ENERCON CORONA TREATING EQUIPMENT & SYSTEMS

Compak™ Power Supplies

Series 2000

Series 9000

Full Function Compak 2000 Remote

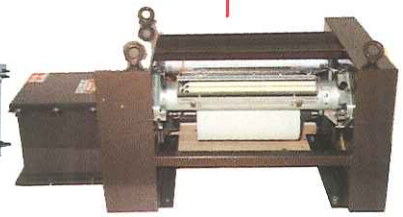
Full Function Compak 9000 Remote

Compak 2000 Watt Density Control

Skip Treater Control & Other Custom Control Options

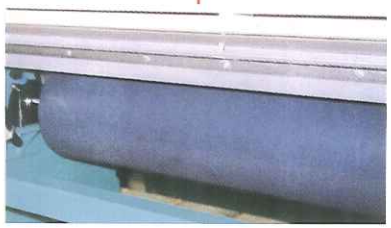
Treater Stations

Bare-Roll

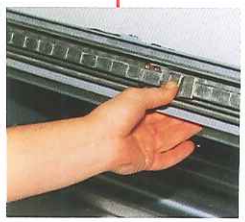


Bare-Roll "H"

Covered-Roll



Conductive Ceramic Treater Roll Coating



E-Z Set-Up Segmented Electrode

Stainless Steel Tube Electrode & Ener-Cote Ceramic Covered Roll

Treater Station Diagnostics Panel

Purged Stations for Hazardous Areas

E-Z Access, Micro Air-Gap Adjustment

Nip Roll & Actuator Mounted Within the Frame Envelope

E-Z Clean, Hinged Electrode Assembly

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Viewpoint

Unraveling the MYTHS AND MYSTERIES of Induction Sealing

By **William F. Zito**

High frequency. Low frequency. Ferrites. Air cooled. Water cooled. Solid state. Vacuum tubes. Microwave.

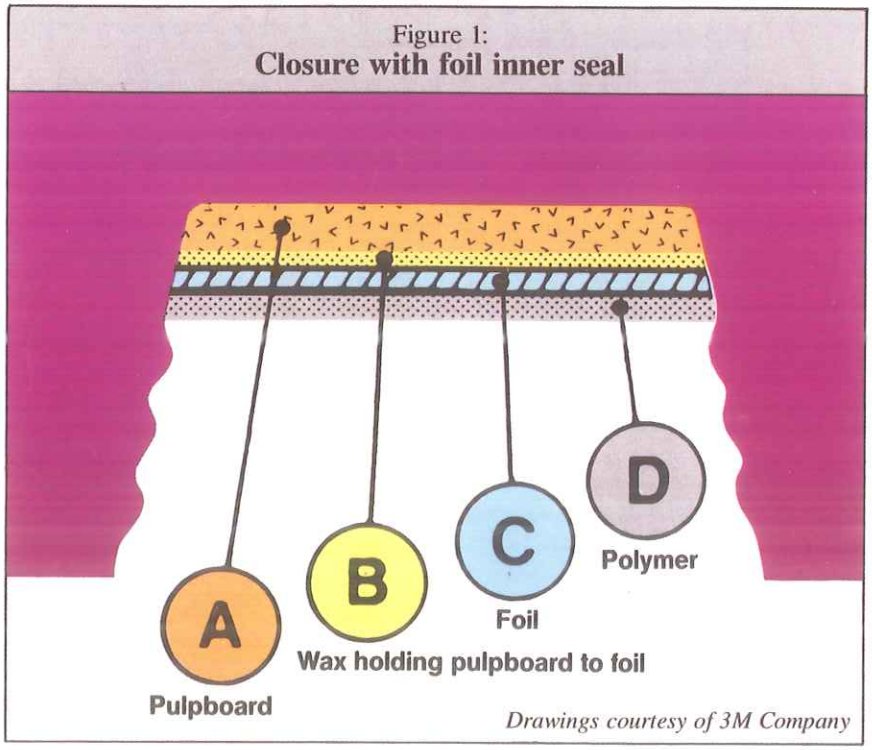
Anyone who has attempted to buy an induction sealing system has been inundated with these terms and many more. There has been a plethora of articles written discussing the technical aspects of induction cap sealing. Many of these have appeared in this Journal, and the uninitiated may want to refer to these to gain information not covered in this offering. The intent of this article is to separate fact from fiction concerning induction sealing in a way that anyone can understand and to offer suggestions to assist in selecting the proper equipment.

Since the inception of induction sealing in the mid-60s, frequently referred to as induction cap sealing, there has been an almost mysterious aura surrounding this phenomenon. Most of the mysteries and misinformation have been generated by the manufacturers and sellers of this equipment.

Just what is induction sealing and what can it do for you? Induction sealing is a noncontact heating process that accomplishes the hermetic sealing of a container with a closure that includes a heat-sealable foil laminate. The typical induction innerseal begins as a multilaminate liner inside a closure. It consists of a layer of pulpboard, a layer of wax, aluminum foil and a layer of polymer that is compatible with the bottle material and capable of heat sealing to the lip of the container (Figure 1).

When the closure is placed onto the container and is passed through an electromagnetic field produced by the induction heater, several things occur. An electromagnetic current, called an eddy current, is induced into the foil portion, resulting in a resistance-type heating effect. The heated foil melts the wax layer, which is absorbed into the pulpboard, releasing the foil from the pulpboard, and the polymer coating melts, hermetically sealing the foil to the lip of the container (Figure 2).

Figure 1:
Closure with foil inner seal



Drawings courtesy of 3M Company

Notice I referred to the induction system as a heater and not a sealer. This clarifies the first misconception. Everyone who manufactures induction equipment for affixing a foil innerseal on a container refers to their generators as induction sealers. The truth of the matter is that we do not seal anything. The only function of the induction system is to heat the foil. You can heat the foil as much as you want, but if it is not in intimate contact with the lip of the container, you will not achieve a seal.

Occasionally, I'll receive a call from a customer who tells me something is wrong with his induction sealer. He goes on to tell me he has run 100 containers under the induction sealing head and only 97 of them sealed. I explain that if 97 of them sealed, there is nothing wrong with the induction system and suggest he look elsewhere for the problem.

Further examination usually uncovers the fact that there was insufficient torque on the three containers that did not seal. Either the foil was not in intimate contact with the lips of the containers, the lips of the containers were deformed or the caps were cocked.

If a series of identical containers are put through an induction field and one of them seals, then all of them should seal. You must realize that when you are dealing with hundreds or thousands, if not millions, of containers and caps, you will experience an occasional bad lip, insufficient torque or cocked cap. When this occurs, poor seals cannot be blamed on the induction equipment.

What about frequencies? The high-frequency/low-frequency confusion was initiated by the manufacturer of vacuum tube equipment. The very first induction systems for heating foil were vacuum tube units, state-of-the-art at that time, which operated at approximately 450 kHz. As more modern devices were developed, many suppliers introduced solid-state generators that operated in the 26 to 100 kHz range. The makers of equipment who resisted change and continued to build vacuum tube systems began referring to the two systems as high-frequency and low-frequency,

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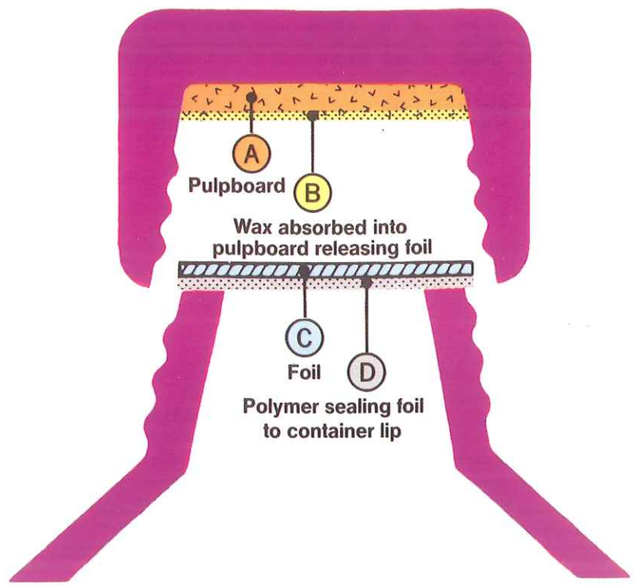
rather than vacuum tube and solid state, which would insinuate their equipment may be old fashioned and not state-of-the-art.

There has been much written about the advantages of low- versus high-frequency induction equipment. It's almost a moot point at this time, since there are very few, if any, vacuum tube units manufactured now. As the older vacuum tube systems fail and become high-maintenance items, they are being replaced with solid-state systems.

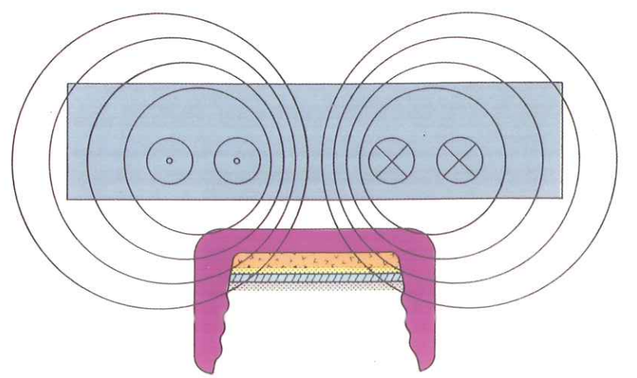
In late 1988, a major manufacturer of induction sealing equipment announced the development of, what they said was, a radically new power supply. They said that because of load matching and variable frequency, their unit would outperform power supplies of higher KW ratings supplied by their competitors. In addition, this unit was advertised as air-cooled. Reports from the field indicate that because of reliability problems and failure to perform at advertised sealing rates, a number of these units have been returned to the manufacturer by dissatisfied customers. One other point: although the power supply and high voltage leads do not require water cooling, the sealing coil requires a water system costing over $2,000.00. So much for air-cooled systems. There is, of course, the possibility that the manufacturer will work the bugs out of this system, and it may become a viable alternative in the future.

Figure 2:
Closure and inner seal after sealing operation



Most makers of induction systems mislead customers by advertising their equipment as being air-cooled. This leads people to believe they do not need any water for cooling. While there are air-cooled power supplies available from all of the major suppliers, all production systems require water to cool the sealing heads where undesirable heat is produced by the current going through the copper tubing that produced the electromagnetic field. The bottom line is that all induction systems require water for cooling, except for small lab-type systems that are used on an intermittent basis.

Figure 3:
Coil flux without ferrites



Some manufacturers of induction sealing systems tout their use of ferrites in the sealing head, as if this is something new and radically different. Ferrites are nothing more than dense homogeneous ceramic structures made by mixing iron oxide with oxides or carbonates of one or more metals such as manganese, zinc, nickel or magnesium. They are pressed, then fired in a kiln at 2000°F and machined as needed.

How and why are they used in induction cap sealing? If you examine the cross section of an induction sealing coil without ferrites (Figure 3) the electromagnetic field radiates equally in all directions.

By surrounding the coil with a ferrite material (Figure 4), the dense ferrites prevent the electromagnetic ferrite material field from radiating and actually concentrates and directs the field, making it more efficient.

Ferrites have been in use as flux concentrates for over fifteen years and are certainly nothing new. Ferrites cannot be used with vacuum tube systems because the high frequency (450 kHz) causes excessive heat in the ferrites. This phenomena does not occur in the solid-state power systems which normally operate in the 26 to 100 kHz range.

Many people who are packaging liquid products are concerned that they will not achieve a good seal if there is product on the lip of the container when it is capped. Not to worry; this is not a problem. Normally the torque applied to the cap will squeeze out most of the liquid, and the heat generated by the induction process will eliminate whatever is left between the lip and the innerseal. Many times I have taken WD-40 lubricant and sprayed the innerseal and lip of the container and then induction sealed them without any problems.

How can you tell which system is right for you? Most people will receive quotations from three or four different manufacturers, all saying their equipment is the best. To further confuse things, the prices are generally not more than a few hundred dollars apart. The truth is there is very little difference among the systems sold by the major sources of induction equipment.

Generally, if you send samples to all of the major suppliers seals and, after getting your samples back, mix them up, I doubt if you will see any difference in the seals.

This is not to say that there are not special applications where one manufacturer has an advantage over the others because of special coil design or other application knowledge. However, these special applications are such a small percentage of the overall industry as to be insignificant.

So what's a buyer to do? How does he know who to believe? Little is accomplished by asking a manufacturer for references.

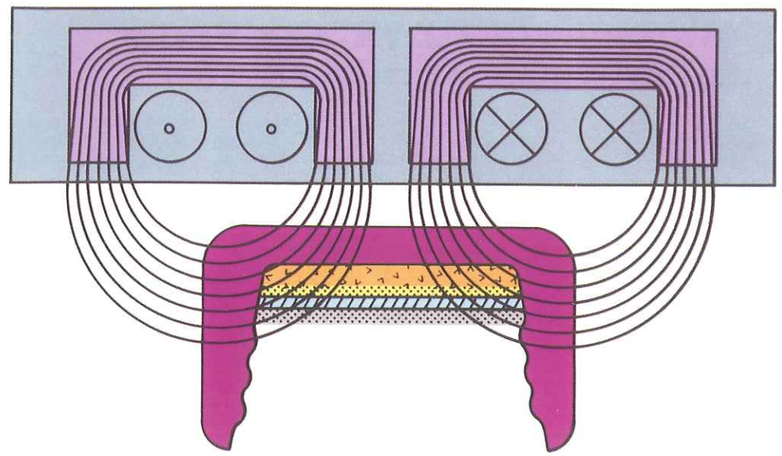
Good sources of information are your suppliers of closures, bottles or induction innerseal materials. They have no axes to grind and, for the most part, can be objective. They are constantly in the field and usually know if a company has a reputation for reliability and good service, which is really what you are looking for.

You should also take a very close look at the warranties offered by the various suppliers. Service can be extremely expensive if you have a problem with your equipment. Don't fall into the parts-and-service trap.

Several companies advertise free parts and service on equipment for a period of one year after your installation. However, the travel and living expenses of the service technician are paid by the customer. This can amount to more than a thousand dollars for a so-called free service call. Only one company includes the service technician travel and living expenses in its warranty on power supplies above 2KW. Another company offers two different warranties in its quotations; one covers the equipment for six months and the other for eighteen months. So, you see, it can be very confusing. It's to your benefit to ask questions about each company's warranty. It could save you a bundle of money. One excellent way of comparing equipment is to personally visit each supplier.

Finally, let's look at the bottom line. The vast majority of induction sealing systems sold today use solid-state devices that operate at low freqency, below 100kHz. All suppliers offer air-cooled power supplies but require some minimal water cooling for the sealing coil. Major differences between suppliers do exist in terms of pre- and post-sale service and in some areas of warranty. The rules haven't changed. To be a smart buyer, read the proposals carefully, investigate the vendor's reputation for product quality and service and ask a lot of questions.

Figure 4:
Coil flux with ferrites

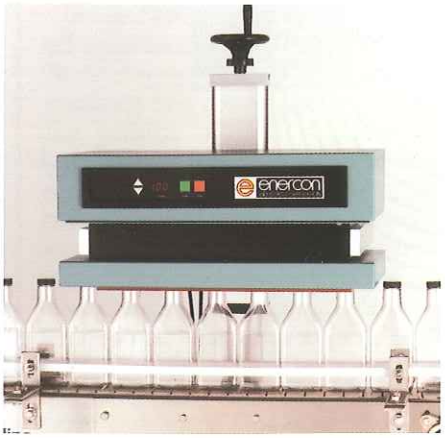


WILLIAM F. ZITO received his B.S. in Mining Engineering from the University of Pittsburgh. He has been National Sales Manager for Enercon Industries in Menomonee Falls, WI, since 1985.

Reprinted from the Journal of Packaging Technology, January 1990

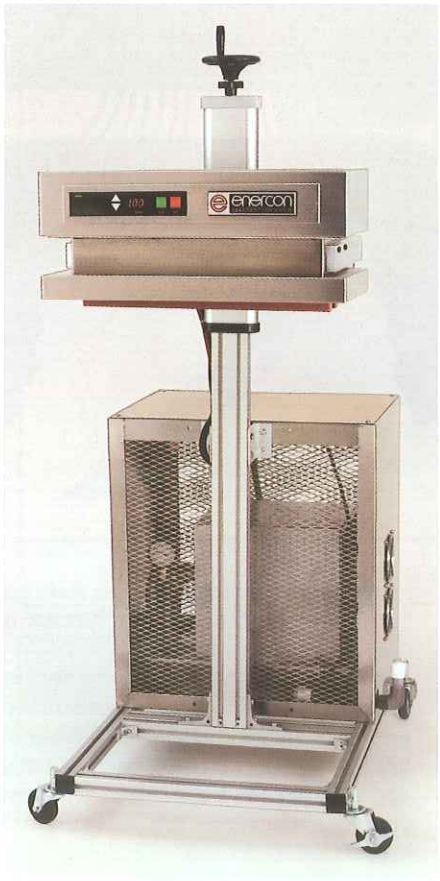
FROM ENERCON . . .
EVERYTHING NEW UNDER THE SUN IN INDUCTION SEALING TECHNOLOGY!

From the All-In-One COMPAK™ Cap Sealer to the Complete Sealing System.



COMPAK

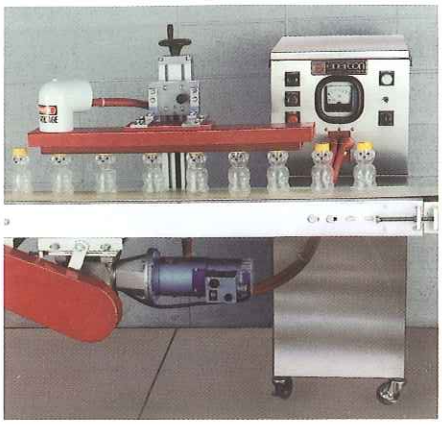
The COMPAK cap sealer with adjustable mount and built-in sealing coil is installed directly over the conveyor. A separate power supply mount is not needed nor are inconvenient water-cooled power cables. High efficiency and consistent hermetic seals via flux density control are achieved with the COMPAK, even at line speeds of up to 300 feet per minute (fpm). Flux-density control enables the system to automatically adjust power and frequency output to precisely match container load under the sealing coil. The COMPAK is offered in both stainless steel and aluminum enclosures.



COMPAK CART

The COMPAK is available on two mobile cart models. The model pictured above features the power supply with built-in sealing coil and a water recirculator mounted on a mobile cart. On filling lines where space is limited, this is a real advantage, as is the mobility of the system.

The second cart model features the power supply and water recirculator as well as a conveyor on one cart. This model is ideal for lab applications or small production lines, and is available with a three to six foot long conveyor. Conveyor belt widths of 60, 85 and 135 mm.



INTEGRAL

The integral cap sealer offers flexibility in both an aluminum and stainless steel enclosure. This stainless steel integral unit offers all the electronic benefits of the COMPAK including flux-density control. Both aluminum and stainless steel enclosures feature full function controls. Available in 1kW, 2kW and 3kW models, the unit is capable of sealing caps from 10mm to more than 130mm in diameter at line speeds up to 300 fpm. Enercon offers a choice of standard coils with special coils available as required.

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Menomonee Falls, WI 53051
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- Water Recirculator
  The water recirculator is a water-to-air heat exchanger which cools the sealing head by pumping water through the sealing head coil via leads connecting the two. Although not required for the actual sealing process, the water recirculator is essential for continued use of the induction sealer to prevent overheating of the head.

How does an Induction Sealer fit on my production line?

The induction sealing head is mounted directly over the conveyor. The power supply and water recirculator can be located either beneath the head or at a remote location, depending upon the availability of floor space. A portable cart can be included with the induction sealer that will allow easy mobility.

What Types of Products and Containers can be sealed?

With the correct type of container and innerseal material, virtually all products can be sealed. Plastic containers are easiest to seal. Glass may need to be treated before the lip of the container will accept a seal. While it is possible to induction seal containers using metal caps, it is not recommended.

The metal cap is heated by the induction field and the innerseal is heated by conduction from the heat in the metal cap. The hot metal cap presents a safety problem to workers who may inadvertently touch it. In addition, the cap may become so hot it melts the plastic threads on the container.

How do I Select the Right Induction Sealer for my Application?

There are two major factors that determine the rating of induction sealer appropriate for a particular application: the size of the cap and the speed of the production line (measured in feet or meters per minute). If it is a food application, a washdown enclosure may be necessary. Other factors to consider are the type and composition of the container, the type of innerseal material used, and the type of product (wet, dry, flammable).

What is IGBT technology and What Benefits Does it Provide?

The state-of-the-art in power device technology, Insulated Gate Bipolar Transistors (IGBT) are found in the newest power supplies. IGBT transistors are more reliable than other types of transistors. They allow the power supply to be designed with fewer internal components and reduced heat generation, resulting in less overheat failure and fewer parts to fail. Kilowatt per kilowatt, IGBT transistors have a greater efficiency at higher line speeds.

Why Induction Seal?

- Tamper Evident seal for consumer protection
- Freshness seal for longer shelf life
- Leakage protection seal to reduce returns
- Pilferage protection seal to eliminate theft

If you have any further questions about induction sealing or induction sealing equipment, feel free to call Enercon at (414) 255-6070 or the representative listed below.

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The Facts About Induction Sealing

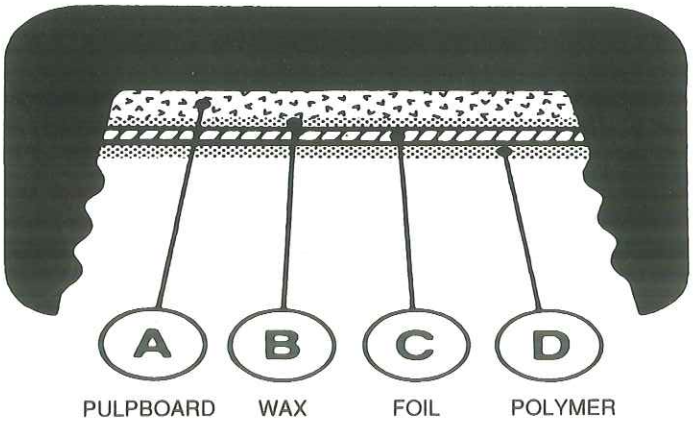
What is induction capsealing and how does it work?

Induction capsealing is a unique non-contact heating process that hermetically seals a container by attaching a foil innerseal material to the lip of a container. Induction sealing requires little, if any, modification to an existing packaging line.

The hermetic seal requires an innerseal material that consists of a layer of pulpboard, a layer of wax, a layer of aluminum foil and a layer of polymer. The polymer must be compatible with the bottle material and capable of bonding to the lip of the container. The innerseal material is die cut and placed inside the cap by the cap manufacturer.

The sealing process takes place after the filling of the containers. Caps are placed onto the already filled containers, in the same manner as it was done previously The containers then simply pass under the induction sealing head as they move on the conveyor. As they do so, they pass through the electromagnetic field created by the induction sealer. An electromagnetic current is induced into the foil layer of the innerseal, and heats it. The heated foil melts the wax layer, which is absorbed into the pulpboard, releasing the foil from the pulpboard. The foil also melts the polymer, bonding the foil over the container's mouth and creating a hermetic seal.

Closure with foil innerseal



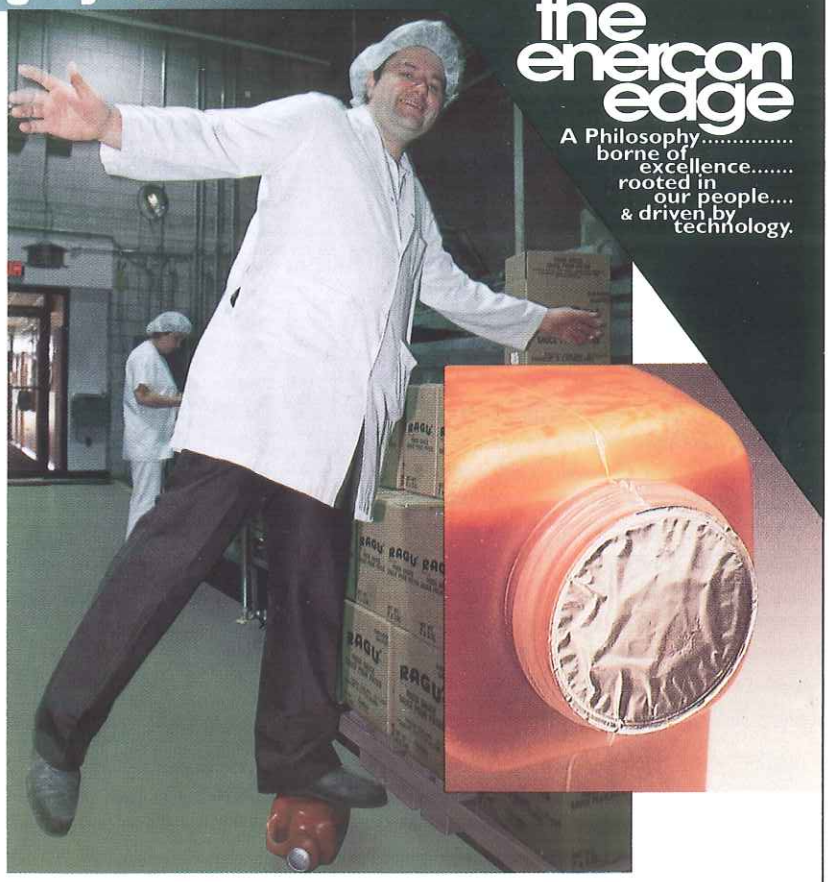
What are the major components of an induction sealer?

- Power Supply
  The power supply is an electrical generator capable of operating at the medium to high frequencies required for the induction sealing process. It supplies the induction head with the current necessary to create an electromagnetic field. The power supply rating required for a specific application will depend upon the size of the closures and the speed of the production line.

- Sealing Head
  The head consists of a plastic housing with an conductor wound to form an inductive coil inside. The head produces an electromagnetic field when energized by the power supply. The most common shapes used in induction sealing are the flat head and the tunnel head. A tunnel head concentrates the current around the sides and above the cap, creating a more uniform electro-magnetic field, and a more consistent seal. A flat head disperses the magnetic field more widely, allowing a larger area (and larger cap) to be sealed.

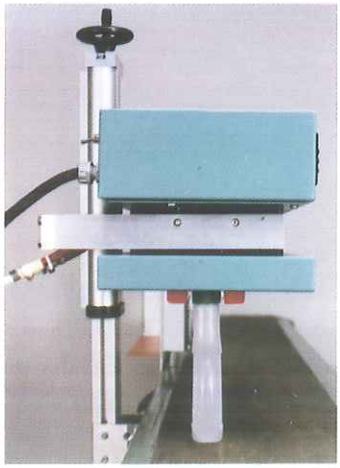
Enercon Induction Sealing Systems

Compak system with water recirculator tucked conveniently under the conveyor.



Customer proves the seal holds under pressure.

"The 1 Coil" can be positioned to heat seal from 20 to over 120 mm foil inner seals.



Side view shows container passing thru tunnel coil.

Compak on dairy application.

Painted aluminum Compak on a cart.

Our modern plant provides 35,000 square feet of engineering, test and manufacturing capability.

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Enercon Induction Sealing Systems

ENERCON INDUSTRIES: A COMPANY PROFILE

the enercon edge
A Philosophy..... borne of excellence..... rooted in our people.... & driven by technology.

Enercon Industries Corporation, the leading manufacturer world-wide of induction cap sealing systems for the pharmaceutical, food, chemical and health & beauty aids industries.

The company, founded in 1974, designs, manufactures and markets all its products from a 35,000 square-foot headquarters in Menomonee Falls, Wisconsin.

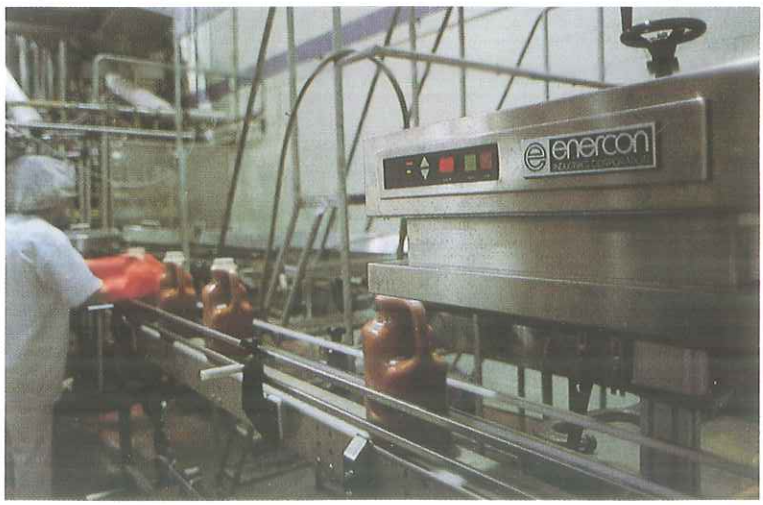
Enercon manufactures a line of induction cap sealing equipment to ease packaging of food, chemical, pharmaceutical and dairy products. The company's newest solid state unit, the Compak™, combines control, power supply and sealing coil into one package. The new design eliminates the need for connecting power cables and can be mounted directly over the conveyor, saving valuable floor space.

The company's newest line of equipment is a pressure belt system, which enables packagers of such products as single serving juice and dairy items, as well as products packaged in tubs such as margarine and cottage cheese, to hermetically seal containers with a simple foil/paper laminate or a snap-top lid.

To help customers determine sizing data and power requirements for particular applications, Enercon Industries has established separate cap sealing and corona treating labs at its headquarters. Both labs are fully equipped with experienced Enercon personnel on-site to aid in testing.

Incredible Shrinking Cap Sealer is demonstrated by this three generation photo of earliest to latest units from left to right.

Stainless steel Compak system on a cart.



Stainless steel Compak on hot-fill food application.

Compak™ Jr:

the portable powerhouse in Induction Cap Sealing!

At 14 pounds and just 7" x 12" x 15", the Compak™ Jr. is small, compact and light, but powerful enough to handle virtually all of your induction cap sealing jobs. With its advanced electronics and specially engineered coil, this self-contained portable system can seal everything from the smallest closures to 110 mm wide-mouth containers.

Once the unit is plugged into standard wall power, it is ready to operate. Set the power mode to either high or low and set the timer to the number of seconds the container requires for a strong and secure seal. To seal, simply place the coil over the container's cap and press the trigger on the handle of the coil. The timer counts down to zero as power is applied into the cap to form the seal. Check the first few containers for seal quality. Adjust torque, power and time until a firm, but not scorched, seal is achieved. Once the correct settings are reached, seals will be secure and consistent.

When the sealing job is completed, the cords and coil pack into a self-contained compartment and the system can then be easily stored or moved to another sealing location. This unit does not require water or special power so it can be used virtually anywhere. The Compak™ Jr. is extremely simple to handle, carry and operate and is the perfect answer to your portable induction sealing needs.

See reverse side for technical details.

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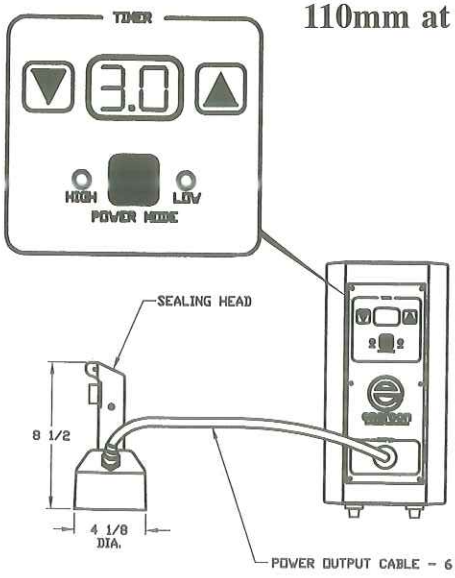
For a quotation on the portable Compak Jr., contact:

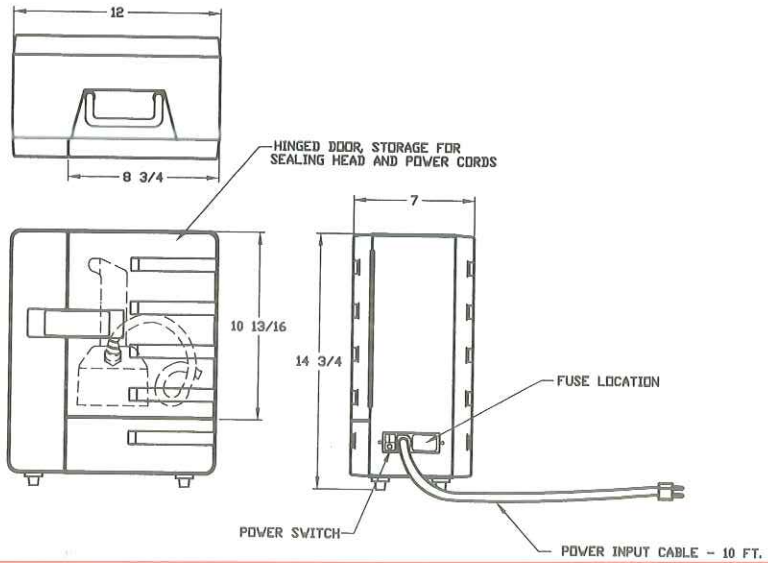
Enercon Industries Corporation
P.O. Box 773, Menomonee Falls, WI 53052-0773
Phone: 414-255-6070 Fax: 414-255-7784

Compak™ Jr.

Portable Induction Cap Sealing System

- Power supply with advanced IGBT circuitry.
- High efficiency hand-held sealing coil creates a consistent heat pattern. Includes "Power On" and "Foil Present" Indicator.
- Membrane control panel with two digit digital timer with a range from 0 to 9.9 seconds.
- Dual power push-button provides two levels of current.
- Dimensions: 7"W x 12"D x 15"H (17.8 x 30 x 38 cm).
- Weight: 14 pounds (6.2 Kg).
- Input Power: 120 VAC, 60 Hz, 700 VA, (230 VAC, 50 Hz available).
- Output Power: 500 Watts.
- No water required for cooling.
- Enclosure: Enercon Blue HDPE.
- Compartment holds input power cord, coil and coil power cord.
- This equipment is designed to seal:
  38mm at 20 containers per minute.
  110mm at 6 containers per minute.





NEW!

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Integral II *Goes Remote!*

The Flexible Induction Sealing System.

•Operator Controls at the Sealing Head over the Conveyor or Wherever It Is Convenient.

•Power Cabinet Located Wherever Space is Available.

Enercon's proven Integral II *goes remote!* This *turn-key* system allows packagers the freedom to arrange their application setup to meet their specific space availability. Location of both the operator control panel and the power cabinet can be varied to provide the most effective line configuration. Then add to that the easy installation allowed by this *turn-key* package.

Most applications will find the operator controls located with the sealing head over the conveyor, but the controls can be located anywhere. The power cabinet, power supply and water recirculator, is a single, compact unit set on castors for easy mobility. The power cabinet can be located remotely from the sealing line.

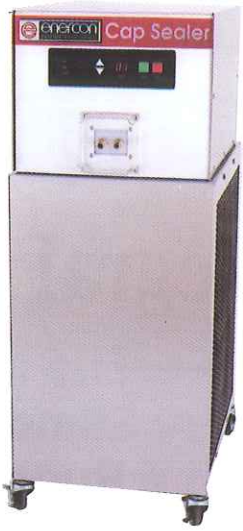
Integral II Remote Systems are available in ratings from 1 thru 4 kW. Further, remote capability is available as a retrofit for most Integral II systems in the field.

Systems are available in NEMA 1 enclosures or in stainless steel, NEMA 4 washdown enclosures.

For further information or application assistance, call: Enercon Cap Sealing Sales at 414-255-6070 or Fax 414-255-7784.

Enercon Integral II: Induction Cap Sealing Capability	Integral II With Water Recirculator					
Output Rating	Input 50/60 HZ		Approximate Dimensions Inches (mm)			Weight
	Volts ± 10%	Amps	H	W	D	Lbs. (Kg)
1 KW	115, 1Ø	20	44 (1,118)	17 (432)	24 (610)	120 (55)
2 KW	230, 1Ø	18	44 (1,118)	17 (432)	24 (610)	120 (55)
3 KW	230, 3Ø	15	44 (1,118)	17 (432)	24 (610)	120 (55)
4 KW	230, 3Ø	19	44 (1,118)	17 (432)	24 (610)	125 (57)

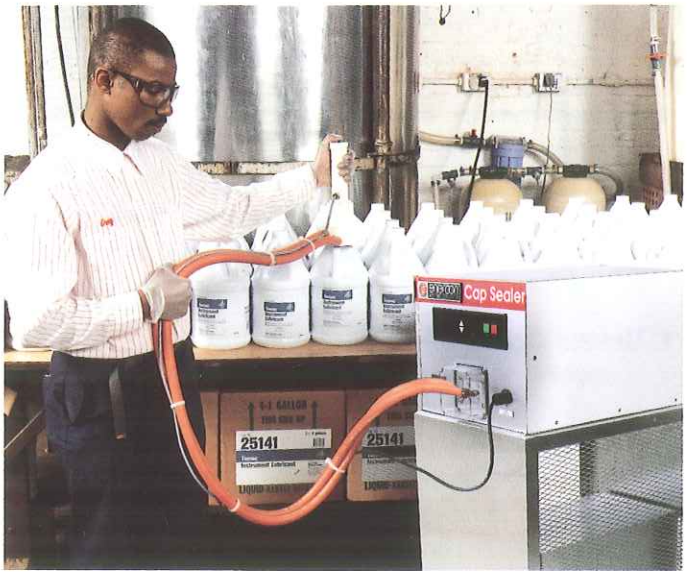
The units listed above are NEMA 1 enclosed. For totally enclosed, NEMA 4 units (suitable for wash-down) add 2" to height and 35 lbs. to weight listed for the desired rating.



Integral II NEMA 1 cap sealer with water recirculator.

High Production Induction Sealer

Integral II NEMA 4 cap sealer system with manually adjustable mount and new high efficiency coil shown on a typical conveyor.



Laboratory/Low Production Induction Sealer

Enercon's laboratory induction sealer provides all the advanced electronic features of our complete line along with a full 1 kW of power. Timer control for automatic sealing cycle and a variety of hand-held coils allows wide range sealing application for lab testing or contract packager.

Economy System

Red-e-System with 1 kW NEMA 1 power supply and hand-held coil.

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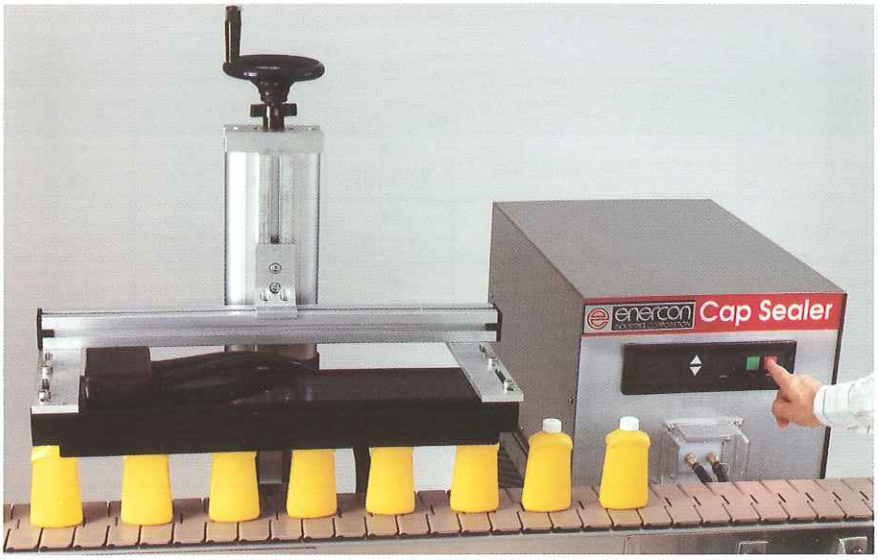
Enercon Induction Sealing System

Integral II:

The New Industry Standard in a Rugged, Functional Package



- **State-of-the-Art Electronics:** Our third generation solid-state design provides the latest in proven, high reliability components and circuits. Both power and control loops incorporate advanced operative, protective and diagnostic elements and circuits to provide a new level of operational reliability and efficiency.
- **Unique Coil Design:** Enercon's coil design capability is second-to-none in the industry. Our new standard coil design increases electromagnetic power coupling into the foil. As a result, uniform currents are induced across large mouth inner seals creating consistent seals with complete wax melt and separation of foil from pulpboard liner. In addition, Enercon offers custom coil design to meet the specific needs of unusual applications reliably and efficiently.
- **Top Total Performance:** Enercon's excellence in power conversion with 95% efficiency and coil design for superior electromagnetic coupling permits effective operation at high line speeds with optimal power usage. **Line speeds exceeding 300 fpm** can be achieved depending upon closure size, innerseal type and container material.
- **Functional Package:** This third generation solid-state induction sealer combines control and power supply in an air-cooled NEMA 1 or a sealed NEMA 4 enclosure that can be integrally mounted on a mobile water recirculator for easy installation, and almost no water usage. Requiring minimal space, the compact sealing coil is easily mounted over the conveyor. Interconnect cables supply power and water lines supply cooling to the sealing coil from the power supply/water recirculator.

Features

- Latest Transistor Power Components for 95% Efficiency
- Automatic Closed-Loop Circuits for Frequency & Flux Density Control
- Automatic Self-Protection and Self-Diagnostic Circuits
- Latest Digital Control Circuits
- Advanced Sealing Coil Design
- Reliable, High Speed Performance: Up to 300 fpm.
- Automatic Wide Load Matching Capability
- Air-cooled NEMA 1 or Sealed NEMA 4 Enclosure
- Second-to-None Customer Support & Service
- Manually Adjustable Coil Support

Options

1. ***Adjustable Sealing Coil Support with Height Indication*** — easy adjustment to a variety of containers.
2. ***Water Recirculator*** — water-to-air heat exchanger reduces costly cooling water usage.
3. ***Motion/Foil Detector Group*** — shuts off power if containers stop under sealing coil & detects missing foil liners.
4. ***Remote Start*** — permits stop/start control via external commands for automated operation.
5. ***Loss of Sealing Indicator*** — alarm circuit contact closure if sealing power falls below preset level.
6. ***Hand-Held Coil*** — allows automatic timed sealing of individual containers.
7. ***Purged Sealing System*** — pressurized cabinet for sealing in hazardous environment

FROM ENERCON: The Complete Induction Sealing Line.

Painted Aluminum Enclosure

Stainless Steel Enclosure

Compak™ Sealer

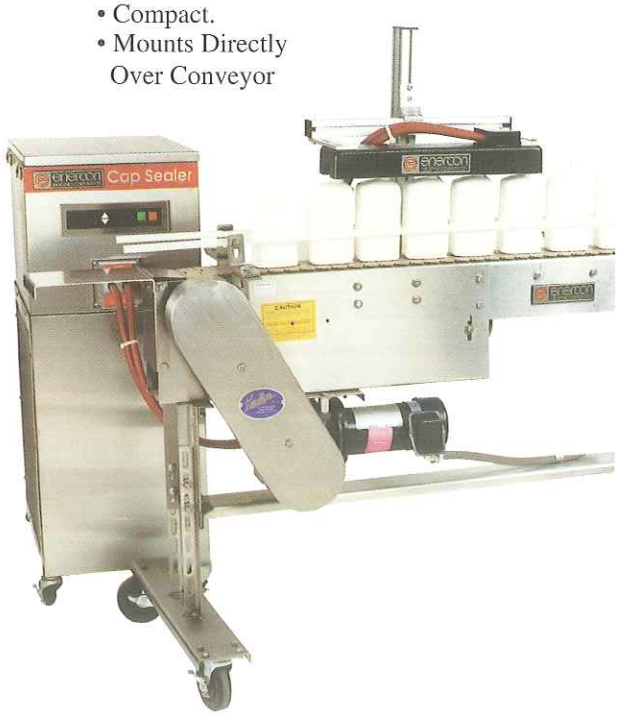
- Compact.
- Mounts Directly Over Conveyor

Compak™ System

- Compact.
- Stable Support.
- Water System.

Compak™ System

- Compact.
- Mobile Cart.
- Water System.
- Built-On Conveyor. *(Optional)*



Integral II

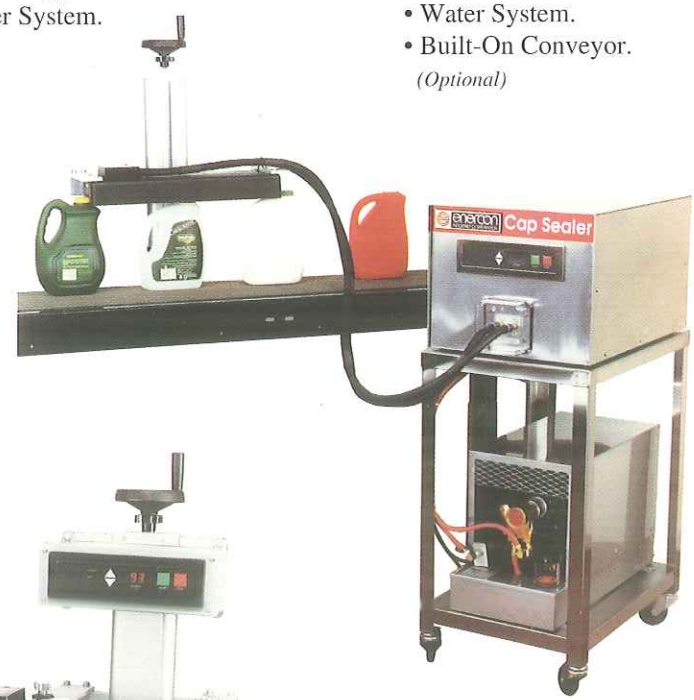
Full Capability With Lower Cost.

- Stainless Steel Enclosure.
- Mobile System.
- Sealing Head On Manual Adjustable Mount

Integral II Remote

Allows Easy Operator Access To Controls.

- Remote & Sealing Head On Deluxe Adjustable Mount.



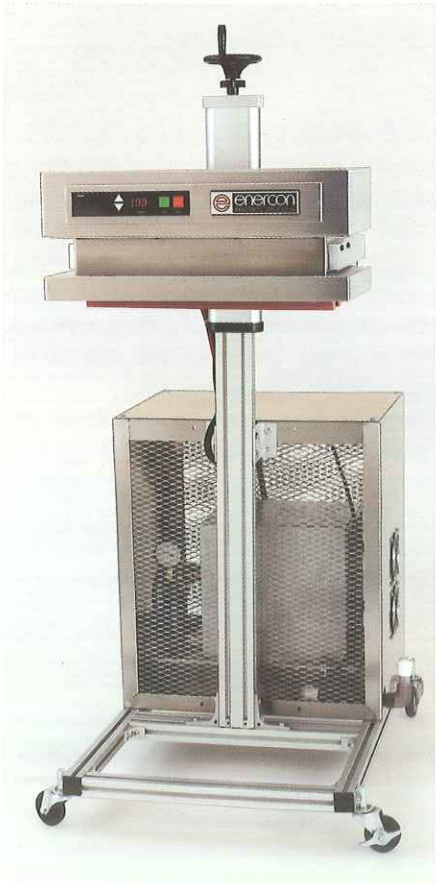
Red-e-System™

Economy Model

- NEMA 1.
- Power Supply Enclosure.
- Stainless Steel Mobile Cart & Water Recirculator
- Hand Held Coil *(Optional)*

Enercon Compak™ Induction Cap Sealing Capability

Output Rating	Input 50/60 HZ		Complete System Approximate Dimensions Inches (mm)			Weight	Water Usage
	Volts ± 10%	Amps	H	W	D	Lbs. (Kg)	GPM (Liters/Min.)
1 KW	115, 1Ø	15	11 (279)	24 (610)	12 (305)	55 (25)	0.35 (1.3)
2 KW	230, 1Ø	15	11 (279)	24 (610)	12 (305)	55 (25)	0.50 (1.9)
3 KW	230, 3Ø	12	11 (279)	24 (610)	12 (305)	55 (25)	1.00 (3.8)
Air-Cooled Power Supply. NEMA 4 enclosure. Suitable for Washdown.							



COMPAK Cart

The COMPAK is available on two mobile cart models. The model pictured above features the power supply with built-in sealing coil and a water recirculator mounted on a mobile cart.

The second cart model features the power supply and water recirculator as well as a conveyor on one cart. This model is ideal for lab applications or small production lines.

The COMPAK is offered in both stainless steel and aluminum enclosures.

Laboratory/Low Production Induction Sealer

Enercon's laboratory induction sealer provides all the advanced electronic features of our complete line along with a full 1kW of power. Timer control for automatic sealing cycle and a variety of hand-held coils allows wide range sealing application for lab testing or contract packager.

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Enercon Induction Sealing System

Compak™ The Perfect Package: The Design That Earned A Patent* Sets The *New* Industry Standard.

- **Perfect Package:** Designed as a compact "All-in-One" system, this third generation solid-state induction sealer combines control, power supply, and sealing coil into one easy to mount and operate package. No messy coil cables to connect. Installed over the conveyor on our rugged, precision adjustable mount, the Enercon system provides the ultimate in flexibility by easily adjusting to a variety of container heights and by presenting the operator easy to reach and read controls and indicators.
- **State-of-the-Art Electronics:** Our third generation solid-state design provides the latest in proven, high reliability components and circuits. Both power and control loops incorporate advanced operative, protective and diagnostic elements and circuits to provide a new level of operational reliability and efficiency. This combination of advancements makes it possible to offer an air-cooled power supply in a fully sealed, NEMA 4 enclosure.
- **Unique Coil Design:** Enercon's coil design capability is second-to-none in the industry. Our new standard coil design increase electromagnetic power coupling into the foil. As a result, uniform currents are induced across small and large mouth inner seals creating consistent seals with complete wax melt and separation of foil from pulpboard liner. Enercon offers custom coil design to meet the specific needs of unusual applications reliably and efficiently.
- **Top Total Performance:** Enercon's excellence in power conversion with 95% efficiency and coil design for superior electromagnetic coupling permits effective operation at high line speeds with optimal power usage. **Line speeds exceeding 300 fpm** can be achieved depending upon closure size, innerseal type and container material.

Features

- Single Compact Package for Easy Conveyor Mounting.
- Adjustable Support for Easy Set-Up to a Variety of Container Heights: includes a Floor Extension for Stability.
- Loss of Sealing Indicator: Alarm Circuit Contact Closure if Sealing Energy is Lost.
- Air-Cooled, NEMA 4 Enclosed Power Supply.
- Dead-Front, Membrane Controls for Easy Operation.
- Latest Digital Control Circuits & Sealing Energy Meter.
- Latest IGBT Power Transistors for 95% Efficiency.
- Automatic Closed-Loop Circuits for Frequency & Flux Density Control.
- Automatic Self-Protection and Self-Diagnostic Circuits.
- Advanced Sealing Coil Design.
- Second-to-None Customer Support & Service.

Options

- ***Water Recirculator:*** water-to-air heat exchanger reduces costly coil cooling water usage.
- ***Motion/Foil Detector Group:*** shuts off power if a container back-up approaches the coil and detects missing foil liners.
- ***Remote Start:*** permits stop/start control via external commands for automated operation.
- ***Mobile Cart System:*** available with or without conveyor.
- ***Manual/Auto Control:*** allows sealing energy control via customer supplied signal.
- ***Adjustable Loss of Sealing Indicator:*** allows setting of low level limit on alarm circuit contact closure.
- ***UL Listing:*** unit built to UL Listing requirements and carrying the UL compliance sticker.

*Design Patent: U.S. Des. 340,937; Nov. 2, 1993.