**MAIN CUSTOMERS**

POWER TRANSFORMERS COOLERS
- ABB Group (Brazil - Canada - Germany - Italy - Spain - Switzerland - Turkey - USA) | ACEA | AEM
- AREVA (Brazil - Turkey - United Kingdom) | EDP | EDISON | ENEL | ENERCO Enterprises | DANZ Transalatko | GETRA | IVEY
- JST Transformers | PAULWEIS TRAIRO | SEI | SIB (SIEMENS Group) (Austria - Italy)
- ALUFINER | EGM | TEMA GROUP | TUR (TUR) | TURKH

MOTOR AND GENERATOR COOLERS
- ABB Sace Vittuone | ABB Automation Vittuone Svizzera | ABB-By Elettrica Macchine Finland
- ABB Switzerland Ltd Electrical Machines | Brush HMA BV Rotteneck Netherlands
- Cantarey Reinosa S.A.U | Laurence Scott & Electromotors LTD

AIR COOLER HEAT EXCHANGERS
- ABB GROUP | AGIP | AGIPPETROLI | ANSALDO ENERGIA | ANSALDO CALDAIE | API | BURCKHARDT | CCT | DRESSER RAND | ENEL | ENI
- ENICHEM | ESSO | FOSTER WHEELER | HOWDEN COMPRESSORS | INGERSOLL RAND | ISG | JORDAN PETROLEUM | K.T.I | KUWAIT NAT. PETROLEUM | LUMMUS GLOBAL | LURPA | MAN TURBO | MACCHI | PERRY EQUIPMENT | POLIMERI EUROPA | Raffineria di Roma | SARAS | SICE | SICHEMI
- SNAMPROGETTI | TECHINT | TECHNIP COFLEXID | TECNIMONT | TECNOMARINA | TRACTEBELL | UHDE

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On the 3rd of March 1909 LUIGI BOLDROCCHI established the activity with the first orders for the supply of ten centrifugal fans.

In 1911 the Officine Termo Meccaniche BOLDROCCHI was set up in Milan with a manufacturing area of 3000 square meters.

In 1914 the first plant for air pollution control was produced.

The company offered a wide range of products including radial and axial fans, fire-tube boilers, coolers, dryers, ventilating and heat-exchange units and plants.

In 1926, the licence for the manufacture of finned tubes was acquired in the USA and the production of extended surface heat-exchangers was developed.

In the twenties and thirties the company becomes a regular supplier of the main Italian industrial groups, the Ministry of Defence, naval yards and State Railways.

The first complete equipment to cool a power transformer was developed and supplied in 1931.

In the post-war period, the activity was carried on by GIULIANO BOLDROCCHI who progressively abandoned standard production to concentrate on tailor made equipment for specific industrial fields such as: power generation, electromechanical industry and major shipbuilders.

In 1970, a new factory was built and, with some later extensions, forms the present headquarter.

In the early 80’s, supplies for the nuclear sector induced the company to introduce a Quality Assurance System. From then on, the product range has been enlarged, particularly for process air coolers and steam condensers. In the environmental field, two independent divisions have been established: Aeroto, part of the group since 1994 keeps the original name of the company Aeroto, active since 1952 in industrial noise protection and gas turbine auxiliaries, and Ecologia, a fusion of our traditional technology with the expertise of De Cardenas, purchased in 1997 and active since 1926 in air pollution control and industrial fans.

Boldrocchi has become a heavy-duty fan leader in the world making the most of its centenary expertise with the ones of De Cardenas and Marelli.

In 2006 a joint-venture manufacturing company has been set up in India.

A wide range of materials are usually used: steel and copper alloys, aluminium, titanium and plastic materials; more than 200 welding procedures have been qualified. The products are subject to intermediate and final testing, witnessed by the Customers.

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HISTORICAL NOTES

In three separate workshops with a total 27,000 square meter manufacturing area, Boldrocchi employs 300 staff, among which 100 are technicians.

The shops are equipped with thermal, acoustic and aeraulic test facilities.

Boldrocchi production is divided into four main lines: heat exchange (exchangers and coolers), fans, industrial noise protection and air pollution control. Today production is featured by highly specialised technical contents, many decades of ‘on site’ experiences, flexibility in design and in production together with high quality standards. Supplies are tailor made to fulfil all Customers’ specific requests. Boldrocchi Quality system is certified according to ISO 9001 since 1993 and according to ASME Code since 1998.

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During 1931 Boldrocchi tested and manufactured the first OFAF transformer oil cooler and since 1948 an engineering department has been exclusively devoted to large electrical machines cooling:

Static electrical machine
- Large power transformers
- Distribution transformers Reactors
- Industrial and furnace transformers

Rotating electrical machine
- Motors
- Generators

More than seventy years of experience in this specific field allows Boldrocchi to offer each customer the best solutions matching all the requirements and to optimize reliability, performance and costs.

Test facilities are equipped to check the thermal efficiency of the coolers by using dielectric oil or water and air to guarantee a reliable know-how and the requested performances.

The most used coolers’ prototypes have been approved with thermal and noise tests witnessed by official boards and customers.

A distinctive feature of Boldrocchi lies in its own expertise to design and to manufacture all the main components of a cooler: the finned tubes, the heat exchanger, the fan, the circulating pump and the electrical devices.

More than 15,000 Boldrocchi Oil Air coolers have been supplied in the latest fifty years.
INDUSTRIAL TRANSFORMER
OIL WATER COOLERS

The transformer oil is warmed by the heat losses of the windings.

The oil is conveyed into the shell side of the cooler. Baffles are used to lead the oil flow around the tubes in cross flow. The cooling side on the tube side is divided in two or more paths. Two water paths are usually used.

Features of single tube cooler execution
When using the single tube coolers the oil pressure must exceed the water pressure in any operation, to avoid water infiltration into the oil circuit in case of leakage.

Features of double tube cooler execution
Unlike single tube coolers, this execution of the tube bundle requires double tubes and doubled tube-plates. This special safety design enables the operation with cooling water pressure not limited by the oil pressure. Double tube coolers in standard design are suitable for a water pressure of 10 bar.

In case of leakage, water or oil are led into the chamber between the double tubes and the two tube plates, therefore the double tube system always prevents water and oil from mixing.

The double tube design is the most valid solution to protect the transformer, especially when, using sea or industrial water, the site maintenance is not easy. Should a leakage happen, an alarm is provided by a magnetic float switch screwed to a collecting box fitting the cooler.

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EAF Transformer
Equipped with No. 3 x 150 kW OFWF coolers Single tube execution

EAF Transformer
Equipped with No. 2 x 450 kW OFWF coolers Single tube execution

EAF Transformer
50 MVA – 35000 / 350 = 500 V
Equipped with No 2 x 350 kW RDT 47/220
OFWF coolers double tube execution

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TRANSFORMER OIL TO WATER COOLERS
(OFWF)

Power Rating range
- 60 - 2000 kW/each

Number of radial pumps
- No.1 + No. 2/each

Cooler Mounting
- Vertical Tank mounted
- Horizontal Tank mounted
- Separate battery

Cooler execution
- Fixed tube plates (Tema BEM)
- Floating tube plates (Tema BEW)
- Single tubes
- Double tubes

For both the above executions (single & double tubes) and depending on the cooling water the following materials are used (o standard):

SINGLE TUBES EXECUTION
- Copper
- Adrinal brass
- Cu/Ni 90/10 or 70/30
- Stainless Steel
- Titanium

Tube Plates
- C-Steel
- Naval brass or Muntz metal
- Cu/Ni 90/10 or 70/30
- Stainless Steel
- Titanium

DOUBLE TUBES EXECUTION
- Copper
- C-Steel
- Inner Tubes on Water Side
- Copper
- Adrinal brass
- Cu/Ni 90/10 or 70/30
- Stainless Steel
- Titanium

Tube Plates
- C-Steel
- Naval brass or Muntz metal
- Cu/Ni 90/10 or 70/30
- Stainless Steel
- Titanium

For naval application can be supplied OFWF coolers according to the requirements of the main marine registers as:
- BV Bureau Veritas
- DNV Det Norske Veritas
- LR Lloyd’s Register of Shipping
- RINA Registro Italiano Navale
- ABS American Bureau of Shipping

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EAF Transformer
50 MVA - 33000/363 ÷ 680 V
Equipped With No. 2 x 400 kW OFWF coolers Single tube execution

EAF Transformer
84 MVA - 30000/490 ÷ 990 V
Equipped with No. 2 x 450 kW OFWF coolers Double tube execution

Furnace Transformer
Equipped with No. 1 x 350 OFWF cooler Double tube execution with n.” 2 oil pumps, instruments and terminal box
CAST RESIN TRANSFORMER
AFWF COOLERS

HYDRO-COOLERS (AFWF)
Power Rating range
- 3 ÷ 100 kW/each
Number of radial fans
- No.2 in operation/each
- No.1+ No.1 stand-by
Cooler execution
- Single tubes
- Double tubes

For both the above executions (single & double tubes) and depending on the cooling water the following materials are used (standard).

SINGLE TUBES EXECUTION

<table>
<thead>
<tr>
<th>Tubes</th>
<th>Copper</th>
<th>Admiralty brass</th>
<th>Cu/Ni 90/10 or 70/30</th>
<th>Stainless Steel</th>
<th>Titanium</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fins</td>
<td>Copper</td>
<td>Aluminium</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Tube Plates</td>
<td>C-Steel</td>
<td>Naval brass</td>
<td>or Muntz metal</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Cu/Ni 90/10 or 70/30</td>
<td>Stainless Steel</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

DOUBLE TUBES EXECUTION

| Outer Tubes on Air Side | Copper | Copper | Admiralty brass | Cu/Ni 90/10 or 70/30 | Stainless Steel | Titanium |
| Inner Tubes on Water Side | Copper | Admiralty brass | Cu/Ni 90/10 or 70/30 | Stainless Steel | Titanium |
| Fins                   | Copper | Aluminium       |                      |                 |          |
| Tube Plates on Air Side | C-Steel| Naval brass     | Stainless Steel      |                 |          |
| Tube Plates on Water Side | Naval brass | or Muntz Metal | Cu/Ni 90/10 or 70/30 | Stainless Steel | Titanium |
| Tube Plates on Water Side | Naval brass | or Muntz Metal | Cu/Ni 90/10 or 70/30 | Stainless Steel | Titanium |

For naval application can be supplied OFWF coolers according to the requirements of the main marine registers as:
- BV Bureau Veritas
- DNV Det Norske Veritas
- LRS Lloyd’s Register of Shipping
- RINA Registro Italiano Navale
- ABS American Bureau of Shipping

COMPONENTS FOR POWER TRANSFORMERS

RADIAL CIRCULATING OIL PUMPS
Single block execution oil pump with immersed motor, provided with correct rotation alarm device
Capacity range: 6 ÷ 44 lts
Frequency: 50 Hz ÷ 60 Hz
Feeding voltage: 230 Volt ± 690 Volt

INLINE CIRCULATING OIL PUMPS
Single block execution oil pump with immersed motor
Capacity range: 16 ÷ 115 lts
Frequency: 50 Hz ÷ 60 Hz
Feeding voltage: 230 Volt ± 690 Volt

AXIAL FLOW FANS
(ONAF Cooling System)
Acoustic Pressure Level range:
70 dB(A) ± 53 dB(A)
Standard range:
740 mm l 1000 mm l 1250 mm
Motor poles range:
6 8 10 12 14 16
Execution range:
Steel galvanized Stainless steel Aluminium

Transformer Oil
Radial Pump Series LB
and sectional view
Transformer Oil
Axial Pump Series DN
and sectional view
Axial Flow Fan VE740
Approved by Enei
More than 26,000 heavy duty electric motors are cooled with Boldrocchi equipment. Particular attention is paid to meet different requirements connected with cooling: dimensions, interface, pressure drop, materials, vibrations, noise, consumption, reliability and maintenance.

Innumerable configurations have been designed. C.A.D./C.A.M. solutions have been adopted to reduce delivery time, even for special solutions.

The production range includes:
- **Cooling groups for D.C. motors**
  These units, directly coupled to the motor, are usually composed of a steel hood containing the water/air heat exchanger, an air filter and a fan. All the components are easily removable from the casing for inspections and maintenance;
- **Air-Air cooling groups**
  These units are composed of two separated circuits with two fans and an exchanger, where the closed circuit air is cooled by the external air.
- **Air-Water cooling groups for A.C. motors**
  These units are equipped with one or more air/water exchangers, fan and noise insulating systems.

The water-air coolers are supplied both as coil type and with finned tubes.

Several tube materials are available: copper, copper alloys, stainless steels and titanium.

For heavy-duty applications, such as offshore platforms, a double tube design is suggested, with titanium internal tube.

The groups are equipped with control devices, special versions and explosion proof type are supplied as well.

The production range for generator coolers includes:
- **Air-Water coolers available** in several designs and with different materials: copper alloys, stainless steel and titanium.
- **Coolers for hydrogen** in closed circuits. These units are particularly sturdy, have considerable dimensions and are designed to operate in presence of high vibrations.
- **Circular coil heat-exchangers** to cool the bearing lubricating oil of large generators and turbines.
- **Medium head axial fans** for cooling air circulation. The construction and the impeller are designed to operate with high rotating speed, up to 3,000 rpm and discontinuously. Strict acceptance tests are carried out in excess of the over speed test at 75 Hz.
A.C./D.C. MOTOR COOLERS

AIR TO AIR COOLERS (CACA)

Power Rating range
- 200 ÷ 1,000 kW/each

Number of axial fans
- No. 2 ÷ No. 3 in operation/each
+ No. 1 stand-by/each

The cooling unit standard execution is provided with silencers and fans in vertical or horizontal arrangement.

UNIT EXECUTION

Tubes
- Aluminium alloy
- C-Steel
- Stainless steel

Tube Plates
- C-Steel
- Stainless Steel

Housing
- C-Steel
- Stainless Steel

Silencers
Provided with panel protected by perforated sheet in galvanized C-Steel or Stainless Steel

AIR TO WATER (CACW)

Power Rating range
- 80 ÷ 900 kW/each

Number of radial fans
- No. 1 ÷ No. 2 operation/each
- No. 1 ÷ No. 2 in operation/each
+ No. 1 stand-by/each

Cooler execution
- Single tubes
- Double tubes

For both the above executions (single & double tubes) and depending on the cooling water the following materials are used (standard):

SINGLE TUBES EXECUTION

Tubes
- Copper
- Admiralty brass
- CuNi 90/10 or 70/30
- Stainless Steel
- Titanium

Fins
- Copper
- Aluminium

Tube Plates
- C-Steel
- Naval brass or Muntz metal
- CuNi 90/10 or 70/30
- Stainless Steel
- Titanium

DOUBLE TUBES EXECUTION

Outer Tubes on Air Side
- Copper
- Admiralty brass
- CuNi 90/10 or 70/30
- Stainless Steel
- Titanium

Inner Tubes on Water Side
- Copper
- Admiralty brass
- CuNi 90/10 or 70/30
- Stainless Steel
- Titanium

Fins
- Copper
- Aluminium

Tube Plates on Air Side
- C-Steel
- Naval brass or Muntz metal
- CuNi 90/10 or 70/30
- Stainless Steel
- Titanium

Tube Plates on Water Side
- Naval brass or Muntz metal
- CuNi 90/10 or 70/30
- Stainless Steel
- Titanium

CACW double tube sea-water cooler for Derrick drilling motor on off-shore platform

CACW double tube cooler equipped with No. 4 coolers, No. 4 fans and induction motors.

CACW cooler for A.C. motor.
Cooling tubes, tube plates and water headers: titanium

CACA generator cooler equipped with No. 3 vertical axial fans.

CACW cooler for synchronous motor, complete with piping, valves and leakage detector system

CACW cooler, Detail of centralization terminal box
Boldrocchi Company designs and manufactures a wide range of air cooled heat exchangers, used worldwide in utilities and industrial applications: serving the petroleum, chemical, gas processing, electrical, power generation, environment and steel industries.

From small coolers for endothermic engines, for compressors and dryers up to several banks of bundles for vapours condensation and for petrochemical processes.

The production includes fin fan coolers for:
- Gaseous and liquid hydrocarbons,
- steam and vapours
- Water and lube oil closed circuit system
- High pressure intercooler and aftercooler
- Compressed air and gases
- Special applications
- Gas heaters and coolers
- Air pre-heater and heat recuperators

With the support of an on-going R&D dep., Boldrocchi can constantly improve its products. A computer aided design network speeds up technical work and enable engineers to examine different approaches and to reach the best solutions.

High efficiency and low noise fans are provided by the daughter Company COMET, strictly related with our design department.

Plant: OFF-SHORE WHITE TIGER FIELD (VIETNAM)
N.4 GAS COOLER (Total 24 Tube Bundles)
Total Duty: 19.100 kW
Design Pressure: 120 bar
Total Installed Power: 416 kW

Plant: AUGUSTA REFINERY (ITALY)
SPLITTER OVERHEAD CONDENSER (Duplex material construction)
Duty: 6.400 kW
Design Pressure: 6 bar
Total Installed Power: 148 Kw
REACTOR EFFLUENT COOLER
Duty: 3.900 kW
Design Pressure: 21.5 bar
Total Installed Power: 120 kw

Plant: SARPOM REFINERY (ITALY) REACTOR EFFLUENT COOLER
Duty: 4.500 kW
Design Pressure: 23 bar
Total Installed Power: 120 kW

N.30 WATER GLYCOL CLOSED CIRCUIT COOLERS
Six Different Power Plants (IRAN)
Total Duty: 73.500 Kw
Design Pressure: 6 bar
Total Installed Power: 88 kW

N. 2 CLOSED CIRCUIT WATER COOLERS
Plant: Power Barge Project (GHANA)
Total Duty: 5.100 kW
Design Pressure: 6 bar
Total Installed Power: 240 kW
AIR COOLED HEAT EXCHANGERS

All projects involve a process of:
- **thermal design** according to current and well established operating techniques and using worldwide recognized software;
- **mechanical design** according to the main standard codes such as TEMA, ASME, API and supply of pressure parts stamped with CE, PED or U mark;
- **structural and stress analysis** with finite element methods;
- **design solutions for low noise** level installations;
- **optimizing the required power**, ensuring easy transportation, installation and maintenance.

To find out the best performance for each case, ensuring heat transfer coefficient combined with low pressure drops, Boldrocchi provides several types of spiral finned tubes. A variety of base tubes: from 1/2 inch to 2 inch diameters and different metals such as carbon steels, stainless and special steels, copper alloys, aluminium and titanium can be finned with several sizes and materials to satisfy customer and design requirements.

Based on a lot of different finning machines Boldrocchi can supply three basic configurations on finned tubes

A task force of skilled craftsmen combined with the best welding techniques ensures high quality welding, guaranteed by radiographic, ultrasonic, magnetic and liquid in-depth inspections and, after assembly, hydrostatic and leak testing.

More than 200 welding procedures have been qualified and tested by international Boards.
**TECHNOLOGY**

1. **G-Type Fins (mechanically embedded)**
   - Rectangular cross-section fin wrapped under tension and mechanically embedded in a groove spirally cut into the outside surface of a tube.
   - Can be used for maximum Design Process Temperature of 400°C

2. **L-footed Fins**
   - L-shaped fin wrapped under tension over the outside surface of a tube, with the tube fully covered by the feet between the fins.
   - Can be used for maximum Design Process Temperature of 130°C

3. **KLM- Knurled footed**
   - L-shaped fin wrapped under tension over the outside surface of a tube, while the foot of the fin simultaneously pressed into the ribbed outer surface of the tube.
   - Can be used for maximum Design Process Temperature of 200°C

4. **G-Type Boldrocchi Double Tubes**

5. **Boldrocchi extruded Low Fin Tube (TRUFIN)**

6. **Axial fan blades**

7. **Exchanger headers**

8. **Finite Element Analysis**

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**R&D**

Boldrocchi Test Facilities
- Heat Run Test witnessed by ENEL
- Low Noise Transformer Oil Air Cooler 65 dB(A)
- Power rating ROT/S 300 kW

Boldrocchi Test Facilities
- Heat Run Test
- Transformer Oil Water Cooler Double Tube Execution
- Power rating 315 kW

Boldrocchi Test Facilities
- Heat Run Test
- Air Water Motor Cooler Double Tube Execution
- Power rating 200 kW

Finite Element Analysis
- Axial fan blades
- Exchanger headers