Reactors

TRENCH

Reactors

Introduction

With 40 years of successful field experience, Trench is the recognized world leader in the design and manufacture of air core, dry type, power reactors for all utility and industrial applications. The unique, custom design approach, along with fully integrated engineering and manufacturing facilities in both North America and Europe have enabled Trench to become the technical leader for high voltage inductors worldwide.

A deep commitment to the power industry, along with extensive investment in engineering, manufacturing and test capability give Trench customers the utmost in high quality, reliable products which are individually designed for each application. Trench reactor applications have grown from small, distribution class, current limiting reactors to complex EHV applied reactors surpassing 300 MVA per coil. Reactors are manufactured in accordance with ISO 9001 quality standard. Trench's highly developed research and development program constantly addresses new technologies and their potential application in reactor products. Trench welcomes challenges for new applications for power reactors.

This brochure outlines the features, capabilities and applications of Trench reactors.
Although air-core, dry type reactors represent the majority of reactor production volume, Trench also produces a highly successful line of iron core/iron shielded and oil type reactors for specific application (eg. Resonance Grounding/ Petersen Coils). These reactors are also described in detail in other sections of the Trench product catalogue.

Design Features of Air-Core Dry Type Reactors

- Epoxy impregnated, fibreglass encapsulated construction
- Aluminum construction throughout with all current carrying connections welded
- Highest mechanical and short circuit strength
- Essentially zero radial voltage stress, with uniformly graded axial voltage distribution between terminals
- Low noise levels are maintained throughout the life of the reactor
- Weatherproof construction, with minimum maintenance requirements
- Design service life in excess of 30 years
- Designs available in compliance with ANSI/IEEE, IEC and other major standards.

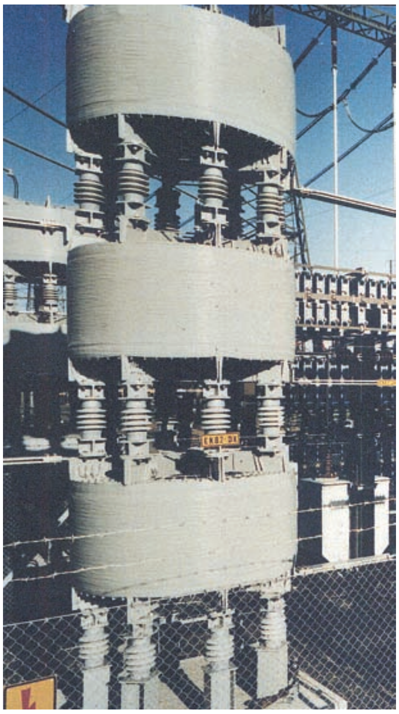


Fig. 1
Three-phase stacked current limiting reactor

Reactor Applications

Trench reactors are utilized on transmission and distribution systems. Although it is not possible to list all reactor applications, some of the most common are described below.

Series Reactors

Reactors connected in series with the line or feeder. Typical uses are fault current reduction, load balancing in parallel circuits, limiting inrush currents of capacitor banks, etc.

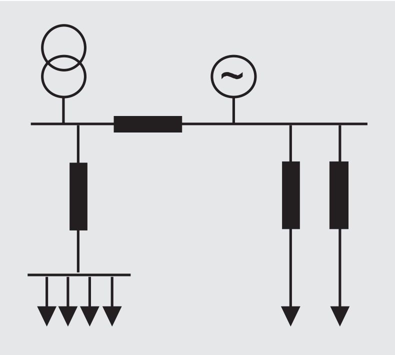


Fig. 2
Schematic diagram

Current Limiting Reactors, reduce the short circuit current to levels within the rating of the equipment on the load side of the reactor.

Applications of current limiting reactors range from the simple distribution feeder reactor to large bus-tie and load balancing reactors on systems rated up to 765 kV/ 2100 kV BIL.

Capacitor Reactors are designed to be installed in series with a shunt connected capacitor bank to limit inrush currents due to switching, to limit outrush currents due to close in faults and to control the resonant frequency of the system due to the addition of the capacitor banks. Reactors can be installed on system voltages through 765 kV/2100 kV BIL.

When specifying capacitor reactors, the requested continuous current rating should account for harmonic current content, tolerance on capacitors and allowable system overvoltage.

Fig. 3
Single phase series reactors

Fig. 4
Current limiting reactor

Buffer Reactors for Electric Arc Furnaces (EAF).
The most effective use of EAFs is achieved by operating the furnace at low electrode current and long arc length. This requires the use of a series reactor in the supply system of the arc furnace transformer for stabilizing the arc.

Duplex Reactors are current limiting reactors which consist of two half coils, wound in opposition. These reactors provide a desirable low reactance under normal conditions and a high reactance under fault conditions.

Load Flow Control Reactors are series connected on transmission lines up to 800 kV.
The reactors change the line impedance characteristic such that load flow can be controlled, thus ensuring maximum power transfer over adjacent transmission lines.

Fig. 5
Buffer reactor for E.A.F.

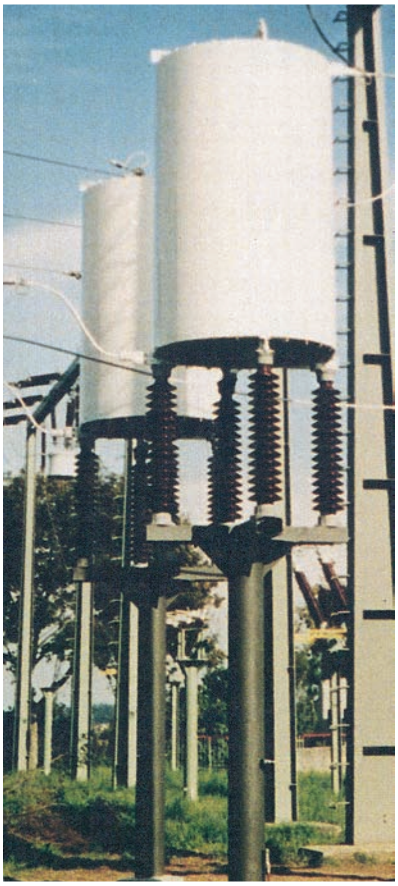
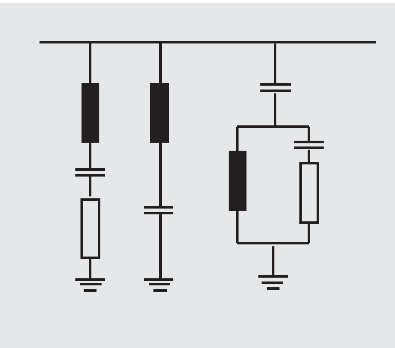


Fig. 6
Load flow control reactors

TRENCH

Filter Reactors

Filter Reactors are used in conjuction with capacitor banks to form series tuned harmonic filter circuits, or in conjunction with capacitor banks and resistors to form broad-band harmonic filter circuits.



When specifying filter reactors, the magnitudes of fundamental and harmonic frequency current should be indicated. If inductance adjustment for fine tuning is required, the required tapping range and tolerances must be specified.

Many filter applications require a Q-factor which is very much lower than the natural Q of the reactor. This is often achieved by connecting a resistor in the circuit.
An economical alternative is the addition of a de Q'ing ring structure on a reactor. This can reduce the Q-factor of the reactor at tuning frequency up to as much as one tenth without the necessity of installing additional damping resistors. (see Fig. 9 below)

These rings, mounted on the reactor are simply coupled to the magnetic field of the reactor. This eliminates the concern of space, connection and reliability of additional components such as resistors.

Fig. 7
Schematic diagram

Fig. 8
Filter reactors

The Capacitor/Filter Protection Relay CPR 04 is a microprocessor based protection relay specially designed for optimized protection of shunt banks and harmonic filter circuits.

Fig. 10
Capacitor/filter protection relay

Fig. 9
Filter reactors with de Q'ing rings

Static VAR Compensators are used on transmission systems to improve the overall reliability, correct for voltage fluctuations and power factor as well as increasing the transmission capability and reducing losses.

Shunt Reactors

Shunt Reactors are used to compensate for capacitive VARs generated by lightly loaded transmission lines or underground cables. They are normally connected to the transformer tertiary winding but can also be directly connected on systems up to 115 kV.

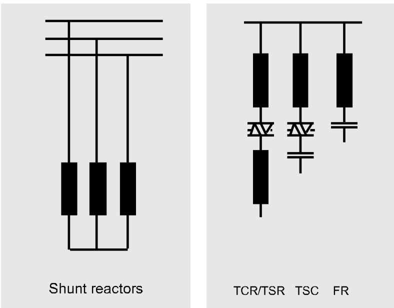


Fig. 11
Schematic diagram

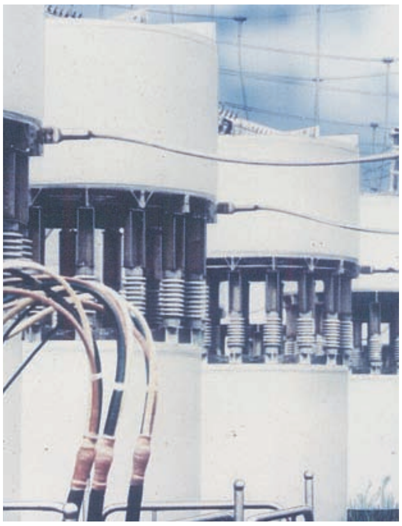


Fig. 12
Tertiary connected shunt reactors

Thyristor Controlled Shunt Reactors are extensively used in static VAR systems, where reactive VARs are adjusted by thyristor circuits. Static VAR compensator reactor applications normally include:

- Thyristor controlled shunt reactors (TCR). The compensating power is changed by controlling the current through the reactor by means of the thyristor valves.
- Thyristor switched reactors (TSR)
- Thyristor switched capacitor reactors (TSC)
- Filter reactors (FR)

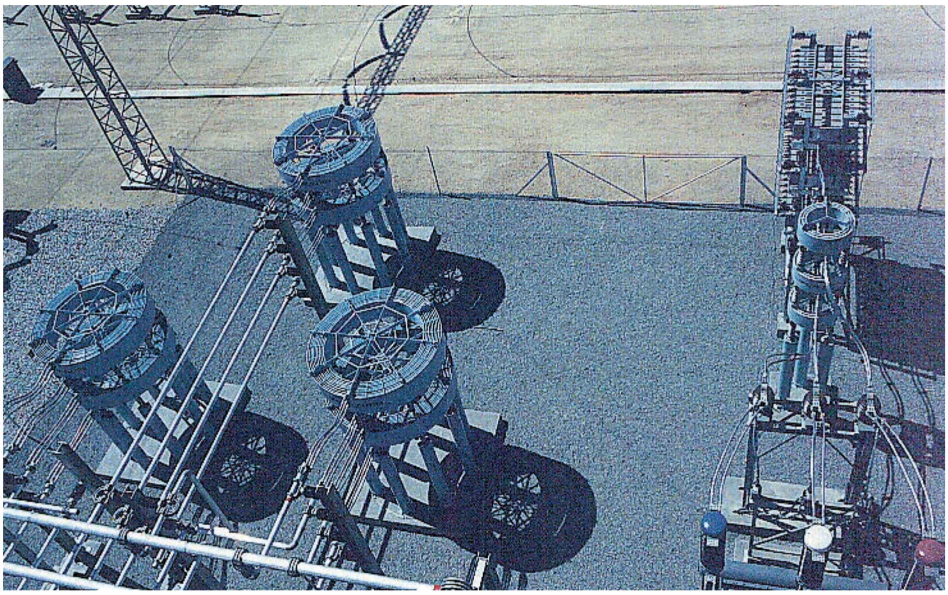


Fig. 13
Thyristor controlled shunt reactors and filter reactors in a Static VAR Compensator

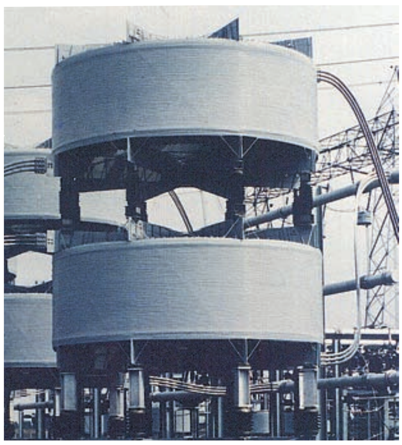


Fig. 14
Thyristor controlled reactor

TRENCH

HVDC-Reactors

HVDC lines are used for long distance bulk power transmission as well as back-to-back interconnections between different transmission networks.
HVDC Reactors normally include Smooting Reactors, AC and DC Harmonic Filter Reactors as well as AC and DC PLC Noise Filter Reactors.

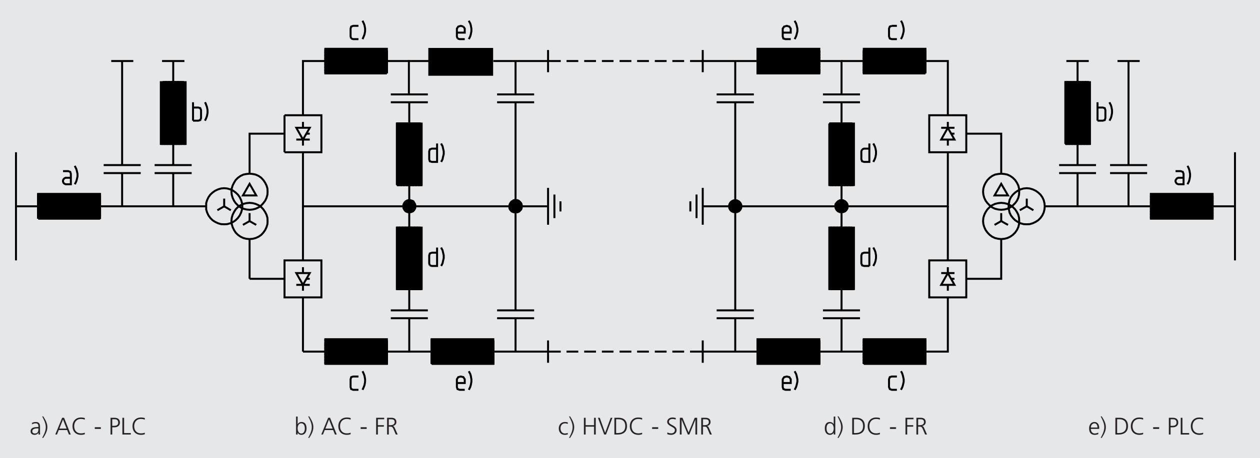


Fig. 15
Schematic diagram

Fig. 16
AC-Filters

Fig. 17
HVDC-Smoothing reactor

Smoothing Reactors

Smoothing reactors are used to reduce the magnitude of the ripple current in a DC system. They are used in power electronics applications such as variable speed drives and UPS systems. They are also required on HVDC transmission lines for system voltages up to 500 kV.
Several design and construction techniques are offered by Trench.

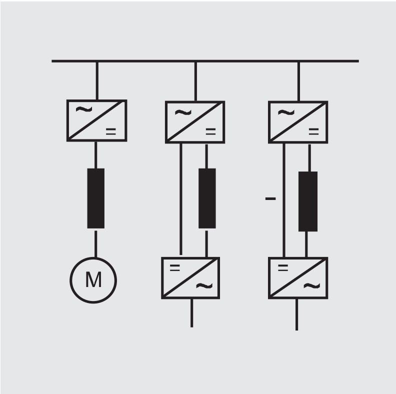


Fig. 18
Schematic diagram

Fig. 19
Iron core,
forced air cooled reactor

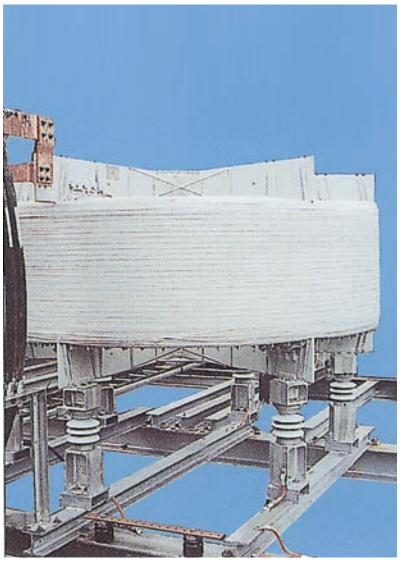


Fig. 20
Air core,
encapsulated winding design

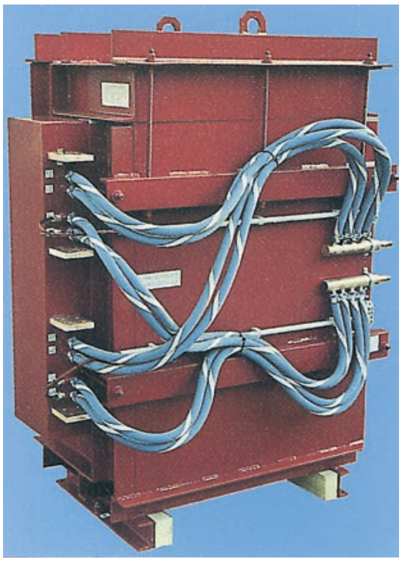


Fig. 21
Iron core,
water cooled reactor